

SUPPLEMENT TO

# JOURNAL OF ATHLETIC TRAINING

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N A T A

*Official Publication of The National Athletic Trainers' Association*

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# Take this Supplement to Nashville and use it as a guide to the Free Communications Sessions

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Dear NATA Members and Friends:

We are pleased once again to present the annual supplement to the *Journal of Athletic Training*. The supplement contains abstracts from the Free Communications Sessions sponsored by the NATA Research and Education Foundation held at the NATA Annual Meeting.

The Free Communications Sessions allow certified athletic trainers and other healthcare providers the opportunity to present and learn about the latest in athletic training research. Research is presented in oral and poster formats and includes general research, Foundation-funded research, thematic posters, and clinical case reports. Abstracts of the research are presented in the order of presentation at the NATA Annual Meeting for your convenience.

Free Communications presentations are divided into categories: basic science, clinical studies, educational research, sports injury epidemiology, and observational studies. In addition, the Clinical Case Reports sessions allow you to test your clinical assessment skills. We encourage you to attend these sessions, especially the popular thematic poster presentations that combine oral and poster formats.

We also urge you to attend the session featuring research funded by the Foundation. The Foundation not only funds research, but also a variety of educational programs. These include home study programs, the Athletic Training Educators' Conference, the District Lecture Series, and summits on issues critical to athletic training, as well as more than 50 scholarships annually to students of athletic training. It is important to note that responsibility for the development of program content and logistics of presentation of these programs has been assumed by the Continuing Education Committee of the NATA Education Council. The Foundation remains responsible for securing funding for financial support.

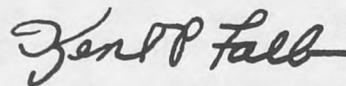
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NATA and its Foundation are happy to offer this supplement as a service to NATA members. We hope that it provides you with theoretical and practical information you can use to improve your effectiveness as a certified athletic trainer. Thank you for your support!

Sincerely,



Marjorie J. Albohm, MS, ATC  
President, NATA Research & Education Foundation



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# JOURNAL OF ATHLETIC TRAINING

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# Free Communications, Oral Presentations: Clinical Case Reports: Hip

Thursday, June 29, 8:00AM-9:40AM, Cleveland A; Moderator: William Ross, PhD, ATC

## Traumatic Hip Dislocation In A High School Football Player

Gray RS: Cleveland Clinic Sports Health, Cleveland, OH

### Personal Data

The subject was a 16 year old high school football player. The subject injured his Left hip during high school football practice. The subject's chief complaint was severe pain in his left hip region. The subject was running the ball, was tackled, on landed on his Left knee. The hip was in neutral and his knee was flexed at ninety degrees. The position of the tackler: behind the athlete and compressing down from the shoulders. This was the first time that this athlete had ever sustained an injury to his hip region.

### Physical Signs and Symptoms

The athlete was laying on his Right side and was able to flex and extend his Left Knee along with being able to plantar and dorsiflex his Left foot and ankle. The athlete rated his pain 8 / 10, a good dorsalis pedis pulse was noted, and a large bony palpable mass was noted in the Left gluteal area. The athlete was blocked in a side-lying position, a pillow was placed between in his knees and then transported to the nearest medical facility by EMS for emergency care.

### Differential Diagnosis

Preliminary diagnosis was a Posterior Dislocation of the Left Hip.

### Results of Diagnostic Imaging/ Laboratory Tests

Radiographs confirmed a posterior dislocation of the Left Hip.

### Clinical Course

After the first attempted reduction, a displaced fracture through the Capital Epiphysis with the Capital Epiphysis still dislocated was noted. After the patient was stabilized, he was transferred to another medical facility and placed under the care of a Pediatric Orthopaedic Surgeon. After the transfer, he underwent an emergency O.R.I.F. and Reduction of the Left Hip. The prognosis for this patient was poor due to the fact that the femoral head was dislocated and completely detached from the proximal femoral metaphysis with no viable blood supply remaining.

### Deviation From the Expected

This was a very serious injury to this young high school athlete. The progression of the athlete has been very slow. Participation in collision/contact sports are out of the question. Even with the best emergency care and medical management, complications can arise. This athlete continues to be involved in a long term study.

## Traumatic Hip Strain In A Collegiate Football Place Kicker

Felton S, Treolo D, Maher D: University of Louisville, Louisville, KY

### Personal Data/ Pertinent Medical History

During a Division I collegiate football game in November, 1999 a 24 year old place kicker, 187.96 cm (6'2"), 100 kg (220 lbs.), sustained an injury to his right groin while attempting a kickoff. At the beginning of the movement the athlete's hip was in the approximate position of 45 degrees of external rotation and 20 degrees of abduction. The knee was flexed approximately 90 degrees. The powerful contraction of the hip adductors resulted in a rupture of the adductor longus and adductor brevis muscles from their origin. It is apparent that the injury occurred at impact between the foot and the ball, as the hip position changed very little from that point. A normal follow-through for this athlete allows the hip to approach 100 degrees of flexion. There was no follow-through on this particular kick further indicating impact as the likely moment of injury. At the conclusion of the play, the athlete remained down on the field and was immediately examined by the team orthopedic surgeon and two certified athletic trainers (ATCs). The athlete had been receiving treatment and rehabilitation for a mild groin strain for a period of four weeks prior to this traumatic episode.

### Physical Signs and Symptoms

During the on field examination, the athlete identified an audible pop and complained of severe pain in the groin area. Further on the field examination revealed normal range of motion and no obvious deformities. The athlete was assisted to the sideline where further examination revealed swelling, ecchymosis and point tenderness at the proximal attachment of the adductor muscles. The team physician determined that the athlete was non-functional due to severe pain and inability to reproduce the kicking motion with the necessary force. The athlete received intermittent cold therapy on the field for the remainder of the game. Athlete was prescribed pain medication by the team physician and instructed to report to the athletic training room the following morning.

### Differential Diagnosis

- 1) Avulsion fracture of adductor muscles
- 2) Acetabular fracture
- 3) Pubic symphysis pathology
- 4) Acute hernia
- 5) Knee injury

### Results of Diagnostic Imaging

The next morning the athlete reported to the training room and underwent examination by the team physician. X-rays and MRI were then ordered of the hip and pelvic region. Results of the MRI revealed rupture of the adductor longus and adductor brevis just distal of their proximal attachment. All other surrounding structures were intact. X-rays were negative for avulsion fracture, femoral head or pelvic fracture.

### Clinical Course

The athlete met with the team physician to discuss options for recovery. The team physician consulted an expert on this injury to discuss treatment options. The treatment for chronic adductor pain is a release of the adductors longus and brevis. This is essentially what occurred to the athlete as a result of the injury. Conservative management of the injury would be initialized immediately. After the rehabilitation program the athlete returned to full football activity two weeks post-injury and competed without incident.

### Deviation from the Expected

This case is unique because tears of the adductor longus and brevis are not common in football. The frequency of this type of injury is more prevalent in Europe, found mainly in soccer players. Groin pain in athletics is common and treated conservatively with great success. However, special consideration should be given to athletes who produce similar forces at the hip to those generated by the kicking motion.

## Bilateral Hip Pain In A High School Soccer Athlete

Blair DF, Wright KJ, Hansen M:  
Wenatchee High School, Wenatchee, WA

### PERSONAL DATA/MEDICAL HISTORY:

This 16-year old female soccer athlete experienced hip pain and audible bilateral hip "snapping" with exercise. She first experienced symptoms in April of 1996. During the fall 1996 soccer season the symptoms worsened and continued to limit her activities. She has a steady course of physical therapy for nearly three years. The pain worsened to the point of her discontinuing all physical education, sports, and other (marching band) activities.

### PHYSICAL SIGNS AND SYMPTOMS:

The athlete suffered from constant anterior hip pain. She had pain when she sat, stood, walked, or climbed stairs. There was pain with active hip flexion as well as audible snapping. She also experienced some radiating pain in the anterior thigh with local parathesia. She also suffered from low back pain beginning in October 1997. The back pain was present in conjunction with the hip pain and located over the lumbar spine at the L3-4 and 4-5 area. There was tenderness over the sciatic notch more on the right than the left. She also had persistent headaches.

### DIFFERENTIAL DIAGNOSIS:

The differential diagnosis includes: snapping of the iliopectineal bursa, labrum injury, entrapment or irritation of lateral femoral cutaneous nerve, referred pathology from low back, femoral hernias, fibromyalgia or reflex neurovascular dystrophy.

### RESULTS OF DIAGNOSTIC IMAGING/LAB TEST:

MRI on the spine - normal; bone scan of hips - negative; plain films of spine- normal; plain films of hips- normal; MRI of hip and pelvis- inconclusive; Diagnostic ultrasound- shows iliopsoas snapping bilaterally; blood tests- normal; MR arthrography under x-ray guidance on right hip- ruled out labral tear; and evaluation for fibromyalgia-negative; Bone scan-negative. Physical examination and diagnosis indicated snapping iliopsoas tendons bilaterally.

### CLINICAL COURSE:

She had nearly three years of physical therapy, activity modification, and anti-inflammatory agents. She was forced to restrict activity in soccer as well as physical education, which was followed by periods of rest. No improvement was noted through this period of restricted activity. Patient referred to a physical therapist where she received a biomechanical gait analysis and was fitted for orthotics. She received ultrasound, massage therapy and flexibility exercises. Her symptoms improved to the point where she could run cross-country, but pain increased with running and all activity was stopped. Deep massage, mild strengthening programs, prolonged stretches and pressure-point therapy were also attempted. Patient also tried the following pharmacological agents in attempt to relieve her direct and indirect (insomnia, migraines, etc.) symptoms; Oruvail, Nortriptyline, Prednisone, Neurontin, Imitrex, and Prozac (for migranes). In December of 1998, pa-

tient underwent right iliopsoas release. There was some improvement in headaches, back pain, and hip pain slightly decreased; snapping continued. She experienced some numbness in her thigh and lower leg that did not disappear within 11 months. The patient experienced persistent snapping in both right and left. In November of 1999, she underwent bilateral iliopsoas releases. Early improvement of patient's symptoms has been remarkable; however, at this writing she has not attempted to return to activity. The planned result is a full return to normal activities and the reduction or elimination of iliopsoas snapping.

### DEVIATION FROM EXPECTED:

This is an unusual cause of this hip pain that has been rarely described in the literature. It is a condition that usually affects young and active patients. The nature of abnormality is uncertain but may relate to the size of the iliopectineal ridge.

## Insidious Leg And Lumbar Pain In A Cross-Country Runner

Kersey RD: California State University,  
Fullerton, CA

### Personal Data:

This case involved a 23-year-old, senior, male, collegiate, cross-country runner. He is 190.5 cm tall and weighed 81.8 kg. Previous running related pathologies included a mild case of iliotibial band friction syndrome during his freshman year and a moderate triceps surae strain as a junior track and field athlete. Both injuries occurred to the right leg and were no longer symptomatic. The athlete has pes cavus, for which he wears prescription orthotics. His diet is balanced and supplemented with daily multiple vitamins. Running gait pattern is typical, with a mid-foot landing. The subject progressively increased his training to about 70 miles per week. His training shoes had about 400 miles of use. Just prior to the start of fall classes, subject participated in a one-week training camp involving about somewhat hilly 80 miles.

### Physical Signs and Symptoms:

During camp, the patient reported an insidious deep aching pain originating in the proximal anteromedial aspect of his right thigh. Lesser pain was felt in his distal thigh, lateral hip, low back, and upper gluteal regions. The initial evaluation included no observable or palpable abnormalities, except for slight tenderness over the adductor region. Strength, neurological, and range of motion tests were all within normal limits. A slight limp existed, and pain increased when the quadriceps were stretched. A few days later, the pain significantly increased following a strenuous workout of five repeat high intensity miles. Single leg stance caused pain and he developed a more significant antalgic gait. Symptoms improved as the athlete warmed up. Tingling was reported in the distal thigh and into the foot. The patient's sleep patterns began to be affected, especially when side-lying on either side. The patient began taking over-the-counter ibuprofen at about 800 mg per day. Following another mile-repeat session the patient was unable to continue with regular workouts. The athlete developed a positive Tinel's sign of the femoral nerve. At that point, conditioning was limited to the weight room and the pool.

### Differential Diagnosis:

Possible pathologies included adductor or quadriceps strain, sacroiliac joint dysfunction, femoral compartment syndrome, femoral stress fracture, nerve root dysfunction, or femoral nerve entrapment.

### Results of Diagnostic Imaging/Laboratory Tests:

One week following onset, the patient obtained standard radiographs of his hip and pelvis, followed by lumbar spine magnetic resonance images that appeared negative. One month after onset, standard radiographs were obtained of the femur that indicated a possible stress fracture. A bone scan was ordered and results indicated a stress fracture of the proximal medial femur.

### Clinical Course:

The patient discontinued running, but continued

## Acute Hip Pain In A High School Baseball Player

Ullery LR: University of Kentucky Hospital, Section of Sports Medicine, Lexington, KY

upper body strength training and pool workouts. He ambulated without assistance. Pain and dysfunction gradually subsided with rest. Three months following the initial symptoms, radiographs indicated complete healing, at which point pain-free training was allowed. Early workouts consisted of 20 minutes of low-intensity running for three days per week. Four months after onset, the patient is asymptomatic with a training regime of 4-5 sessions per week of up to 30 minutes each.

### Deviation from the Expected:

Stress fractures of the femoral diaphysis are relatively uncommon in athletes. Most stress fractures of the femur occur at the anatomical neck. Early on, femoral stress fractures are often misdiagnosed as a quadriceps strain. The current case was originally thought to be an adductor strain. Stress fractures are typically preceded by drastic increases in training duration or intensity. This case involved few changes in training patterns that may have led to the stress fracture. Indeed, the athlete appeared to be adequately prepared for the upcoming cross-country season. Other unusual symptoms developed later in the course of the injury, including a positive Tinel's sign of the femoral nerve and tingling sensations extending the length of the affected leg. This particular athlete presented with a wide variety of signs and symptoms that ranged from the low back all the way to the foot.

### Personal Data

17 yr. old 6 feet one inch high school baseball player who injured his right hip while swinging a bat in which he over-strided on a pitch. The athlete was being used in a pinch-hitter situation, without any time to warm up. Patient comments that he was "fooled" on the pitch. He felt a pop and immediate onset of pain in the anterior right hip and groin. He states that he has no previous history of injury to this hip. He was no longer able to participate after this.

### Physical Signs and Symptoms

On physical exam he was tender on the anterior brim of his pelvis and anterior superior iliac spine area. Patient was unable to walk, or perform a straight leg raise due to pain. Manual muscle testing was not done due to pain. Range of motion was limited due to pain especially in hip flexion. Immediate action was to be sent to clinic the next morning and to continue to ice the area.

### Differential Diagnosis

- Pelvic fracture
- Hip flexor strain
- Abdominal muscle strain
- Hip flexor avulsion

### Results of Diagnostic Imaging

X-rays indicate an avulsion fracture of the tip of the anterior superior iliac spine that was slightly angulated and minimally displaced. A computerized tomograph (CT) scan was also performed to see if the fracture was displaced. The CT scan showed that the bone fragment was displaced laterally and downward. The fragment was seen to be 1 cm. wide and had a length of about 4 cm.

### Clinical Course

Patient underwent a surgical re-attachment of the hip flexor on the iliac spine. This was performed with a single fixation to the right iliac wing. Patient was re-evaluated at one week post-operatively where he was walking without a limp and did not require any crutches. He was given isometric exercises and was told to work on range of motion. At one month, the patient began working out in a pool, and was also able to begin jogging and bicycling. He was instructed to be cautious against any forceful hip flexion. At two months, the patient was completely released to continue his normal activities, but was instructed to maintain his hip flexor strength and flexibility. Due to the baseball season being over, the patient did not go back to competitive activities until 4 months post-op.

### Deviation From Expected

This injury is very rare in athletics; this type of injury is more commonly seen in avulsion fractures in throwing athletes. The amount of force generated in a normal baseball swing is usually not enough to generate this type of avulsion.

## Knee Pain In A High School Football Player

Bolgia LA, Dowling JS, Keskula DR, Minter DB: Medical College of Georgia Center for Sports Medicine, Augusta, GA

**PERSONAL DATA/MEDICAL HISTORY:** A 280# 15-year-old high school football player injured his right knee during a football game. The player stated that an opposing player rolled over the lateral aspect of his right knee while his knee was in a bent position. He heard a pop and experienced immediate discomfort and swelling. There was no associated bony deformity. The player needed assistance from the field and could not resume play in the game. The athlete had no history of previous knee injury. His main goal was to return to baseball and football.

**PHYSICAL SIGNS AND SYMPTOMS:** The patient received a knee immobilizer and crutches because he had difficulty bearing weight through his right lower extremity. He had a 3+ knee joint effusion and tenderness along the medial collateral ligament (MCL). He also had ecchymosis medial to the distal thigh. He had no pain or tenderness to the lateral aspect of the knee. Right knee range of motion was 30°-50°. We deferred manual muscle testing due to the acuity of the injury. The player could not perform a straight leg raise but he did have a visible quad contraction. He was stable to varus and posterior drawer testing. He did open medially to valgus testing done at 30° of flexion. Lachman's testing revealed increased translation without a definable end point; however, the physician had difficulty performing this test because of the athlete's size and muscle spasms. The physician re-examined the athlete 5 days later and again had difficulty assessing the anterior cruciate ligament (ACL).

### DIFFERENTIAL DIAGNOSIS:

- ACL tear
- MCL tear
- Femoral condyle fracture
- Tibial plateau fracture
- Patella dislocation

**DIAGNOSTIC IMAGING:** Right knee AP, lateral and sunrise x-ray views revealed no definite bony injuries or patella displacement. MRI revealed an ACL tear, MCL tear and nondisplaced Salter-Harris type III fracture to the medial femoral condyle. CT scan confirmed the bony changes found on MRI and revealed no tibia plateau injury.

**CLINICAL COURSE:** Although the initial physical examination and plain x-rays suggested a soft tissue injury, the physician ordered an MRI to confirm his original diagnosis of an ACL/MCL tear. Due to scheduling difficulties, the athlete could not have an MRI until 10 days after the injury; however, the physician initiated rehabilitation based on the findings at the original examination. Initial rehabilitation focused on modalities for pain control as well as exercise to promote knee range of motion, lower extremity weight

bearing and quadriceps reeducation. The athlete made substantial gains with range of motion during this 10 day period but continued to have difficulty with weight bearing activities. The MRI performed 10 days after the injury revealed a Salter-Harris type III fracture to the medial femoral condyle, a finding not shown on plain x-rays. The MRI also confirmed both an ACL and MCL tear. Based on these findings, the physician ordered a CT scan to better evaluate the bony anatomy. The CT scan confirmed the MRI findings and ruled out any tibia plateau involvement. At this time the athlete stopped rehabilitation and had his knee splinted. The athlete's knee remained immobilized for 7 weeks. The athlete resumed rehabilitation approximately 9 weeks after the original injury and progressed well with a functional knee program.

**DEVIATION FROM THE EXPECTED:** The usual mechanism of injury for a torn ACL and MCL is a valgus stress to a flexed knee with the foot planted. Common signs and symptoms following such injury include rapid swelling, decreased knee range of motion and strength and inability to bear weight through the affected extremity. Plain x-rays are routinely taken and if no fracture appears the athlete begins a progressive rehabilitation program. A fracture in combination with a ligament tear is less common. Furthermore, a non-displaced Salter-Harris type III fracture is difficult to visualize on plain x-rays. This case is unique because the athlete's subjective history, initial evaluation and initial progress with rehabilitation were consistent with someone having sustained an ACL/MCL injury. Although the physician felt that the physical exam and original x-rays revealed such diagnosis, he ordered additional tests (MRI and CT scan) to confirm the physical findings because he had difficulty performing a conclusive Lachman's exam. Although a fracture in combination with a knee ligament tear is uncommon, sports medicine practitioners should consider using further diagnostic tests if they are unable to perform a conclusive physical exam. As younger athletes are participating in collision sports, health care providers should also consider the potential effects on open growth plates. Finally, sports medicine practitioners should also utilize additional diagnostic tests should an injured athlete not make expected gains during rehabilitation.

## Low Back Pain In A High School Athlete

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**Personal Data:** A seventeen year old male initially sustained injury to his back when he collided into a wall while shooting a lay up in basketball practice. He experienced bilateral back pain and muscle spasm. After refusing treatment from the certified athletic trainer, he attempted to treat himself using gravity boots and stretching. After self-treatment failed, he agreed to be assisted by the certified athletic trainer and was encouraged to see a physician. He then sought treatment from a chiropractor that had previously treated him for muscle spasm. The chiropractor used manipulative therapy and referred him to a massage therapist. The athlete's symptoms improved for one month however, the pain returned during baseball practice after he connected at bat with a ball and was running to first base. The pain was severe enough to stop him from running. The certified athletic trainer again recommended he see his family physician. His family physician diagnosed him with muscle spasm and prescribed muscle relaxants, ibuprofen and low velocity manipulation. This treatment brought no relief.

During this time he was also seeing the certified athletic trainer at his high school. The certified athletic trainer's findings revealed a family history of low back problems that included bone spurs. He had also been involved in several motor vehicle accidents. The athletic trainer treated him with heat and stretching prior to activity followed by ice after activity. After treatment failed to bring relief he was referred to an orthopaedic physician suspecting a possible pars interarticularis fracture.

**Physical Signs and Symptoms:** Initial onsite evaluation by the certified athletic trainer revealed bilateral low back pain with muscle spasm upon palpation of the paraspinal muscles. The athlete did not experience any radiating pain, numbness, or tingling in his lower extremities. Active range of motion was normal, but painful in all directions. The athlete demonstrated a negative supine straight leg raise (Lasegue's) test, Braggard test and Soto-Hall test. Evaluation by the orthopaedic physician found the athlete demonstrated a lordotic posture with bilateral straight leg raise (SLR) of 100 degrees. He had a 2+ forward flexion toe touch and a negative slump test bilaterally. He experienced pain with lateral bending, rotation and extension. He had pain of a low grade nature with palpation of the muscles on the lateral aspect of the lumbar spine. He was neurologically intact without radiculopathy. He had no pain with coughing, sneezing or any bowel and bladder discomfort.

### Differential Diagnosis:

Acute Spondylolysis  
Facet Syndrome  
Lumbar Muscle Strain  
Lumbar Muscle Spasm  
Spinous Process Fracture  
Disc Herniation/Bulge  
Ligament Sprain

### Results of Diagnostic Imaging/ Laboratory Test:

Plain radiographs of the lumbar area showed a possible abnormality at L2 with spondylolysis, as well as, minor degenerative overriding L5-S1 facet joints. A SPECT scan confirmed the increased activity in the pars interarticularis area of L2. Axial CT images of the lumbar area revealed bilateral fractures through the posterior element of the L2 pars, as well as, a fracture through the base of the spinous process. These fractures were found to be "old in age" since there was evidence of bone formation and sclerotic margins. The lumbosacral spine alignment was found to be normal. CT images also revealed diffuse annular bulging without focal disc herniation or central canal stenosis at T12. There were no signs of neural impingement.

**Clinical Course:** The athlete was placed in a thoracolumbosacral molded orthosis (TLSO) for three months and was removed from activity for six months. He was instructed by a physical therapist in proper stretching and abdominal strengthening. He was allowed to swim and ride a stationary bike to maintain his fitness level. After six months radiographs were again performed to determine the course of action. The radiographs revealed the fractures were resistant to non-operative treatment. Surgery was recommended to fuse the spine at L2, but the athlete refused due to lack of insurance. To date, the athlete is in college and continues to complain of pain and muscle spasm with activity.

**Deviation From the Expected:** Spondylolysis occurs in a small percentage of the adult population, but is more common among athletes involved in sports requiring hyperextension and rotation of the low back. Unique to this case is the level at which the spondylolysis occurred. Spondylolysis is most commonly found at the L4 level, but a bilateral fracture at L2, as seen in this case study, is extremely rare. Numerous pathologies were also identified that accompanied and complicated the diagnosis. Due to lack of insurance, initial resistance to seek proper medical attention by the athlete and his parents, may have also contributed to the progression and severity of the injury.

## Foot Pain In A High School Football Player

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**Personal Data/ Pertinent Medical History:** A 15-year-old male football player reported to his high school athletic trainer complaining of "weak ankles". The athlete reported an increase in pain during running activities. The athlete's pain was stated to be minimal before and after practice sessions. In addition, the athlete reported difficulty with the first steps taken in the morning. The history revealed a previous ankle sprain (date unknown) and a fracture of the proximal phalanx of the right great toe (three years). The athlete had previously participated in soccer and basketball.

**Physical Signs and Symptoms:** Physical examination revealed tenderness at the insertion of the Achilles tendon and on both medial and lateral aspects of the calcaneus. Pain was also elicited at the insertion of the plantar fascia. Observation of the athlete's gait pattern showed an early lift-off from heel strike, very short mid-stance, and early forefoot contact. A modest antalgic gait was also noticed during initial evaluation. During practice (day prior), the athlete displayed the majority of weight bearing on his heels during the running gait. Ankle dorsiflexion was observed to be less than ten degrees bilaterally.

**Differential Diagnosis:** Achilles tendinitis, calcaneal stress fracture, calcaneal avulsion fracture, juvenile rheumatoid arthritis (subtalar joint), tarsal coalition, bone cyst or tumor, retrocalcaneal bursitis, plantar fasciitis

**Diagnostic Imaging/ Laboratory Tests:** Plain film radiographs revealed sclerosis and irregular closure of the calcaneal apophysis. A wide-open apophysis at the superior aspect of the calcaneus was present on both lateral and posterior views. Results of a dynamic gait analysis showed a problem and inability to lock the midtarsal joint at the proper time in the gait cycle. This abnormality results in poor shock accommodation and poor limb rotation from above.

**Clinical Course:** The athlete's primary diagnosis was bilateral calcaneal apophysitis with related Achilles tendinitis, and plantar fasciitis. Initial treatment consisted of 1/4 inch heel lifts, ice 2-3 times/day, decreased activity, and Naprelan. A heel cord stretching program was initiated. At two weeks, a follow-up visit showed little improvement. A below the knee soft cast was applied. At four weeks, the soft cast was removed and a new soft cast applied. Six weeks post-injury the second cast was removed, warm whirlpool treatments in conjunction with heel cord stretching and lower leg strengthening exercises were initiated. One-quarter inch heel lifts were also re-introduced. Custom orthotics were prescribed and lower leg strengthening continued. The orthotics were introduced during the eighth week with continuation of the stretching and strengthening program. The athlete's rehabilitation program continued throughout the off-season and at fifteen weeks post-injury, the athlete returned to competitive sports without incident.

**Deviation from the Expected:** Although seen in children and young adolescents, calcaneal apophysitis is rarely seen in athletes 15 years of age and older. The literature suggest that closure of this apophysis typically occurs at the age of 15. Due to the unusual presentation in this case, it is suggested that calcaneal apophysitis and its related conditions be managed carefully by physicians and members of the athletic training community.

## Posterior Ankle Pain In A High School Football Player

Alcorn S: University of Kentucky Sports Medicine Clinic, Lexington, KY

### Personal Data

A 280 pound football lineman, 16 years of age, reported to the athletic training room complaining of posterior ankle pain in his left ankle. He stated he had sustained an inversion type injury approximately two months previous but had not reported it until then. He was wearing an Air Cast® ankle orthotic given him by his primary care physician who had referred him to a sports medicine physician. There was no previous ankle injury.

### Physical Signs and Symptoms

Pain was localized to the region of the achilles tendon approximately three centimeters proximal to insertion. He stated walking was not painful but pushing off of it was. The athlete was point tender over the anterior talofibular and calcaneofibular ligaments. The most pain was elicited by pinching either side of the ankle just anterior and proximal to the insertion of the tendon. There was also swelling over the retrocalcaneal bursa.

### Differential Diagnosis

Achilles tendonitis, retrocalcaneal bursitis, lateral ankle sprain, os trigonum fracture, calcaneal stress fracture

### Results of Diagnostic Imaging

X-rays taken by the sports medicine physician were negative. No further tests were ordered.

### Clinical Course

The athlete did not participate in football the remainder of the season but began a rehabilitation regimen consisting of outpatient physical therapy and a home exercise program for general ankle strengthening. Pain decreased but did not subside during the five month period. In March of the next spring he returned to the sports medicine physician due to his symptoms. An MRI was ordered to rule out Achilles tendon pathology. The MRI was negative. At this time a fracture of the Os Trigonum was suspected and x-rays were re-ordered which confirmed this suspicion. It was determined that since the fracture was not healed and due to the time lapsed, removal of the os trigonum was necessary. The os trigonum was removed with a lateral incision under local anesthesia. The athlete is doing well at this time although due to an increase in weight and hypertension did not participate in football this fall.

### Deviation From Expected

This injury is rare and therefore is easily overlooked by physicians and athletic trainers. Pain elicited by pinching anterior and proximal to the achilles tendon is a symptom that warrants further investigation of the os trigonum versus achilles tendon injury.

## Knee Dislocation In A High School

### Football Player

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#### Personal Data/Medical History

16 year old male football player (ht 72", wt 165 lbs) received a lateral blow to the left knee while his foot stayed planted. He attempted to get up and saw that his knee was "pointed away from him." He crawled off the field as play was still continuing. He was taken by ambulance to the local emergency room and it was found he had a posterolateral knee dislocation. It was reduced in the ER and he was kept in the hospital for two days for observation. He was put in a brace locked in extension and placed on crutches. He was seen by an orthopaedic 2 days after his discharge. He has no previous history of knee problems.

#### Physical Signs and Symptoms

+2 knee effusion with quad atrophy. Grade III opening of the medial side with valgus stress at 30 degrees of flexion and also at 0 degrees. Lachman and posterior drawer were difficult to perform as the athlete was guarding quite a bit. Does have significant AP translation within his range of motion. Was stable with varus stress. Range of motion was 0-40 degrees. Pain is well controlled. He did take an occasional narcotic for pain.

#### Differential Diagnosis

- 1) Medial collateral ligament tear
- 2) Medial collateral and Anterior cruciate ligament tear
- 3) Medial collateral, Anterior cruciate and Posterior cruciate ligament tear
- 4) Medial collateral, Anterior cruciate, Posterior cruciate ligament tears with Medial meniscus subluxation from the joint with coronary ligament failure.

#### Diagnostic Imaging/Laboratory Tests

Initial X-Rays showed a posterolateral knee dislocation. This was concentrically reduced. Repeat x-rays showed this reduction. MRI results showed a complete tear of the anterior cruciate ligament, posterior cruciate ligament, medial collateral ligament tear (primarily from the tibia) and ruptured coronary ligaments with the medial meniscus extruded from the joint. He also had significant capsular injury medially and posteriorly.

#### Clinical Course

Surgery was scheduled for two weeks after the athlete was seen so he could have time to regain more range of motion and decrease his effusion. The posterior cruciate ligament was reconstructed with an achilles tendon allograft and the anterior cruciate ligament was reconstructed with a bone-patellar-bone allograft. The medial collateral ligament was sutured to its attachment on the tibia. The coronary ligaments were also sutured back onto the bone. The medial meniscus was replaced and repaired back into the medial joint. Following surgery, the athlete was non-weight bearing to protect the meniscal repair. He also wore a post-operative knee brace locked in extension. He was placed on homebound school studies and started physical therapy. During his first physical therapy visit, his range of motion was flexion 60

and extension -9. He was not to do any active flexion past 90 degrees to protect the meniscal repair. Quad strengthening consisted of quad sets, e-stim, and assisted straight leg raises. He was also doing passive range of motion at home. At 4 weeks status post, he was doing very well. Complaints of pain were very minimal. He had mild quad atrophy compared bilaterally. Passive flexion was 80 degrees and extension was the same bilaterally. He had excellent stability of the medial side and was also stable to anterior and posterior cruciate testing. Patellar mobility was good. At this time, his physician let him begin gradual weight bearing with his crutches. He was still not cleared for active hamstring motion. At 7 weeks status post, he was cleared to begin active flexion. He had achieved passive flexion to 90 degrees at this time. He was able to perform a straight leg raise with no difficulty. He had no complaints of pain. He was told to continue weightbearing as tolerated in his brace and had no limits on active flexion. At 11 months status post, he was doing very well. Active range of motion was 0-110. He had no joint line tenderness and excellent patellar mobility. He was stable to Lachman, posterior drawer and valgus testing. He was told to continue working on active flexion and quad strengthening. He will remain in his brace for ambulation.

#### Deviation from the Expected

A literature search on sports related dislocated knees showed that they are no longer as rare as once thought. More of them are being diagnosed, especially in football. But there are no cases of dislocations with the medial meniscus totally disrupted from the joint. This type of surgical repair was something not found in the literature. At three months post op, this athlete was doing very well after having two major ligaments reconstructed, two ligaments reattached and his medial meniscus placed and repaired into his medial joint. At this time he was having no problems with stiffness in the knee which is often associated with this type of surgical repair.

## Radiographic Validation And Reliability Of Selected Clinical Measures Of Pronation

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Abnormal pronation of the foot has been associated with a wide range of injuries in the lower extremity. The navicular drop test (NDT) and Feiss' line (FL) are two clinical tests used to estimate the amount of pronation via transcutaneous measurement of inferior displacement of the tarsal navicular. Although widely used in clinical practice for decades, no published record of validation for these special tests exists. The purposes of this study were: (a) to employ radiographic imaging techniques to determine the validity of the NDT and FL measurements in normal and injured limbs, and (b) to establish the intra-examiner and inter-examiner reliability and standard error of measurement (SEM) for these clinical tests. Thirty-two patients (female and male, ages 18-65) who sought medical treatment for lower extremity pathologies were recruited to participate in the study. Radiopaque markers were placed on the medial malleolus of the tibia, navicular tubercle, and head of the first metatarsal to facilitate the calculation of the NDT and FL. Displacement of the navicular, as calculated from the radiographs, served as the criterion measure for validation of the clinical tests, and was compared with the NDT and FL test results using interclass correlation statistical analyses (Pearson  $r$ ,  $\alpha = .05$ ). Repeated measurements of NDT and FL on different days by the same certified athletic trainer, and same day comparisons between two certified athletic trainers were used to calculate intraclass correlation coefficients [ICC (2,1)] and the SEM. The NDT and FL tests had moderate to good ( $r = 0.61 - 0.89$ ) positive correlation values, with the exception of the FL change in position value ( $r = -.09$ ). The intra-examiner reliability results showed good to excellent consistency for all measures of the NDT and FL tests (ICC = 0.82 - 0.93). The inter-examiner reliability measures were poor to moderate for the FL test of pronation (ICC = 0.43 - 0.74), while the reliability for the NDT was moderate to good (ICC = 0.69 - 0.89). These findings suggest that the validity of the NDT was moderate, and that the FL test was weak. The intra-examiner reliability was strong for both the NDT and FL tests, while the inter-examiner reliability was moderate for the NDT and poor for the FL test. Continued use of the NDT as a clinical test of pronation was supported by our findings; however, FL test results should be used with caution.

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## Relationships Between Impairments, Three-Dimensional Kinematics, And Self-Report In Patients With Subacromial Impingement

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**Introduction:** Impingement syndrome of the shoulder is a mechanical compression injury involving structures of the subacromial space. The potential factors that contribute to primary impingement syndrome are bony abnormalities, weak rotator cuff and/or scapular musculature, posterior capsular tightness, and postural dysfunctions of the spinal column and/or shoulder girdle. Theoretically, these non-kinematic factors lead to the kinematic impairments of dysfunctional glenohumeral and scapulothoracic movement patterns, which then lead to impingement syndrome and subsequent functional limitations. A theoretical model, based upon the disablement model, was developed to help elucidate the mechanisms of impingement syndrome.

**Methods:** Prior to examining the relationships between the various levels of disablement, the measure for the assessment of functional limitations (The American Shoulder and Elbow Surgeon's Self-Assessment Form: ASES) was assessed for reliability, validity, and responsiveness. Patients with various shoulder pathologies ( $n=63$ ) were recruited from 12 different clinics, completing on 3 occasions the ASES, a generic measure (SF36) of overall health, and another shoulder functional limitations measure (University of Pennsylvania Shoulder Form). To examine the relationships between levels of the disablement model, subjects ( $n=47$ ) with shoulder impingement syndrome were recruited. The impairments of AROM, strength, forward shoulder posture, thoracic spine posture, scapular and humeral kinematics and pain were collected by various methods, the ASES self-report questionnaires for functional limitations, and the Short-form 36 for a disability measure. **Results:** The ASES demonstrated an acceptable level of internal consistency, test-retest reliability, as well as construct, divergent, and discriminate validity. The error estimate with a single application (SEM) of the ASES was found to be 6.4 points, and the error estimate with repeated applications (minimal detectable change) of the ASES was 16 points. Regarding the impairment measures, there was a significant relationship between the non-kinematic the measures of strength and pain with the kinematic measures of scapular posterior tilting and external rotation and glenohumeral kinematics. Additionally, there was a significant relationship between function and both kinematic and non-kinematic measures. **Discussion:** The results indicate that the ASES is a reliable, valid, and responsive outcome tool. It can be applied with confidence, utilizing the parameters of error to make

decisions regarding patient prognosis and treatment. It appears that impingement syndrome is multifactorial, therefore it should be treated as such. However, the impairments that appear to most related to functional limitations and disability is that of strength loss, pain, and abnormal scapulothoracic and glenohumeral kinematics. Clinically, by focusing treatment towards these impairments, kinematics of the shoulder and therefore function may improve. This is the future of subsequent research.

Doctoral research grant sponsored by Active Ankle Systems, Inc.

## The Effects Of Creatine Supplementation On Intracellular And Extracellular Water Content

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Immediate weight gain is a common side effect associated with creatine (Cr) supplementation. Because this weight gain occurs over a short duration, it is likely that it is due to water retention. Thus, the purpose of this study was to determine if increases in muscle total creatine (TCr) concentrations, as a result of Cr supplementation, were associated with increases in total body water (TBW) and intracellular water (ICW). Sixteen male (age = 22.8 +/- 3.0 yr., height = 179.8 +/- 7.1 cm, mass = 84.8 +/- 11.2 kg) and sixteen female (age = 21.8 +/- 2.5 yr., height = 163.4 +/- 5.9 cm, mass = 63.6 +/- 14.0 kg) subjects were measured for body mass, muscle TCr concentration (via biopsy analysis), extracellular water (ECW), TBW, and ICW. The body water measurements were obtained using deuterium oxide and sodium bromide dilution analyses. Each subject was then randomly assigned to either a Cr supplementation or placebo group in a double blind fashion. Subjects in the Cr group ingested 25-g/day Cr monohydrate (Experimental and Applied Sciences, Inc., Golden, CO) for 7 days followed by 5-g/day for 21 days. Subjects in the placebo group ingested a sugar placebo using the same protocol. Subjects were then reassessed on days 7, 14, 21, and 28 of the supplementation protocol. Mixed model ANOVAs were performed on all data and a regression analysis was used to determine the relationship between changes in muscle TCr and changes in ICW. A significant increase in muscle TCr [ $F(2,48) = 4.75, p = .013$ ] was observed during Cr supplementation. The increase in muscle TCr occurred during the loading phase and was maintained throughout the maintenance phase. Both groups experienced significant increases in body mass [ $F(4,112) = 2.44, p = .05$ ] and TBW [ $F(2,56) = 3.86, p = .027$ ] during the supplementation period. The Cr group experienced a greater body mass on days 7, 14, 21, and 28 as compared to pre-supplementation, while the placebo group experienced a greater body mass on day 14 only. The Cr group also experienced increases in TBW during both the loading and maintenance phases while the placebo group experienced an increase during the loading phase only. These increased TBW appeared to be the result of non-significant changes in both the ECW and ICW contents. These results suggest that Cr supplementation is associated with an increased TBW, however, this is not due to an increased ICW content.

This study was funded by the NATA Research & Education Foundation.

## Psychological Distress Following Athletic Injury

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An estimated 17 million athletic injuries occur annually of which a substantial portion are thought to be accompanied by significant psychological distress which in turn is thought to influence rehabilitation treatment compliance. However, because few studies have employed adequate control groups and no published study has included pre-injury assessment, accurate data regarding the severity and duration of psychological distress and reactive depression as a result of injury has been difficult to ascertain. Moreover, although the National Athletic Trainers Association (NATA) requires certified athletic trainers to be knowledgeable regarding psychological aspects of injury and includes counseling as a competency area, a recent national survey revealed that many athletic trainers feel unprepared to adequately address psychological issues that may arise. Data and experience gained from the present study can be used to educate athletic trainers to facilitate athletes' emotional adjustment to injury and enhance athletes' satisfaction with care and possibly treatment compliance. The present study assessed the extent, severity, and duration of psychological distress among men and women high school and collegiate athletes incurring a severe athletic injury. Additionally, athletic trainers' assessment of injured athletes' psychological distress was gathered and correlated with athletes' self-report. Four major findings were derived from the study. 1) After accounting for relevant control factors, injured athletes experienced more psychological distress in the form of self-reported and clinician-rated depression than noninjured athletes. 2) Injured athletes were also more likely than non-recently injured athletes to report the presence of bothersome intrusive thoughts regarding an athletic injury which appeared to persist beyond the period of full physical recovery from injury. 3) Beyond severity of injury and post-injury negative mood state, pre-injury negative mood and specific behavioral disruptions (e.g., sleep disruption and anhedonia) are particularly salient in identifying injured athletes at risk for further psychological maladjustment and possible formal mood disorder diagnoses. 4) With respect to their emotional response to injury, athletes showed a clear preference for speaking with athletic trainers as compared to coaches and other sports medicine professionals. However, athletic trainers' ratings of athletes' level of psychological distress was poorly correlated with athletes' self-reported distress. These data will be discussed with respect to specific behaviors and brief interview techniques that athletic trainers may use to better assess psychological distress and identify athletes at risk for more serious psychological disturbance.

This study was funded by the NATA Research & Education Foundation.

## Selection And Evaluation Guidelines For Clinical Education Settings In Athletic Training

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The responsibility to provide quality clinical education experiences within athletic training education programs is increasing dramatically. Availability of high quality clinical education settings is vital to the profession of athletic training. The purpose of this study was to develop and test standards and associated criteria for the selection and evaluation of a clinical education setting in athletic training. A previously validated set of 20 physical therapy clinical education setting standards, criteria, and 2 related evaluation forms were systematically revised and adapted through a survey process. Program directors, clinical instructors, and students involved with athletic training clinical education (representing college/university, high school, and clinic-based settings) from 28 NATA-approved or CAAHEP-accredited athletic training education programs participated in this study. Respondents' critiques and ratings were tabulated by type of respondent. Items were judged as to whether they were relevant, clear, practical, and predictive of high quality clinical education settings. We accepted a final set of 12 standards and 31 associated criteria to measure these standards. The student form lists 23 criteria relevant to these accepted standards. The accepted standards are as follows: learning environment; program planning; learning experiences; ethical standards; administrative support; effective communications; staff number; clinical instructor selection; principles of teaching and learning; professional associations; adequate space; and setting coordinator of clinical education. The 12 standards/criteria and related forms developed in this research project are considered relevant, clear, practical, and predictive of high quality clinical education settings (clinic-based, college/university, high school) in athletic training. These standards/criteria should be used as guidelines rather than as minimal requirements. They could be helpful in forming an impression not only about a particular clinical setting, but also about the requirements of clinical education in general. Further research should include evaluating and comparing perceptions among genders and ethnic groups concerning their clinical education experiences. Also, standards/criteria for clinical instruction in athletic training should be systematically developed.

This study was funded by the NATA Research & Education Foundation.

**Analysis Of Single Leg Multiaxial Postural Control**

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Despite the popularity of utilizing multiaxial (MA) platforms for postural control training and assessment, limited data exists describing how the postural control system maintains equilibrium while standing on MA surfaces. The purpose of this investigation was to conduct an analysis of kinematic and platform movement patterns during single leg MA surface stance. Fourteen volunteers (9 males, 5 females, age=24±3.2 years, height=175.4±8.8cm, weight=72.6±11.7kg) stood (dominant limb) on a MA support surface (Biodex Stability System, Level 6) for three 12s trials under both eyes open (EO) and closed (EC) conditions. Kinematic data was collected using an electromagnetic device (Motion Monitor, IST, Inc.) with sensors on the C7, sacrum, and upper and lower leg. MA orientation data in the frontal (MAf) and sagittal (MAS) planes was collected using an accelerometer. In addition to the position of the sacral sensor within each plane (SSf, SSs), 6 angles were calculated: frontal and sagittal plane trunk-hip angles (SPTHA, FPTHA), lower leg orientation to frontal (LLF), sagittal (LLS) and transverse (LLT) planes, and knee flexion (KF). The average standard deviation (SD) for the 3 trials of each angle and platform variable was calculated and analyzed using a two factor (vision by angle) repeated measures analysis of variance (ANOVA). In addition, the maximal cross-correlational coefficient (CCmax) (maximum phase lag 1s) was calculated between the sacral sensor position and the platform orientation in each plane and averaged within visual condition. The ANOVA revealed a significant ( $p<.05$ ) vision by angle interaction, as well as significant main effects for vision and joint. While the SD of each variable was higher during EC than EO, post hoc analysis of the interaction revealed a significance difference for MAs and MAf. Post hoc analysis of the main effect for joint revealed MAs SD to be significantly higher than the SPTHA, KF, LLS, and LLT SD, and the MAf SD to be significantly higher than the SPTHA, KF, and LLT SD. For both visual conditions, moderate positive CCmax were revealed between MAs and SSs (EO=.68±.06, EC=.77±.08), whereas weak inverse CCmax were revealed between the MAf and SSf (EO=-.37±.17, EC=-.44±.19). This data suggests that across vision, the highest angular fluctuations occur at the ankle with the lower leg remaining vertical. Additionally, the body's center of mass moves in-phase with the MA surface in the sagittal plane but anti-phase in the frontal plane. These results have application for practitioners utilizing MA surfaces for rehabilitation and orientation measures as representative of MA postural stability.

**Kinematic And Kinetic Assessment Of Single Leg Stance On A Firm Surface**

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The purpose of the investigation was to conduct an in-depth kinematic and kinetic assessment of dominant single leg stance on a firm surface. Fourteen subjects (M=9, F=5, age = 24.2 ± 3.3 yrs, ht = 175.4 ± 8.8 cm, wt = 72.6 ± 11.7kg) stood on a firm surface in a standardized position for three 12s trials under eyes open (EO) and eyes closed (EC) conditions. Six joint angles including frontal and sagittal plane trunk-hip angles (FPTHA, SPTHA), lower leg orientation with respect to the frontal (LLF), sagittal (LLS) and transverse (LLT) planes, and knee flexion (KF) were calculated from The Motion Monitor (IST, Inc, Chicago, IL) electromagnetic tracking device. Sensors were placed on C7, the sacrum, upper leg, and lower leg. Similarly, the position of the sacral sensor within the frontal and sagittal plane (SSf and SSs) was calculated. Kinetic variables included both anteroposterior and mediolateral horizontal force data (Fap, and Fml), and center of pressure data (COPap and COPml) from a forceplate sampled at 100 Hz. The average standard deviation (SD) for all joint angles and the forceplate variables were calculated. Data were analyzed with separate two factor repeated measures ANOVAs for both the kinematic (vision x joint) and kinetic (vision x direction) variables. Maximum cross-correlation (CCmax) coefficients (maximum phase lag 1s) were calculated between the sacral sensor position and kinetic variables. Significant interactions existed ( $p<.05$ ) for vision by joint and vision by direction with significant main effects for joint and direction. Post hoc analysis revealed a significant increase in FPTHA, SPTHA, KF, and LLT between EO and EC. FPTHA was significantly greater than all other joints for EC. For the vision by direction interaction, Fml increased compared to Fap for EC. Fml was significantly greater than Fap while COPap was greater than COPml across visual conditions. Strong negative CCmax for both conditions between COPap and SSs (EO = -.72±.10, EC = -.75±.23) and between COPml and SSf (EO = .86±.07, EC = -.73±.23) were present while weak CCmax existed between Fap and SSs (EO = .29±.14, EC = -.26±.18) and between COPml and SSf (EO = -.23±.14, EC = -.31±.19). The results suggest that once vision is eliminated, more corrective action tends to occur in the frontal plane as evident by increased frontal plane hip motion and increased Fml SD. Additionally, COP moves in anti-phase to the body's center of mass (COM) in both planes. COP measures may be more indicative of COM stability than horizontal force measures.

**Kinematic Analysis Of The Hip And Trunk During Bilateral Stance On Firm, Foam, And Multiaxial Support Surfaces**

Blackburn JT, Riemann BL, Myers JB,  
Lephart SM: Neuromuscular Research  
Laboratory, University of Pittsburgh,  
Pittsburgh, PA

During double-leg stance the hip strategy provides postural control in the sagittal plane, while loading and unloading of the lower limbs at the hips provides control in the frontal plane. These sway control patterns result from motion at the hips and trunk, however the proportion of motion occurring at each joint (trunk vs. hip). The purpose of this study was to differentiate hip and trunk motion in the sagittal and frontal planes during double-leg stance on firm (FI), foam (FO), and multiaxial (MA) support surfaces under eyes-open (EO) and eyes-closed (EC) conditions. Fourteen volunteers (7 males, 7 females; ht=172.36 ± 10.91 cm, wt=73.90 ± 15.35kg; age=21.0 ± 1.9 yrs) performed a standardized double-leg stance for three 12s trials on each support surface (FI, FO, MA) and visual conditions (EO, EC). The Motion Monitor (IST, Inc) electromagnetic tracking device was used to measure six joint angles: trunk flexion, trunk lateral flexion, and right and left hip flexion and abduction. Sensors were placed on C7, the sacrum, and the upper legs. The average standard deviation (SD) across the 3 trials for each angle was calculated and analyzed using separate three-factor (vision x surface x joint) repeated measures analysis of variance (ANOVA) for each plane. Results for the frontal plane identified significant ( $p<.05$ ) surface x vision x joint, vision x joint, surface x joint, and surface x vision interactions, and main effects for joint, vision, and surface. Post hoc analysis of the three-way interaction revealed significant differences for the MA EC condition compared to the other conditions across all joints. Additionally, the SDs of both hips were observed to be significantly greater than the trunk. The results of the sagittal plane ANOVA also identified significant ( $p<.05$ ) surface x vision x joint, vision x joint, surface x joint, and surface x vision interactions, and joint, vision, and surface main effects. Post hoc analysis of the three-way interaction revealed significant differences for the MA EC condition compared to the other conditions across all joints. Additionally, the SD of the left hip was significantly greater than the right hip and the SDs of both hips were significantly greater than the trunk. These results suggest that movement patterns designed to control postural sway in the frontal and sagittal planes involve similar amounts of motion occurring at the hips and trunk, with the exception of the MA EC condition. Further research should consider the etiology of this bilateral difference in sagittal plane hip motion demonstrated during the MA EC condition.

## Effect Of Dorsiflexion And Plantar Flexion Muscle Fatigue On Postural Control

Sites HM, Riemann BL, Lephart SM:  
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University of Pittsburgh, Pittsburgh, PA

Previous studies considered muscle fatigue on single-leg (SL) fixed surface stance through utilization of forceplate measures. The purpose of this study was to determine the effects of muscle fatigue on SL stance under fixed (FI) and multi-axial (MA) support surface conditions by considering joint kinematics and support surface measures. Fifteen healthy subjects (7 males, 8 females; age=23±2.3 years, height=172.9±10.6cm, weight=67.0±13.4kg) attended two sessions each consisting of a pretest, treatment (fatigue or control) and post-test. The fatigue protocol consisted of concentric-eccentric dorsiflexion (DF) (2 sets, 15 reps) and plantar flexion (PF) contractions (3 sets, 15 reps) on an isokinetic dynamometer (30°/sec) with 45° knee flexion. Postural control testing consisted of 3 trials (10s) under 2 visual conditions, eyes open (EO) and eyes closed (EC), and 2 support surfaces, FI (forceplate) and MA (Biodex Stability System Level 6). Kinematic measures were provided by an electromagnetic tracking system (Motion Monitor, IST, Inc.) with sensors placed on the lower leg, upper leg, sacrum and C7. The average standard deviation (SD) of 6 angles across the 3 trials was calculated: frontal and sagittal plane trunk-hip angles (FPTHA, SPTHA), lower leg orientation with respect to the frontal (LLF), sagittal (LLS) and transverse (LLT) planes, and knee flexion (KF). In addition, the average SD of the shear forces (FI) and platform orientation (MA) in the medial-lateral and anterior-posterior directions were calculated across the trials. Separate statistical analysis were conducted for each support surface and visual condition. Three factor repeated measures analysis of variance (ANOVA) were completed on the kinematic angles (session by test by joint) and support surface measures (session by test by direction). Kinematic results identified a significant ( $p < .05$ ) fatigue by test interaction for FI-EO and significant joint main effect for FI-EO and FI-EC. Post hoc of the interaction revealed significantly higher angular SD following fatigue compared to the pretest. Support surface results identified a significant session by test interaction for FI-EC and significant direction main effect for all conditions. Post hoc of the interaction revealed significant improvement during the control session (pretest > post-test). Post hoc of the direction main effect revealed higher instability in the medial-lateral direction for all conditions except MA-EO. These results suggest that fatigue of the DF and PF (except gastrocnemius) does not adversely effect SL postural stability as measured by the kinematics of support surface measures. Future studies need to consider the effects of inversion and eversion muscle fatigue on SL stance under similar visual and support conditions.

This study was funded by the NATA Research & Education Foundation.

## The Effects Of Muscle Fatigue On Lower Body Proprioception As Measured By Dynamic Postural Stability

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Dodd SL, Rozea G: University of Florida,  
Gainesville, FL

Dynamic Postural Stability (DPS) is a measure of proprioception that indicates an individual's response to perturbations in the surface beneath the subject's feet. Reaction to this instability relies on proprioceptive mechanisms to maintain one's balance. The purpose of this study was to investigate the effects of anaerobic muscle fatigue on proprioception as measured by DPS. Thirty-three healthy subjects (17 male, 16 female; age 24.7±3.9; height 172.3±8.9cm; weight 70.1±13.8kg) participated in this study. Subjects were tested for leg dominance. The stance leg was chosen as the unilateral test extremity. DPS was measured by the Biodex Stability System (Biodex Medical Corporation, Shirley, NY) and computed into three specific indices: overall stability index (OSI), anterior posterior stability index (APSI), and medial-lateral stability index (MLSI). After three familiarization trials (level 6, 20 seconds duration, 30 seconds rest), each subject performed three pre-fatigue trials (preDPS). Subjects the participated in the fatigue protocol which consisted of repetitive forty-yard sprints with fifteen-second rest intervals. When the subjects exceeded 150% of their initial time, they were considered fatigued. The subject returned to the BSS for three post-exercise trials (postDPS). OSI, APSI, and MLSI were compared across three conditions: preDPS average, postDPS average, and postDPS<sub>1</sub> (first postDPS trial scores) by ANOVAs with repeated measures. There were significant decreases ( $p < .05$ ) in DPS following the fatigue protocol for OSI, APSI, and MLSI. Post hoc tests showed significant differences between preDPS and postDPS, preDPS and postDPS<sub>1</sub>, and postDPS and postDPS for OSI and APSI. MLSI demonstrated significant differences between preDPS and postDPS, and preDPS and postDPS<sub>1</sub>. The results of this investigation suggest that there is a significant decrease in proprioceptive response following anaerobic fatigue. The study presents rationale for further research in proprioception, balance training, balance technology, muscle firing patterns, and conditioning protocols.

This study was funded by the NATA Research & Education Foundation.

## Utilization Of Ambulatory Medical Services Among Youths With Activity-Related Injuries, United States 1997

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Youths aged 8-18 years are the largest segment of the population engaged in sports and recreation activities, yet little is known about the medical care associated with pediatric activity-related injuries. The purpose of this study was to characterize ambulatory medical care visits for activity-related injuries among persons aged 8-18 years. The National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Medical Care Survey (NHAMCS) collect annual data on the utilization of ambulatory medical care provided by office-based physicians and hospital outpatient and emergency departments. The NAMCS/NHAMCS uses a four-stage probability design which allows for the calculation of national estimates of patient visits from a sample of sites providing ambulatory medical care. From information provided in the patient's medical record, data collectors recorded if the visit was for an injury or poisoning. A text description of the events preceding the injury was provided for all injury visits. For the purpose of this study, any injury visit in which sports or other recreational activities were mentioned as the cause of injury were termed an activity-related injury visit. In 1997, persons aged 8-18 years accounted for 12.5 million ambulatory medical care visits in the US. Approximately 5 million (39%) of these visits were for injuries attributed to sports and recreation activities. Fifty-three percent of patients were seen in physician offices and 41% were seen in hospital emergency departments. Males accounted for the majority of visits (67%) and almost 90% of visits were among persons aged 10-18 years. Activity-related injuries occurred most frequently in sports/recreation areas (43.1%) and schools (21.5%). X-rays were ordered at 59.7% of all activity-related injury visits. CT and/or MRI scans were infrequently ordered (1% of injury visits). The top three physician diagnoses were 1.) Ankle sprain/strain, 2.) Pelvis sprain/strain, and 3.) Closed phalangeal fracture. Among physician office and hospital outpatient department visits, injury prevention counseling/education was ordered or provided at only 16.4% of visits. Only a small proportion (1.5%) of emergency department pediatric activity-related injury visits resulted in hospitalization. These data suggest that a significant proportion of ambulatory medical care visits among persons aged 8-18 years are related to injuries sustained in sports and recreation activities. Public health injury prevention programs should be targeted towards the teenage population engaged in sports and recreation activities.

## Sports Participation And Drug Use Among Adolescents Who Use Tobacco

Elder C, Leaver-Dunn D, Nagy S, Leeper J: The University of Alabama, Tuscaloosa, AL

Gateway drug use theory has traditionally proposed marijuana as the linking substance to more illicit drug use like cocaine. However additional investigations revealed that more common licit drugs like alcohol and tobacco were actually the precursors to marijuana use. These findings, along with recent reports by the Youth Risk Behavior Surveillance System and the Monitoring the Future Project that tobacco use is rising among adolescents, have prompted many researchers to investigate possible protective factors for substance use. Sports participation has been promoted as a protective factor for substance use because of the associated decrease in deviant behavior and increase in social bonding. The purpose of this study was to assess this association by investigating the relationship between school sports participation and other drug use of adolescents who use tobacco in a representative sample of adolescents in the southeastern United States. Data were collected using the Alabama Adolescent Survey, which incorporates items from the Youth Risk Behavior Survey. It was administered in over twenty public school systems in 1993 and 1998 to 5900 and 2280 adolescents, respectively.

We assessed tobacco use from questions that pertained to cigarettes and those that specifically identified smokeless tobacco. Using a multiple logistic regression procedure we analyzed the relationship of school sports and tobacco use with alcohol and illicit substances using SPSS Base 8.0 for Windows (SPSS, Inc., Chicago IL). Results indicate that adolescents who smoke cigarettes were more likely to use smokeless tobacco, drink alcohol, and use illicit drugs regardless of whether or not they participated in school sports ( $p = .0001$ ). However, those adolescents who participated in school sports, were less likely to use all drugs than those who did not participate in school sports ( $p = .0001$ ). Additionally, gender was not a significant factor for either group of school sports participation. Previous studies have supported physical activity and group participation as a factor that may help prevent substance use and that tobacco is a gateway drug to further substance use. Our results suggest that adolescents who participate in school sports follow the same path to new substances although they are less likely to use illicit and illicit drugs than their non-participant peers. Further investigation is needed to assess what additional factors influence the decision making process of adolescents who participate in school sports.

## Influence of Ethnicity On Multiple Substance Use Among Interscholastic Adolescent Athletes

Barrett C, Leaver-Dunn D, Leeper JD, Nagy S: The University of Alabama, Tuscaloosa, AL

Research has shown that rates of substance use and abuse are higher among certain ethnic groups. The purpose of this study was to assess the relationship between ethnicity and the use of alcohol, marijuana, and cigarettes among adolescent athletes. One thousand five hundred seventy-two athletes, enrolled in four public school systems across Alabama completed 69-item self-report Adolescent Health Survey. Seventy-nine percent ( $n=1242$ ) were White, 17.6% ( $n=276$ ) were Black, and 0.6% ( $n=10$ ) were Hispanic. Of the White subjects, 57.2% ( $n=706$ ) reported alcohol use, 28.2% ( $n=346$ ) used marijuana, and 44.7% ( $n=552$ ) used cigarettes in their lifetime. Black subjects reported 52.7% ( $n=144$ ) used alcohol, 40.1% ( $n=109$ ) used marijuana, and 34.6% ( $n=94$ ) used cigarettes. Hispanic subjects reported 70.0% ( $n=7$ ) used alcohol, 40.0% ( $n=4$ ) used marijuana, and 60.0% ( $n=6$ ) used cigarettes. The SPSS program made for Windows 8.0 chi-square crosstabulations were used to analyze the data with the alpha level set at .05. In this sample crosstabulation, the majority 32.1% ( $n=278$ ) Whites began drinking alcohol in the 7th or 8th grade. Of the Blacks who reported alcohol use, 24.1% ( $n=40$ ) began in the 9th grade. One hundred twenty-nine (28.9%) Whites began smoking marijuana in the 9th grade. Thirty-seven (33.9%) Blacks started smoking marijuana in the 7th or 8th grade. Both groups initiated cigarette smoking in the 7th or 8th grade with Whites representing 34.3% and Blacks representing 30.6%. These results will allow Certified Athletic Trainers to be more aware of substance use among interscholastic adolescent athletes. This will enable the Certified Athletic Trainers to recognize problems such as illness or injury related to substance use that may occur in the early adolescent years. This information may also be used to initiate a substance use educational program for interscholastic athletes. Additional research is needed to investigate the influence of stress levels and peer groups in the decision to use alcohol, marijuana, and cigarettes.

## Predictors Of Physician Utilization Among Adolescents Receiving Preparticipation Physical Evaluations

Leaver-Dunn D, Donahue RE, Leeper JD:  
The University of Alabama, Tuscaloosa, AL

The objective of this study was to determine factors associated with utilization of physician services among adolescent interscholastic athletes. This study consisted of a retrospective, cross-sectional survey of adolescents receiving a preparticipation physical evaluation (PPE) in Tuscaloosa County, Alabama for the 1998-99 school year. Of the 1,702 interscholastic athletes surveyed, 31% were female and 69% were male. Racially the sample was composed of 33% African-American students and 67% white, non-Hispanic. Subjects were enrolled in grades 7-12, with a fairly even distribution ranging from 15-19% in each grade. Ages ranged from 11-18 with a mean of 14.8. Questionnaires were completed during registration for the PPE. Students responded to questions addressing demographics, physician utilization for sports injuries and other conditions, non-sport physical status, and sport participation. Data were analyzed using logistic regression procedures with the SPSS-PC (Chicago, IL) version 9.01 software. Only 27% of the adolescents had seen a physician in the past year for any reason other than a sports physical. Statistically significant predictors of physician utilization were race ( $p = .0000$ ), gender ( $p = .0157$ ), and type of school ( $p = .0240$ ). White females attending urban schools were the most likely to see a physician. Of the adolescents surveyed, 31.7% of the white students and 18.6% of the black students saw a physician. Among the athletes, 32.6% of the females and 24.3% of the males did so, while 28.8% of those at urban schools and 22.7% of those enrolled in rural schools visited a physician for other than a sports physical. Analysis revealed number of sports played was not statistically significant in the model. Adolescent interscholastic athletes in Tuscaloosa County are currently failing to obtain appropriate preventive health care services. This study suggests educational interventions should target black males in rural schools. ATCs are ideally positioned to facilitate appropriate and timely health care utilization among adolescent athletes. These professionals' access to adolescent athletes, their parents, administrators, and the medical community makes them uniquely qualified to address this deficiency. Additional research is needed with more diverse populations in other geographic locations.

**Knee Pain - Basketball**

Ireland M, Ellis J: Kentucky Sports Medicine, Lexington, KY

**Personal Data**

Almost 17-year-old male was seen with complaints of knee pain and swelling after participating in basketball camp four months ago. He denied any specific injury. He did admit having some discomfort over the past year but no swelling or pain that prohibited play.

**Physical Signs and Symptoms**

Knee exam revealed a ligamentously stable knee. There was no effusion and full ROM. There was tenderness to palpation over the medial femoral condyle. Negative McMurray's test.

**Differential Diagnosis**

1. Osteochondritis dissecans medial femoral condyle.
2. Medial meniscus tear.
3. Osteochondral fracture.

**Results of Diagnostic Test**

X-rays revealed a large radiolucent lesion involving the majority of the weight bearing surface. Magnetic resonance imaging revealed unstable lesion of the medial femoral condyle with fluid beneath the fragment. Other intraarticular structures were normal.

**Clinical Course**

Arthroscopy was performed. The lesion could be hinged open and fibrous scar was debrided. Due to the large size of the lesion, 2 X 4 cm., a medial arthrotomy was used. Fixation was accomplished using two 3.5 mm bioabsorbable screws. Initial immobilization for two weeks, then active range of motion was implemented. He remained nonweight bearing for 8 weeks.

**Deviation From the Expected**

This case is unique because of the initial delay in seeking treatment, size of the lesion, and the use of new generation bioabsorbable screws. Presentation will include video of the patient's arthroscopy and arthrotomy to enhance understanding of OCD lesions and healing process.

**Persistent Wrist And Hand Pain In A Collegiate Ice Hockey Player**

Drysdale CL, Tsang KKW, Putukian M, McGuire DT, Denegar CR: Pennsylvania State University, University Park, PA

**Personal Data:** A 20-year-old male collegiate ice hockey player reported poorly localized, intermittent pain along the dorsal/ulnar aspect of his left hand with grasping of a hockey stick during normal play. The athlete denied any direct trauma to the hand prior to the gradual onset of pain.

**Signs and Symptoms:** Upon initial evaluation no swelling or point tenderness were found over the palmar aspect of the involved hand, although mild point tenderness was elicited upon palpation of dorsal surface of the triquetrial and hamate bones. Ulnar deviation (active and passive) recreated pain, as did resisted motions (abduction, adduction, flexion, extension) of the 5th digit. An increase in pain was also noted with passive extension of the wrist. Results of neurological testing were negative. Three weeks after the initial evaluation the athlete reported being struck over the hypothenar eminence by a hockey stick, after which he presented tenderness over the hook of the hamate.

**Differential Diagnosis:** Initial evaluation: strain of the intrinsic muscle of the hand, wrist extensor tendonitis, ligamentous sprain between carpal bones, and triangular fibrocartilage complex injury. At 3 weeks post-initial evaluation: contusion of the hypothenar eminence and metacarpal fracture.

**Diagnostic Testing:** Routine anterior-posterior, oblique, and lateral radiographs of left wrist taken at initial evaluation revealed no abnormalities. Radiographs repeated three weeks after initial evaluation included a carpal tunnel view, which revealed a fracture of the hook of the hamate. The fracture margins were sclerotic in nature, indicative of previously established healing.

**Clinical Course:** After initial diagnosis of an abductor strain, the athlete continued to participate in ice hockey. Treatment consisted of modalities and taping. After the diagnosis of the hook of the hamate fracture, the course of action was to allow the athlete to continue to play ice hockey as tolerated while wearing a donut pad over the hamate along with wearing a wrist splint during the day. The athlete was evaluated daily for any alterations in neurological functions of the ulnar nerve. Upon completion of the season, the status of healing of the fracture will be re-evaluated. Surgical intervention may be necessary to excise the hook of the hamate to allow for normal pain free hand function.

**Deviation from Expected:** This case is unique as the symptoms presented by the athlete did not resemble those of a typical fracture. Initially, the symptoms of the injury were presented as those resembling a strain of the abductor/flexor muscles

of the 4th & 5th digits. Point tenderness over the hook of the hamate was not present until 3 weeks later, after the athlete was struck in the hand. It is important to note that the proximal attachments of the intrinsic muscles of the 5th digit (flexor digiti minimi, opponens digiti minimi), and the pisohamate and pisometacarpal ligaments are found on the hook of the hamate. As such, it is easy to understand why a fracture of the hook of the hamate would present with similar symptoms as those found with an injury to the adjacent soft tissues.

This patient demonstrates a case of hamate fracture despite an initial absence of hamate tenderness. Therefore, we believe that routine radiographic examination, which includes a carpal tunnel view, is warranted when persistent diffuse hand pain is concomitantly presented with dorsal point tenderness of the hamate.

## Persistent Foot Pain In A Female Collegiate Soccer Player

Domorski SN, Evans TA, Sebastianelli WJ, Putukian M, Hertel J: Pennsylvania State University, University Park, PA

**Personal Data:** Prior to her sophomore year, a 20 year-old female collegiate soccer player presented burning localized pain at her left forefoot. She was evaluated by the team physician and conservatively treated with anti-inflammatory medication, therapeutic modalities, activity modification, and orthotics. Although she was still able to compete, the pain was persistent and increased progressively during the regular season. She denied experiencing any significant trauma prior to the onset of her pain. Her symptoms resolved during the post-season, however they returned with increased severity during off-season conditioning, forcing her to discontinue all activities. In addition, she developed minimal pain in her right foot, which had been relatively asymptomatic.

### Physical Signs and Symptoms

Initially, she experienced burning pain in her left foot between her third and fourth metatarsal heads. Physical examination revealed moderate swelling in the area of her left 3rd and 4th metatarsophalangeal joints, a positive compression test, and maximal pain at the 3rd metatarsal head. Resisted extension and passive flexion of the toes reproduced the pain. She exhibited minimal tenderness in the right second metatarsal head only upon palpation. Analysis of her running mechanics revealed that she predominately ran on her toes, without heel strike. When the symptoms returned in the off-season, she presented increased point tenderness and swelling in both feet.

**Differential Diagnosis:** Morton's neuroma, concomitant extensor tendonitis, metatarsal stress fracture, synovial conditions, Freiberg's infarction.

**Results of Diagnostic Imaging:** Initial radiographs revealed bilateral deformities of the metatarsal heads with associated sclerosis. There was some flattening of the 3rd left metatarsal head. No stress related fractures were apparent. A bone scan revealed abnormal uptake at the 3rd left metatarsal as well as the 2nd right metatarsal. An MRI correlated with the bone scan and radiographs, showing flattening of the metatarsal heads with irregularity of the articular surfaces, indicating avascular necrosis of the metatarsal heads.

**Clinical Course:** Based on the diagnostic imaging and the physical findings, a final diagnosis of Freiberg's infarction was established. Although the athlete was able to complete the season, conservative treatment was unsuccessful and her pain progressively increased with activity. Therefore surgical intervention was considered. In April of her sophomore year, she underwent arthroplasty and debridement of osteophytes in the dorsal half of the left 3rd metatarsal head and right 2nd metatarsal head (one month apart). She was able to return to full participation status for her junior season. However, she still experienced pain, swelling, and decreased motion throughout the entire

season. Currently, she is 19 months post-surgery and continues to play soccer with minimal pain, without limitations, and without deficits in performance.

**Deviation from Expected:** Although foot pain is common in soccer players, avascular necrosis is not a common consideration. Furthermore, it is even less common to occur bilaterally. In this case, a collegiate soccer player was diagnosed with bilateral Freiberg's infarction. Freiberg's infarction is avascular necrosis (osteonecrosis) localized in the second and third metatarsal heads. It is associated with flattening, fragmentation, and sclerosis of the metatarsal heads. Even though this athlete may have been predisposed due to her abnormal running biomechanics, only ten percent of all cases of Freiberg's infarction occur bilaterally.

**Key Words:** Avascular necrosis, Freiberg's infarction, sclerosis, osteochondrosis, metatarsal head.

## Syndesmotic Ankle Disruption In An Intercollegiate Football Player

Vanic KA, Hauth JM, Primiano GA: East Stroudsburg University, East Stroudsburg, PA

**Personal Data/Medical History:** A 22-year-old male intercollegiate football player reported to the athletic training facility with a chief complaint of right ankle pain. Athlete can not recall specific etiology, however, this injury did not occur while participating in athletic competition. Post-game activities may have dictated his present injury status. Further investigation was warranted. Past medical history of lower extremity injury was unremarkable.

**Physical Signs and Symptoms:** Twenty-four hours following initial insult, the patient presented with diffuse swelling around the right ankle. There was no obvious deformity, however, moderate ecchymosis was developing in the subcutaneous tissue distal to the medial malleolus. He denied any neurovascular changes and appeared intact.

**Differential Diagnosis:** Anterior talofibular ligament sprain, Calcaneal-fibular ligament sprain, talar dome fracture, fibular fracture, osteochondral fracture, heterotrophic ossification with associated synostosis.

### Results of Diagnostic Imaging/Laboratory Tests:

Radiographic findings were unremarkable for an underlying fracture, and/or any lytic or blastic changes to the distal lower extremity. However, obvious joint diastasis was observed through mortise radiography. The medial ankle joint space was widened to greater than 1mm. In addition, AP views indicated partial overlap of the tibia and fibula, verifying the distal syndesmosis was ruptured with persistent widening.

**Clinical Course:** Such displacement would indicate a disruption of the distal tibiofibular ligament and subsequent interosseus membrane separation. Open reduction internal fixation (ORIF) of the ankle mortise was indicated. A standard course of ankle rehabilitation was pursued. Standard post-operative management and therapy are progressing well.

**Deviation from the Expected:** Due to the severity and structures involved with this type of injury, athletes who have suffered from a syndesmosis ankle injury should be informed of a prolonged recovery time. In comparison with lateral ligamentous ankle sprains, research has shown that the syndesmotic complex presents a unique situation often characterized with a prolonged prognosis.

## Free Communications, Oral Presentations: Thermoregulation

Friday, June 30, 2:40PM-3:45PM, Cleveland A; Moderator: William R. Holcomb, PhD, ATC, CSCS\*D

### Salt Depletion Heat Exhaustion In A Hypertensive Collegiate Football Player

Godek JJ, Fowkes Godek S: West Chester University, West Chester, PA

**Personal Data:** The patient is an otherwise healthy 21 year old football player with diagnosed mild hypertension which was being managed by his personal physician and with 20mg of Zestril (lisinopril) daily. During his pre-participation medical screening the patient was measured at 6ft. 4in. and 294 lbs. with a sitting blood pressure of 160/80. The patient was cleared by his personal physician for unlimited physical activity with a request to monitor blood pressure.

**Physical Signs and Symptoms:** At one hour and fifty minutes into the second practice (approximately 5:20 pm) on the tenth day of two-a-day pre-season drills the athlete reported to his position coach that he felt ill. The athlete complained to the athletic trainer of feeling light-headed and experiencing fatigue, weakness, nausea, headache, and muscle soreness. On-site examination revealed no apparent increase in body temperature as determined by body touch. The athlete's radial and carotid pulses were barely discernable. The history of onset and findings of a neurological evaluation eliminated concern of head trauma. Suspecting salt depletion heat exhaustion, the football ATC had the athlete transported to the athletic training room with a request that the ATC on duty there begin voluntary oral re-hydration with Gatorade® and obtain blood pressure, pulse and body temperature readings. Initial attempts to obtain a blood pressure resulted only in a systolic reading of 78 with no diastolic reading or accurate pulse count. Subsequently another ATC was able to get a blood pressure of 80/50, but no pulse and a body temperature of 96.4°F. At approximately 50 minutes after onset of illness the football athletic trainer obtained a blood pressure of 82/56 with a pulse of 70b/min and a body temperature of 96.4°F. Forced oral re-hydration Gatorade® was initiated. The athlete was placed in the shock position with his legs elevated 8"-12", and the team physician was notified.

**Differential Diagnosis:** Possible diagnoses included: viral illness, bacterial illness, or salt depletion heat illness.

**Results of Diagnostic Imaging/Laboratory Studies:** No diagnostic imaging or laboratory studies were ordered by the team physician.

**Clinical Course:** A discussion among the team physician and two of the ATCs resulted in the diagnosis of salt depletion heat illness. The decision was made to continue forced oral re-hydration with Gatorade® and monitoring of blood pressure and pulse. The athlete was also instructed to discontinue his Zestril until further notice. A prognosis of gradual improvement was made. Any sign/symptom contradictory to this prognosis was to result in hospitalization for intravenous dramatically reduced and he was discharged to his dormitory under the supervision and observation of a senior student athletic trainer. The next morn-

ing the athlete reported to the athletic training room with mild to moderate symptoms and blood pressure of 84/44 with a pulse of 74b/min and a body temperature of 96.7°F. The athlete was again placed in the shock position and forced oral re-hydration with Gatorade® was re-initiated. By 11:15 am the athlete's blood pressure had risen to 104 over 48 and his pulse was 70. At 1:40pm the athlete's blood pressure was 98/146 with a pulse of 72b/min. In the seated position the athlete's blood pressure fell to 88/42 with no discernable pulse. He was returned to the shock position and re-hydration was continued. By 2:20pm his blood pressure was 110/58 and his pulse was 64b/min with a body temperature of 96.9°F. At 3pm his blood pressure was 122/58 and his pulse was 68. When moved to a seated position his blood pressure was 118/50 and his pulse was 72. The athlete was again discharged in the care of a senior student athletic trainer. In the morning of day 3 the athlete had a blood pressure of 110/60 and a pulse of 70b/min. Forced oral re-hydration with Gatorade® was re-started and by 6:15pm his blood pressure in the seated position was 112/56 and his pulse was 78b/min. The following morning the athlete had a seated blood pressure of 134/82, a pulse of 76b/min, and a body temperature of 98.2°F. He stated that his appetite had returned the previous evening. He was cleared by the team physician for a gradual return to previous levels of physical activity, but was instructed to withhold his daily dose of Zestril for one more day. Two days later the athlete safely and successfully participated in a lengthy afternoon scrimmage session and the following day he returned to full activity.

**Deviation from the Expected:** The diagnosis of salt depletion heat exhaustion is often overlooked. The specific signs and symptoms occurring with heat exhaustion depend upon the relative losses of salt and water. Since sweat contains relatively little salt compared to plasma, excessive sweating causes dehydration. However, if an athlete consumes enough water to offset losses via sweating, but does not consume enough salt the resulting heat exhaustion will be due to salt depletion. The subject of this report was very conscientious regarding fluid replacement as is verified by his loss of only 1lb/day of body weight prior to this episode, however he carefully avoided fluids with significant salt content. Three other factors exacerbated the situation for this athlete: 1.) His food intake was limited by his desire to control his weight and the early onset of his symptoms, 2.) He was on a low salt diet that he followed zealously, and 3.) He was taking 20mg of Zestril (lisinopril) daily. This drug is a long acting angiotensin converting enzyme (ACE) inhibitor that diminishes Na re-absorption in the kidneys. The team physician felt that the combination of ces-

sation of the ACE inhibitor, forced oral re-hydration, rest and careful monitoring by the athletic training staff would result in a steady improvement in this athlete's health and his safe and timely return to physical activity.

## Assessing If Two Tympanic Temperature Instruments Are Valid Predictors Of Core Temperature In Hyperthermic Runners And Does Drying The Ear Canal Help

Knight JC, Casa DJ, McClung JM, Caldwell KA, Gilmer AM, Meenen PM, Goss PJ: University of Connecticut, Storrs, CT

This study assessed the accuracy of tympanic (aural canal) temperature instruments when used as an indicator of body temp in hyperthermic athletes. In addition, we wished to examine if drying the aural-canal with a q-tip before the measurement would enhance the quality of the reading, postulating the removal of sweat from the aural canal may enhance the measurement. To induce hyperthermia 17 heat-acclimated highly-trained distance runners (age-28±2 yrs, body fat-11.2±1.3%, weight-68.5±2.1 kg, height-180±2 cm, training volume-89±10km/wk) completed a hilly trail run (approx. 19 km and 86 min) in the heat (WBGT=27°C) at an individually selected "comfortable" pace on 3 (1-wk apart) occasions. The 3 trials (random, cross-over design) included: 1) Distance run (DR) then 12 min of ice-water (5.15±.20°C) immersion (IWI); 2) DR then 12 min of cold-water (14.03±.28°C) immersion (CWI); 3) DR then 12 min of mock (no water, air temp=28.88±.76°C) immersion (MI). Water immersion included submerging torso and upper legs. Start-immersion (SI) and each min during immersion rectal temp (RECT), tympanic temp (with 2 instruments), and q-tip tympanic temp (via 2 instruments, qTYM1 & qTYM2) were recorded. Tympanic instrument #1 (TYM1) purported to give tympanic temp while tympanic instrument #2 (TYM2) purported to predict rectal temp. The measurements from all 3 trials (n=51) were pooled and q-tip measurements were recorded and pooled during 6 of each of the trials (n=18). SI RECT averaged 39.48±.16°C (103.1°F). RECT were greater (p<.05) than TYM1, TYM2, qTYM1, and qTYM2 at the SI and each min throughout immersion. RECT was on average the greater than TYM1 (2.45, 1.93, 1.46, 1.23°C), TYM2 (2.91, 3.03, 2.56, 2.2°C), qTYM1 (2.19, 1.53, 1.43, 1.21°C), and qTYM2 (2.89, 2.73, 1.93, 1.61°C) at SI, min4, min8, and min12, respectively. Correlations between RECT and TYM1 (.69, .52, .39, .29), TYM2 (.38, .36, .16, .20), qTYM1 (.54, .40, .45, .46), and qTYM2 (.33, .25, .05, .01) at SI, min 4, min 8, and min 12, respectively indicate a very poor relationship. The data indicates that tympanic temperature instruments, used with or without a q-tip, should never be used as an indicator of core temperature in hyperthermic athletes. The great disparity between RECT and the tympanic temp (SI RECT 4.41, 5.20, 3.94 and 5.20°F greater than SI TYM1, TYM2, qTYM1, and qTYM2 SI, respectively!) indicates their use could hinder the appropriate medical care for a potentially serious exertional heat illness.

## Establishing A Medical Protocol For Cooling Hyperthermic Runners: Ice-Water Immersion Versus Cold-Water Immersion

Casa DJ, Knight JC, McClung JM, Blake AS, Meenen PM, Gilmer AM, Caldwell KA: University of Connecticut, Storrs, CT

The purpose of this study was to assess if ice-water immersion (IWI) is the superior medical protocol for rapidly cooling hyperthermic runners when compared to cold-water immersion (CWI). 17 heat-acclimated highly-trained distance runners (age-28±2 yrs, body fat-11.2±1.3%, weight-68.5±2.1kg, height-180±2cm, training volume-89±10 km/wk) completed a hilly trail run (approx. 19 km and 86 min) in the heat (WBGT=27°C) at an individually selected "comfortable" pace on 3 (1-wk apart) occasions. The 3 trials (random, cross-over design) included: 1) Distance run (DR) then 12 min of IWI (5.15±.20°C); 2) DR then 12 min of CWI (14.03±.28°C); 3) DR then 12 min of mock (no water, air temp = 28.88±.76°C) immersion (MI). Water immersion included submerging torso and upper legs. 3 min elapsed following the DR and the start of immersion (SI). Core temp was recorded SI, each min of immersion and 3, 6, 10, and 15 min post-immersion (PI). No rehydration occurred during any trial. Length of DR, time to complete DR, rectal temp (39.48±.16°C) and % dehydration (-3.70±.20%) following DR, and the WBGT was similar (p > .05) among all trials. No differences (p > .05) for cooling rates were found when comparing IWI (.20±.04, .15±.02, .18±.03°C/min), CWI (.20±.03 & .15±.02, .16±.01°C/min), and MI (.13±.03, .11±.02, .13±.02°C/min) at SI to 4 min, 4 to 8 min, and SI to 8 min, respectively. IWI (.11±.01, .16±.02, .16±.01, .13±.01, .12±.01, .10±.01, .09±.01°C/min) and CWI (.12±.01, .17±.02, .16±.01, .13±.01, .11±.01, .09±.01, .08±.01°C/min) cooling rates were similar (p > .05) to each other and greater (p < .05) than MI (.08±.01, .11±.01, .10±.01, .09±.00, .07±.01, .07±.00, .06±.00°C/min) at 8 to 12 min, SI to 10min, SI to 12 min, SI to 3 min PI, SI to 6 min PI, SI to 10 min PI, and SI to 15 min PI, respectively. CWI reported enhanced comfort (p < .05) compared to IWI with the immersion process. Cooling rates are nearly identical for IWI and CWI while both are superior (by 38%) to MI after 12 min of immersion. Given the similarity among IWI and CWI cooling rates and the enhanced comfort and ease of administration with CWI then CWI may be the cooling mode of choice when treating hyperthermic athletes.

## Two Methods Of Rapid Rehydration (Oral And Intravenous) In Dehydrated College Football Athletes

Fowkes Godek S: Temple University, Philadelphia, PA, and West Chester University, West Chester, PA

Intravenous infusion is employed by some sports medicine professionals. The purpose of this study was to compare two methods of rapid rehydration (oral and intravenous) in dehydrated football athletes by evaluating cardiovascular, renal, fluid consumption, thirst and body weight responses, immediately after 15 minutes of rapid rehydration, and for 3 hours following rehydration. Seven healthy division I football athletes were apprised of the risks involved and signed informed consent forms. All subjects underwent two randomly assigned rehydration treatment protocols after exercise induced dehydration in a warm, humid environment, to reduce body weight by 2.5%. Blood samples were tested for serum osmolality, Hb and Hct.. Urine samples were collected for volumetric and osmolality measurements. Ratings of thirst were recorded. All subjects consumed fluids ad lib between 150 and 180 minutes, total volume consumed and final body weights were recorded. Repeated measures ANOVA (group x time) was used to evaluate differences between groups. One-way ANOVA with Tukey's post hoc testing was used to detect differences over time. Between group analysis of temperature, humidity, weight loss, fluid consumed and urine production was done by paired t-tests. An alpha level of 0.05 was used. Environmental conditions during dehydration were not different between trials. All subjects were still dehydrated at the conclusion of each day. Immediately after rehydration, blood and plasma volumes were significantly lower in the oral group than in the i.v. group. A 6.7% drop in blood volume from baseline at 0REHY in the oral group was also significant (p<.05). Urine osmolality was significantly higher at 180PostREHY in the IV group compared to the oral group (p<.02). Renal tubular conservation of water, T<sub>H2O</sub> was significantly higher in the i.v. group between 60 and 120 minutes. There were no significant group differences in urine volume at anytime or in total urine production. Both groups had significantly lower urine volumes at 180PostREHY versus 30PostREHY (p<.05). The i.v. group had significantly higher ratings of thirst at 0, 15, 30 and 120 minutes post rehydration. Serum osmolality was significantly higher in the i.v. group at (p<.029). groups in total amount of fluid consumed ad libitum. Results suggest that although the i.v. group generally maintained higher blood and plasma volumes, was thirstier and conserving more water three hours after rehydration; total fluid consumed, total urine production and level of hydration did not differ from the oral group.

## Knee Injury – Football

Ellis J, Ireland M, Barton B: Kentucky Sports Medicine, Lexington, KY

### Personal Data

A 21YO male football player injured his right knee while performing box squats in July. He reported pain and popping during a squat repetition and experienced immediate swelling. Four years previously he underwent ACL reconstruction and medial meniscectomy repair. He did use a brace on his right knee.

### Physical Signs and Symptoms

Physical exam revealed a moderate effusion with medial greater than lateral joint line tenderness. McMurray's test was positive medially with popping and pain. Bounce home test was positive. Lachman test was positive without end point, ROM 10-120 with pain. Hamstring spasticity great.

### Differential Diagnosis

1. Failed anterior cruciate ligament reconstruction.
2. Medial meniscus tear.
3. Chondral injury medial femoral condyle.

### Results of Diagnostic Tests

AP, lateral, notch views of the right knee and bilateral patellar views were obtained. Two interference screws were present. Osteochondral surfaces were smooth. On the notch view, the femoral interference screw was prominent intraarticularly.

### Clinical Course

The patient underwent right knee arthroscopy. Findings were an incompetent ACL graft with unstable vertical bucket handle medial meniscus tear and osteochondral fracture of the lateral femoral condyle. The femoral screw was removed after it was found to be partially backed out. Drilling of the lateral femoral condyle lesion was done. Medial meniscus was repaired with absorbable sutures. Thermal modification of the remaining ACL was done. Postoperatively the patient remained nonweight bearing for three weeks. Against advice, by five weeks he started doing full squats, said his knee felt good and stated that his derotational brace fit well. He returned to full football activities eight weeks postop. He did well throughout the remaining six games.

### Deviation From the Expected

The case is unique because of the extent of injury to the athlete's knee and risks of returning to football. The significant extent of the arthroscopic findings would not well correlate with how well he did following his arthroscopy. He does not have any significant instability but his muscular build and coordination helped to stabilize his knee. There is certainly an important factor in this case relating to the very strong desire of the athlete to return to the playing field despite the extensive injury to his knee. How do we as athletic trainers and physicians follow and counsel athletes who ignore and deny that they have any knee problems. As the patient protector and advocate, is it in his best interest to allow him to continue to play football?

## Knee Dislocation In A College Gymnast

Cavanaugh JT, Altchek DW: Sports Medicine, Performance & Research Center, Hospital for Special Surgery, New York, NY

**Personal data:** A 21 year old female participating in a college gymnastics practice sustained a left knee dislocation upon landing from a vault. The mechanism of injury was described as valgus/rotation with resultant deformity. The athlete was transported to the local emergency room with subsequent reduction Doppler testing declared the left lower extremity vasculature sound.

**Physical Signs and Symptoms:** The athlete presented at our facility six days post injury donning knee immobilizer, non-weight bearing, with chief complaint of stiffness. Range of motion was restricted,  $-2^{\circ}$  extension to  $64^{\circ}$  flexion. A severe effusion was present. Quadriceps contraction was rated fair. Neurovascular exam was intact except for a slight decrease in temperature of the left foot when compared to the right. Marked laxity was noted to valgus stress without endpoint. Lachmann test was rated 2B. Posterior laxity and external rotation could not be adequately tested secondary to decreased motion. Varus testing was stable.

**Differential Diagnosis:** Complete tear of the anterior cruciate and medial collateral ligaments left knee, possible involvement of posterior cruciate ligament and posterior lateral ligament complex.

**Diagnostic imaging/laboratory results:** X-rays revealed no significant bony fractures status post knee dislocation with reduction. MRI revealed complete disruption of anterior cruciate and medial collateral ligaments, a high grade partial tear of the posterior cruciate ligament with only a small remnant evident at the tibial insertion and a complete displaced tear of the lateral meniscus with multiple fragments. An adjacent chondral injury was present without full thickness chondral defect. Magnetic resonance arteriography of the left knee demonstrated no evidence of occlusive disease.

**Clinical course:** The athlete attended a three week course of pre-operative rehabilitation achieving significant gains in range of motion  $0-90^{\circ}$ , decreased effusion, improved patella mobility, and improved quadriceps control. Having met her pre-operative goals, a reconstructive procedure was performed. The athlete underwent a left knee arthroscopic anterior cruciate ligament reconstruction with bone-patella tendon-bone graft from the right knee, posterior cruciate ligament reconstruction with semitendinosus and gracilis tendons from the right knee, medial collateral ligament repair with augmentation with gracilis tendon of the left knee and complete lateral meniscectomy. The athlete was started immediately on a post-operative rehabilitation program for both lower extremities. The athlete progressed extremely well throughout the post-operative course. Careful

attention was paid to patella tendon harvest site on right knee in therapeutic exercises and daily activity so as to reduce morbidity in the early post-operative period. Range of motion, bilateral lower extremity strength, and weight bearing status were gradually progressed via a criteria based post-operative guideline. At seven months post-op, the athlete had returned to normal activities of daily living and recreational activities such as cycling and hiking. Range of motion had improved to  $0-136^{\circ}$ . NeuroCom testing in the Weight Bearing/Squat and Forward Step Down tests were within normal limits. Hop test revealed 72% limb symmetry. KT1000 knee ligament arthrometer testing at 89N revealed 4mm and 2mm side-to-side difference in total AP displacement at 30 and 90 degrees respectively. The athlete is now considering recommended lateral meniscus allograft surgery.

**Deviation from the expected:** Knee dislocation is a traumatic injury, often resulting in an unstable and dysfunctional knee. Early management including assessment of vascular integrity, diagnostic testing, and clinical evaluation are essential in determining course of treatment. Pre-operative rehabilitation to improve range of motion and lower extremity strength improved post-operative outcome. An alternative surgical procedure utilizing grafts taken from the contralateral non-involved knee was utilized resulting in a very successful clinical outcome. Post-operative rehabilitation integrating two simultaneous programs for involved and non-involved (donor) knees resulted in an excellent outcome.



**Treatment Of Acute Muscle Cramps With Pickle Juice: A Case Report**

Williams RB, Conway DP: University of Northern Iowa, Cedar Falls, IA

**Personal Data/ Pertinent Medical History:**

A 21 year old male Division I basketball player (180 pounds, 70 inches) suffered bilateral involuntary muscle contractions of the gastrocnemius. The cramping began during the earlier part of the first half of a basketball game. The athlete has a history of muscle cramping but has been preventing the muscle cramps by taking 1 ounce of dill pickle juice before each game. For this particular game the athlete did not take the dill pickle juice prior to the game.

**Physical Signs and Symptoms:**

The athlete had severe bilateral involuntary muscle contractions at the musculotendonous junction of the gastrocnemius. Upon visual inspection the involuntary contractions were apparent. The athlete was assisted off of the floor due to pain. The left gastrocnemius was more painful and point tender than the right and both gastrocnemii had loss of normal muscle function.

**Differential Diagnosis:**

1. Muscle strain of the gastrocnemius
2. Muscle tear of the gastrocnemius

**Results of Diagnostic Imaging/Laboratory Tests:**

Due to the nature of this injury there were no diagnostic imaging or laboratory tests performed.

**Clinical Course:**

Based upon the evaluation the athlete was diagnosed with having bilateral cramping of the gastrocnemius. The athlete was then given two ounces of dill pickle juice. The muscle cramps ceased 30 seconds after taking the pickle juice. The athlete returned to the game and continued throughout the entire game until five minutes was left in the second half. The cramps returned and the same treatment was administered to the athlete. The cramps went away again and the athlete returned for the rest of the game.

**Deviation from the expected:**

The athlete has been taking one ounce of pickle juice before each game and has not suffered any muscle cramping. However, when the athlete refrained from taking the pickle juice he started cramping early in the first half of competition. It was not expected that the pickle juice would relieve the involuntary contractions after they had already begun however, the cramps subsided within 30 seconds after taking the juice. The athlete continues to take once ounce of pickle juice prior to competition and has not suffered any other muscle cramping.

**18-Year-Old Collegiate Basketball Player With An Accessory Soleus Muscle: A Case Study**

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**Objective:** To identify the history, diagnosis and surgical treatment of an 18-year-old collegiate basketball player with an accessory soleus muscle.

**Background:** Previous to surgery the athlete complained of insidious bilateral lower leg pain during high school. As a result of increased intensity and duration of the competitive collegiate season, complaints of pain elevated. Paresthesia in her right foot became more severe during practice. Long duration functional activity became impossible due to the increased pressure in the anterior and lateral compartments. Palpation of the right lower leg caused severe pain. Radiographic tests were negative, EMG studies were within normal limits, and the MRI showed the attachment of the accessory soleus. On visual observation of the medial aspect of the right ankle, a 1cm<sup>2</sup> soft tissue mass protruded from the skin's surface during dorsiflexion. Compartment pressure tests were inconclusive. The initial diagnosis was medial tibial stress syndrome. The treatment during the first month consisted of workouts on the bike, stair climbing, upper body ergometer, flexibility, and ice. Treatments including iontophoresis, ice massage, lidocaine strips, and ultrasound were used to decrease pain and inflammation. Progressive resistance exercises were used to increase muscle strength. Surgery was scheduled following the season. **Differential Diagnosis:** Medial tibial stress syndrome, distal attaching soleus muscle, tarsal tunnel syndrome, superficial peroneal nerve entrapment, posterior tibial nerve irritability, stress fracture, chronic exertional compartment syndrome, fascial hernia, lumbar disc pathology, tumor. **Treatment:** Surgery consisted of accessory soleus muscle excision, superficial peroneal and deep posterior nerve releases. Initial treatment consisted of active dorsiflexion, toe scrunches, heel slides, towel stretches, and ice with elevation 2-3 times a day. The patient began partial weight bearing after the first week. Active toe flexion returned very slowly. Progressive resistive exercises and functional activities were used in the late stages of rehabilitation. The athlete returned to practice and competition the following season.

**Uniqueness:** Studies have shown that accessory soleus muscles are very uncommon. The incidence of an accessory soleus muscle in humans ranges from .7% to 5.5%. **Conclusion:** Although uncommon, anatomical anomalies could be the underlying cause of trauma.

**Lower Leg Pain In A Collegiate Football Player**

Frechette R, Hoffmann S, Burnett Q, Highhouse K: Western Michigan University, Kalamazoo, MI

**Personal Data/Pertinent Medical History**

A 21 year old male Division I football place kicker with a history of medial tibial stress syndrome reported intense shin pain during spring season conditioning drills. The athlete reported a gradual onset of intense pain, bilaterally, in the lower leg, which continued through conditioning drills until the intensity of pain forced him to discontinue activities and report to the athletic trainer. He denied any history of trauma.

**Physical Signs and Symptoms**

Examination revealed bilateral lower leg numbness in distribution of the peroneal nerve, a bilateral decrease in capillary refill, loss of function including ankle dorsiflexion, ankle eversion, and extension of phalanges, and severe pain with ambulation. Physical exam of the lower leg showed significant bilateral edema with a shiny appearance to the skin, pain with palpation, and pain with passive range of motion of the toes, there were no palpable venous cords.

**Differential Diagnosis**

1. Bilateral exertional compartment syndrome
2. Bilateral deep vein thrombosis
3. Bilateral acute medial tibial stress syndrome
4. Popliteal artery entrapment syndrome
5. Stress Fracture

**Results of Diagnostic Imaging/Laboratory Tests**

The patient was referred immediately to the team physician who determined no diagnostic imaging/testing was needed.

**Clinical Course**

Bilateral anterior compartment fasciotomies with surgical exploration was performed within hours. Three days post-operatively the patient developed a cellulitis of the right lower leg which required five days of intravenous antibiotics. One week post-operatively the left lower leg was improved but the patient's right ankle showed no improvement of dorsiflexion, eversion, or extension of the phalanges. Rehabilitation consisting of range of motion and direct current stimulation elicited a trace response. Three weeks post-operatively, electromyography (EMG) studies revealed no function of the peroneal nerve at the level of the fibular head. Magnetic Resonance Imaging (MRI) revealed a hematoma over the lateral fibular head. A second surgical procedure was performed six weeks after the initial surgery to debride the hematoma and fibrous tissue which were impinging the peroneal nerve against the fibular head. Comprehensive post-operative rehabilitation was performed bilaterally, which included active and passive range of motion exercises, functional activities, balance training, achilles stretching, strengthening, and cardiovascular activities. Four months after the initial surgery a second

## Treadmill Injury: A Case Study

Jacobs D, Gorczyca J, Thompson B: The University of Kentucky Sports Medicine and The University of Kentucky Division of Orthopedic Surgery, Lexington, KY

EMG study revealed a partial return of function to the extensor mechanism of the right lower leg. No EMG response from the peroneal nerve was elicited. A six month rehabilitation program resulted in significant improvement of motor and sensory function of the right lower leg.

### Deviation From the Expected

Sudden onset of bilateral exertional anterior compartment syndrome in a well trained and conditioned Division I athlete. The resultant amount of internal trauma due to soft tissue swelling. Also, the development of cellulitis post-operatively and the formation of a hematoma compromising neural integrity of the right lower leg.

### Personal Data

An otherwise healthy 56 year old businessman had been jogging on a treadmill as part of his daily fitness routine and was in the process of walking to cool down. While attempting to remove a sweatshirt, he placed his right foot on a stationary part of the machine which caused him to lose his balance. He fell and was pushed off the treadmill by its moving surface, twisting his right ankle, and landed behind the treadmill. After the accident he experience severe pain in his right lower leg.

### Physical signs and Symptoms

Upon initial evaluation the patient was noted to have an external rotation deformity of the distal leg. He had palpable dorsalis pedis and posterior distal pulses with intact sensation and motor function in the foot. The skin was intact but contused.

### Differential Diagnosis

Ankle dislocation  
Ankle sprain  
Compartment syndrome  
Fracture to fibula and tibia  
Diagnostic Imaging

X-ray revealed a non-displaced spiral fracture to the distal tibia with an intra-articular extension to into the ankle joint and a displaced fracture to the fibula.

### Clinical Course

At the scene the patient was placed in a posterior splint made from a rolled magazine and sent to the emergency room. After the complete exam and a review of x-rays, the patient was given non-surgical and surgical treatment options; details and risks were discussed. He opted for operative stabilization for a quicker return to his active life style. The fibula was reduced and stabilized with a lag screw, and a one fourth tubular plate. The tibia fracture was then stabilized with an intramedullary nail which had been modified by removing the distal nail tip one cm to assure that the two interlocking screws to be placed in the distal tibia. The patient refrained from weight bearing and placed on an ankle range of motion and theraband strengthening physical therapy program. For the next two months he continued with the range of motion and strength program, then progressed to weight bearing as tolerated and a gait training physical therapy program. At four months his fracture had healed and he was walking without a limp and without assistance. With the aggressive physical therapy programs he achieved 20 degrees of dorsi flexion and 40 degrees of plantar flexion. He was able to continue exercising. Uniqueness

This case should serve to raise the awareness of athletic trainers and other health professionals in

the clinical setting that severe injuries can occur with the use of exercise equipment and machinery. In this particular case the non-displaced fracture could have displaced if caution was neglected and the initial treatment was inappropriate. The injury was treated with immediate immobilization and the patient was not allowed to bear weight on the injured leg. Injuries that occur in the clinical setting should be treated as an injury during a sporting event. The injured area should be immobilized and protected until a full exam is completed. A review of the literature was done to provide a full appreciation of the spectrum of injuries that have been reported involving the use of exercise equipment.

### Traumatic Shoulder Injury In An Intercollegiate Football Player

Maher D, Treolo D, Pitcock C:  
University of Louisville, Louisville, KY

**Personal Data:** During a collegiate all-star football game on April 4, 1999 a 22-year-old male outside linebacker, 187.96 cm (6'2") 95.45 kg (210 lbs), sustained an injury to his left upper extremity. While attempting to tackle a running back, the athlete's head and neck were forcefully lateral flexed and rotated. The contact resulted in a violent force along the brachial plexus. At the conclusion of the play, the athlete remained down on the field and was immediately examined by three certified athletic trainers (ATCs).

**Physical Signs and Symptoms:** During the on-field examination, the athlete complained of loss of function in left upper extremity, no obvious deformities were present. Further on-field assessment ruled out cervical spine involvement. The athlete was able to jog off of the field. On the sideline, the athlete presented loss of function in the deltoid and bicep muscle groups. Functional deficits were present with wrist and finger flexors and extensors. Sensory deficits were also present throughout the left upper extremity. The team physician was contacted and instructed the athletic trainers to monitor athlete's condition over next half hour. Athlete's left upper extremity began to ache after approximately 15 minutes and worsened as time went time. The athletic trainers continually monitored the athlete's physical condition every ten minutes over the next hour. Athlete's pain continued to increase as time progressed with no signs of function returning. The athlete was examined by team physician approximately one hour post injury. Athlete was then transferred to hospital via EMS.

#### Differential Diagnosis:

- 1) Cervical spine fracture
- 2) Concussion
- 3) Cervical disk pathology
- 4) Shoulder dislocation
- 5) Humeral Fracture
- 6) Clavicular fracture

**Results of Diagnostic Imaging:** The athlete was taken to the emergency room for further evaluation. Plain x-ray of the chest and left shoulder were unremarkable showing no fractures, dislocations or pneumothoraces. A cervical and thoracic spine series revealed only loss of the normal cervical lordosis felt to be secondary to muscle spasm. Once the C-spine was cleared, flexion and extension views were obtained and appeared to show slight widening of the C5-6 intervertebral disc space with mild anterior subluxation of C5 on C6 suggesting laxity in the posterior ligaments. An axial CT scan was obtained with views from C2 to T4 and was read as normal except for mild hypertrophic changes but no cord effacement, canal or foramina stenosis. Because of the athlete's significant neurological deficits involv-

ing the left brachial plexus, an MRI with attention to bilateral brachial plexuses was obtained. The T2 weighted images with fat suppression revealed hemorrhage and edema along the left brachial plexus from the scalene muscles to the axilla. The axial images revealed the spinal cord to be shifted to the right and nerve root avulsion at the foramina of C5-6 and C6-7 levels. Upon arrival to his hometown the athlete underwent a myelogram, which confirmed the root avulsion at C5, C6 and C7. NCV and EMG were next performed with no function of the suprascapular, lateral pectoral, musculocutaneous, axillary, radial, and ulnar nerves. These findings were consistent with proximal multi-root avulsion at C5, 6 and 7, with proximal plexopathy of the upper and middle trunks with some involvement of the lower trunk as well.

**Clinical Course:** The athlete was started on intravenous corticosteroids and a morphine PCA pump in an effort to control edema, prevention of a pseudo-meningocele and pain control. Once stabilized, the athlete returned to his hometown to undergo restorative surgery to his left brachial plexus. The athlete was evaluated by plastic and reconstructive surgery and placed in the care of a pain management specialist. The athlete did have some recovery of function of his left hand prior to his surgery but none of the muscles innervated by the upper trunk were functioning, he was experiencing considerable pain in the limb as well. The decision was made to perform left brachial plexus exploration with possible nerve grafting. During the neurotization, the distal accessory was neurotized to the suprascapular nerve. Two branches of the medial pectoral nerve were graft to the axillary nerve and another branch grafted to the brachialis and biceps nerve using two grafts harvested from the medial antebrachial cutaneous nerve. A redundant portion of the ulnar nerve was grafted to the biceps branch directly. Evaluation of the neurotization with repeat EMG and NCV are yet to be performed at the time of this writing, however with physical therapy, function of the left limb is improving.

**Deviation from the Expected:** This case is rare because injury to the brachial plexus of this magnitude is rarely seen in athletic competition. Generally, when an athlete receives trauma that results in a "burner" or "stinger", sensory and motor function begins to reestablish itself immediately. With this athlete, the pain only worsened, and motor function did not return. It is important that the certified athletic trainer is aware that an injury of this severity can occur.

### Brachial Plexus Injury: Prevalence By Position Classification Among Football Athletes In Two Division III Athletic Conferences

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Granville, OH

This study was conducted in order to determine the prevalence of the brachial plexus injury by position classification for football athletes in two division III athletic conferences. The study hypothesis was that athletes in high collision positions would report a higher incident of brachial plexus injury when compared with offensive line, defensive line, and limited collision positions. The population parameter was defined by the 1,325 athletes listed on the final football roster at each of the Ohio Athletic Conference and North Coast Athletic Conference member institutions for the 1995 season. Sample population included 1,041 single position athletes that completed and returned the questionnaire. The self-report questionnaire included a definition of "burner/stinger" as any transient weakness, burning or numbness in the arm caused by a blow to the head, neck, or shoulder. Athletes were asked to indicate the number of times they experienced this injury during the season. Subjects were also expected to identify their assigned football position and provide age, height and weight information. Data were analyzed for group differences using the Chi-Square statistic. Results indicated that 40.7% of respondents experienced a brachial plexus injury during the season. No group differences were observed between the high collision positions (45.8%) and offensive line (41.1%), or defensive line (50%) positions. There were however significant differences between high collision, offensive line, defensive line positions and the limited collision (23.2%) positions. Results from this study indicate that football athletes in high collision, offensive line, and defensive line positions all have similar risk of suffering at least one brachial plexus injury. The risk assumed by participants in these positions is greater than the risk assumed by participants in limited collision positions. Further, results indicate that the prevalence of brachial plexus injury among division III college football athletes is slightly less than previously reported.

### Effects Of Cervical Orthoses On Angular Displacement In The Sagittal Plane During Functional Contact By Collegiate Football Defenders

Vaughan FJ, Wilson SG, Cordova ML, Ingersoll CD, Sandrey MA: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** Little data exists concerning the efficacy of various cervical orthoses in limiting cervical spine range of motion during dynamic loading. Thus, the purpose of this study was to analyze the effectiveness of four cervical orthoses in reducing cervical spine angular displacement during functional-speed contact. **Design & Setting:** A 1x4 factorial design was used for this study. The dependent variable was cervical spine angular displacement in the sagittal plane. The independent variable was cervical orthoses with four levels: McDavid® Cowboy Collar, Cramer® Collar, Active Ankle® A-Force, and a control. This study was performed in a gymnasium at Indiana State University. **Subjects:** Eleven male defensive football players (age = 20.8±1.4, ht = 185.2±6.6, mass = 98.6±13.1 kg) from Division I-AA and III collegiate programs, volunteered for the study. Each had at least one year of experience at the collegiate level, and were chosen from the linebacker, defensive end, or safety positions. Subjects were eliminated from participation if they experienced any head/neck trauma within one month prior to the study. **Measurements:** Each subject performed 5 trials with each orthosis in place. These trials were performed in a counterbalanced order and the subjects were instructed to utilize a "heads-up" hitting technique, and to hit as they would in a game/practice type situation. The shoulder pads and helmets were fitted and used in accordance with the manufacturer's instructions. A high speed motion analysis system was used to measure cervical spine motion in the sagittal plane. A 240 Hz CCD camera was interfaced to a video processor that communicated to a desktop computer. A single camera producing two-dimensional data was used for the collection of data. Forty mm retro-reflective markers were used to define the segments for which cervical spine motion could be assessed. A one-way repeated ANOVA was used to determine if differences existed between neck orthoses on cervical spine angular displacement. **Results:** There was no significant effect of cervical orthoses on cervical spine range of motion ( $F_{(3,30)} = .334, P = .793$ ). **Conclusion:** It appears that neither of the orthoses provide more restriction than wearing no orthosis at all. Subjects hit the sled with maximum force, but other variables that may contribute to extreme cervical spine movement involved in game or practice situations were not presented. Very little data exists in the literature that can validate or refute the findings of our study.

### The Effects of A Polyurethane Football Helmet Cover On The Cervical Spine: An Increased Risk For Injury

Berg TL, Fisher HD, Sandrey MA, Ingersoll CD, Cordova ML: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** The use of the ProCap has been shown in studies to help with the prevention of concussive-type injuries, but its involvement with cervical spine injuries has not been established. The purpose of this study is to model the amount of torque produced at the cervical spine by measuring the distance of the torque arm in a football player wearing a football helmet and a helmet with a ProCap, and modeling various amounts, and angles of force to note their relationship to the change in torque values produced. **Design & Setting:** A 2x2x2 factorial was used. The dependent variable was amount of torque produced at the cervical spine, with the independent variables of condition (football helmet, football helmet with a ProCap), angle (15° and 25°) and force (900N and 1340N). The study took place at the Indiana State University Sports Injury Research Laboratory. **Subjects:** 15 male volunteers from Indiana State University were used in this study. All subjects completed an informed consent form, which was approved by the School of Health and Human Performance Human Subjects Committee at Indiana State University. **Measurements:** The subjects were fitted with football helmets and asked to stand with their shoulder against a piece of paper. The subjects were then asked to flex and extend their neck. The pencil attached to the top of the helmet recorded the arc made by the flexion and extension movement. Using a compass, a circle was created from the flexion and extension movements. A protractor was used to design the angles of force application (15° and 25°). Next a ruler was used to measure the torque (lever) arm. These measurements were then put into the torque formula. **Results:** A three way ANOVA indicated significant differences. Three 2- way interactions occurred between condition x angle, ( $F(1,14) = 37.525, p = .0001$ ), condition x force ( $F(1,14) = 56.536, p = .0001$ ), and angle x force ( $F(1,14) = 3041.938, p = .0001$ ). A 3- way interaction occurred between condition x angle x force ( $F(1,14) = 37.525, p = .0001$ ). Main effects were shown for the three independent variables of condition, angle and force. Paired t tests indicated that there was a significant difference ( $P \leq 0.05$ ) among the variables of angle, force and condition combinations regardless of the pairings. **Conclusions:** Results from this study indicated that the length of the lever arm along with modeling various amounts and angles of force increased torque values with the addition of the ProCap. Even though we are protecting the athletes from reoccurring head injuries, by using the ProCap, we may be predisposing the athlete to injuries of the C-spine. Therefore, torque values should be considered when determining if a ProCap should be used for the prevention of concussive type injuries.

### Effect of Head Position And Football Equipment On Cervical Spinal Cord Space

Tierney RT, Mattacola CG, Sitler MR, Maldjian C: Temple University, Philadelphia, PA, and College of Allied Health Professions, University of Kentucky, Lexington, KY

The purpose of this study was to assess the effect of head position and football equipment on cervical spinal cord space in individuals lying supine on a spine board. Twelve males (age = 24.3 ± 2.1 yrs, height = 181.1 ± 5.7 cm, weight = 93.9 ± 3.6 kg) participated in this study. This study was approved by an university institutional review board and all subjects signed an informed consent prior to participation. The research design consisted of a 4 x 5 analysis of variance (ANOVA) with repeated measures. The independent variables were head position (no helmet and shoulder pads at 0, 2, and 4 cm occiput elevation; and with helmet and shoulder pads) and cervical spine level (C3, C4, C5, C6, and C7). The three dependent variables were sagittal space available for the cord (SAC) (mm), sagittal spinal cord diameter (mm), and cervical-thoracic angle (deg). MRI was performed with a TGE Signa Scanner (General Electric Medical Systems, Milwaukee, WI). The results of the study revealed that SAC was significantly greater ( $p < .01$ ) for 0 cm (mean = 5.50 mm) than for 2 cm (mean = 4.86 mm) and 4cm (mean = 5.07 mm). SAC was also significantly greater ( $p < .01$ ) for the pads condition (mean = 5.34 mm) when compared to 2 cm and 4 cm. There was no significant difference ( $p = .093$ ) in SAC between 0 cm and the pads condition. The mean cervical-thoracic angle for 0 cm and the pads condition were 22.9 degrees and 18.1 degrees, respectively. The results of this study support the previous literature which maintains that the helmet and shoulder pads should be left on during the spine board immobilization of the injured football player. Similarly, during immobilization of an athlete without football helmet and shoulder pad, the head should not be elevated as SAC was greater at 0 cm than 2 or 4 cm of occiput elevation. However, further research should be done to examine the entire cross-sectional area of the cord while lying supine in varying head positions and wearing football equipment.

### Abdominal Injury In A College Football Player

McKnight CM, Reed A: Azusa Pacific University, Azusa, CA

**Personal Data/Pertinent Medical History:** An 18 year old male wide receiver dove for a ball and landed on his stomach on a dry, grass field. His arms were reaching outward and upward and his back was extended. Contact with the ground occurred in the upper abdomen-lower thoracic region. He immediately felt pain on the left side of his abdomen. Past medical history was insignificant.

**Physical Signs and Symptoms:** Initially, the athlete presented with a rigid abdomen in both upper quadrants with no point tenderness. His vital signs were within normal limits. He had no rib point tenderness, but did have a small abrasion on the left thoracic region. Approximately one-hour post injury, the athlete was pale and nauseas with persistent, increased pain in the abdomen and chest, especially with respiration, and was splinting his left side. His pulse was 72, respiration shallow at 20, and blood pressure was 136/69. Upon palpation, no masses or rebound tenderness were found in the upper quadrants. His urine was light brown in color, indicating the presence of blood. His lungs were clear and no crepitus was present in the ribs. The thoracic compression test was negative. Full range-of-motion was observed in the cervical, thoracic, and lumbar regions.

#### Differential Diagnosis:

1. Spleen rupture
2. Rib fracture
3. Rib fracture with internal injury
4. Kidney rupture
5. Other internal injury

#### Results of Diagnostic Imaging/Laboratory

**Tests:** Laboratory testing revealed increases in hemoglobin and red blood cell count. Ultrasound and CT exams discovered a left kidney laceration in the upper pole with a large perinephric hematoma. The ureter was displaced slightly anterior and medial by the hematoma.

**Clinical Course:** The diagnosis was a fractured left kidney. The prognosis was a possible reduction or loss of function of the kidney. It was decided at this time not to do surgery, but to leave the kidney in. It would need to be removed, however, if the athlete became unstable or if his hemoglobin started dropping. The athlete was admitted to the hospital for bed rest and observation. He received an IV with normal saline as well as antibiotics and analgesics. After four days, the athlete was discharged. Both his hemoglobin and red blood cell count were within normal limits. He was sent home with his parents and instructions to continue to take the antibiotics and analgesics, maintain bed rest, and to follow-up with a urologist. The athlete withdrew from school for the fall semester to recover. Two months after injury, the athlete's urine was finally clear of blood and he had a normal abdominal examination. The

athlete was cleared for normal activity, except contact sports, at that time. He was told that his kidney was functioning well and that he would be allowed to play football the following season. At three months post-injury, the athlete was performing normal activities, including surfing.

**Deviation from the Expected:** This mechanism was unique for a kidney injury. The force was anterior and was a relatively diffuse force; whereas, kidney injuries usually occur from a sharper, posterior force. The possibility of a kidney injury must not be overlooked with the mechanism of an anterior blow. Also the kidney was not removed, but was allowed to remain and given a chance to heal, even though the initial prognosis was that the kidney had little chance of healing. Thus, the athlete was spared a major surgical operation and was returned to optimal health.

## Mid-Epigastric Discomfort In A Collegiate Recreational Athlete

Doyle RJ, Jones AL, Bell GW: Athletic Training Education/Sports Injuries Research, University of Illinois at Urbana-Champaign, Urbana, IL

**Personal Data/ Medical History:** A twenty-one year old African-American male presents with stomach pain. He states the pain has been persistent for approximately one and a half weeks. He has constant burning in the mid-epigastric region. He wakes up at night secondary to pain felt in his stomach. He also states the presence of nausea. He stated that he has had a history of gastric ulcers since he was about ten years old. The patient is an otherwise healthy male who is a very active recreational athlete.

**Physical Signs and Symptoms:** His vitals were taken and presented as follows; temperature 98.4, Blood Pressure 140/53, Heart Rate 76. He states he has no known allergies and is not currently taking any medications. An ear, nose, throat examination was performed with normal results. His abdomen was soft with tenderness in mid-epigastric region. He had normal abdominal sounds and no McBurney site tenderness.

### Differential Diagnosis:

- 1) Peptic ulcer
- 2) Gastroenteritis
- 3) Non-ulcer Dyspepsia
- 4) GERD
- 5) Cholelithiasis
- 6) Cholecystitis
- 7) Appendicitis
- 8) Neoplasm of the Stomach

**Labs Results:** A complete blood count with a differential was conducted. The total chemistry screen showed that the individual's creatine kinase was elevated at 656u/l with the normal range between 4.0 and 222u/l. When questioned about diet the individual stated he was taking a creatine supplement. The supplement was considered the cause for the increase in creatine kinase, however it was not determined if it was linked to the stomach discomfort. The hematology screen showed that the white blood cells count was normal, but the segments count was low at 42 and the lymphocytes count was high at 54. This indicated that the individual could have been fighting off an infection. The serology screen showed the presence of antibodies for the Helicobacter Pylori (H. Pylori) bacteria.

**Clinical Course:** The choice of medications was Prevacid, Biaxin, and Amoxicillin. Prevacid, a proton pump inhibitor, was prescribed at 30mg, b.i.d., for 14 days. This medication will reduce the amount of acid the stomach produces. Biaxin, an antibiotic, was prescribed at 500mg, b.i.d., for 14 days. Biaxin has shown positive results directly related to eliminating H. Pylori infection. Amoxicillin, an antibiotic, was prescribed at 500mg, t.i.d., for 14 days. H. Pylori can develop resistance against single drug therapy therefore Amoxicillin is prescribed in addition to the Biaxin to eliminate the infection.

**Deviations From The Expected:** The athlete has been dealing with self proclaimed ulcer "flare-

ups" since he was approximately ten years old. Upon a two month follow-up the athlete stated that he had not experienced any more stomach discomfort and that he was very satisfied with his treatment. Peptic ulcers are continually linked with such factors as poor diet or stress. The presence of the H. Pylori bacterium is a significant finding when dealing with peptic ulcers. This bacterium has been confirmed as a cause for ulcer disease. This bacterium has been shown to be present in approximately 73 percent of stomach ulcer cases and approximately 92 percent of duodenal ulcer cases. It is also estimated that 1 in 10 Americans will suffer from peptic ulcers. The fact that a bacterium is linked with peptic ulcers shows that the disease is curable. With the high stress athletes are expected to endure day to day ulcer symptoms can not be disregarded as a part of the game. There may be underlying pathology that should be further evaluated. It is suggested that any individual with a history of peptic ulcers be tested for the presence of H. Pylori.

## Abdominal Pain In A Female Division I Swimmer

Ostrowski S, Morgan B: University of Tennessee, Knoxville, TN

**Personal Data:** An 18 y/o female division I swimmer presented in the ER with a 76 hour history of increasing abdominal pain, burning and cramping in the mid-epigastria. The athlete experienced stomach irritation approximately 7-8 hours after eating lunch. Subsequently, abdominal pain increased when food was ingested.

**Physical Signs and Symptoms:** Upon examination, the athlete complained of sharp pains in the abdomen and severe nausea immediately after eating. She denied any previous history of abdominal pains, however a history of amenorrhea and patterns of disordered eating were noted. There were no signs or symptoms of fever, chills, cough or other respiratory problems. The athlete experienced no significant change in bowel habits. Furthermore, it was noted that the pain and discomfort eased when in a semi-reclined position. The athlete presented with a soft abdomen, with no rebound tenderness or muscle guarding and a continued feeling of fullness and bloating in her abdomen.

### Differential Diagnosis:

- 1.) Influenza/Upset Stomach
- 2.) Viral Gastroenteritis
- 3.) Peptic Ulcer
- 4.) Duodenitis/gastricritis
- 5.) Hepatitis

**Tests and Results:** The tests for CBC, CAT Scan, liver enzymes and urinalysis were not indicative of significant injury or illness. Abdominal radiographs taken in the emergency room indicated clear lungs and what was later discovered to be a small puncture in the stomach mirroring a perforated ulcer. An administration of an oral contrast and 140 cc of IV Omnipaque 300 revealed small amounts of gas in the peritoneal cavity anterior to the liver and in the hepatic fissure.

**Clinical Course:** The athlete was hospitalized for 48 hours with a diagnosis of a stomach perforation. During the hospital stay emphasis was placed on relative bowel rest. An IV fluid was administered to counter dehydration and a course of antibiotics was dispensed. The diagnosis made was a perforated stomach. Nothing by mouth was given for 24 hours to aid in the healing process. Upon further investigation to specific foods ingested during the onset period, it was concluded that a fish bone had punctured through the stomach lining thus causing the sharp pains and bloating feeling during digestion.

**Deviation from the Expected:** The unique feature of this case is the fact that the signs and symptoms of the athlete had the hospital and athletic training staff perplexed prior to admittance into the emergency room. A radiologist in the emergency room discovered the small puncture in the stomach only upon further analysis of the films. This case study provides a vivid example of what else to look for upon evaluation of abdominal pain. Good communication and a thorough medical history are important in assessing any injury or illness. Proper knowledge and awareness of abdominal pain and deviations from the expected are a necessity for health care providers.

## Posterior Sternoclavicular Joint Dislocation In An Intercollegiate Football Player

Stilger V, Alt J, Michael A, Hubbard D:  
West Virginia University, Morgantown,  
WV

### Personal Data/Pertinent Medical History:

During a Division I football game, a 21-year-old male athlete (187.96 cm, 81.82 kg) was injured while returning a punt. The injury occurred when the athlete landed on the lateral aspect of his right shoulder while being tackled by two opponents.

**Physical Signs and Symptoms:** The athlete complained of pain from his sternum to mid-clavicle but indicated no popping, snapping, or other odd sensations. Evaluation revealed no acute acromioclavicular (AC) pain, no breathing difficulties, but extreme pain in the medial 1/3 of the clavicle. The team orthopedist immediately referred the athlete to the athletic training room for x-rays. While being prepped for x-rays, the athlete's pain was aggravated by even the slightest movement or motion. A slight depression and swelling were noted directly over the SC joint. He also stated he felt as if "something was stuck in his throat."

### Differential Diagnosis:

- 1.) Acromioclavicular (AC) sprain
- 2.) Clavicular fracture
- 3.) Costoclavicular sprain
- 4.) Salter-Harris fracture
- 5.) Sternoclavicular (SC) sprain

**Results of Diagnostic Imaging:** X-rays were negative for a clavicular fracture but the athlete still exhibited extreme pain in the medial 1/3 of the clavicle towards the sternoclavicular (SC) joint. After evaluating the x-rays, the team orthopedist immediately referred the athlete to a trauma surgeon. The trauma surgeon ordered additional x-rays using the Rockwood or "serendipity" view. Radiographic analysis using the Rockwood view revealed the right clavicle had shifted posteriorly and the left clavicle was centered and intact. Computed tomography (CT) was obtained to demonstrate the nature of the dislocation. The CT scan revealed that the trachea had shifted to the left, which accounted for the athlete feeling as if something was stuck in his throat. Final diagnosis was a right posterior SC joint dislocation with an accompanying left tracheal shift.

**Clinical Course:** A closed reduction was attempted with the athlete under general anesthesia. During the procedure, the athlete's clavicle immediately relocated with a force directed posterolateral on the shoulder by the surgeon. The closed reduction was confirmed under fluoroscopy as well as clinical examination. Upon retraction of the shoulders, the athlete's trachea shifted back into position with no internal injury or trauma to the trachea. Following closed reduction, the athlete was placed in a sling and swathe, was neurovascularly intact, exhibited no signs of dysphagia, and was hospitalized overnight. At this time, the course of action was immobilization with a sling and swathe, ice, and medication for pain control. The athlete went through a rehabilitation program, and in the ensuing off-season participated in all conditioning drills and weight-

training activities as tolerated. The athlete was seen by the team orthopedist prior to spring drills commencing and was given clearance to participate in spring football practice.

**Deviation from the Expected:** Posterior sternoclavicular joint dislocations account for 0 to 1% of all dislocations. Athletic trainers need to be able to recognize the signs and symptoms associated with a posterior sternoclavicular joint dislocation and seek medical attention immediately in order to avoid more serious complications. Some complications associated with a posterior sternoclavicular joint dislocation are potentially life threatening due to the close proximity of vital structures within the superior mediastinum. Therefore, this type of injury should be handled with extreme care and urgency.

## Free Communications, Oral Presentations: Electromyography

Sunday, July 2, 8:30AM-10:00AM, Cleveland A; Moderator: Randy Schmitz, PhD, ATC

### Motor Unit Recruitment Differences In Isotonic And Isokinetic Contractions Of The Knee Extensors

Schmitz RJ, Westwood KC: University of North Carolina Greensboro, Greensboro, NC

Previous research has attempted to determine whether isometric or isotonic strength training is more effective in strength development. The majority of these attempts were based upon the number of repetitions and gave little consideration to work performed. Since motor unit recruitment is of critical importance in the development of muscle force, the purpose of this study was to determine whether isotonic or isokinetic contractions were most effective in the recruitment of motor units (as determined by surface EMG) for a given unit of work. Subjects (10 male, 11 female) (age =  $20.3 \pm 1.6$  yr, ht =  $75.9 \pm 10.5$  cm, mass  $74.4 \pm 15.6$  kg) were recreationally active college students who first performed three maximal voluntary isometric contractions (MVIC's) of the dominant knee extensors (3 s) for EMG normalization purposes. Exercise testing (performed on the Biodex System 3 Dynamometer) involved 10 isokinetic contractions at  $180^\circ \text{ s}^{-1}$  and 10 isotonic contractions with the resistance set at 50% of the MVIC. Velocity of the isotonic contractions was controlled by asking subjects to perform each knee extension over 1 s. Surface EMG signals were collected from vastus medialis and lateralis then integrated (IEMG) over the concentric phase of each repetition for both exercises. The IEMG was divided by the total work performed during the concentric phase for each exercise (IEMG/W). The IEMG/W data were analyzed using a 1 between (gender), 2 within (exercise and muscle) repeated-measure ANOVA. There was a significant main effect for exercise ( $F(1,19)=33.6, p<.05$ ) with isotonic IEMG/W value being significantly greater than the isokinetic IEMG/W. Additionally, the IEMG/W relationship appears not to be affected by gender or individual muscle tested. No other significant main effects or interactions were demonstrated. These results suggest that per unit of work performed the isotonic contractions require greater motor unit recruitment and/or an increased rate of firing. This may have implications in the early phase of rehabilitation when goals include complete motor unit recruitment of injured or atrophied muscles.

### The Mechanomyographic Mean Power Frequency Of The Superficial Quadriceps Femoris Muscles During Isometric Muscle Actions

Ebersole KT, Housh TJ, Weir JP, Johnson GO, Evetovich TK: University of Nebraska, Lincoln, NE

Mechanomyography (MMG) quantifies the lateral oscillations of active skeletal muscle fibers and may provide a reliable, non-invasive method to examine the mechanical component of torque production. The purpose of this study was to examine the MMG mean power frequency (MPF) responses of the superficial quadriceps femoris muscles (rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM)) during incremental isometric muscle actions at leg flexion angles of 25, 50, and 75°. Seven male and nine female subjects (Mean age  $\pm$  SD =  $23.3 \pm 2.6$ ) performed isometric muscle actions of the leg extensors at 25, 50, 75, and 100 percent maximal voluntary contraction (%MVC) on a CYBEX 6000 isokinetic dynamometer at each leg flexion angle (25, 50, and 75°). A piezoelectric MMG recording device was placed over the belly of the RF, VL, and VM muscles of the dominant leg. A four-way mixed factorial ANOVA (%MVC by leg flexion angle by muscle by gender) and Tukey post-hoc comparisons were used to analyze the MMG MPF (Hz) data. For both genders, the MMG MPF of the RF, VL, and VM increased from 25 to 75 %MVC. From 75 to 100 %MVC, however, the MMG MPF versus isometric torque relationship either plateaued (male RF; female RF and VL) or increased (male VL and VM; female VM). Thus, the MMG MPF patterns were muscle specific near maximal isometric torque production. It is possible that the increase in MMG MPF up to 75 %MVC was due to recruitment of additional fast-twitch motor units. From 75 to 100 %MVC, the plateau in MMG MPF may have been due to motor unit synchronization where as the continued increase in MMG MPF may reflect an increase in motor unit firing rate. The present results also indicated gender-specific MMG MPF responses which may be due to differences in the thickness of the subcutaneous tissue and/or biomechanical differences that influenced the activation strategies of the superficial quadriceps femoris muscles. Future studies should examine the MMG MPF in healthy as well as injured muscle to gain insight into the influence of muscle activation strategies on the mechanical component of muscle contraction during rehabilitation.

### Lower Extremity Muscle Activation During The Star Excursion Balance Tests

Earl JE, Hertel J, Vairo GL: Pennsylvania State University, University Park, PA

**Purpose:** Our purpose was to identify the integrated EMG (I-EMG) activity level of 6 lower extremity muscles during the 8 star excursion balance tests.

**Subjects:** Ten healthy young adults (5 males, age =  $24.9 \pm 4.2$  yrs, mass =  $72.7 \pm 17.2$  kg, height =  $152.6 \pm 7.9$  cm) with no significant history of lower extremity joint injuries volunteered as subjects. The right legs of all subjects were tested as were the left legs of 5 of the subjects.

**Methods:** The star excursion balance tests require subjects to maintain balance on their stance leg and slowly reach as far as possible with their contralateral foot along one of 8 lines extending from a common axis at 45° intervals on a 360° grid. The eight directions were labeled according to the direction of the excursion in relation to the stance leg: anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL), lateral (L), and anterolateral (AL). Subjects performed 3 trials in each of 8 directions. EMG signals were recorded for the vastus medialis (VM), vastus lateralis (VL), medial hamstring (MH), biceps femoris (BF), gastrocnemius (G), and anterior tibialis (AT) muscles. The I-EMG activity of each muscle was averaged for the 3 trials in each direction and normalized to the maximum voluntary isometric contraction of each muscle.

**Statistical Analysis:** Six one within factor ANOVAs were run to compare the I-EMG values during the 8 directions of excursion. A separate ANOVA was run for each muscle tested. Pairwise post hoc comparisons with Bonferroni corrections were calculated to identify significant differences in normalized I-EMG activity between specific directions of excursion.

**Results:** Significant differences were found in the analyses of all muscles ( $p<.001$ ), except G ( $p=.08$ ). VM activity was found to be significantly greater with A excursions as compared to L excursions ( $p=.03$ ). VL activity was significantly greater with A, M, and PM excursions as compared to L excursions ( $p<.04$ ). MH activity was significantly higher with P excursions as compared to AM and L excursions ( $p<.05$ ). The activity of the BF was significantly greater with P, PL, and L excursions as compared to A, AM, and M excursions ( $p<.03$ ). AT activity was significantly lower with L excursions as compared to A, AM, M, and AL excursions ( $p<.04$ ).

**Conclusions:** Performance of the different star excursion balance tests results in different lower extremity muscle activation patterns. When selecting dynamic balance tasks to recruit specific muscles, this information may serve as a useful guide.

### The Effect Of Orthotic Intervention On Muscular Response Times And Activation Patterns At The Knee

Rose HM, Shultz SJ, Arnold BL, Gansneder BM: University of Virginia, Charlottesville, VA

### Vastus Lateralis And Vastus Medialis Oblique Activity During A Straight Leg Raise And Knee Extension With Lateral Hip Rotation

Livecchi NM, Armstrong CW, Cordova ML, Merrick MA, Rankin JM: Department of Kinesiology, University of Toledo, Toledo, OH

### A Biomechanical Analysis Of Pelvic Tilt Control And Trunk Muscle Activity During Isometric And Dynamic Lifting

Miller MA, Liemohn WL, Haydu TL, Zhang S: The University of Tennessee, Knoxville, TN

**Objective:** Research suggests that excessive navicular drop (ND) may influence risk of ACL injury. When considering possible preventative measures, orthotics have been shown to alter lower extremity biomechanics and decrease transverse tibial rotation at the knee. However, we found no studies that have evaluated the influence of a corrective orthotic on neuromuscular control at the knee. Therefore, we evaluated the effects of a semi-rigid orthotic foot device on muscular response times and activation patterns of the quadriceps, hamstring and gastrocnemius muscles in hyperpronated individuals following a weight bearing, lower extremity perturbation. **Design and Setting:** To evoke a reflex response, we used a lower extremity perturbation device, designed to produce a forward and either internal or external rotation of the trunk and femur on the weight bearing tibia. Subjects were tested in both orthotic and non-orthotic conditions in a counterbalanced fashion. Five trials for each orthotic condition were completed for both internal (IR) and external rotation (ER) perturbation. **Subjects:** Thirteen healthy, males (age =  $20.4 \pm 1.04$  years, ht =  $181.4 \pm 8.46$  cm, wt =  $91.91 \pm 17.4$  kg, ND =  $12 \pm 1.87$  mm) participated in the study. **Measurements:** Long latency myoelectric reflex times were recorded via EMG for the medial and lateral hamstring, gastrocnemius, and quadriceps muscles. **Results:** An experimental mixed model, repeated measures ANOVA with two within factors (muscle, orthotic condition) revealed no significant difference in muscle reaction time between orthotic conditions for either IR ( $p = .227$ ) or ER ( $p = .952$ ) perturbation. We also found no significant difference in muscle recruitment order for either IR ( $p = .797$ ) or ER ( $p = .855$ ) perturbation. **Conclusions:** Our findings suggest that a semi-rigid orthotic does not influence neuromuscular control at the knee. We found the average change in ND between the orthotic and non-orthotic condition in our subjects was only  $3.23 \pm 1.69$  mm. It is possible a more rigid orthotic may result in greater mechanical correction, thus having a greater influence on limb alignment and neuromuscular control. In addition, we measured only acute response adaptations. It is unknown whether activation patterns may change over time with chronic wear. Further research is needed to evaluate both the acute and chronic effects of a variety of foot orthotics on neuromuscular control of knee stability. **Acknowledgements:** Orthotics were provided by Foot Management, Inc. (Pittsville, MD).

**Objective:** The purpose of this study was to compare the average electromyogram (EMG) activity of the vastus medialis oblique (VMO) and vastus lateralis (VL) while performing a straight leg raise and knee extension exercise with the hip in neutral and lateral rotation. **Design and Setting:** A  $1 \times 4$  factorial design was used in the study. Subjects performed all four conditions: straight leg raise with the hip flexed at  $40^\circ$  with the hip in neutral position, straight leg raise with hip flexed at  $40^\circ$  with the hip maximally laterally rotated, knee extension ( $30^\circ-0^\circ$ ) with the hip in neutral, and knee extensions ( $30^\circ-0^\circ$ ) with hip maximally laterally rotated. A Latin square was used to counter balance the order of exercise. The resistance used for each trial represented 5% of the subject's calculated lean body mass as measured by a skin caliper. A goniometer was used to ensure that joint position was maintained during exercises. All tests were performed in the Applied Biomechanics Laboratory. **Subjects:** Thirteen healthy male college students (age =  $24.6 \pm 3.7$  yr, height =  $178.3 \pm 4.8$  cm, and mass =  $80.4 \pm 7.5$  kg) with no previous history of significant knee or quadriceps injury volunteered for this study. **Measurements:** Surface electrodes were placed over the muscle bellies of the VL and VMO on the right leg to acquire the average EMG activity during each of the four conditions. **Results:** The values obtained represent a percentage of the muscle's peak activity during the trials for each condition. Average EMG for one trial was normalized against the peak muscle activity during that same trial. For VMO activity, no differences were found between each of the four exercise conditions ( $F_{(3,36)} = .646, P > 0.05$ ). No differences were found between each exercise on VL activity ( $F_{(3,36)} = 1.08, P > 0.05$ ) and VMO/VL ratio ( $F_{(3,36)} = .598, P > 0.05$ ), as well. **Conclusions:** Activation of VMO or VL does not change with respect to hip position or exercise. Additionally, there was no difference between each exercise on the VMO/VL ratio.

The purpose of this study was to perform a quantitative biomechanical analysis of the lumbar spine as subjects performed isometric and dynamic lifting tasks to determine the degree to which voluntary muscle contraction can control the attitude of the pelvis during these activities. Twenty-two healthy subjects ( $\bar{X} = 22.7$  years; 69.5 kg; 173.7 cm) volunteered from the University of Tennessee at Knoxville, Community. Pelvic tilt, lumbar lordosis, hip, knee and ankle angles were measured using videography as subjects performed 1) isometric and isokinetic lifts (30 & 60 cm/s) on a Cybex Liftask dynamometer and 2) functional box lifts. Electromyography (EMG) was used to monitor activity from the internal oblique (IO), external oblique (EO), erector spinae (ES) and gluteus maximus (GM) muscles as the subjects performed the lifts. Force data were quantified for the isometric and isokinetic lifting tasks. In addition, video and EMG data were also collected during functional box lifts. Each subject served as his or her own control. Upon completion of the four lifting conditions, subjects underwent a training session on the neutral spine posture and muscular co-contraction technique; all lifting conditions were then repeated using the neutral spine posture. The results of the repeated measures ANOVA demonstrated no significant pre to post EMG changes; however there were significant differences in activity among the four muscles, with the ES exhibiting the highest activity for all conditions. The force values were significantly reduced in the neutral spine posture conditions, which may be partially explained by the change in the posture itself or due to changing the complexity of the lifting task by incorporating the neutral spine technique. Kinematic results demonstrated that during standing isometric and dynamic lifting (isokinetic and box), utilization of the neutral spine posture via muscular co-contraction limited the range of pelvic and lumbar spine movement, as compared to lifting without a neutral spine position. These results also demonstrated that same day instruction of the neutral spine technique was effective in producing lumbar spine stabilization. The significance of these findings has implications in injury prevention and rehabilitation in occupational, athletic and recreational settings. Utilization of the neutral spine technique during these activities may serve to minimize the forces on the low back, thereby reducing injury incidence and facilitating pain management and rehabilitation.

## Functional ACL Bracing: A Survey Of Current Opinion And Practice

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**Introduction:** The purpose of this study was to survey orthopaedic sports medicine specialists regarding their ACL bracing practices. The role of functional knee bracing for anterior cruciate ligament (ACL) deficiency, or after reconstruction, is still unclear. In general, subjective data supports the use and benefits of functional braces. Conversely, objective data shows failure of braces to control anterior tibial translation at physiologic loads (>400 Newtons). Without clear scientific data to determine prescription parameters for bracing, it is useful to know how other physicians actually use ACL braces. **Methods:** Surveys were mailed twice to the 1,200 US members of the AOSSM. The data were analyzed descriptively and inferentially. Differences in bracing percentages were compared using the Wilcoxon Signed Ranks Test, and regionalized responses were compared using the Kruskal-Wallis Test. Bonferroni-adjusted p value was set at .05/11 or .0045. **Results:** The survey data of 287 (24%) respondents were analyzed. The only statistically significant finding was that doctors prescribe off-the-shelf (OTS) braces more frequently for deficient patients (D) than for reconstructed patients (R) ( $p=0.000$ ). There was no difference in the overall pattern of prescription of functional braces for D versus R ( $p=.529$ ), nor in the pattern of prescription of custom braces ( $p=.083$ ). The frequency of responses indicating that a doctor never uses functional braces was higher for R, with 36/282 (12.8%) saying they never prescribe a functional brace, while for D, only 8/285 (2.8%) said they never brace. In deciding whether to brace or which brace to prescribe, 60% of respondents said the patient's activity level was the most important factor to consider for both D and R. There was no difference in the use of functional braces by geographic region. Finally, regarding change in practice over the past five years, 139 doctors said they're bracing D less frequently and 146 said they're bracing R less frequently. Only 4 (D) and 5 (R) said they're bracing more frequently, while 73 (D and R) said their bracing practices were unchanged. **Conclusions:** Most AOSSM doctors surveyed use functional braces for both D and R. If the doctors will leave a patient unbraced, it is more likely to be a reconstructed patient. The patients' activity level is most important to these doctors when they are making brace decisions. There is no regional difference in brace prescription patterns. The most common change in practice over the past five years is that the doctors are bracing less frequently.

## Prophylactic Lateral Knee Bracing Does Not Affect Force Development During A Vertical Jump

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**Objective:** The effect of prophylactic lateral knee bracing on functional performance and isolated knee joint torque has been well studied. However, the potential effect of these braces on force production during a sport-specific task remains unknown. Thus, the purpose of this study was to examine two widely used prophylactic lateral knee braces and their effect on lower extremity force development while performing a one-legged vertical jump. **Design and Setting:** A 1 x 3 factorial was used in this study. The single independent variable was knee brace with 3 levels: 1) McDavid Knee Guard; 2) Anderson Knee Stabler; 3) control (no brace). The dependent variables of interest were time to peak force (TPF) and normalized average vertical ground reaction force (AVGRF). Data were collected in the Biomechanics Laboratory at Indiana State University. **Subjects:** Twelve healthy, college-aged males (age =  $24.9 \pm 1.2$  years, ht =  $177.2 \pm 2.9$  cm, mass =  $83.1 \pm 3.9$  kg) with no history of lower extremity injury within the past 12 months participated. **Measurements:** All subjects were acclimated to each brace tested over a 24 hr period before testing. Subjects completed each knee brace condition in a counterbalanced fashion. One-legged vertical jumps without arm movement were performed on a Kistler piezoelectric force platform interfaced to a controlling laptop computer. The Ariel Performance Analysis System Software was used to determine the average vertical ground reaction force and time to peak variables from the ground reaction force time-history. A one-way repeated measures ANOVA was used to detect differences across braces on both AVGRF and TPF. Statistical significance was accepted at  $P < 0.05$ . **Results:** No difference existed between each of the three brace conditions on AVGRF and TPF. **Conclusion:** Prophylactic lateral knee bracing does not alter variables associated with lower extremity force production during a functional task. Furthermore, an acclimation period of 24 hr appears to be sufficient in allowing subjects to become comfortable with the brace without hindering force production during an explosive movement.

## The Combined Effects Of Ankle And Spat Taping On Vertical Ground Reaction Force During Drop Landings

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The purpose of this study was to evaluate the effects of ankle taping and spat taping on vertical ground reaction force (vGRF) data during drop landings. Nineteen recreationally active, healthy volunteers (9 male, 10 female; mean age =  $20.8 \pm 1.54$  y, height =  $170.3 \pm 10.4$  cm, mass =  $67.9 \pm 11.7$  kg) performed soft and stiff drop landings from two heights, under three treatment conditions (control, tape, & combined ankle/spat tape). A modified closed basketweave was applied to both ankles using 1 °-inch athletic tape. The spat taping procedure was applied in a similar fashion minus the three stirrup tape strips. Subjects were asked to land with maximum knee flexion and minimum knee flexion when executing a soft and stiff landing, respectively. Subjects completed six trials for each of the six conditions from both a low (45 cm) and high (60 cm) height (total = 72 landings per subject) with tape conditions and heights counterbalanced between subjects. All testing was completed during one session. A force platform was used to collect vGRF at a sampling frequency of 1000 Hz. vGRF data were smoothed using a Butterworth second order filter (60 Hz cutoff) and normalized to body mass (N/kg). A set of two kinetic and two temporal variables describing the vGRF profiles was compiled for each trial using laboratory software. Within each landing style, separate two factors (height by condition) repeated measures ANOVA were performed on each variable. Significant main effects for condition were revealed for forefoot impact force (FFI) (soft), rearfoot impact force (RFI) (soft & stiff) and time to rearfoot impact force (TRIF) (soft & stiff), and significant main effects were revealed for height for RFI (soft & stiff). Post hoc analysis of the FFI revealed the spat to be significantly greater than the tape and control conditions. Post hoc analysis of the condition main effect for RFI revealed significant differences between the three conditions (spat>tape>control) for both soft and stiff landings. Post hoc analysis of the condition main effect for TRIF revealed significant differences between the three conditions (spat<tape<control) for both soft and stiff landings. The results of this study suggest that ankle taping and the combined effects of ankle and spat taping increase rearfoot impact force, while decreasing the time to absorb rearfoot impact force during landing. This may impede the ankle's ability to act as an efficient shock absorber, thus transmitting the impact force to the more proximal joints of the lower extremity.

## The Effects of Prophylactic Ankle Taping And Shoe Application On Postural Stability

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The use of balance stability and proprioception are components for the evaluation of return to play criteria for an athlete following and injury. Most baseline testing of postural stability evaluates the athletes in a barefoot condition only. However, this barefoot condition is not conducive to make immediate return to play decisions on the field. **Methods:** Twenty-one male volunteer subjects were assessed for postural sway utilizing the Balance Error Scoring System (BESS). Criteria for inclusion in this study were: no previous lower extremity or head injuries within the past six months and not being treated for an inner ear infection, migraine, or vertigo with medications. Subjects were evaluated for postural sway utilizing six different balance tasks (double leg stance, single non-dominant leg stance, and tandem stance performed on a firm and foam surface). Four foot conditions were presented for assessment: barefoot, barefoot with low-cut turf football shoe, ankle with closed basket-weave prophylactic taping and no shoe, and ankle with prophylactic taping and shoe. Each balance task lasted for twenty seconds with the number of errors counted during this period. Two evaluators trained in the BESS recorded sway errors for each of the six tasks. A reliability analysis was utilized to determine Intraclass Correlation coefficients (ICC) to assess inter-tester reliability. An analysis of variance (ANOVA) with a Scheffee Post Hoc Test was utilized to assess differences in sway error scores of the four conditions. The alpha level was set at  $p < .05$  for all analyses. **Results:** The average measure ICC = .89 with a lower bound of .77 and an upper bound of .97 for the four conditions. With comparisons to the barefoot condition, we found significantly fewer errors with the barefoot and shoe condition ( $p = .048$ ) and no significant difference between barefoot and taped ( $p = .078$ ) or taped/shoe condition ( $p = .083$ ). **Conclusions:** Postural sway performance with the BESS can be affected by different conditions of the foot. When making return to play decisions utilizing postural sway error scores, applications of a shoe to the foot will significantly decrease the number of errors.

## Prophylactic Ankle Bracing And Proprioception In Uninjured And Functionally Unstable Ankles

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Despite appropriate initial care and follow-up rehabilitation, reoccurrence rates as high as 60% have been reported following an initial episode of inversion ankle sprain. Ankle bracing has been shown to be effective in the prevention of ankle injuries in uninjured populations; however the literature is void examining the effects on those with functionally unstable ankles (FAI). The purposes of this study were to determine if prophylactic ankle bracing or taping enhances ankle joint proprioception as measured by threshold to detection of passive motion (TTDPM) and to see if differences in TTDPM exist between the unstable and uninjured ankles. Sixteen male (8) and female (8) subjects (age=21.6±1.7 yr., wt=73.5±15.0 kg, ht=172.9±8.8 cm) with unilateral FAI consented to participate in this study. All subjects were examined by an orthopedic surgeon and were cleared from having any mechanical instabilities. In addition, all subjects had to satisfy ten criteria used to determine their functional instability prior to participating. TTDPM measurements were derived from a specially built device used to measure passive ankle movement (inversion and eversion) in degrees, while maintaining a constant speed of 0.5°/sec. TTDPM was measured while the subject was blindfolded and listening to white noise through headphones. The foot to be tested rested on the footplate of the device. As the device moved the tested ankle into either inversion or eversion, the patient would stop the device using a handheld on-off switch that they controlled as soon as they felt the movement. The number of degrees of movement was recorded and used for data analysis. Data were analyzed using an ANOVA with repeated measures. The within subject factors included condition (unbraced, Aircast Air-Stirrup® (Aircast, Inc., Summit, NJ), Swede-O Ankle Lok® (Swede-O, Inc., North Branch, MN), tape), ankle (FAI, uninjured) and motion (inversion, eversion). There were no differences in TTDPM scores between the two ankles under each of the four conditions. However, there was a significant main effect [ $F(3,45)=3.90, p < .015$ ] for condition resulting when TTDPM scores for both inversion/eversion and FAI/uninjured ankles were pooled together. The unbraced (no tape) ankle (2.99°±2.58°) was able to detect the passive movement much sooner (less degrees of motion) than both the Ankle Lok® (3.75°±3.31°) and Air-Stirrup® (3.76°±3.30) ankle bracing conditions. The results of this study suggest that TTDPM scores do not differ in uninjured and FAI ankles, however that bracing with either the Ankle Lok® or Air-Stirrup® negatively affects one's ability to detect passive motion as compared to either no tape or tape conditions. Further studies involving the use of other measures of proprioception, such as joint position sense scores, under these same conditions are needed.

## Long-Term Ankle Brace Use Does Not Affect Peroneus Longus Latency During Sudden Inversion In Normal Subjects

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**Objective:** The use of external ankle support is widely used in sports medicine. However, the use of ankle bracing over a long sustained period with a healthy ankle has been scrutinized due to possible neuromuscular adaptations resulting in diminished dynamic support offered by the peroneus longus. Although this claim is anecdotal in nature, we sought to investigate the effects of long-term ankle brace application using two commonly used appliances on peroneus longus latency in normal subjects. Our second purpose was to evaluate the effects of ankle bracing on peroneus longus latency prior to a period of extended use. **Design & Setting:** A 3 x 3 x 2 with repeated measures on the first and third factor was employed in this study. All data were collected in the Sports Injury Research Laboratory on campus. **Subjects:** Twenty (12 males & 8 females) physically active college students (age = 23.6±1.7 yrs, height = 168.7±8.4 cm, and mass = 69.9±12.0 kg) free from ankle pathologies or lower extremity injuries 12 months prior to the study. Furthermore, all subjects had not been involved in a strength training or conditioning program 6 months prior to the study. **Measurements:** Peroneus longus latency was evaluated studying the electromyogram of the muscle following sudden foot inversion. **Results:** Application of a lace-up and semi-rigid brace did not affect peroneus longus latency. Additionally, 8 weeks of long-term ankle appliance use caused no effect on peroneus longus latency. **Conclusions:** The duration of the peroneus longus stretch reflex (reaction time) is neither facilitated or inhibited with the extended use of external ankle support. It appears that proprioceptive input provided by the muscle spindles within the peroneus longus is not compromised with the long-term use of ankle braces.

## Effect of General Anesthesia On Passive Knee Extension Motion

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Flexibility is promoted as an essential component of physical fitness, but the efficacy of stretching and the mechanism from which increases in range of motion (ROM) occur have not been clearly defined. Two hypotheses which have been offered as limits to flexibility are mechanical constraints and neural constraints. The purpose of this study was to investigate the effects of general anesthesia on passive knee extension (PKE). It was hypothesized that PKE ROM would increase following the administration of general anesthesia. Eight subjects (age = 24.0 +/- 6.9 yrs, mass = 82.8 +/- 17.7 kg) undergoing orthopedic surgeries unrelated to the tested limb volunteered to participate. Three measurements of PKE were taken using fluid goniometers prior to and following the administration of general anesthesia. The force applied during the PKE measurements was consistent between the pre and post-anesthesia trials. A dependent t-test was performed to compare PKE ROM before and after anesthesia. Mean PKE ROM was significantly higher before anesthesia (75.0° +/- 11.8°) as compared to following anesthesia (53.3° +/- 17°) (t=5.6, p<.001). Pearson product correlation revealed a significant correlation between the mean difference in PKE ROM between treatment conditions and subjects' body weight (r=.91, P<.05). As subject body weight increased, the difference in PKE ROM also increased. We hypothesize that these findings may be attributed to diminished neural drive. Prior to anesthesia, neural drive to the quadriceps likely assisted the examiner in moving the knee into extension. After anesthesia a decreased neural drive to the quadriceps prevented the quadriceps from assisting the examiner in extending the knee. Because the pre- and post-anesthesia measurements were taken at the same force levels and the limbs of heavier subjects had greater decreases in ROM, the post-anesthesia ROM was likely decreased because it was not assisted by an active quadriceps muscle group. Further investigation into the role of neural constraints to ROM are warranted.

## Soleus Motoneuron Recruitment Changes During A 2 Minute Static Stretch With And Without Warming

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**Objective:** Stretching exercises are often performed in conjunction with a warm-up prior to participating in physical activities. Presently, no studies have investigated the potential effect that warm-up has on motoneuron pool excitability during a static stretch. The purpose of this study was to determine soleus motoneuron pool recruitment during static stretching with and without warm-up. **Design & Setting:** A 2x5 factorial design with repeated measures was used. The independent variables were treatment (warm-up and no warm-up) and time (0, 30, 60, 90, 120 seconds). The dependent variable was soleus Hoffmann reflex (H-reflex). This study was performed in the Sports Injury Research Laboratory at Indiana State University. **Subjects:** Twenty healthy college age students (8 males, 12 females, age=20-25 yrs) volunteered to participate in this study. None had suffered any knee or lower leg injuries to the extremity in the last 3 months. Subjects were also free from any neurological or orthopedic dysfunction. **Measurements:** Motor neuron pool recruitment was measured using H-reflex amplitudes. Five measurements (0, 30, 60, 90, 120 seconds) were taken during a 2-minute static stretch for both treatments. **Results:** There were no significant interactions between treatment and time intervals. H-reflex measures were not different between warm-up and no warm-up treatments. All time intervals were all different from each other, increasing over time. **Conclusions:** We conclude that warm-up does not cause a change in motor neuron pool recruitment compared to no warm-up during a static soleus stretch.

## Retention Of Flexibility 3 Weeks After A One-Week Training Regime

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**Objective:** To determine if flexibility gains are retained 2 days and 3 weeks after concluding a 5-day stretching program with or without high-intensity-pulsed short wave diathermy to the hamstrings.

**Design and Setting:** A 3 x 7 repeated measures factorial design with treatment (control, stretch, diathermy & stretch) and day (1, 2, 3, 4, 5, 8, 30) as independent variables. The dependent variable was flexibility as measured by a Sit and Reach test. Subjects were randomly assigned to one of 3 treatment groups.

**Subjects:** 33 volunteer college students (M=11, F=22, age=20.6±1.8yrs, ht=169.5 ± 8.5cm, wt=66.7 ± 4.9kg).

**Measurements:** Subjects were tested pre and post treatment for 5 consecutive days (approx. the same time of day). Sit and Reach testing was done with the left leg bent and the right ankle plantar flexed (approx. 45°). The best of 3 pre-treatment sit and reach scores was recorded to the nearest 0.25 cm and used for analysis. Testing with no other intervention occurred on days 8 and 30. Control subjects lay prone for 15-min., stretch only subjects received a 15-min. sham diathermy treatment, and diathermy/stretch subjects received a 15-min. diathermy treatment. Both treatment groups performed three 30-second stretches before post-testing. The stretch was a unilateral standing right leg hamstring stretch. The left leg was used for support and externally rotated (approx. 45°), the right leg was fully extended and supported on a 75cm tall plinth, and the ankle was plantar flexed (approx. 45°). During each stretch distance reached by the arms was given.

**Results:** There was no significant difference between groups in either flexibility development or in retention of flexibility gains 25 days thereafter (Day 30). Subjects were 20% more flexible on day 5 (34.0±7.1cm) and day 30 (34.4±7.6cm) than the first day (29.4±8.1cm) of the program following 25 days of normal activity (no stretching), but 6% less than Day 8 (35.7±7.2cm).

**Conclusion:** Gains in flexibility (Sit and Reach Test) are retained for at least 3 weeks following the stretching program. The type of stretching program had no effect on retention. It appears that 2 sets of 3 repetitions of a Sit and Reach test is sufficient to induce long term flexibility gains.

## The Combined Effect Of Warm-Up, Stretching, And Cool-Down On Delayed Onset Muscle Soreness (DOMS)

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The purpose of this study was to evaluate the preventive effect of a combined treatment consisting of a warm-up, stretching routine, and cool-down on delayed onset muscle soreness, and to investigate whether males and females respond differently to an intense eccentric exercise and/or to the combined treatment. Forty healthy, recreationally active volunteers (20 males, 20 females, age =  $25.25 \pm 3.2$  yrs, ht =  $168.75 \pm 8.75$  cm, wt =  $63.03 \pm 12.33$  Kg) were randomly assigned to a control or a treatment group with equal numbers of males and females in both groups. Subjects in the control group performed an intense eccentric biceps brachii exercise to induce DOMS while those in the treatment group performed a warm-up, stretching routine, and cool-down in addition to the eccentric exercise. The eccentric exercise consisted of 50 eccentric contractions of the subjects' non-dominant elbow flexors using dumbbells and a biceps curl preacher bench. We repetitively measured perceived muscle soreness (PMS) by a visual analog scale; resting elbow flexion angle (REF), active elbow flexion angle (AEF), and active elbow extension angle (AEE) by a standard goniometer (Jamar, Inc., Clifton, NJ); and isometric maximum voluntary contraction (MVC) by a KINCOM dynamometer (Chattecx Corp. Chattanooga, TN) to assess the preventive effect of the combined treatment on DOMS. We measured these variables 24 hours before the eccentric exercise and 20 minutes, 24 hours, 48 hours, and 72 hours following the exercise. All data were analyzed using a 3-way repeated measures ANOVA (treatment x gender x time). Results revealed a significant time main effect ( $p < .001$ ) and a significant gender main effect on REF, AEF, AEE, and MVC; but not on PMS. Differences between control and treatment groups were not significant for any variable. We concluded that performance of a warm-up and stretching routine before an intense eccentric exercise, followed by a cool-down and stretching routine after the exercise, did not reduce the PMS, REF, AEF, AEE, or MVC associated with DOMS. We also concluded that both genders responded similarly to the DOMS-inducing exercise and the combined treatment.

## Methodological Considerations When Assessing Lower Extremity Function With A Single-Leg Hop For Distance Test

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Lower extremity function is often assessed using a single-leg hop for distance test. To assess lower extremity function clinicians often use the mean (MN) or maximum (MAX) score of a pre-determined number of repetitions. Our purpose was to determine if there were any differences in these methods of analysis. Twenty ACLR reconstructed (ACLR) subjects (age=25.8 +/-8.1 yrs, ht=175.8 +/-8.5 cm, and wt=73.3 +/-14.0 kg) and 20 age matched controls (age=24.5 +/-6.9 yrs, ht=175.8 +/-8.3 cm, wt=71.4 +/-12.1 kg) were randomly selected to participate in this study. The single-leg hop was performed three times with each extremity. The mean score in centimeters was calculated using all three scores. Two 1-between (Group) 1-within (Method) repeated measures ANOVAs were used to assess differences between Group (ACLR, Control) and Method (MN of 3 trials, MAX of 3 trials) for the involved and uninvolved extremity. There was a significant Group x Method interaction [F (1,38)=4.66, p=.037] for the involved but not the uninvolved extremity [F (1,38)=2.62, p=.114]. Tukey HSD post-hoc analysis revealed a significant difference between the MN and MAX for the ACLR group (MN=162.5 +/- 24.2cm, MAX=173.32 +/- 27.9cm) and the Control group (MN=180.14 +/- 29.7cm, MAX=187.24 +/- 28.2cm) for the involved extremity. The results demonstrate that MN values are significantly different than those obtained using the MAX score for a 3-repetition test. These results are important to consider when assessing the involved extremity of an ACLR subject. Assessment of function using only the mean score may be an underestimate of performance. To determine if there were differences between trials, two repeated measures ANOVAs with 2-within factors (Extremity, Trial) were used to assess differences between the Extremities (Involved, Uninvolved) and Trial (Trial 1-Trial 3) for the ACLR and Control groups. There was a significant main effect for Trial for both the ACLR and Control groups. Post-hoc analysis using t-tests with Bonferroni correction (.05/3=.016) determined that there were significant differences between Trial 1 & Trial 2 and Trial 1 & Trial 3 (p=.001) for both extremities of the ACLR and Control groups. There was a significant difference between Trial 2 & Trial 3 for the involved extremity of the ACLR group (p=.003) but no difference for either extremity of the control group (p>.016). These results support our visual observations that while performing a single-leg hop for distance test ACLR subjects perform differently between trials and often build confidence as the trials progress. Therefore, we suggest that a maximum test be used when assessing single-leg hop for ACLR subjects because the mean of three trials may not be representative of maximum performance.

## Role Of Foot Position On Hamstring Contraction During Isometric Contraction

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Knee stability is dependent on the inert ligament structures working in conjunction with the surrounding muscles to control the range of motion within its physiological limits. If ROM is exceeded an injury will occur to the ligament resulting in instability. The hamstring functions as a dynamic restraint to the knee through decreasing anterior tibial translation (ATT) and is therefore important in the prevention and rehabilitation of knee injuries, especially those involving the ACL. The gastrocnemius also crosses the knee as a flexor and is thought to provide some influence to the stability of the joint. Ankle position changes the tension of the gastrocnemius and therefore may adjust the activation need by the hamstring to function as a dynamic restraint. The purpose of this study was to measure the effect of changing foot position on the activation level of the hamstring. Thirty-four (17 males, 17 females), recreationally trained individuals with an age range of 18-34 and no history of knee pathology gave informed consent to participate in this study. We collected isometric electromyographic (EMG) activity from the quadriceps (VMO), hamstrings (MH and LH), and gastrocnemius (MG and LG) at various knee (45°, 60°, and 90°) and ankle angles (0°, 30°) in a closed kinetic chain activity using an isokinetic dynamometer. The EMG mean % was normalised from the EMG at a 90° knee and a 0° ankle position. The subject practised, and then completed each maximum voluntary contraction (MVC) test for five seconds. The hamstring (MVC) EMG mean % activity was compared using a three way (knee angle x ankle angle x gender) repeated measures ANOVA. For the lateral hamstrings significant interaction (knee and ankle [F(1,50) = 3.645, P = .033] and ankle and gender [F(1, 25) = 7.286, P = .012]) and main effects (knee [F(2, 50) = 9.906, P = .000] and ankle [F(1, 25) = 31.796, P = .000]) were observed. Post-hoc tests revealed that the 90/30 condition had higher (P < .0005) EMG mean % than the 90/0 condition. The knee test angle of 45° and 60° had greater EMG mean % activity than at 90°, and the position of ankle plantar flexion (30°) increases the value of the hamstrings compared to ankle neutral position (0°) (P < .000). Difference in lateral hamstring activation was also observed between genders at 30° of plantar flexion. Similar main effects were found for the medial hamstring. The interaction and main effect of knee and ankle position on the lateral hamstrings suggest that there is more activity in this muscle at the straighter knee angles and with plantar flexion. This finding can contribute to the analysis of injury mechanism positions and strategies of rehabilitation.

## Changes In Knee Joint Compliance Index And Maximal Displacement Across The Menstrual Cycle

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**Objective:** The influence of sex hormones on musculoskeletal stability and ACL injury risk has yet to be adequately studied. We examined the change in knee joint compliance and maximal displacement across days of the menstrual cycle. **Design and Setting:** Subjects were tested at the onset of menses (M), day of ovulation (O), and at two (O+2) and four (O+4) days post ovulation. We supplied each subject with an ovulation kit to determine when ovulation occurred. **Subjects:** Twenty, physically active females (age = 20.1±3.3 yr, ht = 169.1±8.8 cm, wt = 67.8±11.7 kg.) with normal menstrual cycles were recruited from a local University and high school. **Measurements:** We used the KT-1000 to measure anterior tibial displacement of the tibia on the femur. We recorded force at each 1mm of displacement from 0 through maximal displacement (D). D was defined as the mm of displacement at which further displacement would exceed 30 lbs. A compliance index (CI) (D displacement / D force) was calculated between 1 and 5 mm of displacement. **Results:** Two separate repeated measures ANOVAs found a significant difference in D (F<sub>(3,57)</sub> = 5.15, p=.003) and CI (F<sub>(3,57)</sub> = 3.709, p=.017) across days of the menstrual cycle. Tukey's HSD revealed a greater CI at O+2 (.53±.17) compared to M (.42±.20), with no other pairwise comparisons being significant. Displacement was greater at O (8.1±1.4), O+2 (8.3±1.2) and O+4 (7.7±1.2) compared to M (7.2±1.2); and O+4 was greater than O. **Conclusions:** Knee joint displacement and compliance index increased at or near ovulation with both being significantly greater at 2 days post ovulation compared to menses. These findings suggest that at two days post ovulation, the ligament can displace further with less force. This may be a delayed response to the increase in estrogen at ovulation. This study is limited by the selected time points across the cycle, the lack of direct measures of hormone levels, and the use of a compliance index (difference between two displacements) rather than compliance (ligament behavior across a full range of forces) as the primary measure. To obtain a complete profile of the relationship between hormonal levels and ligament behavior, further studies should assess daily serum hormone concentrations and compliance across one complete menstrual cycle.

## The Effects Of Artificial Knee Effusion On Quadriceps And Soleus Motoneuron Pool Excitability

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**Objective:** A knee effusion injury model allows for investigation of neuromuscular changes in the motoneuron (MN) pools of knee joint musculature without conflicting variables of pain and inflammation. The quadriceps show an inhibitory response to joint effusion, but the measurement of quadriceps MN pool activity is more difficult than that of the soleus. If a neurological relationship exists between the quadriceps and soleus, then quadriceps inhibition may be exhibited by the soleus MN pool. The purpose of this study was to examine changes in quadriceps and soleus MN pool activity resulting from knee joint effusion over a 4 hr period. **Design and Setting:** A repeated measures before-after trial design was used for this study. Soleus and vastus medialis Hoffman reflex (H-reflex) measures were collected from each volunteer before, at 30 min, 90 min, 150 min, and 210 min intervals over a four hour period following knee effusion. **Subjects:** Eight, neurologically sound volunteers (age 23.3±2.1 yrs., ht 171.8±15.9 cm, mass 65.5±17.7 kg) participated in this study. **Measurements:** An area superomedial to the patella was cleaned, and injected subcutaneously with 2cc of lidocaine for anaesthetic purposes. With a second disposable syringe, 30ml of sterile saline was injected into the knee joint capsule to mimic mechanical joint effusion. The soleus H-reflex was elicited by applying a percutaneous stimulus to the tibial nerve in the popliteal fossa and recording the response through surface electromyography. The vastus medialis H-reflex was elicited by applying the aforementioned stimulus to the femoral nerve in the femoral triangle and recorded from surface electrodes placed over the vastus medialis. Seven to 12 stimuli were delivered at 20-sec intervals with varying intensities to find the maximum H-reflex. The maximum H-reflex was measured 5 times at the same stimulus intensity with 20-sec rest intervals. **Results:** All soleus H-reflex measures following effusion (30min 5.89±92 V; 90min 6.16±48 V; 150min 6.59±50 V; 210min 6.70±56 V) were increased in relation to the pre-effusion measure (5.01±79 V). The vastus medialis H-reflex measures at 30 (4.23±94 V) and 150 (4.16±57 V) minutes following effusion were lower than the pre-effusion measure (5.88±1.44 V;  $P < 0.05$ ). **Conclusions:** Afferent activity from the knee joint capsule resulted in an inhibitory effect on the vastus medialis and a facilitatory effect on the soleus. Although the MN pool activity of each muscle was not strongly correlated ( $r = -0.58$ ;  $r^2 = 0.34$ ) over time, each muscle's H-reflex measurements tended to move in opposite directions, eventually leveling out in an inhibited (vastus medialis) or facilitated (soleus) state. Knee extensors are inhibited in the absence of perceived pain in this study. Facilitation of the soleus in cooperation with other lower extremity musculature could be a mechanism for compensation of the inhibited quadriceps to maintain lower kinetic chain function.

## Effect Of Slide Board Exercise On Agility Performance In Collegiate Ice Hockey Players

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The purpose of this study was to assess the effects of an interval slide board exercise protocol on an instrumented agility task. Thirteen male collegiate ice hockey players (age=20.3 +/- 1.4 years, height=183.1 +/- 6.8 cm, mass = 84.1 +/- 9.0 kg) underwent baseline and pre-exercise tests of the "Getback 2-2" agility task on the Reactor (Cybex Inc., Ronkonkoma, NY). These sessions were consisted of one practice trial and three recorded trials each separated by 1 minute of rest. Subjects then performed an interval exercise protocol consisting of seven bouts of 60 seconds of slide boarding each interspersed by 2 minutes of rest. Within each 60 second bout, subjects performed exercise at a self-selected moderate pace from seconds 0 to 15 and 30 to 45. Subjects performed slide board exercise as hard and fast as possible from seconds 15 to 30 and 45 to 60. The exercise protocol was designed to simulate one period of a competitive ice hockey game. Immediately following slide board exercise, subjects were retested on the Reactor by performing 3 additional trials of the agility task. Means and standard deviations for the baseline, pre-exercise, and post-exercise agility tests were calculated. A one factor within subjects ANOVA performed on test order identified significant differences in agility performance across the testing sessions ( $p = .007$ ). Post-hoc analysis revealed that subjects performed the agility task significantly faster in the pre-exercise session than the baseline session ( $p = .01$ ) and significantly slower in the post-exercise session than the pre-exercise session ( $p = .016$ ). No significant differences were found between the baseline and post-exercise conditions. The significant improvement from baseline to pre-exercise performance supports previous research that has demonstrated significant learning effects with repeated trials of agility tasks on the Reactor. The increased time to complete the agility task post-exercise as compared to pre-exercise demonstrates that intense, interval slide board exercise was associated with an impairment of agility performance. A decrease in agility following extended periods of intense exercise may predispose athletes to injury.

## A Comparison Of Strength, Proprioception, Laxity, Flexibility, And Balance Between Basketball And Non-Basketball Collegiate Female Athletes

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The alarming incidence of anterior cruciate ligament (ACL) injuries in female athletes as compared to their male counterparts has been well documented. Specifically the injury rate is higher for female basketball athletes than female athletes participating in most other sports. Thirteen collegiate female basketball athletes and twelve collegiate female non-basketball athletes (age = 19.6 ± 1.4 years; height = 170.3 ± 13.8 cm; weight = 66.7 ± 11.8 kg) with no previous history of serious knee injuries of the dominant leg underwent the following testing procedures: general joint laxity (modified Beighton's test), ACL laxity (KT-1000 device), hamstring flexibility (Active Knee Extension Test), knee joint proprioception with threshold to detection of passive motion at 15° and 45° of flexion (Proprioception Testing Device), multiaxial balance testing under both eyes open and eyes closed visual conditions (Biodex Stability System Level 6 and 8 respectively), and knee joint isokinetic strength (Biodex System III) at 60°/s measuring peak torque to body weight for knee extension and flexion. The testing conditions within the balance and proprioception assessments were counterbalanced. All data were analyzed using multiple independent t-tests with a significance level set at  $p < 0.05$ . No significant differences in strength, proprioception, ACL laxity, or balance existed between groups. However, significant differences in general laxity ( $t = -3.649$ ,  $p = 0.001$ ) and hamstring flexibility ( $t = 3.291$ ,  $p = 0.003$ ) between groups were found. The basketball athletes demonstrated significantly less general laxity ( $2.4 \pm 1.9$ ) than the non-basketball athletes ( $5.3 \pm 2.2$ ). The basketball athletes also exhibited significantly less hamstring flexibility ( $18.0 \pm 9.7$ ) than the non-basketball athletes ( $6.4 \pm 7.8$ ). A Pearson's product moment correlation found general laxity and hamstring flexibility to have a significant inverse relationship ( $r = -0.413$ ,  $p = 0.04$ ). This indicates a low general laxity score correlates with a high flexibility score suggesting less general laxity and less flexibility. This data suggests that there may be inherent differences in the physical characteristics of general laxity and hamstring flexibility between female basketball and non-basketball athletes. Future research should consider these characteristics as possible contributing factors to the higher incidence of female ACL injuries in basketball versus other sports.

### Retrospective Analysis Of Time To Return To Activity For Distal Tibiofibular Syndesmotom Ankle Sprains In Division I Football Players

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**Purpose:** To determine the time required for an athlete sustaining a distal tibiofibular syndesmotom sprain to progress through specific rehabilitation phases.

**Methods:** A retrospective analysis over a 3 year period revealed 6 syndesmotom ankle sprains in 5 athletes. The athletes (Age  $20.5 \pm 1.76$ ; Ht.  $182 \pm 8$ cm; Wt.  $92.25 \pm 24.9$ kg) consisted of 4 African-Americans and 1 Caucasian. The diagnosis of a syndesmotom ankle sprain was determined by palpable tenderness along the distal anterior and/or posterior tibiofibular joint, a positive external rotation test, and a history of internal tibial rotation on a fixed foot. Information regarding the mechanism of injury, shoe wear, physician visits, diagnostic tests, and pertinent dates regarding rehabilitation progress was primarily obtained from medical records. **Results:** All injuries occurred on grass while wearing standard 7-stud cleats. Four of the injuries were sustained during a game while 2 occurred during practice. All athletes were clinically examined by the team orthopedic surgeon and underwent plain X-rays that revealed no bony injury. Mechanism of injury was recorded as eversion for 4/6, plantar flexion 1/6, and inversion 1/6. Three athletes were immediately immobilized in a combination air-stirrup and ankle boot while the others were immobilized in only an air-stirrup. 5/6 athletes were placed non-weight bearing for an average of 4.20 ( $\pm 1.10$ ) days. These athletes were transitioned to partial weight bearing for 2.00 ( $\pm 0.89$ ) days. The one other athlete was placed partial-weight bearing for 1 day, attempted to play the next week but was unable, due to ankle pain and weakness. All athletes obtained full weight bearing status without a limp and pain within 5.50 ( $\pm 2.59$ ) days. Acute management of inflammation began immediately for all athletes. Active and passive range of motion exercises were started within 2 days post-injury. Resistive exercises were initiated 5.6 ( $\pm 3.78$ ) days post-injury. All athletes returned to functional sport specific drills 13.20 ( $\pm 3.42$ ) days post-injury with their ankle taped and braced. Athletes were advanced to "practice as tolerated" status by 25.00 ( $\pm 5.39$ ) days. Full participation status was achieved in 30.2 ( $\pm 4.1$ ) days. The only support used by the athletes at full participation was adhesive strapping. **Conclusion:** This data provides timelines that may assist in educating the injured athlete and others in the time needed to return from this type of injury. This information serves as a benchmark to guide the success of future rehabilitation interventions.

### Joint Laxity, Range of Motion, And Talar Glide After Lateral Ankle Sprain

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Lateral ankle sprains are one of the most common sport related injuries. A troubling phenomenon is the high recurrence rate, estimated to be between 70 and 80 percent. The high recurrence rate has been attributed to multiple factors including impaired proprioception and neuromuscular control, residual ligamentous laxity and loss of dorsiflexion range of motion. Limited joint motion may result from extraarticular or intraarticular restrictions. Although loss of dorsiflexion has been identified as a risk for reinjury to the ankle, the source of motion loss has not been extensively studied. Thus, the purpose of this study was to examine ankle joint motion in an athletic population with a history of unilateral ankle sprain. Twelve student-athletes (7 females,  $19.3 \pm 1.6$  yrs,  $174.6 \pm 12.7$  cm,  $68.7 \pm 15.3$  kg) with an average of 1.6 ankle injuries (range 1-5) in the past 22 weeks ( $11.3 \pm 8.1$  wks) participated in the study. Each ankle was assessed for dorsiflexion range of motion, in standing and supine, with the knee straight and bent. Subjects were also assessed for posterior talar glide and ankle joint laxity bilaterally. Joint laxity was assessed on physical examination using anterior drawer, talar tilt, and medial subtalar glide tests. Although small, nonsignificant differences were found for all measures of dorsiflexion range of motion between injured and uninjured ankles, significant differences were found in posterior talar glide and ankle laxity measures. Injured ankles were more lax and posterior talar glide was restricted in 11 of the 12 subjects. These results suggest that a restriction of posterior talar glide is common following lateral ankle sprain. These results also suggest that this arthrokinematic restriction is compensated for over time by stretching of extracapsular structures. We believe additional investigation is warranted as an anteriorly displaced talus may be a common contributor to ankle reinjury.

### Functional Ankle Instability Does Not Affect Lower Extremity Functional Performance

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**Objective:** Although considerable research has explored the role of proprioception and muscle function as contributing factors to functional ankle instability (FI), the relationship between FI and actual functional performance has received little attention. Our purpose was to determine if functional performance is impaired in individuals with self-reported functional ankle instability. **Design and Setting:** Actions and forces imposed on the ankle joint during sport activity were simulated using three functional performance tests. Prior to testing, all subjects performed a 5-minute warm-up, followed by a series of stretches for the lower extremity muscles. Subjects then performed a shuttle run, agility hop, and co-contraction test, in a counterbalanced fashion. For the shuttle run, subjects completed two consecutive up-and-back 6.1 m lengths as fast as possible, pushing off the involved ankle. For the agility hop test, subjects single-leg hopped in a consecutive pattern to 6 spots marked on the floor, holding their balance for 5 seconds on each spot. For the co-contraction test, subjects shuffle-stepped behind a 2.44 m radius against a heavy resistance tubing attached to the wall, completing five wall-to-wall lengths as fast as possible. Three trials for each functional test were completed and averaged for analysis. **Subjects:** Twenty males (age= $20.4 \pm 2.5$  yr., wt.= $93.0 \pm 17.0$  kg, ht.= $187.3 \pm 7.6$  cm) with a history of 1) at least one significant ankle sprain and 2) episodes of at least one repeated ankle injury and/or feelings of instability or "giving way" were compared to twenty males (age= $19.8 \pm 1.9$  yr., wt.= $90.6 \pm 16.3$  kg, ht.= $186.8 \pm 8.0$  cm) with no prior history of ankle injury. Subjects were matched according to age, height, weight, and activity level. **Measurements:** The co-contraction test and the shuttle run were measured on time to completion in seconds. The agility hop test was measured on an error point scale. **Results:** Three separate independent, two-tailed t-tests found no significant difference between groups for either the shuttle run ( $p = .680$ ), agility hop ( $p = .902$ ), or co-contraction ( $p = .452$ ) tests. **Conclusions:** Functional ankle instability is a subjectively reported phenomenon defined as the tendency to "give way" during normal activity. Although athletes commonly complain of FI, our study suggests that this phenomenon does not negatively influence actual functional performance. Future research should evaluate other, more demanding functional performance tests to further substantiate these findings.

## Usefulness Of The "Timed Cross Over Hop Test" To Determine Readiness To Return To Sports After Lateral Ankle Sprains

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The purpose of this study was to determine the validity, and reliability of the "cross over hop test" in order to determine readiness to return to sport after lateral ankle sprains. A total of 63 healthy subjects (34 male, 29 female) with no ankle sprains during the last six months and no complaints in the lower extremities, and 10 symptomatic subjects (6 male, 4 female) following a recent ankle sprain participated in this study. All symptomatic subjects could run with a normal gait pattern, run figure eights and hop from one leg to the other with minimal observable deficits. All subjects performed a timed crossover hop test in which the subjects hopped back and forth over a 10' H 1.5" line while hopping forward, backward, right and left along the line. The test was timed and a 1 second penalty was assessed each time the subjects jumped on the line, jumped twice on the same side of the line or stepped down with both feet. We randomized the order of the leg the subjects used to hop (right versus left or injured versus non-injured) of all subjects. We recorded the best of three trials for each leg as the test score. We computed limb asymmetry as  $(\text{Right} - \text{Left} - 1) \times 100$  for the healthy subjects, and  $(\text{Injured} - \text{Non-injured} - 1) \times 100$  for the symptomatic subjects. We defined a normal score as  $\leq \pm 15\%$  limb symmetry. In addition, we tested the healthy subjects between 2 and 6 times to determine test reliability. Test validity was defined as a high rate of test specificity (1 - false positive rate) and test sensitivity (1 - false negative rate). Test reliability was determined by computing Kappa Correlation Coefficients within and between testers. The timed crossover hop test had a specificity of .88 and a sensitivity of .90. Within tester Kappa Correlation Coefficients ranged from .7 to 1.0. Between tester Kappa Correlation Coefficient was computed as .64. The timed cross over hop test appears to be a valid and reliable test to distinguish between symptomatic and healthy subjects, if the same tester is used. We suggest using this test as an additional method to determine readiness to return to sport after a lateral ankle sprain.

## A Survey Of Athletic Training Scholars' Perceptions Of Qualitative Research

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The purpose of this study was to investigate athletic training scholars' educational background and current perceptions of qualitative research. A mail survey was sent to 224 athletic training scholars identified through their authorship of articles printed in the *Journal of Athletic Training* between 1995-1998. The questionnaire consisted of six questions relative to research training/experience, nine Likert scale items pertaining to their perceptions of qualitative research, and an opportunity to write open-ended comments about the nature of qualitative research in athletic training. Overall, athletic training scholars received approximately three times more formal training related to quantitative research than to qualitative. Not surprisingly, the results of the survey revealed that individuals with qualitative training felt more knowledgeable about and prepared to conduct qualitative studies ( $p < .05$ ). Overall, athletic training scholars agreed that qualitative research would have a positive future impact on the profession, that it is equally as important as quantitative methodology, and that it provides useful information. However, a negative correlation existed between the level of quantitative training and the future impact of qualitative research indicating that those individuals with more formal quantitative training perceive that qualitative research will make less of a positive future impact on the profession of athletic training ( $p < .05$ ). Athletic training scholars also agreed that qualitative research is academically rigorous and trustworthy. They rated their knowledge of qualitative research and preparedness for conducting qualitative studies the lowest of all of the Likert scale items indicating a general lack of understanding related to qualitative research among athletic training scholars. The open-ended comments were treated as units of textual data and were analyzed inductively. Two emergent themes were discovered including 1) issues of paucity and 2) both paradigms are valuable. Many athletic training scholars who responded thought that the paucity of qualitative studies in athletic training might be the result of qualitative reports being more difficult to publish. The second theme revealed that those who participated in the study believe that both research paradigms are necessary. As the profession of athletic training grows and the use of qualitative methodology to generate theory increases, consumers of research in athletic training may need to be better educated about the value of qualitative research methodology and its potential impact on the socio-professional context of the profession.

## Student Athletic Trainer Recruitment, Attrition, And Retention: Opinions Of CAAHEP Accredited Program Directors

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**Purpose:** The purpose of this study was to gather the opinions of program directors at CAAHEP accredited institutions with regards to the recruitment, attrition, and retention of student athletic trainers. **Subjects:** Subjects were 50 athletic training education program directors at 50 randomly selected CAAHEP accredited institutions. **Methodology:** Each athletic training curriculum director was sent an introductory letter which explained the purpose of the study and when initial contact would be made. Telephone interviews were conducted using a set of 10 standardized questions. A pilot study was conducted to verify the instrument's validity. **Results:** Twenty-five curriculum directors were contacted via telephone. This research indicated that the larger the school enrollment yielded a larger number of student athletic trainers (SATs) which were matriculating through each athletic training education program. In addition, a lower tuition cost supplied an increase in the number of SATs at the institution, respectively. State college/universities had an average enrollment of 36 SATs while private schools produced an average enrollment of 21 SATs. All of the private schools conducted active SAT recruitment, while 38% of the state schools did not recruit prospective SATs. The most common methods of recruitment were mass mailings, High School visitations, web sites, and admissions office efforts. With regards to attrition, the most common reasons for students leaving were change of academic interest, grade requirements, and time commitments. Curriculum directors noted that most SATs leaving the athletic training education program did so in the first 2 semesters following formal acceptance into the program. In addition, 60% of the curriculum directors reported that the issue of attrition had not been discussed within their institution. As such, these programs had an average of 36 SATs, while the remaining 40% had an average of 29 students. The most common alternative courses of study reported were Exercise Science and Physical Education. **Recommendations:** This research indicated that the larger schools with an annual enrollment greater than 10,000 and tuition costs less than \$5,000 have a larger number of prospective SATs available for academic consideration. Consequently, having a greater number of available SATs affords such larger institutions the choice of not having to actively recruit students and the large programs are not as concerned with the attrition of students as smaller institutions. Further research is warranted to include a larger sample of athletic training education programs concerned with the recruitment, attrition, and retention of SATs, which may help in fortifying the ability of curriculum directors to attract the highest quality of students in their education programs.

## Athletic Training Educators' Salaries And Employment Characteristics Within NATA/CAAHEP Accredited Athletic Training Educational Programs

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Faculty compensation was identified as one of the most pressing problems confronting American higher education in the 1980's. Since the first athletic training educational programs (ATEPs) were initiated in the 1960's, there has been a steady increase in the number of programs, athletic training educators (ATEs), and their responsibilities. The purpose of this study was to determine the relationship between ATEs' salaries and their employment characteristics (gender, educational background, academic rank, Carnegie classification, and institution type). An ATE questionnaire was developed and validated based on the literature and similar studies conducted in other health professions. Next, the researchers mailed packages (containing 5-9 questionnaires, consent forms, and return envelopes) to every program director (PD) of a NATA and CAAHEP accredited ATEP ( $n = 98$ ). The PDs were asked to distribute questionnaires to each NATA certified athletic trainer in their ATEP who taught at least 1 athletic training course per year, collect them when they were finished, and return them to the researchers. A total of 147 questionnaires were returned by 52 ATEPs (53%). The data were coded and analyzed with SPSS-X 9.0. The educators in this study ranged from 22-68 years old ( $x = 37$  years) with 0-39 years of teaching ( $x = 12.36$  years) and 1-35 years as a NATA certified athletic trainer ( $x = 13.57$  years). The average 1998-1999 annual salaries were \$46,000 for males and \$36,529 for females. Surprisingly, none of the females earned over \$60,000, while 21% of the male educators did earn over \$60,000. Twenty-seven percent of the educators were tenured and earned an average salary of \$53,269, followed by tenure track ATEs (\$42,155) and non-tenure track ATEs (\$36,036). One would expect those educators who have tenure and higher academic rank and educational background to have higher salaries. Most (36%) of the educators in this study were assistant professors with an average salary of \$44,104. Associate and full professors earned \$51,053 and \$61,538 respectively. Those educators with their doctoral degree earned \$48,720 and those with their masters degree earned \$39,320. There was also a difference in the types of institutions who hired these ATEs. In the Carnegie classification, Research II institutions averaged \$45,000, followed by Research I (\$44,423), Doctoral II (\$43,333), and Doctoral I (\$42,857). Private colleges paid an average of \$41,078, while public colleges paid \$42,005. Both institutional administrators and college graduates need to consider financial compensation for quality educators.

**A Five-Year (1995-1999) Analysis Of Scholarly Activity Among Institutions Publishing In The *Journal Of Athletic Training* And Supplement To The *Journal Of Athletic Training***

Voll CA, Pitney WA, Storsved JR, Pitney LV: Purdue University, Lafayette, IN, and Oklahoma State University, Stillwater, OK

The purpose of this investigation was to examine the amount and type of scholarly activity conducted by institutions publishing in the *Journal of Athletic Training (JAT)* and Supplement to the *JAT* and to rank these institutions according to their productivity. This study also attempted to determine which domain represented the majority of research conducted by these institutions. Frequency counts were performed for the first institution associated with each publication from the *JAT* and Supplement to *JAT* from 1995 to 1999. Additionally, each article and abstract was classified by performance domain based on its content. Data revealed the following productivity ranking for the top 15 institutions: 1) Virginia; 2) Indiana State; 3) Pittsburgh; 4) Brigham Young; 5) Temple; 6) North Florida; 7) North Carolina-Chapel Hill; 8) Florida; 9) Kentucky; 10) Illinois State; 11) both Nevada-Las Vegas and Toledo; 12) San Diego State; 13) both Pennsylvania State and DCH Medical Center; 14) Slippery Rock, Ball State, and San Jose State; and 15) Wisconsin, Hawaii, Georgia Southern, and Alabama. For these top 15 institutions, 42.4% of scholarly activity was conducted relevant to domain 3, rehabilitation and reconditioning of athletic injuries, 26.1% relevant to domain 2, recognition, evaluation, and immediate care of athletic injuries, and 19.3% relevant to domain 1, injury prevention. A paucity of scholarly activity was conducted pertinent to domain 5, professional development and responsibility, and domain 4, health care administration, at 7.6% and 4.6% respectively. Data revealed the following Approved Graduate Athletic Training Curriculums (AGATCs) productivity ranking: 1) Virginia; 2) Indiana State; 3) Temple; 4) North Carolina-Chapel Hill; 5) Florida; 6) San Jose State; 7) Western Michigan; 8) Indiana; 9) both Arizona School of Health Sciences and Illinois-Urbana; 10) both the California University of Pennsylvania and Oregon; and 11) Old Dominion. Consistent with the data for the top 15 institutions, the scholarly activity specific to the AGATCs was 49.4% for domain 3, 24.7% for domain 2, and 18.5% for domain 1. As with the top 15 institutions, there was a dearth of productivity relevant to domain 4 and 5, as they were 4.9% and 2.5% respectively. Potential students can utilize this information to identify whether institutions are productive in areas of particular interest to them in order to make informed decisions about continuing their education. Consumers of this research must understand, however, that productivity rankings may not be indicative of the quality of research or education provided by a particular institution.

**Tenure-Track Program Directors—Can You Have It All?**

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The termination of the internship route to certification in 2004 has resulted in a flood of athletic training program director openings in the 1999 and 2000 hiring years. These newly hired athletic training program directors (and those to follow in the immediate four years) are going to be facing a much different academic environment than the program directors of the past. Today's academic expectations include athletic training education program accreditation and tenure pursuits through quality teaching, research, funded grants, other scholarly activities, and university/community service. The purpose of this study was to investigate publication rates, funded grants, athletic involvement, and their affect on tenure acquisition for athletic training program directors of CAAHEP accredited programs. Undergraduate CAAHEP accredited athletic training programs (N=88) were identified by the 1997-1998 Accredited Athletic Training Education Programs Publication by the NATA. A questionnaire was developed that included inquiries regarding institutional tenure expectations and other job responsibilities of the athletic training program director. The program directors were contacted by telephone and asked to answer the survey. The data was coded, entered into, and analyzed by SPSS software. The telephone survey resulted in an 87% response rate (N=77). Forty-two percent of the program directors had been in their position less than 7 years. Twenty-nine percent were on the tenure rack and 42% had already acquired tenure. Only 15% of the program directors could correctly name their institution's Carnegie classification level. Thirty-six percent of the program directors had never published a single article. The program directors, as a group, had published 275 total refereed articles. Tenured faculty contributed 14% of that total, while 63% of the articles (N=172) were published by the tenure-track group. Forty-nine percent of the program directors had secured funded grants. The program directors were diversified in extra commitment to athletics. Forty-two percent were involved in sports coverage and 27% traveled with sports teams. A major problem foreseen by this research is of new tenure track program directors learning (on the job) how to be fully recognized faculty members across their campuses (through teaching, research, publications, and service beyond athletics) while achieving tenure and advancing up the ranks to associate and then full professor. Without proper faculty development, the athletic training program directors of the early 21st century will prostitute their personal careers, not achieve tenure, and be forced to walk away from the athletic training educational programs that they developed.

**Job Responsibilities Among Athletic Training Educators In NATA/CAAHEP Accredited Athletic Training Educational Programs**

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Like other health professionals, the majority of athletic training educators (ATEs) have multiple responsibilities. However, the workloads of ATEs may be greater since there are fewer educators and clinicians in athletic training educational programs (ATEPs). Therefore, the purpose of this study was to determine the relationship between ATEs' primary job responsibility and other employment characteristics (length of appointment, academic rank, tenure status, teaching load, advisee load, publications/presentations, and grants). After an ATE questionnaire was developed and validated, the researchers mailed packages (containing 5-9 questionnaires, consent forms, and return envelopes) to every program director (PD) of a NATA and CAAHEP accredited ATEP (n = 98). The PDs were asked to distribute questionnaires to each NATA certified athletic trainer in their ATEP who taught at least 1 athletic training course per year, collect them when they were finished, and return them to the researchers. A total of 147 questionnaires were returned by 52 ATEPs (53%). The data were coded and analyzed with SPSS-X 9.0. The results indicated that the primary job responsibility of the educators in this study were as follows: PD (22%), other full-time professor (27%), associate or assistant athletic trainer (22%), and head athletic trainer (14%). Sixty ATEs (41%) were employed by their institutions on a 9-month contract, while thirty-eight (26%) were employed on a 12-month contract. Academic rank and tenure status can also contribute to the educator's job responsibilities. While only 13 ATEs (9%) were Full Professors, the primary academic faculty (36% of PDs and 60% of full-time professors) had Assistant Professor status and the primary clinical faculty (40% of head athletic trainers and 50% of assistant athletic trainers) had Instructor status. Furthermore, eight-two educators (56%) were in a non-tenure track position - most of the PDs (48%) and other full-time professors (40%) were already tenured. With respect to academic responsibilities, most educators taught only two (36%) or three (30%) undergraduate classes per semester. As advisors, PDs and full-time professors saw undergraduate students (88% and 92%) and masters students (85% and 75%, respectively). With respect to scholarship, only about 78% of the PDs and 38% of the primary clinical faculty published articles in referred journals. In addition, forty-seven percent of all ATEs have published articles in non-referred journals, 80% gave professional oral presentations, and 36% wrote grant proposals. In order to gain recognition among academic peers from other disciplines, athletic training educators are accepting more job responsibilities.

## Effects Of Magnesium Sulfate And Warm Baths On Non-Traumatized Ankle Volumes

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The use of Magnesium Sulfate, better known as Epsom Salts (ES), has been a common medical and home treatment for the management of soft tissue injuries. In particular, ES baths are purported as an effective clinical treatment in controlling extremity edema. The purpose of this study was to examine the effects of ES and warm baths (WB) on non-traumatized ankle volumes. Thirteen males and three females; age =  $24.3 \pm 1.3$  yr., height =  $178.2 \pm 7.0$  cm., weight =  $83.6 \pm 14.2$  kg.; participated in the study. Each subject reported for two randomly assigned experimental conditions on two separate days. For each experiment, subjects rested supine for 15 minutes prior to the initial limb volume measurements. Ankle volumes were determined by placing the limb in a customized tank and weighing the amount of displaced water (1ml = 1g). Repeated measurement of a volume-standard Plexiglas cylinder using this system have produced high validity (measurement error = -0.7-0.1%) and reliability (coefficients of  $r = 0.92-0.96$ , coefficient of variation = 0.5%) factors. Each subject was exposed to two treatment conditions; 1) warm water bath at 40°C, 2) ES baths (120 grams per liter of water) at 40°C for 20 minutes after the initial limb measurement was calculated. Immediately following each experimental condition a second ankle volume measurement was taken. Ankle volumes for WB were  $1261 \pm 171$  ml and  $1280 \pm 175$  ml for pre and post measurements respectively; pre and post ES ankle volumes were  $1259 \pm 174$  ml and  $1273 \pm 172$  ml respectively. Paired t-tests were used to examine differences between pre and post treatment conditions ( $P < 0.05$ ). Epsom Salts and WB caused significant increases in ankle volumes after 20 minutes of exposure. We conclude that ES baths, in the manufacture's recommended solution concentration, and warm baths significantly increase ankle volumes in non-traumatized subjects. Clinicians and patients who use ES and/or warm baths should be cognizant of the significant increases in ankle volume that occur from these therapies.

## Back Plasters Do Not Increase Muscle Temperature During Exercise

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**Objective:** To examine the effects of commercial back plasters and their ability to change intramuscular temperature of the gastrocnemius during a 15 minute exercise session. **Design and Setting:** Intramuscular temperature was measured at a depth of 2 cm using a 23-gauge thermistor needle connected to a monitor. Each subject was tested with one back plaster applied to the posterior aspect of one calf, while an identical size piece of moleskin was similarly applied to the contralateral calf. Each subject exercised for 15 minutes on a squatting board angled at 65 degrees. Placement of the back plaster and moleskin were randomly selected. **Subjects:** Fourteen males, (age =  $22.9 \pm 2.1$  years; height =  $182.15 \pm 10.89$  cm; weight =  $87.72 \pm 28.18$  kg;) volunteered to participate in this study. **Measurements:** Intramuscular temperature was measured at the beginning of each exercise session (baseline), every minute during exercise for 15 minutes and every minute after exercise for 5 minutes. Heart rate was also recorded every minute throughout the study. **Results:** Data were analyzed with a two-way ANOVA with repeated measures on one factor. The results showed no significant difference in muscle temperature between the back plasters and moleskin groups. The results showed a statistically significant temperature increase of both the back plaster and moleskin over the 6th time period of exercise, however, the temperature changes were minimal ( $< .4$  °C). At the end of the exercise bout, we asked the subjects which leg felt warmer. All but 1 of the 14 subjects perceived that the leg with the back plaster applied felt warmer. **Conclusions:** Although back plasters produce a sensation of muscle warmth, they do not cause a significant increase in intramuscular temperature, when compared with a placebo product (moleskin).

## Therapeutic Magnets Do Not Affect Tissue Temperatures

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**Objective:** Manufacturers of commercially available "therapeutic" magnets claim that these magnets cause physiological thermal effects that promote tissue healing. This study was conducted to determine if skin or intramuscular temperatures differ between a magnet, sham, or controls over 60 minutes of application to the quadriceps. **Design and Setting:** A 3 x 3 mixed model factorial design with repeated measures on both independent variables was used. The first independent variable, application duration, was random and had three levels (20, 40, 60 minutes). The second independent variable, treatment, was fixed and also had three levels (magnet, sham, and control). The dependent variable was tissue temperature change (°C). Measurement depth served as a control variable, with two levels: skin and 1 cm below the fat layer. Data were analyzed using a repeated measures ANOVA. **Subjects:** Thirteen healthy student volunteers (8 male, 5 female, age  $20.5 \pm 0.9$  y, height  $176.8 \pm 10.4$  cm, weight  $73.8 \pm 11.8$  kg, anterior thigh skinfold  $16.9 \pm 6.5$  mm), participated in this study. **Measurements:** Temperatures were measured at 30-second intervals using surface and implantable thermocouples. Temperature data at 20, 40, and 60 minutes were used for analysis. Each subject received all three treatments on different days. **Results:** Neither skin nor intramuscular temperatures were different across the three treatments at any time. Additionally, no increase in temperature was seen over time during any of the treatments. **Conclusions:** No significant thermal effect was observed with any treatment over time. We conclude that these flexible therapeutic magnets are not effective at increasing skin or deep temperatures, contradicting one of the fundamental claims made by magnet distributors.

### A Therapeutic Magnet Has No Effect On Grip Strength

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**Objective:** To determine the effects, if any, of a Nikken Kenko mini magnetic disc on grip strength

**Design and Setting:** A single-blind 1x3 repeated measures factorial with three levels of the independent variable (control, placebo magnet, active magnet) guided this study. Hand grip strength was measured as the dependent variable.

**Subjects:** 30 college females volunteered to participate

**Measurements:** Subjects performed 6 sub-maximal grip strength trials followed by 9 maximal contractions (3 for each of 3 conditions). Subjects rested 2 minutes between trials and an additional 3 minutes between conditions. Order of conditions was established with a Balanced Latin Square. Grip strength was measured with a JAMAR Grip Strength dynamometer. Active and placebo disks were taped to the forearm over the belly of the finger flexors with a strip of 1" adhesive tape. The placebo disc was made with Orthoplast and black moleskin and appeared to be the same size, shape, and color of the active disc.

**Results:** There were no differences in grip strength (average or maximal) between conditions.

**Conclusion:** Nikken Kenko Mini disc magnets have no effect on grip strength of untrained female subjects. Prospective buyers of magnetic products should be weary of advertisements and testimonials claiming strength gains from wearing magnets over the muscle.

### Kinesiotape® Does Not Reduce The Pain Or Swelling Associated With Delayed Onset Muscle Soreness

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**Objective:** Kinesio Tape® is being marketed with claims that it helps to alleviate numerous medical afflictions by lifting the skin and purportedly stimulating the neurological and circulatory systems. To date, these claims have not been examined in the scientific literature. Therefore, we investigated the effects of KinesioTape® on pain and swelling using a delayed onset muscle soreness (DOMS) model in the wrist flexors. **Design and Setting:** A 3 x 6 mixed model factorial with repeated measures on the second variable (time). The first independent variable, tape application was fixed with three levels (immediately following DOMS induction, 24 hours post-induction, and control). The second independent variable, post-DOMS time, included six levels (0, 24, 48, 72, 96, and 120 hours). Dependent variables were pain and swelling. Data were analyzed using a MANOVA, univariate main effects testing, and Tukey post-hoc comparisons. **Subjects:** Fifteen individuals (age = 24.9 ± 1.2 y, mass = 68.5 ± 3.7 kg, height = 168.1 ± 8.7 cm) participated in this study after completing health-status questionnaires. Subjects with history of upper extremity pathology within the past year were excluded. **Measurements:** Dependent measures were assessed immediately following the induction of DOMS in the wrist flexors and every 24 hours thereafter for 5 days. Pain was assessed using a 10 cm visual analog pain scale while the subjects' wrist flexors were passively stretched with a 11.36 kg dumbbell. Swelling was assessed gravimetrically using a volumeter and a top-loading balance to measure the mass of the collected run-off. A wetting agent was added to the water to reduce surface tension, improving emptying of the volumeter. **Results:** There were no differences between any of the tape conditions ( $F_{(4,20)} = 1.0, p = 0.41$ ). A main effect was noted for post-DOMS time ( $F_{(10,20)} = 4.6, p < 0.001, h^2 = 0.28$ ) for both dependent variables. For the time main effect, pain was greater at 48 hours than at 24 or 72 hours, pain at 96 hours was greater than at 120 hours, and swelling was greater at 48 hours than at 24 hours or 72 hours. **Conclusion:** When applied immediately or at 24 hours post-exercise, KinesioTape® does not reduce the pain or swelling associated with DOMS. With DOMS, changes in both pain and swelling are seen over time with a peak at 48 hours post-exercise and declining to near baseline levels by 120 hours.

## Intramuscular Temperatures During Cryotherapy With Three Different Cold Modalities

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**Objective:** Because different cold modalities possess different thermodynamic properties, that they may produce different intramuscular temperatures. The purpose of this study was to examine the magnitude of cooling produced by three commonly used forms of cryotherapy. **Design and Setting:** A 3 X 4 X 4 factorial with repeated measures on the first (depth) and second (treatment) variables was used. Independent variables were depth of temperature measurement (surface, fat + 1 cm, fat + 2 cm), treatment (ice bag, Ice-Pak®, Flex-I-Cold®, control) and ordinal position of treatment (first, second, third, fourth). The dependent variable was lowest temperature recorded during treatment. Treatment order was counter-balanced using a Latin Square. Data were analyzed using a repeated measures ANOVA, simple main effects testing and Tukey post-hoc procedures. **Subjects:** Fifteen volunteers (age 21.7 ± 1.2 y, height 177.8 ± 8.9 cm, mass 75.2 ± 3.4 kg, anterior thigh skinfold 19.3 ± 4.1 mm) who were free of lower extremity pathology served as subjects for this study. **Measurements:** Skin and intramuscular temperatures (1 cm & 2 cm below subcutaneous adipose layer) of the thigh were measured at 30 second intervals both before and during the 30 minute treatments with the coldest temperature reached used for analysis. All temperature measurements were made using a thermocouple thermometer and Type T surface and implantable thermocouples. Compression was standardized across all treatments. **Results:** Significant main effects were observed for depth ( $P < 0.005$ ) and treatment ( $P < 0.005$ ) and a significant interaction effect was observed between depth and treatment ( $P = 0.04$ ). For the depth main effect, superficial measurement depths were colder than deeper depths. For the treatment main effect, all cold treatments were colder than controls, and the two ice-based treatments were colder than the frozen gel pack (Flex-i-Cold®). For the interaction effect, temperature differences between treatments at the skin surface were greater than at either of the intramuscular depths. Cold treatments were colder than controls at all depths and the icebag and Ice-Pak® were colder than the Flex-i-Cold® at the skin surface and at 1cm. Order of treatments did not produce a significant effect. At the skin surface, lowest temperatures observed were Flex-I-Cold 8.42 ± 3.41°C, ice bag 6.47 ± 3.37°C, Ice-Pak 6.24 ± 1.42°C. At 1 cm sub-adipose, lowest temperatures observed were Flex-I-Cold 29.46 ± 2.4°C, ice bag 27.72 ± 3.46°C, Ice-Pak 27.21 ± 3.67°C. At 2 cm sub-adipose, lowest temperatures observed were Flex-I-Cold 33.07 ± 1.49°C, ice bag 31.82 ± 2.24°C, Ice-Pak 30.59 ± 2.95°C. **Conclusions:** The use of modalities that undergo a phase change results in statistically lower skin and 1cm intramuscular temperatures than cold modalities that do not possess these properties, but these differences are not seen at deeper measurement depths.

## The Relationship Between Intramuscular Temperature, Skin Interface Temperature, And Skin Fold Measurement During And After Cryotherapy

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**Objective:** Controversy exists concerning the relationship between subcutaneous adipose thickness and intramuscular temperature. The twofold purpose of this study was to examine the relationship between skin and intramuscular temperature and to describe the relationships between muscle temperature, skin temperature, room temperature, body core temperature, and subcutaneous adipose thickness. **Design and Setting:** A multiple linear regression was used. The independent variables were skin temperature, body core temperature, subcutaneous adipose thickness, and room temperature. The dependent variable was intramuscular temperature. **Subjects:** Fifteen volunteers (age = 22.9 ± 1.5 y ht=169.16 ± 8.41 cm; wt = 69.79 ± 13.13 kg; anterior thigh skin fold = 21.19 ± 8.60mm) without vascular disease, neurological problems, or thigh skin fold measurements greater than 40 mm participated. **Measurements:** Intramuscular temperature (2 cm + subcutaneous adipose layer), room temperature, and skin temperature were measured with a thermocouple thermometer using 4 surface thermocouples and one implanted intratissue thermocouple. Body core temperature and anterior thigh skinfold were also measured. **Results:** Pearson product moment correlation coefficients were determined for each predictor variable of intramuscular temperature during (skin temperature:  $r = 0.463$ ; skinfold:  $r = 0.373$ ; time:  $r = -0.593$ ; core temperature:  $r = 0.208$ ; room temperature:  $r = -0.474$ ) and following (skin temperature:  $r = 0.705$ ; skinfold:  $r = 0.272$ ; time:  $r = 0.759$ ; core temperature:  $r = -0.046$ ; room temperature:  $r = -0.206$ ) cold applications. Curve estimations were used to determine the equation of the line of best fit for each variable. A multiple regression equation ( $R^2 = 0.759$ ) was developed to predict intramuscular temperature during ice application. A separate equation ( $R^2 = 0.810$ ) was developed to predict muscle temperatures following ice application. **Conclusions:** During and after ice application, no single predictor adequately explained the change in intramuscular temperature. Clearly, the use of skin surface temperature independently to measure the efficacy of cryotherapy on underlying tissues is inadequate. Therefore, cryotherapy researchers should use direct measurement of intramuscular tissue or use our equation to estimate intramuscular temperature.

## Pain Perception Is Greater During Ankle Ice Immersion Than During Ice Pack Application

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**Objective:** Our clinical observation is that cold applications during immediate care of sports injuries are rarely painful for the athlete, whereas during rehabilitation, they almost always cause pain until the athlete adapts to the cold. Is this because pain is a function of cold intensity (ice packs do not cause as great of a temperature decrease as immersion does) or because the pain associated with injury may counteract the cold pain. Our purpose, was to compare pain perception in healthy subjects between and during ice pack application and immersion in 1°C water. **Design & Setting:** A 2 x 6 factorial with modality (crushed ice pack & immersion) and time (0,5,10,15,20,25) as independent variables was used. Five measures of pain perception were computed from the Borg and McGill pain scales: Borg intensity and McGill sensory, affective, evaluative, and miscellaneous. Treatments were administered in the Sports Injury Research Laboratory. **Subjects:** 38 uninjured male and female college student volunteers. **Measurements:** Subjects recorded their pain perception by circling appropriate descriptors on a single sheet of paper within the first 10 seconds of the cold modality application and at each 5 minute interval thereafter for a total of 6 measures (between the 5<sup>th</sup> and 6<sup>th</sup> immersion measure, subjects walked around the lab for 3 minutes and the 6<sup>th</sup> measure was taken immediately after re-immersion). Data were analyzed with a 2-way MANOVA, 5 2-way ANOVA's, 10 1-way ANOVA's and Duncan multiple range tests. **Results:** Pain (all 5 indices) was greater during immersion than during ice pack application and greater immediately after modality application than during subsequent measurements. For ice pack, there was no further decrease in pain after 5 minutes. For immersion, pain immediately after immersion >5min >10 & 15 min. Initial pain was less immediately after re-immersion than during the initial and 5 minutes of the first immersion. **Conclusions:** It appears that cold pain during immersion is greater than during ice pack application. Also, pain during a second immersion is less than during a first immersion (at least in this situation, which included walking for 3 minutes between immersions).



## Intramuscular Temperature Does Not Differ Among Hydrocortisone Preparations During Phonophoresis

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**Objective:** Hydrocortisone treatments constitute the majority of phonophoresis treatments. However, the concentrations of mixtures that best allow for the thermal benefits of ultrasound remain unknown. Therefore, the purpose of this study was to determine if a pre-prepared mixture of hydrocortisone powder suspended in ultrasound gel is more effective in allowing for increases in intramuscular tissue temperature during phonophoresis treatments than a cream based hydrocortisone and ultrasound gel mixture at the concentrations of 1% and 10%. **Design and Setting:** A 2x5 factorial design with repeated measures on both variables was utilized. The independent variables were treatment type (10% hydrocortisone cream and ultrasound gel mixture, 1% hydrocortisone cream and ultrasound gel mixture, 10% hydrocortisone powder and ultrasound gel mixture, 1% hydrocortisone powder and ultrasound gel mixture, and the control 100% ultrasound gel) and depth (3cm and 5cm). The dependent variable was change in tissue temperature during a phonophoresis treatment. The study took place in the Sports Injury Research Laboratory at Indiana State University. **Subjects:** Twenty-five male and female students (22-27 years old) volunteered for the study after signing a human consent form. Those who had circulatory problems, blood-clotting problems, or any conditions that were contraindicated by ultrasound or hydrocortisone were excluded from the study. **Measurements:** The change in intramuscular temperature was measured with thermocouples that were inserted 3cm and 5cm deep in the medial triceps surae. Muscle temperature was recorded every 30 sec during the 90 sec stabilization period and the 7-minute 1MHz ultrasound treatment at an intensity of 1.5W/cm<sup>2</sup>. **Results:** Intramuscular temperatures were not different between the five treatment groups across the two depths for tissue temperature change ( $F_{(4,25)} < 1, p = 0.443, 1-b = 0.252, \text{effect size } (h^2) = 0.163$ ). Intramuscular temperature was greater at 3cm than 5cm ( $F_{(1,25)} = 11.27, P = 0.003, \text{effect size } (h^2) = 0.36$ ). No differences were observed for the depth and group interaction ( $F_{(4,25)} < 1, P = 0.95, 1-b = 0.559, \text{effect size } (h^2) = 0.314$ ). **Conclusions:** When the thermal effects of ultrasound are desired during a phonophoresis treatment, any of the studied hydrocortisone mixtures will result in similar temperature changes.

## Intramuscular Temperature Does Not Differ Between Direct Ultrasound Application And Application With Commercial Gel Pads

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**Objective:** Intramuscular temperatures during ultrasound using commercial gel pads have not been well described. The purpose of this study was to compare the changes in tissue temperature during ultrasound with a commercially manufactured gel pad and ultrasound gel. **Design and Setting:** A repeated measures design was used. The independent variable was treatment with two levels, gel pad and gel alone. The dependent variable was peak tissue temperature. **Subjects:** Thirteen physically active male and female student volunteers (age = 21.3 ± 1.4 y) without lower extremity pathology gave consent and participated in this study. **Measurements:** Subjects reported to the lab on two separate occasions for ultrasound treatments, once with standard ultrasonic gel as the conducting medium and once with the gel pad as the medium. A 1-MHz continuous ultrasound treatment was administered for 7 min at an intensity of 1.5 W/cm<sup>2</sup>. The ultrasound head was moved 4 cm/sec covering an area whose length was twice the diameter of the sound head and the width was equal to the diameter of the sound head. Tissue temperature was measured every 10 seconds using implantable thermocouples inserted to a depth of 3 cm below the surface of the right, medial calf. Data were analyzed using an ANCOVA with mean pre-temperature measurement as the covariate. **Results:** Tissue temperatures increased over time during both treatments, but no difference in temperature was observed between ultrasound treatments using gel and those performed using gel pads. were not different from each other. **Conclusions:** Because temperature changes were similar with both treatments, we conclude that these coupling methods are equivalent. When thermal ultrasound effects are desired, gel pads can be used in place of the conventional method of applying ultrasonic gel.

## The Cumulative Effect Of Multiple Phonophoresis Treatments On Dexamethasone And Cortisol Concentrations In The Blood

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The purpose of this study was to assess the effects of ultrasound treatments on the penetration of dexamethasone sodium phosphate. It was hypothesized that thermal ultrasound parameters would significantly increase the amount of dexamethasone that penetrates the stratum corneum and enters the blood stream. Thirty healthy male and female subjects between 18-33 yrs of age volunteered to participate in the study. Subjects were assigned to one of three treatment groups (thermal, non-thermal, and sham) through a modified random assignment. This study required an 8-day subject commitment during which each of the 30 subjects received a total of 4 phonophoresis treatments, while 6 blood samples were drawn. A repeated measures ANOVA and Tukey post hoc analyses for dexamethasone revealed a significant Group x Test interaction  $F(10,135) = 2.354; p = 0.014$ . The analyses for cortisol revealed no significant Group x Test interaction  $F(10,135) = 0.318; p = 0.975$ . These results indicate that the thermal ultrasound group had significantly increased penetration of dexamethasone when compared to both the baseline measurements and the sham ultrasound group after each of the first two treatments. From this we can conclude that thermal ultrasound parameters are the most beneficial ultrasonic parameters to utilize when administering dexamethasone by phonophoresis. Additionally, following treatment days 3 and 4, the dexamethasone levels were still elevated but not significantly above the levels of the baseline and sham values. From this we can conclude that the metabolism of the dexamethasone through the liver is at such a rate that the amount of penetration is slightly less than the amount that is being metabolized. Thereby, we can conclude that dexamethasone phonophoresis should only be utilized for 2-3 days before it is no longer considered beneficial. Conversely, non-thermal ultrasound also increases penetration of dexamethasone, however, not at a significant level. The results of this study allow us to conclude that both the thermal and non-thermal ultrasound parameters increase dexamethasone penetration, yet thermal parameters are the most beneficial. A clinician must choose ultrasound parameters depending on the stages of healing, with the addition of dexamethasone most beneficial when administered with thermal ultrasound. Future research should further investigate ideal treatment parameters, and when during a treatment session dexamethasone should be administered. Additional research utilizing actual tissue samples will allow for a better understanding of target tissue absorption and penetration depth. At this time it can be concluded that thermal ultrasound is the most beneficial ultrasound to utilize during phonophoresis with dexamethasone sodium phosphate.

### Significant Intramuscular Temperature Rise Obtained When Topical Analgesics: Nature's Chemist And Biofreeze, Were Used As Coupling Agents During Ultrasound Treatment

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**Objective:** To determine the effectiveness of Nature's Chemist as an ultrasound coupling agent compared to Biofreeze, Aquasonic 100, and a sham treatment in producing intramuscular temperature increase during a typical ultrasound treatment. **Design and Setting:** Subjects were randomly assigned to one of four treatment groups. Groups 1-3 received continuous ultrasound at 1.0 W/cm<sup>2</sup> for 10 minutes at a frequency of 3 MHz over their posterior calf. Group 4 received a sham treatment. Group 1 used 100% Aquasonic 100, Group 2 used 50% Biofreeze/50% Aquasonic 100, Group 3 used 50% Nature's Chemist/50% Aquasonic 100, and Group 4 used 50% Aquasonic 100/50% Nature's Chemist. We used a modified visual analogue scale, to measure each subject's perception of heat at the treatment area during and after treatment. **Subjects:** Forty college students (age = 22.5 +/- 2.0 yr; ht = 175.5 +/- 8.0 cm; wt = 71.6 +/- 13.1 kg; calf skinfold = 17.8 +/- 7.2 mm) volunteered to become subjects. **Measurements:** Intramuscular temperature was recorded at 15 sec intervals for 25 min at 1 cm below the subcutaneous fat with a thermocouple. Differences were analyzed within and between groups at the beginning of the treatment (T0), the end of the ultrasound treatment (T10), and 15 min post-treatment (T25). **Data Analysis:** Overall differences between groups were analyzed by a MANOVA on the major time points of interest. ANOVA's were used to analyze temperature change from (T10-T0) and from (T25-T0). We used the Duncan's Multiple Range test as our post-hoc test to see where the individual differences between groups were. **Results:** Intramuscular temperature increases in groups 1-3 were significantly different from Group 4 (Sham) but they were not significantly different from each other. Group 1 (Aquasonic 100) increased 7.47 +/- 1.8°C, Group 2 (Biofreeze) increase 6.52 +/- 1.6°C, Group 3 (Nature's Chemist) increased 6.99 +/- 1.1°C, and Group 4 (Sham) decreased .56 +/- 0.3°C. There were no significant differences between group 1-3 in their perception of heat at T5 and T10. **Conclusion:** Our results indicate that at a frequency of 3 MHz and an intensity of 1 W/cm<sup>2</sup>, Nature's Chemist and Biofreeze mixed 50/50 with Aquasonic 100 are effective coupling agents. Perceptions of heat by the patient may not be indicative of actual temperature increases within the muscle.

### The Effect Of Superficial Pre-Heating On The Magnitude And Duration Of Temperature Elevation With 1 MHz Ultrasound

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Ultrasound is frequently used in rehabilitation to provide penetrating heat. Recent studies have identified appropriate parameters required to raise temperature to different levels at various depths. Ultrasound with these parameters will raise temperature to a therapeutic level but must be terminated to prevent overheating, resulting in a short duration of therapeutic heating. The purpose of this study was to assess effectiveness of superficial heating prior to ultrasound on the subsequent magnitude of temperature elevation and rate of temperature decline. Ten subjects (age 25.3±3.6 yr, 1.84±.07 m, 93.1±19.3 kg) received ultrasound under the following conditions, 1) ultrasound only and 2) ultrasound following superficial heating. Temperature was allowed to return to baseline between trials and the treatment order was counter-balanced. Skin over the left triceps surae was shaved and thoroughly cleaned. The skin and underlying muscle were anesthetized with a 1-cc injection of 1% lidocaine. A microprobe (Phystek MT-23/5, Physitemp Instruments, Clifton, NJ) was inserted into the medial belly of the triceps surae so that the temperature sensitive tip was 3.75 cm below the surface of the skin. This represents the center of the depth of penetration range for 1 MHz ultrasound. The microprobe was interfaced to a digital monitor (Bailey Instruments BAT-10, Physitemp Instruments, Clifton, NJ). Superficial heat was provided by hydrocollator packs (Chattanooga Group, Inc., Hixson, TN) and ultrasound was provided with a Forte® 400 Combo (Chattanooga Group, Inc., Hixson, TN) via a 5 cm<sup>2</sup> sound head. A 10 cm<sup>2</sup> template was centered over the microprobe tip and the area within was covered with transmission gel. Continuous ultrasound was administered with 3 MHz frequency and 2.0 W/cm<sup>2</sup> intensity. Temperature was continuously monitored during 15 minutes of ultrasound and for 15 minutes after ultrasound was terminated. The temperature increase and percentage of temperature decline were analyzed separately with paired dependent t-tests. The temperature increase with ultrasound was significantly greater following pre-heating (p=0.0053) with mean temperature increases of 4.0°C following pre-heating and 3.0°C with ultrasound alone. The percentage of temperature decline was significantly less with pre-heating (p=0.0019) with percent declines of .56 when pre-heating was used and .70 with ultrasound alone. Therefore, to increase the magnitude and duration of temperature elevation with ultrasound, superficial pre-heating is recommended. The rate of temperature elevation with ultrasound in this study was less than that previously reported in the literature. Therefore, future research should compare the effectiveness of different ultrasound units.

### Pulsed Short-Wave Diathermy Application Prior To Stretching, Does Not Appear To Aid Hamstring Flexibility

Miner L, Draper DO, Knight KL, Ricard RM: Brigham Young University, Provo, UT

**Objective:** To compare the effects of low-load, long duration stretching after or without high intensity pulsed short-wave diathermy (PSWD) on hamstring flexibility. **Design and Setting:** A single blind, repeated measures design (pretest and posttest for all treatments) that included a placebo was used. The three independent variables were treatment mode, pretest/posttest measurements and day. Treatment mode had three levels including PSWD and stretch, stretch alone and control. The dependent variable was range of motion. Subjects were randomly assigned to each of the three groups. Subjects were treated and tested each day (at approximately the same time) for 5 days, with a follow-up test administered 72 hours later. Flexibility was tested before and after each treatment. Diathermy/stretch subjects received a 15 minute PSWD (Magnatherm™, Kansas City, MO) treatment on the right hamstring at a setting of 7000 pulses per second with an average pulse width of 95 µsec. Stretch only subjects received a 15 minute sham PSWD treatment. Both PSWD/stretch and stretch only subjects then performed three 30 second stretches before being retested. Control subjects lay prone for 15 minutes before being retested. **Subjects:** Thirty-seven (M = 11, F = 26, age = 20.46 ± 1.74 years) healthy college students volunteered to participate. **Measurements:** Hamstring flexibility was measured using a sit-and-reach box before and after each treatment. **Results:** The average increase in hamstring flexibility over the five treatment days for the PSWD/stretch, stretch only, and control groups was 6.06 cm (19.6%), 5.27 cm (19.7%), and 3.38 cm (10.4%), respectively. Three days later (after no treatment) the values for the PSWD/stretch, stretch only, and control groups were 8.27 cm (26.7%), 6.83 cm (25.3%), and 4.15 cm (14.2%), respectively. There was no significant difference in hamstring flexibility between the two treatment groups. **Conclusion:** Our results show that PSWD/stretch is no more effective than stretching alone at increasing hamstring flexibility.

## Pulsed Short Wave Diathermy Restricts Swelling And Bruising Of Patients

Draper DO, Castel JC, Abergel RP, Schlaak C: Brigham Young University, Provo, UT

**Objective:** The purpose of this study was to evaluate the effect of pulsed short-wave diathermy on the recovery of patients undergoing liposuction. **Subjects:** Ten female patients (38.4 yrs., height = 168.5 cm., weight = 69 kg) volunteered to participate in the study as part of their liposuction surgery. **Design and Setting:** One day prior to the surgery, subjects signed an informed consent form and underwent pre-operative screening. At this time girth measurements were taken of the widest portion of each thigh while standing. The next day, a nurse treated one thigh with 27.12 Mhz pulsed short-wave diathermy for 20 minutes prior to surgery, while the contralateral thigh received no diathermy treatment. The surgeon then performed liposuction evenly to both thighs. The surgeon was blinded to which thigh received the diathermy treatment. **Measurements:** Patients returned for follow up visits 1 day and 5 days post-op. On these visits, patients swelling, bruising and level of pain were measured, and they were given another 20 minute pulsed short-wave diathermy treatment. **Results:** The area treated with diathermy demonstrated a significant decrease in swelling at day 1 (+.66 cm vs +1.38 cm) and day 5 (-0.5 cm vs -0.1 cm). The area treated with diathermy also resulted in significantly less bruising at day one (15.31 cm<sup>2</sup> vs 18.62 cm<sup>2</sup>). There was no significant difference in bruising on day five. Pain was rated as mild, and thus showed no significant difference when comparing the two areas. **Conclusions:** Pulsed short-wave diathermy restricts and decreases swelling and bruising following liposuction surgery. **What does this study have to do with athletic training? Plenty.** Two of the factors often dealt with in treatment of injuries are swelling and bruising. To date, researchers have had a difficult time inflicting bruising and swelling in a human model in an effort to study modality intervention, but have had to wait for an athlete to get injured. When the athlete gets injured, usually the contralateral limb remains unharmed, so we don't have a true control group. In this study, swelling and the associated bruising were induced in both limbs. This allowed us to treat one limb with diathermy, while the contralateral limb served as the control. Because of the aggressive nature of liposuction, most patients experience post-operative swelling and bruising. If, as we have shown, pulsed short-wave diathermy prevents and/or decreases swelling and bruising of liposuction patients, it may indeed decrease swelling and bruising associated with athletic injuries.

## Free Communications, Oral Presentations: Ankle Edema

Friday, June 30, 2:45PM-3:30PM, Cleveland B; Moderator: Michael G. Dolan, MA, ATC, CSCS

### The Effects Of Focal Compression On Swelling Associated With Lateral Ankle Sprains

Nettles RJ, Kaminski TW, Horodyski MB, Nicolette G: University of Florida, Gainesville, FL

Reduction of edema associated with acute lateral ankle sprain has been a primary treatment objective of clinicians in the early phase of treatment for many years. Recent studies have suggested that an effective method for reducing edema can be accomplished through the use of focal compression. The purpose of this study was to determine if differences existed between a "U" shaped pad (horseshoe pad) with a compression wrap, the Aircast Air-Stirrup® brace (Aircast, Inc., Summit, NJ) and the Omni Advanced Ankle Orthosis® (AAO) (Omni Scientific, Inc., Springville, UT) in their ability to reduce swelling associated with grade II lateral ankle sprains. A total of sixteen male (9) and female (7) subjects (age=20.4±2.1 yr., wt=72.6±13.6 kg, ht=174.8±11.8 cm) participated in this study. Each subject was diagnosed with a grade II lateral ankle sprain by a licensed physician and referred to the study within 24 hours after the injury. Each subject was randomly assigned to one of the three treatment groups: "U" shaped pad (5), Air-Stirrup® (5) and AAO (6). Volumetric displacement (ml), subjective pain measurements using a visual analog scale (VAS), and functional ability measurements using a VAS were recorded at 0, 24, 48 and 72 hours post-injury. A standardized daily treatment routine was provided to all participants in two 20-minute cryotherapy sessions. The Aircast Cryoboot® was utilized to provide a uniform treatment across all subjects. Separate mixed model ANOVA's with repeated measures were utilized to determine if differences in the DV's existed across groups. Reductions in volume displacement and subjective pain plus improvements in perceived functional ability resulted after 72 hours in all subjects, however no significant differences existed between the three groups. The results suggest that none of the compression treatment methods was far superior to the others in bringing about any noticeable changes in the three dependent variables measured in this study. Compression in one of these three forms is important in producing changes in volume displacement, a decrease in pain and aid in regaining perceived functional ability. One potential flaw with volumetric displacement measurements lies with the inability of the volumeter to detect specific changes in the location of the edema. Future studies involving other means of quantifying edema reduction and the amount of ligamentous healing should be pursued to help determine whether one type of compression is far superior than another.

### Effects Of Focal And Circumferential Compression On Non-Traumatized Ankle Volumes

Marvar PJ, Ragan BG, Dolan MG, Teprovich JM, Bibi KW: Canisius College, Department of Sports Medicine and Exercise Sciences, Buffalo, NY

Compression is a component of the universally accepted PRICE method of treating acute athletic injuries. Traditionally, circumferential compression is the accepted method of controlling acute edema formation. It has been suggested that focal compression is more effective in the treatment of edema formation following ankle sprains. The purpose of this study was to examine the effects of two different modes of compression on non-traumatized ankle volumes. Eight males and eight females; age = 23.6 ± 4.1 yr., height = 175.00 ± 9.4 cm, weight = 75.3 ± 14.9 kg; participated in the study. Subjects reported for three experimental conditions on three separate days. Prior to each experiment, subjects rested supine for 15 minutes. Limb volumes were then measured in a customized tank in which volumes were determined by weighing the water displaced (1 ml = 1g). Repeated measurements of a volume standard Plexiglas cylinder using this system have produced high validity (measurement error = -0.7 - 0.1%) and reliability (coefficients of r = 0.92 - 0.96, coefficient of variation = 0.5%) factors. Subjects were exposed to the three treatments in a randomized order after the first limb measurement was recorded. Conditions were 1) dependent positioning, 2) focal compression, 3) circumferential compression. A post-volumetric measurement was taken immediately following a 20-minute treatment. Paired t-tests were used to determine differences between pre and post volumetric measurements for the three treatment groups (p < 0.05). The results indicate that dependent positioning of the limb does not cause a significant increase in ankle volumes over a 20 minute treatment. However, both circumferential and focal compression caused significant increases in ankle volumes. Further research must investigate the short-term and long-term application of compression to substantiate whether a rebound phenomenon (increased ankle volume) exists following the application of short-term compression.

### The Effects Of Gravity Dependent Positioning Following Elevation On The Volume Of Uninjured Ankle

Tsang KKW, Hertel J, Denegar CR, Buckley WE: Pennsylvania State University, University Park, PA

Although the treatment protocol of elevation is routinely prescribed during the initial management of soft tissue injuries, the individual must often resume activity in an upright position. As such, the resultant effect of gravity dependent positioning following elevation has not been extensively examined. To quantify changes in edema volume due to elevation and the return to gravity dependent positions, the effects of these positional changes must first be elucidated in a non-edematous environment. The purpose of this study was to examine the effects of gravity dependent positioning following elevation on the volume of uninjured ankles. Ten subjects (4 males, 6 females, age = 21.0 ± 0.94 yrs, height = 167.6 ± 10.1 cm, mass = 65.99 ± 15.5 kg) participated in the study. Subjects were free of previous injury, surgery, or vascular disease to either ankle or foot prior to participation in the study. Each subject rested for 10 minutes in a gravity dependent position (sitting) prior to the collection of volumetric measurements. Ankle volume was determined by immersing the limb into a volumetric tank followed by weighing the displaced water (1mL = 1g). The reliability of this volumetric measurement system was established prior to this study. This procedure provided intraclass correlation coefficient (ICC) of 0.99 and a standard error of measurement (SEM) of 1.48 to 1.64 g. After baseline measurements were obtained the subjects were placed supine on a treatment table with their right leg elevated to a position as close to vertical as possible without eliciting tension in the hamstring muscles. The treatment period lasted 30 minutes, after which the subject was returned to a gravity dependent position, sitting in a chair with both feet on the ground. Volumetric measurements were then performed every 5 minutes for the first 30 minutes, followed by two more measurements taken 15 minutes apart. The repeated measures analysis of variance revealed significant differences between the pre-treatment and post-treatment measurements (p < 0.05). Tukey post-hoc analysis revealed significantly decreased volumes (with a range from 15.3 mL immediately post treatment to 9.8 mL 60 min post treatment) between the pre-treatment measurement and each of the post-treatment measurements (0, 5, 10, 15, 20, 25, 30, 45, 60 min). The effects of the elevation treatment lasted for at least 60 minutes after the limb was returned to a gravity dependent position. Based on these results, we speculate that elevation effectively decreases volume in a non-edematous environment via increases in venous flow and lymphatic uptake of interstitial fluid. Although the results appear to support the clinical use of elevation in decreasing volume, further study must be conducted to examine if similar effects exist in injured ankles.

## Serial Testing Of Postural Control Following Lateral Ankle Sprain

Hertel J, Denegar CR, Buckley WE:  
Pennsylvania State University, University Park, PA

**Purpose:** Our purpose was to identify changes in measures of postural control during single leg stance in the 4 weeks following lateral ankle sprain (LAS). **Subjects:** Seventeen young adults (9 males, age = 21.8 +/- 5.9 yrs, mass = 74.9 +/- 10.5 kg, height = 176.9 +/- 7.1 cm) suffered acute mild or moderate LAS. Nine sprains were to the right ankle. **Methods:** Subjects reported for testing on 3 occasions: 1) within 48 hours of return to full weight bearing following LAS (day 1), 2) 2 weeks after initial testing (week 2), and 3) 4 weeks after initial testing (week 4). Postural control measures were obtained for both the injured and uninjured limbs during three 10-second trials of single leg standing on a force plate (Bertec Corp., Columbus, OH). Identical testing was performed during each testing session. The care received by subjects was left to the discretion of each subject's personal health care providers. **Statistical Analysis:** Three separate 3 factor repeated measures MANOVAs were performed on postural sway length (PSL), root mean square velocity of sway (VEL), and range of sway (RANGE). The dependent measures of postural control were calculated separately in the frontal and sagittal planes. Independent variables were side (injured versus uninjured), session (day 1, week 2, week 4), and plane (frontal versus sagittal). Post hoc testing was performed to identify specific differences. **Results:** Significant side by session by plane interactions were found for PSL ( $p=.004$ ), VEL ( $p=.011$ ), and RANGE ( $p=.009$ ). The interaction for PSL is explained by greater differences existing between injured and uninjured frontal plane PSL scores at day 1 as compared to sagittal plane PSL scores. PSL was greater on injured limbs on day 1 and week 2, but not week 4. VEL scores responded very similarly to PSL scores. The interaction for RANGE is explained by injured limb frontal plane RANGE scores being greater than uninjured values at day 1 and week 2, but not at week 4. Sagittal plane RANGE scores were greater on the injured limbs compared to the uninjured limbs at all 3 sessions. **Conclusions:** These results demonstrate significant impairments in postural control between injured and uninjured limbs at day 1 and week 2 following LAS, but not week 4. Consistent improvement in postural control measures on both injured and uninjured limbs were seen over the course of 4 weeks following LAS.

Doctoral research grant sponsored by Active Ankle Systems, Inc.

## Balance As A Predictor Of Ankle Sprain Injuries In High School Basketball Players

McGuine TA, Greene JJ, Best T, Levenson GL: University Of Wisconsin Sports Medicine Center, Madison, WI

The purpose of this prospective study was to determine if a pre-season measurement of balance could predict susceptibility to ankle sprain injury in a cohort of high school basketball players. Data were collected at five high schools during the 1997/98 and 1998/99 basketball seasons. Two hundred ten (119 male, age = 16.1 ± 1.1 yr; height = 182.98 ± 7.4 cm; weight = 76.4 ± 10.9 kg and 91 female age = 16.3 ± 1.3 yr; height = 170.9 ± 7.8 cm, 63.4 ± 8.4 kg) high school basketball players who did not sustain a time loss ankle or knee injury within the previous 12 months served as subjects. Balance was quantified from postural sway scores measured while subjects performed unilateral balance tests with eyes both open and closed on the NeuroCom New Balance Master® version 6.0 (NeuroCom International, Clackamas, OR). Testing to determine postural sway consisted of having subjects standing on a single leg, for three trials of 10 seconds, with their eyes open and repeated with their eyes closed. Subjects then underwent the same assessment while standing on the other leg. Postural sway was defined as the average degrees of sway per second (°S/S) for the 12 trials producing a compilation (COMP) score. Subjects were monitored by ATC's who documented all injuries and exposures throughout the season. Logistic regression analysis was carried out to determine if gender, leg dominance and balance scores were related to ankle sprain injuries. In addition, Fischer's exact test was used to determine if the percentage of subjects who sustained ankle injuries was the same whether the subject had poor, average or good balance. Subjects who sustained ankle sprains had a pre-season COMP score of 2.01 ± 0.32 (Mean ± SD), while athletes who did not sustain ankle injuries had a score of 1.74 ± 0.31. In general, higher postural sway scores corresponded to increased ankle sprain injury rates ( $p = 0.001$ ). Subjects who demonstrated poor balance (high sway scores) had nearly 7 times as many ankle sprains as subjects who had good balance (low sway scores) ( $p = 0.0002$ ). In this cohort, pre-season balance measurement (postural sway) served as a predictor of ankle sprain susceptibility.

## Differences In Postural Control Measures Among Healthy Individuals With Different Foot Types

Gay MR, Hertel J, Denegar CR:  
Pennsylvania State University, University Park, PA

**Purpose:** Our purpose was to identify if differences in measures of postural control exist between healthy individuals who have different architectural foot types.

**Subjects:** Thirty healthy young adults (15 male, age = 21.9 ± 2.0 yrs., mass = 71.6 ± 16.7 kg, height = 168.4 ± 13.6 cm) volunteered as subjects.

**Methods:** The feet of each subject were classified into one of three categories (pes cavus, normal, pes planus) based on of rearfoot and forefoot alignment measures according to previously reported methods. The right and left feet of the same subject could be classified into two different categories. Following classification, there were 19 pes cavus feet, 23 normal feet, and 18 pes planus feet. Subjects performed three 10 second trials of single leg stance on the left and right legs with eyes open while standing on an AMTI Accusway® force platform (AMTI Corp., Watertown, MA) interfaced with a laptop computer utilizing Swaywin® software (AMTI Corp., Watertown, MA). Dependent measures of postural control were postural sway area and postural sway velocity. Postural sway area represents the area of distribution of center of pressure excursions during a trial, while postural sway velocity represents the average speed of center of pressure movement over the course of a trial.

**Statistical Analysis:** The mean of the three trials for each dependent variable was calculated and two separate ANOVAs were conducted with foot type serving as the independent variable and mean postural sway area and mean postural sway velocity serving as the dependent variables. Post hoc analysis were performed using Tukey's tests. **Results:** Significant differences were found in measures of postural sway area among the different foot types ( $p=.035$ ). Post hoc analysis revealed that pes cavus feet were associated with significantly larger postural sway area measures than normal feet ( $p=.031$ ). No significant differences were found in postural sway velocity measures between different foot types ( $p=.91$ ,  $b=.94$ ). **Conclusions:** These results indicate that healthy individuals with pes cavus feet utilize a significantly larger area for center of pressure excursions during single leg stance than do individuals with normal feet. Thus, we recommend that when selecting matched control subjects for single leg stance postural control studies comparing pathological and healthy subjects that subjects be matched for foot type, as well as other characteristics such as age, gender, and activity level.

## The Effects Of Proprioceptive Perturbation Training On Postural Sway And Joint Reaction Times On Healthy Subjects

Eisenhauer MH, Ognibene J, Dutton S, McMahon K: Belmont University School of Physical Therapy, Nashville, TN

**Background and Purpose:** Ankle sprains are among the most common orthopaedic injuries seen today. Therefore, any mechanism that can reduce the incidence of ankle injuries would be beneficial. Unstable surface training with an ankle disk has been linked to a decreased postural sway and decreased risk of ankle re-injury. However, there are no studies using a training protocol with a means of self-perturbation. The purpose of this study was to determine how training on an unstable surface, while performing self-perturbations, will affect postural sway and ankle joint reaction time. The null hypothesis stated there would be no change in reaction times and postural sway between the control and experimental group. Our research hypothesis stated there would be a decrease in reaction times and postural sway between the groups. **Subjects:** Forty healthy male and female subjects ages 22 to 42 ( $X=27.4$ ) were recruited from the community. **Methods and Materials:** Subjects were screened for previous diseases that would affect balance as well as mechanical instability of the ankle and knee. A pre-test was performed on the EquiTest and Balance Master equipment (developed by NeuroCom) to assess reaction times to perturbations and postural sway, respectively. After the pre-test, the experimental group performed the training program three days a week for four weeks. At the end of the four weeks, both groups returned to perform the post-test. **Results:** An  $\alpha \leq .05$  was reached in two of the EquiTest conditions, backward perturbations and plantarflexion/inversion perturbations. Due to the directionality of the research hypothesis, the null hypothesis was accepted in the plantarflexion/inversion condition, while the null hypothesis was rejected for the backward perturbations. An  $\alpha \leq .05$  was also reached in two of the Balance Master conditions, eyes open and eyes closed on a foam surface. The null hypothesis was rejected for both of these conditions. **Conclusion:** The results show that this training program does not have a significant effect on measured joint reaction times, however it was able to decrease postural sway on unstable surfaces. **Clinical Significance:** Studies have shown that decreased postural sway is correlated to a decrease in the incidence of injury. It has also been shown that people with recurrent ankle injuries have greater postural sway. Therefore this training protocol may be an effective component of ankle injury prevention or rehabilitation.

## Effect Of A 4-Week Agility Training Program On Postural Sway Of The Functionally Unstable Ankle

Hess DM, Joyce CJ, Arnold BL, Gansneder BM: University of Virginia, Charlottesville, VA

**Objective:** Strength training and balance/coordination training have demonstrated improvements in the symptoms of functional instability, but these types of training are not sport specific. We examined the effect of a four-week agility training program on proprioception of the functionally unstable ankle as measured by a static single-leg balance test. **Subjects:** Twenty college-aged volunteers (13 females, 7 males: age =  $20.9 \pm 3.02$  yr; height =  $171.6 \pm 9.15$  cm; weight =  $74.2 \pm 12.75$  kg) with one functionally unstable ankle and no uncorrected visual or vestibular problems participated in this study. **Design and Setting:** We randomly assigned subjects into one of two groups. Those in the experimental group performed agility training three times per week for four weeks. Subjects in the control group did not perform agility training, and were asked to refrain from initiating any new activities during the study. **Measurements:** All subjects were tested for static single-leg balance prior to and following the four-week training period. We assessed subjects for anterior/posterior sway amplitude, medial/lateral sway amplitude, and sway index using the Chatter Balance System. **Results:** We found a significant main effect for gender [ $F_{(1,16)} = 6.507$ ,  $p = .021$ ] (males = 4.74 cm, females = 3.51 cm) and group [ $F_{(1,16)} = 5.937$ ,  $p = .027$ ] (control = 4.71 cm, experimental = 3.54 cm) and a significant gender by group interaction [ $F_{(1,16)} = 5.796$ ,  $p = .028$ ] (male control = 5.90 cm, male experimental = 3.57 cm, female control = 3.52 cm, female experimental = 3.50 cm) for the anterior/posterior sway amplitude measure. There was also a main effect for gender [ $F_{(1,16)} = 5.318$ ,  $p = .035$ ] (males = 2.16 cm, females = 1.77 cm) and group [ $F_{(1,16)} = 6.307$ ,  $p = .023$ ] (control = 2.18 cm, experimental = 1.75 cm) for the medial/lateral sway amplitude measure. Finally, we found a significant main effect for group [ $F_{(1,16)} = 4.663$ ,  $p = .046$ ] (control = 1.02 cm, experimental = .80 cm) and a significant gender by group interaction [ $F_{(1,16)} = 8.193$ ,  $p = .011$ ] (male control = 1.27, male experimental = .75, female control = .77, female experimental = .85) for the sway index measure. There were no significant differences in any measure between pre-test and post-test for either gender or group. Post hoc analysis revealed a significant difference between the male control subjects and male experimental, female control, and female experimental subjects. **Conclusions:** Agility training did not improve the static single-leg balance measures in subjects with functionally unstable ankles. This suggests that either the agility training was ineffective or that the static single-leg balance test was an inappropriate measure to assess improvements from agility training. Future research should examine the effects of other agility training programs and the relationship between agility and other balance and kinesthesia measures.

## Free Communications, Oral Presentations: Mild Head Injury

Saturday, July 1, 9:45AM-11:00AM, Cleveland B; Moderator: Kevin M. Guskiewicz, PhD, ATC

### The Effect Of Continued Activity Following Concussion

Ferrara MS, Peterson CL, Marzik M, Cooper E, Courson R, Elliott R: Department of Exercise Science, University of Georgia, Athens, GA

Recently there has been an increased awareness in the evaluation of concussion in sports. Current literature supports the use of neuropsychological and balance testing to be used as part of the clinical evaluation and in making return to play decisions. Recent evidence suggests significant short term neurocognitive deficits following concussion which may last a few seconds to several days. The challenge for clinicians is to accurately assess the injury and determine if the athlete can return to participation. However, the short term effects of returning an athlete to participation following an injury have not been investigated. The purpose of this study was to compare athletes who continued to play immediately following their injury to those athletes who did not return to play.

**Methods** Baseline tests consisting of neuropsychological tests to include the Hopkins Verbal Learning Test (HVLT), Trails A and B, Symbol Digit Modality Test (SDMT), Digits Forward and Backward and Controlled Oral Word Association Test (COWAT). Ten athletes were diagnosed with a Grade I or Grade II concussion by a physician using the American Academy of Neurology scale was selected for comparison. Five injured athletes were either cleared by a physician to return to sport participation immediately (< 15 minutes) post-injury or reported their injury post game/practice. For comparison purposes, these athletes were matched to 5 other athletes not immediately cleared to return to play and did not participate in the remainder of the game/practice. The matching criteria were injury severity and SAT score. All athletes were tested serially on day 1, day 2 and day 3 post-injury. A 2 (returned vs not returned) x 4 (day) MANOVA was performed to compare the groups.

**Results** For those athletes who returned to participation, they had significantly higher scores for self-reported concussion symptoms ( $p=.004$ ), lower HVLT scores ( $p=.011$ ), and lower SDMT scores ( $p=.032$ ) compared to the not returned group during the course of recovery. **Conclusions** The results suggest different rates of recovery for MTBI between the groups. The returned group demonstrated increased symptoms of post concussion symptoms and deficits in short term memory and executive function. Previous research has shown that the delay in recovery could be due to the increased use of glycogen during the immediate post-injury exercise period which may lead to delayed healing and slower recovery from the injury.

### Relationships Among A Standardized Measure For Concussion, Postural Stability, And Function In Non-Injured Athletes

Greco JA, Mattacola CG, Sittler MR: Temple University, Philadelphia, PA, and College of Allied Health Professions, University of Kentucky, Lexington, KY

The purpose of this study was to establish normative data for examining the relationships among the Standardized Assessment for Concussion (SAC) instrument, postural stability using the Biodex Stability System (BSS) and dynamic balance using a single-plane balance board (SPBB). Sixty Temple University football players (age =  $21.06 \pm .22$  yr, wt =  $103.04 \pm 5.50$  kg, ht =  $186 \pm .36$  cm) volunteered to participate in this study prior to the 1998 football season. Subjects reported for a total of two testing sessions (familiarization and testing). Subjects completed the SAC and performed two postural stability tests (using the BSS and SPBB) and a functional test consisting of a single-leg hop for distance test. The results demonstrate that dynamic postural stability scores (BSS and SPBB) were not strongly correlated with the SAC and the SLH for distance test. The strongest relationships were between the indexes of postural stability. The stability index (SI), as measured with the BSS; is a composite of anterior/posterior and medial/lateral sway. The SI was strongly related to the anterior/posterior index (API) ( $r = .95$ ) and the medial/lateral index (MLI) ( $r = .89$ ). Postural stability scores measured via the BSS were poorly related to balance scores using the SPBB ( $r = .00$  to  $.02$ ). There was a significant inverse relationship between SPBB anterior/posterior total touches and the SLH for distance test ( $r = -.37$ ,  $p \leq .05$ ). The relationship between the SI and SAC and SLH were  $r = -.18$  and  $r = -.24$ , respectively. There was a significant inverse relationship between the SAC and SPBB anterior/posterior and the medial/lateral total touches ( $r = -.07$  and  $r = .02$ ,  $p \leq .05$ , respectively). There was a significant correlation between anterior/posterior total touches (A/Ptot) and medial/lateral total touches (M/Ltot) ( $r = .29$ ,  $p \leq .05$ ) as assessed with the SPBB. The findings demonstrated that there was little correlation among the standardized assessment for concussion, postural stability, and functional ability in a non-injured population. Subjects in this study were uninjured and variance among this group was small. It remains to be seen if similar results will be attained in a cognitively or neurologically injured subjects.

### Symptomatology Following Cerebral Concussion And Its Relationship With Neuropsychological And Postural Stability Tests

Ross SE, Guskiewicz KM, Onate JA: The University of North Carolina at Chapel Hill, Chapel Hill, NC

Clinicians regularly assess concussion according to the symptoms that athletes manifest at the time of injury. Recently, cognition and postural stability have been studied following concussion, however, there is little understanding of how these measures are related to symptomatology. The purpose of this study was to examine the relationship between concussion symptomatology and the measures of cognition and postural stability following injury. Sixteen male and four female Division I athletes who sustained a sport-related concussion participated in this study. All subjects had been previously baseline tested for cognition and postural stability. The postural stability protocol consisted of the NeuroCom Smart Balance Master's Sensory Organization Test (SOT) and a clinical balance test called the Balance Error Scoring System. The cognitive tests consisted of the Trail Making B Test, Controlled Oral Word Association Test, STROOP Color Word Test-3, Hopkins Verbal Learning Test, Symbol Digit Modality Test, and Digit Span Test. Data was collected for each of the variables on days 1, 2, and 3 post-injury. A 16-item symptom checklist was administered at the time of injury, and at each of the three post-injury days. A repeated measures ANOVA for overall symptom severity (accumulation of severity score, 0-6, for all 16 symptoms) revealed a significant difference between time of injury and each of the three subsequent days post-injury ( $p < .05$ ). Additionally, there was a significant reduction in symptom severity across each successive post-injury day ( $p < .05$ ). Results of repeated measures ANOVA for each of the four neuropsychological and two postural stability tests revealed similar trends beginning with pre-season baseline testing through day 3 post-injury. The most interesting finding is that multiple regression analyses revealed no significant combination of variables that best predicted the symptom severity on post-injury days 1 and 2 ( $R^2 = .45$  and  $R^2 = .39$  respectively;  $p > .05$ ). As the symptoms resolved at day 3, the combination of Digit Span, Trail Making B, and SOT explained a significant amount of the variance in symptom severity ( $R^2 = .64$ ;  $p < .01$ ). Additional day 1 post-injury regression analysis performed specifically on dizziness severity could not be predicted from the balance measurements ( $R^2 = .03$ ;  $p > .05$ ), nor could the symptom score for headache severity be predicted from any combination of the neuropsychological tests ( $R^2 = .41$ ;  $p > .05$ ). The clinical significance of these findings is that although symptom severity, cognition, and postural stability are all affected initially following concussion, they are not necessarily related. Clinicians should therefore use a combination of these evaluation tools when managing concussion.

## Predicting The Development Of Post Concussion Syndrome From Initial Signs And Symptoms Following Mild Traumatic Brain Injury

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The purpose of this study was to determine whether the signs and symptoms present during the initial 20 minutes following an episode of mild traumatic brain injury (MTBI) could have predictive qualities with regard to the subsequent development of post concussion syndrome (PCS). All episodes of MTBI that were evaluated by the athletic training room staff from October 1997 through October 1998 were included in the data set. A total of 243 consecutive cases of MTBI were analyzed. The categorical data on the initial signs and symptoms present following an episode of MTBI were collected at 5-minute intervals for 20 minutes following each reported case. Certified athletic trainers, using a standardized protocol for the initial evaluation of MTBI, collected all data. Of the 243 cases of MTBI, 61 (25%) patients developed signs and symptoms of post concussion syndrome while 182 (75%) did not. Proportional hypothesis testing was conducted to determine if there were statistically significant differences between the patients who developed PCS and those who did not for each of the signs and symptoms present during the initial evaluation. Following proportional hypothesis testing, Bayes Theorem, a mathematical modeling technique, was used to compare PCS cases to cases that did not develop PCS in order to identify valid predictors. Several signs and symptoms were identified to be significant predictors of PCS. Results indicate that the presence of amnesia, balance abnormalities, tinnitus, and visual impairments at 20 minutes post injury are statistically significant predictors of PCS. Additionally, based on the available data, patients who had a headache and exhibited signs of amnesia at 5 minutes post injury had an 87% probability of developing PCS. Similarly, patients who reported a headache, dizziness, and exhibited balance abnormalities at 20 minutes post injury had a 73% probability of developing PCS. Based on these data, it may be possible to predict whether athletes that experience an episode of MTBI will develop PCS.

## A Comparison Of Concussion Incidence And Recovery In Collegiate Football Players With And Without Previous History Of Concussion

Onate JA, Guskiewicz KM, McCrea MA: The University of North Carolina at Chapel Hill, Chapel Hill, NC

The incidence of repeated concussions and the long-term sequelae that follows has been a topic of considerable debate in the sports medicine literature. Of recent concern is the effect of previous head injury on the risk of subsequent head injury and post-injury recovery time. The present study was designed to examine these issues as part of a much larger research project on concussion in collegiate football players. Prior to the 1999 football season, 2,470 collegiate football players at 33 NCAA institutions provided a self-reported history of previous concussions sustained within the last eight years. Twenty-two percent of the players reported sustaining at least one previous concussion prior to the 1999 football season and 5.5% reported having sustained two or more previous concussions. A chi-square test of independence performed on 73 players who sustained an injury during the 1999 season revealed a significant difference in occurrence of concussion by those players with and without a prior history of concussion ( $\chi^2=9.25$ ;  $p<.05$ ). Players who reported a history of concussion experienced a higher incidence compared to those reporting no history of any previous concussions within the last eight years. In addition, we studied 25 of the injured players to determine the effects of previous concussions on symptomatology and cognitive functioning during the week following injury. A 16-item symptom checklist and The Standardized Assessment of Concussion (SAC) were administered at pre-season, and at days 1, 2, 3, 5, and 7 post-injury. A repeated measures ANOVA revealed a significant group x day interaction ( $F(5,115)=2.46$ ,  $p<.05$ ) for the SAC total score. Post-hoc analyses found that the injured players with a history of concussion demonstrated minimal improvements in SAC scores across test days and did not demonstrate a significant recovery learning effect until day 5 post-injury. In contrast, players who had no history of concussion showed a definitive learning curve and revealed a significant recovery learning effect by day 2 post-injury. Also of note was a lack of significant differences between severity of multiple symptom scores (i.e., headache, nausea, dizziness, etc.) reported by the two groups following injury. The clinical significance of these findings is that collegiate football players with a previous history of concussion appear to be at greater risk for recurrent injury and lengthier post-injury recovery time compared to those with no history of concussion. Additionally, the severity of symptoms does not always explain the entire status of a concussed athlete.

## Free Communications, Thematic Poster Session: Teaching Athletic Training

Saturday, July 1, 2:15PM-3:45PM, Cleveland B; Moderator: Catherine L. Stemmans, PhD, ATC

### An Investigation Of Undergraduate Athletic Training Students' Learning Styles And Program Admission Success

Brower KA, Stemmans CL, Ingersoll CD, Langley D: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** The term learning style refers to the method used to obtain and utilize information in order to learn. Personal learning styles can be assessed by specifically designed inventories. This study was conducted to determine if undergraduate athletic training students possess a dominant learning style, according to Kolb's Learning Style Inventory IIA (KLSI IIA), and whether this style is related to education program admission success. **Design and Setting:** The independent variable was learning style type with 4 levels (converger, diverger, assimilator, or accommodator). The dependent variable was admission status. **Subjects:** Forty undergraduate students (21 males, 19 females, age=20.7 ± 1.7 yrs, grade point average = 3.26 ± 0.43 [of 4.0]) from 3 institutions participated in this study. All subjects had not previously taken KLSI IIA, and none had a diagnosed learning disability. **Measurements:** KLSI IIA was administered to the participants at their respective institutions. Two separate X<sup>2</sup> analyses were used to determine if the observed distribution of learning styles differed from the expected distribution. Additionally, a Mann-Whitney U test was performed to determine if the learning style distributions of those subjects who were successfully-admitted to the selected programs differed from those who were not. **Results:** No significant differences existed between the observed distribution and the expected distribution for those admitted (X<sup>2</sup> (3) = 3.85, P = .28) and those not admitted (X<sup>2</sup> (3) = 3.14, P = .37). Also, no significant differences existed between the learning style distributions of both groups when compared to each other (U = 158, P = .51). **Conclusions:** No dominant learning style among undergraduate athletic training students led to program admission.

### Student And Instructor Knowledge Similarities As Determined By The Pathfinder Program

Miller MG, Holcomb WR, Berry DC: Ohio University, Athens, OH

Structural representations are cognitive "maps" formed in the brain about relationships of concepts within a particular domain. Students with maps similar to their instructor usually perform better academically, while students with poorly organized knowledge maps perform worse. These cognitive maps assist the instructor to determine if students are learning the presented information effectively. Therefore, the purpose of this preliminary study is to assess the knowledge structures of students in a particular class and compare their knowledge with their instructor. A program called Pathfinder analyzed and mapped the knowledge structures of the students and the instructor to determine similarities. A total of 25 students in a CAAHEP Accredited Athletic Training Program were recruited for the study. A list of 20 concepts from the domain of orthopedic knee assessment was inputted into the Pathfinder program and given to the students. The concepts were randomly paired together and the students rated these pairs in terms of relevance. The students rated concepts before and after formal lectures on orthopedic knee assessment. The Pathfinder program then computed similarities of related pairs of concepts between the students and the instructor. These rated pairs of concepts produced proximity data that was then analyzed by algorithms. A network is produced in Pathfinder in which concepts are represented as nodes and the relations between concepts are represented as links connecting the nodes. Comparisons were also determined between the student's GPA and their test results for the orthopedic knee assessment domain. The results using paired sample t-tests and correlations indicated that there was a difference in rated pairs of concepts between the students and the instructor. Students initially had a mean similarity score of (M = .154), however after formal lectures on orthopedic knee assessments, students had significantly higher similarities scores (M = .294), t (24) = -10.146, p < .001, suggesting that students had scores more similar to their instructor. Students with high scores on the orthopedic knee assessment exam had statistically significant correlations with GPA, r(25) = .626, p < .001. By knowing knowledge structures, educators can determine how students organize information and recall important ideas or concepts. The knowledge representations can be useful for determining methods of instruction and understanding knowledge acquisition in the field of Athletic Training.

### Clinical Instructor And Student Athletic Trainer Perceptions Of Helpful Clinical Instructor Characteristics

Laurent TG, Weidner TG: Ball State University, Muncie, IN

Clinical education is used by many health care professions as an integral part of professional preparation. This experience gives students an opportunity to integrate theoretical information into real life situations. The purpose of this study was to compare the perceptions of students and clinical instructors on clinical instructor characteristics to determine the most and least helpful clinical instructor characteristics. A survey containing helpful clinical instructor characteristics for facilitating student learning was developed from a review of the medical and allied health clinical education literature. Using a Likert scale respondents rated clinical instructor characteristics from 1 = *among the least helpful* to 10 = *among the most helpful*. Respondents also identified the overall 10 most helpful and 10 least helpful characteristics using an open-ended format.

NATA District 4 CAAHEP accredited athletic training education programs were surveyed (n = 20). Sixteen (80%) of the program directors returned surveys. The respondent sample consisted of 208 undergraduate students and 47 clinical instructors. Individual item and subgroup mean scores were computed for students, clinical instructors, and combined students and clinical instructors. Pearson product-moment correlations were computed to evaluate the level of agreement between mean student and instructor responses. Correlations were also computed to evaluate the level of agreement between open-ended responses and the Likert scale mean responses. There was a high level of agreement between the students' and clinical instructors' ratings of individual items (r = .88). There was also a high level of agreement between individual item means and the open-ended 10 most helpful (r = .83) and 10 least helpful (r = .95) clinical instructor characteristics. Modeling professional behavior was considered the most helpful subgroup of clinical instructor characteristics (mean rating = 8.86). Integration of knowledge and research into clinical education was considered the least helpful subgroup of clinical instructor characteristics (mean rating = 7.31). There was no clear discrimination among the helpfulness of the following subgroups: student participation, clinical instructor attitude toward teaching, problem solving, instructional strategy, humanistic orientation, and self perception (mean range 8.43 - 8.64). The authors concluded that clinical instructors should model professional behavior to best facilitate student learning and integration of research into clinical education may need more emphasis. Further research should compare clinical instructor characteristics with student success in mastering entry-level skills and competencies. Further research is also needed to determine the influences of student characteristics and clinical environment on student learning.

### Comparison Of Sports Rehabilitation Knowledge Acquired By Students In Athletic Training And Physical Therapy

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Each allied health profession has its particular expertise, but may also share commonalities with other disciplines. Sports rehabilitation is an area that is shared by both athletic training (AT), and physical therapy (PT). The purpose of this study was to compare the knowledge that is acquired in sports rehabilitation by students enrolled in accredited AT and PT educational programs. The 75-question, multiple choice test that accompanies the Human Kinetics text on *Sport Rehabilitation*, was initially administered to 54 students. The pre-test subject population consisted of 20 AT students, and 14 PT students enrolled in the first-semester introductory classes of their healthcare specialties. The post-test was completed by 63% of the initial respondents after they had graduated from their respective undergraduate educational programs. The CAAHEP-Accredited AT program was a 4-semester program, and the CAPTE-Accredited PT program was a 7-semester program, both with approximately 800 clock hours of clinical experience. None of the students used the *Sport Rehabilitation* text during their education. The data were analyzed by ANOVA and *t*-tests, and are reported as mean percentage scores ( $\pm$  S.D.). A significant main effect ( $p < 0.05$ ) was found for all scores, but there was no significant difference ( $p > 0.05$ ) in pre-test scores between AT & PT. Pre-test scores were 53.38% (6.3), and 57.64% (7.73) for AT, and PT, respectively. Post-test scores were 73.42% (5.82), and 61.91% (15.8) for AT, and PT, respectively. There was no significant difference ( $p > 0.05$ ) between pre-test and post-test scores for PT, but there was a significant ( $p < 0.05$ ) improvement in AT scores from pre-test to post-test. These preliminary data indicate the amount of knowledge gained in sports rehabilitation by students enrolled in these accredited AT and PT educational programs, but is limited to the students at this particular institution. Both the AT and PT programs at this institution have individual classes in therapeutic modalities and therapeutic exercise, but only the AT program has a specific class in the rehabilitation of athletic injuries. These data suggest that PT curricula might also benefit from a dedicated course in sports rehabilitation.

### Learning Styles Of Athletic Training Educators

Harrelson GL, Leaver-Dunn D, Martin M: DCH Health System and The University of Alabama, Tuscaloosa, AL

**Context:** It is the general prevailing theory that one's learning style will also be their preferred teaching style. Thus the way an individual learns will also be the way information will predominantly be presented in the classroom.

**Objective:** To assess the learning styles of athletic training educators.

**Design and Setting:** The Learning Style Inventory (LSI) (Kolb, 1985) was administered to the attendees at the 1999 National Athletic Trainers Association Professional Educators Conference.

**Subjects:** One-hundred and sixty athletic training educators from various universities/colleges around the United States.

**Measurements:** Each subject's learning style was plotted on the Learning Style Grid (Kolb, 1985). Frequency distribution of scores was used to determine the percentage of subjects in each learning style quadrant.

**Results:** Collectively the subjects fell in the converger learning style quadrant, but very close to the vertical axis separating the converger and assimilator quadrants. Sixteen percent of the educators were accommodators, 8% were divergers, 39% were convergers and 37% were assimilators. Seventy-six percent of the educator's were classified predominately as a converger or assimilator learning style, which fell on the abstract axis of the grid.

**Conclusions:** Based on this data athletic training educators have learning styles that fall predominantly on the abstract axis of the learning style grid. When the distribution of educator scores is compared to the student's data we have collected using the LSI, students have a more equal distribution of scores between the four learning style quadrants. By athletic training educators being aware of their learning style, which is thought to influence how information is presented in the classroom, they can make a conscious effort to include instructional methodologies that will also appeal to other learning styles, particularly those students who are more concrete learners.

### The Effect Of A Computer-Based Training Protocol On Students' Potential Success On The Written Section Of The N.A.T.A.B.O.C. Certification Examination

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To date, no studies have investigated the effects of a computer-based training protocol to determine a student's predictive success on the Written section of the N.A.T.A.B.O.C. Certification Examination. The purpose of this study was to determine the predictive validity of a computer-based training protocol (Exam-Master 2.0, copyright 1995 - Cramer Products, Inc.) utilized by student athletic trainers in preparation for the N.A.T.A.B.O.C. (National Athletic Trainers' Association Board of Certification) Certification Examination. The computer-based training protocol was designed to replicate the actual Written section of the N.A.T.A.B.O.C. Certification Examination. Seventeen volunteers (10 male, 7 female) from four CAAHEP-accredited Undergraduate Athletic Training Education Programs (The University of Southern Mississippi, Whitworth College; University of Nevada-Las Vegas; and University of Illinois-Champaign), took a randomized 150-question multiple-choice format test (using the computer-based training protocol) within one-week prior of taking the N.A.T.A.B.O.C. Certification Examination. All students were first-time applicants for the N.A.T.A.B.O.C. Certification Examination. The testing session was conducted in a similar fashion as the actual examination, with the subjects having a four and one-half hour time limit to take the computer-based training protocol. Subjects reported to a designated facility to take the computerized examination. After the subjects arrived to the designated area, research procedures were explained and all necessary human subject consent forms were completed prior of testing. After completion of the computer-based protocol, the subject's score was recorded. After taking the N.A.T.A.B.O.C. Certification Examination, subjects then voluntarily reported their scores from only the Written section of the N.A.T.A.B.O.C. Certification Examination to the researchers. Findings of the study revealed that the mean scores on the computer-based training protocol ( $M = 100.52941$ ,  $s = 9.50077$ ) and students' mean scores on the Written section of the N.A.T.A.B.O.C. Certification Examination ( $M = 106.94118$ ,  $s = 9.64022$ ) were significantly different ( $t = -2.568$ ;  $df = 16$ ; sig 2-tailed = .021). However, statistical analyses, using a Pearson correlation, revealed that the computer-based protocol was not significant ( $r = 0.42$ ) in predicting students' success on the Written section of the N.A.T.A.B.O.C. Certification Examination. The lack of significance in predicting the students' success may be attributed to several outlying scores as well as the small sample size. The following conclusions were made from this study: 1) the computer-based training protocol used in the study can be used by students in their preparation for the Written section of the N.A.T.A.B.O.C. Certification Examination; and 2) this study should be replicated involving a larger sample size.

## Division I Athletic Trainers' Perceptions Of The Effects Of Eliminating Internship Programs

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Natchitoches, LA

The purpose of this study was to survey the questions and concerns of present athletic trainers concerning the elimination of internship programs and actions that may be taken as a result of the change. The elimination of these internship programs as a route to certification is a concern for internship programs as well as those schools developing degree programs as a route to certification. The survey was mailed out along with two stamped envelopes and a cover letter to all Division I District 9 Head Athletic Trainers currently of schools currently utilizing the internship to meet NATABOC certification requirements. This included 49 colleges/universities within the states of Alabama, Georgia, Florida, Kentucky, Louisiana, and Tennessee. Twenty-six of the 49 subjects participated, yielding a 53% response. Subjects were asked how many student athletic trainers had left the program in the past four years. Responses ranged from 0-15 with a mean of 4.88. Subjects reported that 88% of these students had voluntarily quit the program while 22% were fired. It was reported that 30% of these students had decided to change their major, 28% were "burned out", and 42% had left the program for other reasons. First-time pass rate on all three sections of the NATABOC exam ranged from 0 to 100% with a mean of 38.4% and 8 subjects reporting that they had not had any students take the exam since they had been Head Athletic Trainer. When asked what their plans were for certification, 48% reported that they would pursue an undergraduate program, 20% reported that they would pursue a graduate program, and 32% reported that they would not pursue accreditation at all. Those subjects which reported that they would pursue accreditation were asked if more full-time staff were needed. 10 responded yes, 7 responded no, and 2 were undecided. Subjects were also asked to list additional resources that would be required in order to continue to pursue accreditation. When asked whether they thought the elimination of internship programs would be detrimental to the profession, 54% responded no, 45% responded yes, and 1% was undecided. At the conclusion of the survey, subjects were asked to list any additional concerns that they may have regarding the elimination of internship programs as a route to certification.

Journal of Athletic Training

## The Effects Of Ankle And Axillary Cooling On The Human Soleus Hoffman Reflex

Krause BA, Hopkins JT, Ingersoll CD, Cordova ML, Edwards JE, Merrick MA: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** The Hoffman reflex (H-reflex) has been identified as a reliable measure of motoneuron pool recruitment. The reported effects of cooling on neurological pathways and motoneuron pool recruitment are varied. However, most of the literature indicates that H-reflex decreases or remains constant during the initial phases of cooling. Whether the effects of local and peripheral cooling affect motoneuron pool recruitment differently have not been examined. The purpose of this study was to compare changes in soleus H-reflex measures during ankle ice application, axillary ice application, and no ice application and during the subsequent rewarming periods. **Design and Setting:** A repeated measures design was used for this study. Soleus H-reflex measures were collected from each volunteer in three treatment groups, ankle ice bag application, axillary ice bag application, and control (no ice application), prior to the treatment, at 30 sec, 1 min, 5 min, and 10 min, 25 min, and 35 min intervals over a 40-min period. Ice was applied during the first 20 minutes followed by a 20-min rewarming period. H-reflex measures were normalized using pre-treatment values. Treatment order was assigned using a balanced Latin Square. **Subjects:** Ten healthy, physically active college males and females (age=23.4±1.8yr;ht=172.5±8.5cm; wt=68.9±10.1kg) volunteered for this study. **Measurements:** The soleus H-reflex was elicited by applying a percutaneous stimulus to the tibial nerve in the popliteal fossa and recording the response through surface electromyography. The electrical stimulation was delivered at 75% of the current necessary to produce a maximum H-reflex for each subject. Ankle and axillary temperatures and soleus H-reflex measures were collected at the designated time intervals during cooling and rewarming. **Results:** A time by treatment interaction was detected ( $F_{(10,90)}=27.9, P<.0001$ ). Simple main effects testing was undertaken. At 30 seconds, the H-reflex was greater for the control condition than axillary cooling and axillary cooling was greater than ankle cooling ( $P<.05$ ). At 1 minute, axillary cooling and control condition were greater than ankle cooling ( $P<.05$ ). At 5 minutes, axillary cooling and ankle cooling were greater than the control condition ( $P<.05$ ). From 10 to 35 minutes, ankle cooling was greater than axillary cooling which was greater than the control condition ( $P<.05$ ). **Conclusions:** Ankle and axillary cooling causes an initial inhibition of the soleus. By 10 minutes of cooling, and throughout rewarming, both ankle and axillary cooling cause a facilitation of the soleus. Ankle cooling causes greater facilitation than axillary cooling. The mechanisms for this recruitment are likely both local and central in nature. This facilitory effect may explain increases in functional capabilities during cryokinetics.

## Foot/Ankle Cold Pressor Pain Causes Soleus Inhibition With Or Without Verbal Persuasion

Bodensteiner JA, Ingersoll CD, Cordova ML, Kuhlman J: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** Numerous factors have been shown to affect motoneuron pool recruitment, including local cold applications and environmental stimuli. The effects of verbal persuasion on altering decreased motoneuron pool recruitment remains unknown. The purpose of this study was to investigate whether perceived pain resulting from a cold pressor test would induce muscle inhibition, and whether the intensity of inhibition due to perceived pain could be altered by verbal persuasion. **Design and setting:** The independent variable was verbal persuasion (feedback or no feedback). The dependent variables included soleus muscle motoneuron pool recruitment (measured by the change in H-reflex) and pain (measured using Part II of the McGill Pain Questionnaire). The study took place in the Sports Injury Research Laboratory at Indiana State University. **Subjects:** Twenty volunteers (22-27 years old, 14 females and 6 males) served as subjects. Subjects who had previous injury to the lower extremity within the last 6 months, or any known vascular or neurological disturbances were excluded from this investigation. **Measurements:** The subjects were randomly assigned to one of two groups (feedback or no feedback). A maximum H-reflex measurement was used as a direct measurement of motoneuron pool recruitment. Five trials of the mapped, maximum H-reflex were averaged. This measurement was taken before and after foot immersion into an ice bath. Part II of the McGill Pain Questionnaire was used to measure pain intensity. The data were analyzed using a Hotellings T2 and paired t-tests. **Results:** Motoneuron pool recruitment and pain were not different between the groups ( $T2_{(17)}=.142, P=.323$ ). H-reflex measurements were diminished during cold immersion compared to pretest measures ( $t(19)=2.59, p=.018$ ), representing inhibition. **Conclusion:** Cold immersion of the foot/ankle causes soleus inhibition. However, there was no difference in pain or motoneuron pool recruitment with verbal persuasion.

## The Effects Of Ankle Cryotherapy On Balance Strategy Selection In Bilateral Stance

Gardner CH, Aiken S, Robinson WF, Condra VD, McGinnis S: Belmont University, Nashville, TN

**Purpose:** Cryotherapy is used extensively in conjunction with active exercise in the rehabilitation of individuals with musculoskeletal injuries, yet few studies have examined the effects of cryotherapy on balance in weight-bearing situations. The purpose of this study was to determine if ankle ice immersion increases postural sway during static standing, thereby causing an inappropriate shift from an ankle to a hip strategy for balance. If ice immersion is found to affect balance strategy selection as measured by the EquiTest®, the safety of performing weight-bearing exercises immediately following ice immersion should be questioned. **Methods:** A repeated measures design was used to compare balance strategy and postural sway measurements before and after 20 minutes of bilateral ankle ice immersion. Balance testing took place using the EquiTest® Sensory Organization Test protocol in the gait lab at Vanderbilt Stallworth Rehabilitation Hospital. **Instrumentation:** The EquiTest®, developed by Nashner, et al utilizes the Sensory Organization Test (SOT) to determine the relative contributions of the visual, vestibular, and somatosensory systems by analyzing the amount of postural sway and the strategy used to maintain balance during six sensory testing conditions. **Subjects:** This study was a two group, pretest-posttest design involving fifty-nine male and female volunteer subjects, 40 experimental and 19 control, ranging in age from 18 to 35 years. Subjects were recruited from a local university and were randomly assigned to control and experimental groups. **Data Analysis:** Four 2x2 repeated measures analyses of variance for equilibrium score data and four 2x2 repeated measures analyses of variance for balance strategy data were examined for significance. **Results:** No significant difference in equilibrium score or balance strategy values was found when analyzing the interaction effects for sensory test conditions 1,2,4 and 5. However, significance was found when analyzing the pretest and posttest data for the main effects of equilibrium score and balance strategy for condition 5 ( $p=0.001$  and  $0.002$ , respectively). **Conclusions:** The intent of our study was to assess the affects of a standard clinical protocol, ankle cryotherapy, on balance. The results of this study indicate that postural sway and balance strategy selection are not significantly affected following 20 minutes of ankle ice immersion as measured by the EquiTest®. Therefore our study supports the use of ankle cryotherapy by athletic trainers to reduce the pain and swelling associated with acute ankle injury.

## The Effects Of Ice And Compression To The Ankle Joint On Two Measures Of Functional Performance

Duck MA, Kaminski TW, Horodyski MB, Bauer JA: University of Florida, Gainesville, FL

Cryotherapy is commonly used as a treatment for pain associated with acute and chronic musculoskeletal injury. Athletes often return to activity following cryotherapy treatment with a goal of improving performance through a reduction in pain. However, previous research has suggested that cryotherapy may also reduce muscle strength, nerve conduction velocity, and proprioception, all of which are important to function in an athletic environment. The purpose of this study was to investigate the effects of ice with compression to the ankle joint on functional performance as measured by the single-leg (SL) vertical jump and 40-yard dash time in a group of female, collegiate athletes. Twenty Division I female athletes (age=19.8±1.7 yr., wt=62.4±6.9 kg, ht=169.6±5.6 cm) with no previous injury to the lower extremity 1 year prior, participated in this study. Subjects attended three testing sessions separated by at least 48 hours. The three treatment conditions consisted of two ice bags applied to the treatment ankle for 10-minutes, 20-minutes or a 20-minute control session involving no cryotherapy. The amount of ice (0.5 kg) was standardized across all subjects. The compression wrap was applied in the same manner each time by the PI. The treatment ankle was determined as the ankle used for the SL vertical jump. The order of treatment was randomized across all subjects using a Latin square. Single-leg vertical jump measures were recorded pre and post treatment using a Vertec (Sports Imports, Columbus, OH) measuring device. The 40-yard dash times were measured using a Brower (Brower Timing Systems, Salt Lake City, UT) infrared timing system. A single-group time-series design was employed in this study. An ANOVA with repeated measures was conducted to determine if differences in the DV's result due to manipulation of the IV. The analysis resulted in a significant difference between the pre and post test SL vertical jump [ $F(2,38)=14.29, p<.0001$ ] and 40-yard dash [ $F(2,38)=9.71, p<.0001$ ] measurements in both the 10 and 20 minute ice treatment groups. As expected, there were no differences in the pre and post test measurements in the control group. These results suggest that SL vertical jump and 40-yard dash performance are significantly reduced immediately after the application of 10 and 20 minute cryotherapy treatments in a group of female collegiate athletes. Caution should be practiced when cryotherapy is utilized prior to or during participation in an athletic environment. Future study involving male athletes or cryotherapy applications to other joint regions is warranted.

## Shoulder Function Following A Cryotherapy Modality Application

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The shoulder requires afferent neural input to function properly. Unfortunately, afferent information from peripheral receptors to the central nervous system (CNS) can be delayed by the use of cryotherapy due to a decrease in nerve conduction velocity (NCV) and/or an alteration of peripheral receptor threshold. The neural input from peripheral receptors to the CNS relay important information contributing to dynamic stability and performance about a specific joint. This dynamic muscular control ensures stabilization of the joint while also allowing for normal function. The purpose of this study was to determine the effect of a 20-minute cryotherapy treatment on function of the shoulder. Seventeen healthy subjects (11 males, 6 females; age = 21.53 ± 2.60 yrs; ht = 175.26 ± 10.74 cm; wt = 74.52 ± 9.77 kg) participated in this study. Two assessments, separated by 10-minutes, were performed prior to the 20-minute cryotherapy treatment to control for a learning effect. Upon completion of the cryotherapy treatment, a final assessment was performed to observe any differences in functional ability of the shoulder following cryotherapy. Shoulder function was assessed utilizing the Functional Throwing Performance Index (FTPI). A target was placed on a wall four feet from the floor and fifteen feet away from the subjects. Subjects were instructed to throw a rubber playground ball (50.8 cm. circumference) into the target as many times as possible over three (thirty-second) trials. The FTPI was calculated as the number of accurate throws divided by the total number of throws per trial. The average FTPI for the three trials was used for data analysis. A repeated measures ANOVA model (1 between, 1 within) was performed to determine if a significant difference existed between pre and post cryotherapy measures ( $p<.05$ ). Tukey HSD post hoc analysis revealed that following cryotherapy, function was found to be significantly decreased compared to pre-treatment measures ( $F = 9.442, p = .001$ ). Consequently, cryotherapy negatively affects functional performance specific to the dominant shoulder. This suggests that the dynamic muscular control mechanism may be altered following cryotherapy. This alteration in dynamic muscular control may predispose an athlete to injury. Therefore, therapists should be cautious when applying cryotherapy prior to athletic events and/or dynamic rehabilitation protocols.

## Free Communications, Thematic Poster Session: Face Mask

Sunday, July 2, 8:30AM-10:00AM, Cleveland B; Moderator: Douglas M. Kleiner, PhD, ATC

### The Effects Of Practice On Face Mask Removal Skills

Kleiner DM, Almquist JL, Hoenshel RW, Angotti DD: University of North Florida, Jacksonville, FL

Although it is logical to assume that practicing the skill of face mask removal will increase one's skill level, no data has been reported to verify that assumption, or to quantify the amount of improvement that can occur with practice. Therefore the purpose of this study was to evaluate the influence of practice on the time that it takes to cut the face mask loop-straps. Twenty-two student athletic trainers (14 females, 8 males) served as subjects. After receiving standard instructions, each subject cut through the two lateral Schutt™ ArmorGuard™ face mask loop-straps and retracted the face mask using the two anterior loop-straps as a hinge. Each subject repeated this task with the Trainers Angel™ (TA) and an anvil pruner (AP), before and after seven days of practice. The sequence of trials was randomly selected by each subject. The subjects also reported a rating of satisfaction with a 10-point scale. The data were analyzed by ANOVA and *t*-tests, and are presented as means ( $\pm$  S.D). Each subject cut an average of 53.36 ( $\pm$  16.75) loop-straps during the practice period. Pre-test to post-test values improved significantly ( $p < 0.05$ ) for each condition (time and rating) for each tool. The TA times improved from 194.48 s ( $\pm$  102.1) to 57.44 s ( $\pm$  27.75), and the AP times improved from 80.42 s ( $\pm$  44.57) to 28.02 s ( $\pm$  10.43), for pre-test and post-test, respectively. The TA ratings improved from 2.59 ( $\pm$  1.59) to 4.5 ( $\pm$  1.79), and the AP ratings improved from 7.32 ( $\pm$  1.46) to 8.14 ( $\pm$  1.08), for pre-test and post-test, respectively. Significant differences ( $p < 0.05$ ) were also detected between the TA and AP for both time and ratings, indicating that the AP is faster and better-liked by the subjects than the TA. These data indicate that practicing the task of face mask removal can significantly improve performance and comfort with the task. These data serve to validate the guideline from the Inter-Association Task Force for the Appropriate Care of the Spine-Injured Athlete that those involved in the pre-hospital care of athletes should practice the skill of face mask removal.

### The Sharpness Of Face Mask Removal Tools And Performance

Sanville M, Hoenshel RW, Angotti DD, Kleiner DM: University of North Florida, Jacksonville, FL

During previous studies, we have observed that face mask removal tools become dull with repeated use, rendering them ineffective. The purpose of this study was to evaluate the time that it takes to cut the face mask loop-straps with two popular tools, both when they are sharp and after they become dull. Fifty student athletic trainers (25 females, 25 males) served as subjects. After receiving standard instructions, each subject cut through the two lateral Schutt™ ArmorGuard™ face mask loop-straps and retracted the football helmet face mask using the two anterior loop-straps as a hinge. Each subject repeated this task with the Trainers Angel™ (TA) and an anvil pruner (AP) on consecutive weeks, with sharp (new) tools, and with dull (used) tools. The sequence of trials was randomly selected by each subject. The subjects also reported a rating of satisfaction with a 10-point scale. Data were analyzed by ANOVA and *t*-tests, and are presented as means ( $\pm$  S.D). The sharp tool was significantly ( $p < 0.05$ ) faster than the dull tool for both the TA and the AP. The TA times were 128.08 s ( $\pm$  89.39) and 261.36 s ( $\pm$  245.96), and the AP times were 68.87 s ( $\pm$  63.06) and 142.25 s ( $\pm$  117.43), for sharp and dull tools, respectively. The TA ratings were 3.14 ( $\pm$  1.91) and 2.28 ( $\pm$  2.23), and the AP ratings were 7.28 ( $\pm$  1.77) and 5.36 ( $\pm$  2.15), for sharp and dull tools, respectively. Significant differences ( $p < 0.05$ ) were also detected between the TA and AP for time and ratings under each condition. These data indicate that the TA and the AP are less effective when they are dull, than when they are sharp. Furthermore the AP is more effective (faster and better preferred) than the TA, during both sharp and dull conditions. There was no significant difference ( $p > 0.05$ ) in time between the sharp TA condition and the dull AP condition. While practicing the skill of face mask removal is encouraged, excessive practice can dull a tool, making it virtually unusable. We recommend that only new tools be available for use on-the-field, and that secondary tools be used for practice.

### The Most Efficient Technique For Using The FM Extractor

Angotti DD, Hoenshel RW, Kleiner DM: University of North Florida, Jacksonville, FL

The FM Extractor™ comes with instructions from the manufacturer that describe a primary method for use, and two alternate techniques. The purpose of this study was to evaluate the time it takes to cut the face mask loop-straps with the three different techniques. Technique A (the primary method) involves placing each end of the tool on the loop-strap, between the side face mask bars. Technique B involves locking the semi-circular notch of the tool onto the face mask bar, and technique C involves resting the semi-circular notch on top of the face mask bar. Thirty-seven student athletic trainers (18 females, 19 males) served as subjects. After receiving standard instructions, each subject cut through two lateral Schutt™ ArmorGuard™ face mask loop-straps and retracted the football helmet face mask using the two anterior loop-straps as a hinge. Every subject performed this task once with each technique. All trials were completed on the same day. The sequence of trials was randomly selected by each subject. The subjects also reported a rating of satisfaction with a 10-point scale. The data were analyzed by ANOVA and are presented as means ( $\pm$  S.D). There was a significant ( $p < 0.05$ ) difference between techniques for both time and ratings of satisfaction. The times were 135.23 ( $\pm$  101.75), 109.55 ( $\pm$  100.74), and 89.94 s ( $\pm$  68.91), for methods A, B, and C, respectively. Only the post-hoc comparison between A and C was significant ( $p < 0.05$ ) for time. The ratings of satisfaction were 4.03 ( $\pm$  1.96), 5.00 ( $\pm$  2.24), and 5.24 ( $\pm$  1.91), for A, B, and C, respectively. There were significant ( $p < 0.05$ ) pair-wise comparisons for each combination except B vs. C. These data indicate that the primary method suggested by the manufacturer is not the fastest or better-preferred method. Still, it is an impressive feature that the FM Extractor™ has three options for use. It is interesting to note that method C is the only technique that requires the subject to make two cuts on each loop-strap, and most closely resembles the technique used with the anvil pruner. We recommend that each individual use the method with which they are most skilled and practiced.

## An Objective Evaluation Of The FM Extractor™

Hoenshel RW, Angotti DD, Kleiner DM:  
University of North Florida, Jacksonville,  
FL

For many years the Trainers Angel™ (TA) was the only tool available that was specifically developed for face mask removal. However, when tested with new-generation loop-straps, some limitations were identified, especially when compared to the anvil pruner (AP). Previous publications called for the development of new tools, and in 1999 the FM Extractor™ (FM) was produced. However, no scientific testing has been reported on the FM. The purpose of this study was to compare the time that it takes to cut the face mask loop-straps with the FM, TA, and AP. Thirty-nine student athletic trainers (21 females, 18 males) served as subjects. After receiving standard instructions, each subject cut through the two lateral Schutt™ ArmorGuard™ face mask loop-straps and retracted the football helmet face mask using the two anterior loop-straps as a hinge. Each subject completed this task once with each tool. The sequence of trials was randomly selected by each subject. The subjects also reported a rating of satisfaction with a 10-point scale. The data were analyzed by ANOVA and are presented as means ( $\pm$  S.D.). There were significant ( $p < 0.05$ ) differences between tools for both times and ratings of satisfaction. The times were 63.10 s ( $\pm$  38.35), 75.91 s ( $\pm$  48.40), and 32.04 s ( $\pm$  20.89), for FM, TA, and AP, respectively. Post-hoc analysis revealed significant ( $p < 0.05$ ) pairwise comparisons for each combination except FM vs. TA. The ratings of satisfaction were 6.03 ( $\pm$  1.60), 4.26 ( $\pm$  2.04), and 8.08 ( $\pm$  1.16), for FM, TA, and AP, respectively. Post-hoc analysis revealed significant ( $p < 0.05$ ) differences for each pair-wise comparison. These data indicate that the FM is comparable to the TA in time, and is better-preferred by the subjects. However, the AP is still faster and easier to use than either tool designed specifically for face mask removal. While the FM possesses many positive design features that other tools do not, it was not significantly better than the TA. Design modifications to the TA and the AP may serve useful. We recommend additional research with more subjects and different loop-straps. We further recommend the development of new tools, and that improvements be made to existing tools.

## An Assessment Of The Response Time Prior To Face Mask Removal

Almquist JL, Rehberg RS, Kleiner DM:  
University of North Florida, Jacksonville,  
FL

Previous studies have reported the time it takes to retract the face mask from a football helmet (an average of 165.9 s [ $\pm$  194.3]). However, these studies were conducted in laboratories under controlled environments. In these studies, the subjects knew what to anticipate, and had tools readily available. The limitation of these studies is that they were conducted in less-than real-life environments. The purpose of the present study was to describe the amount of time it takes to prepare for the task of face mask removal. Twenty-one Certified Athletic Trainers were presented with a football helmet during a football game or practice, and were given standard written instruction that said: "We have a downed player with compromised breathing and a suspected neck injury. We need to access the airway. I'll stabilize the head", followed by the verbal command: "We need access to the airway". The investigator then started a stopwatch, and ended the time when a tool approached the helmet. Data are presented by descriptive statistics, analyzed by *t*-tests, and presented as means ( $\pm$  S.D.). Eighteen subjects (86%) had a tool available, and were included in the data. Three subjects (14%) had no tool available, although one attempted the pocket-mask insertion technique. The mean time to produce the tool was 42.6 s ( $\pm$  36.3). Fifty percent had the tool on their person (fanny pack, or pocket), and 50% had the tool in a kit or elsewhere on the field. There was a significant improvement ( $p < 0.05$ ) in time, when the tool was carried (20.4 s [ $\pm$  11.5]) vs. when it was not (64.8 s [ $\pm$  39.6]). The tools produced included; Trainer's Angels (44.4%), PVC pipe cutters (22.2%), pruners (16.7%), scissors (11.1%), and Cramer emergency shears (5.6%). These data indicate that carrying the tools for face mask removal can significantly improve response time, and serve to validate the guideline from the Inter-Association Task Force for the Appropriate Care of the Spine-Injured Athlete that: "Those involved in the pre-hospital care of injured football players should have the tools for face mask removal readily available". These data, along with previous data, provide a more complete description of emergency response time.

## A Description Of How Chin Straps Are Attached To High School Football Helmets

Knox KE, Kleiner DM: DMH Sports  
Medicine & Physical Therapy, Decatur  
Memorial Hospital, Decatur, IL

The Inter-Association Task Force for the Appropriate Care of the Spine-Injured Athlete recently distributed guidelines for the emergency management of an injured football player with a suspected cervical spine injury. One guideline is to remove only the face mask, and to leave the helmet and chin strap in place. The chin strap and helmet act together to prevent movement of the head and spine during immobilization and transportation. However, if the chin strap is secured to the helmet incorrectly, it can prevent the face mask from being removed or retracted. Four-point chin straps are secured to the football helmet by either an all-low (LO) strapping method or a high-low (HL) method. Only the HL method can interfere with face mask removal. The purpose of this preliminary study was to describe the manner in which chin straps are secured to the helmets in the high school setting. A secondary purpose was to examine the influence of having a certified athletic trainer on the correct placement of the chin strap. The placement of each chin strap was observed and recorded by the principal investigator. Descriptive statistics are given in percentages. Of the 753 football helmets studied from twenty-two high schools in central Illinois, 61.3% ( $n = 475$ ) employed the LO technique, and 36.1% ( $n = 278$ ) used the HL method. Of those with HL attachments, 18.3% ( $n = 51$ ) were attached incorrectly and would have interfered with face mask removal/retraction. Of the schools evaluated, 57% ( $n = 12$ ) had one or more helmets with the chin strap secured incorrectly. Ten schools had a full time (FT) certified athletic trainer (ATC), eight had a part time (PT) ATC, and three schools had no one (NO) providing athletic training services. When analyzed by athletic training coverage, the data revealed incorrect attachments for 10.7%, 22.8% and 22.9%, for FT, PT and NO, respectively. These preliminary data indicate that chin straps are not all being attached properly, which can pose a significant obstacle in the emergency management of a spine-injured athlete. These data further suggest that the presence of FT ATCs can attenuate this problem. Future research in other geographical regions, and at other levels of participation is recommended.

## Effect Of Selected Tools On Face Mask Removal Time And Head Motion

Surace AF, Goldfuss AJ, Hauth JM, Wagner LE: East Stroudsburg University, East Stroudsburg, PA

**Purpose:** The main purpose was to compare selected tools used by athletic trainers (n=10) to remove face masks from football helmets. Face mask removal time and head motion during the removal process with each tool, were the primary variables examined. The tools used were: anvil pruner (AP), Trainers Angelä (TA), and phillips screwdriver (PS). Tool selection was based on responses to a survey by 52 (28 males, 24 females) NATA certified athletic trainers from Northeast Pennsylvania who covered football practices and games. Survey data also included: years of experience, tool preference and experience using tools during practice and emergencies. The relationship between grip strength and face mask removal time using each tool was also analyzed. **Procedures:** Ten subjects (6 males, 4 females) having experience with (TA), (AP) and (PS), attended an orientation session where they practiced removing masks from helmets using all three tools. On two subsequent days, each tool was used to remove the face mask from a helmet worn by a student volunteer who assumed the role of an unconscious football player. His head was stabilized by an athletic trainer during all face mask removal trials. Each trial was repeated a second time during each session, and order of tool use was randomly selected. All trials were videotaped using two camcorders positioned 15 ft. from each side of the 'unconscious' subject. Removal time began at first tool contact with a face mask on one side of helmet and ended when face mask began to be lifted after cutting or freeing strap on the other side. Time, (seconds), and sagittal head motion (degrees) was determined from videotapes using PEAK® video analysis system. Grip strength measurements were obtained with a Lafayette (Model 76618) grip dynamometer. **Results:** ANOVAs revealed the PS took significantly less time (X=36.6 secs.) to use compared to AP (X=77.9 secs.) and TA (X=84.4 secs.). Mean head motion was also significantly less using the PS (2.35°) compared to AP (3.51°) and TA (3.31°). Low correlations (r=-.02 to .11) were found between grip strength and face mask removal time using AP and TA. Using PS over both days correlations were higher (r=.25 and .6). **Recommendations:** Although the phillips screwdriver was the most efficient tool under the conditions tested, a follow-up should focus on possible lateral head motion. Furthermore, the phillips screwdriver could be useless (and fatal) if screws and nuts holding the face mask hinges to the helmet are rusted. Rustproof hardware was recommended.

## Patient Satisfaction Following Thermal Shrinkage Of The Glenohumeral Joint

Perkins SA, Massie JE: Southern Illinois University, Carbondale, IL

The purpose of this study was to determine if patients were satisfied after a thermal shrinkage procedure was performed on the capsule of the affected glenohumeral joint. Eight recreational and intercollegiate athletes, 4 males and 4 females, with a mean age of 21 from Southern Illinois University volunteered to participate in the study. Each had sustained a traumatic injury to their glenohumeral joint resulting in multi-directional instability. An assessment of the affected shoulder was performed preoperatively and 2 months postoperatively. The assessment included both a physical examination of the affected shoulder and a patient survey which was conducted and administered by a Certified Athletic Trainer. The physical examination evaluated glenohumeral laxity and labral deformity using the anterior/posterior drawer test, relocation test, sulcus test, clunk test and goniometric measurements. The patient survey consisted of questions designed to measure pain with daily living activities, their current level of physical activity, satisfaction with shoulder function, and completion of a modified UCLA pain scale. Data was analyzed by researchers using simple descriptive statistics.

Of the 7 subjects with positive anterior/posterior drawer tests preoperatively 6 had negative anterior/posterior drawer tests 2 months postoperatively. Seven subjects had positive sulcus tests preoperatively and 5 demonstrated a decrease in laxity 2 months postoperatively. Of the 5 subjects who had positive relocation tests preoperatively, only 2 tested positive 2 months postoperatively. All subjects with a positive clunk test preoperatively had a negative clunk test 2 months postoperatively. Both active extension and external rotation at 90 degrees of abduction increased in all patients. When compared to the preoperative state, pain with many daily living activities was decreased 2 months postoperatively. These daily living activities included washing and drying their hair, sleeping on the affected side, opening and closing a door, and putting clothes on over their head. Six of the eight subjects reported a decrease in the amount of pain 2 months postoperatively when compared to the preoperative state. All 8 subjects were satisfied with the thermal shrinkage procedure and 7 of the 8 subjects felt they were better. In conclusion, thermal shrinkage of the capsule of the glenohumeral joint is a viable surgical procedure resulting in a high level of patient satisfaction and reduction in pain.

## The Effect Of The Sully® Shoulder Stabilizer On Active Joint Reposition Sense In Stable And Unstable Shoulders

Chu JC, Kane EJ, Arnold BL, Gansneder BM: University of Virginia, Charlottesville, VA

**Objective:** To compare the effects of shoulder bracing on active joint reposition sense in stable and unstable shoulders.

**Design and Setting:** Two subject groups, stable and unstable shoulders, performed a shoulder active joint reposition test under braced and unbraced conditions. For the braced condition, The Sully Shoulder Stabilizer (The Saunders Group, Inc.) was fitted on each subject according to manufacturer's instructions.

**Subjects:** Forty subjects (22 males, 18 females; age =  $21.85 \pm 3.12$  years; ht =  $173.97 \pm 10.08$  cm; wt =  $71.27 \pm 11.68$  kg) volunteered to participate in this study. Twenty subjects each were assigned to the stable and unstable shoulder groups. The stable group consisted of subjects with no history of shoulder dislocation. Subjects in the unstable group had a history of an anterior glenohumeral dislocation(s) and had not had surgery to correct the instability. Subjects' instability was assessed with a questionnaire and clinical tests.

**Measurements:** Each subject's ability to perceive joint position sense in space was tested by actively reproducing 3 preset angles ( $30^\circ$  internal rotation,  $30^\circ$  external rotation, and  $10^\circ$  from full external rotation) with and without the shoulder brace. The dominant shoulder was tested for the stable group, and the affected shoulder was tested for the unstable group. Each subject was instructed to actively move the shoulder from the starting position of neutral rotation to one of the three angles. After returning to the starting position, the subject was asked to actively reposition their shoulder to the target angle. The degree of error was determined by subtracting the repositioned angle from the initial preset angle. A total of three trials for each angle was performed and an average of the absolute value of the three errors was used for statistical analysis.

**Results:** A mixed-model ANOVA revealed a significant brace-by-angle-by-group interaction ( $F(2,76)=5.271, p<.05$ ). Tukey post hoc analyses revealed that at  $10^\circ$  from full external rotation, the unstable group's joint reposition sense mean error ( $4.6 \pm 2.9^\circ$ ) was significantly decreased from the stable group's ( $8.9 \pm 4.2^\circ$ ) in the braced condition. A main effect for test angle ( $F(2,76)=8.804, p<.001$ ) and post hoc testing revealed significantly greater mean error scores at ten degrees from full external rotation ( $7.5 \pm 0.562^\circ$ ) as compared to  $30^\circ$  internal rotation ( $4.6 \pm 0.314^\circ$ ) and  $30^\circ$  external rotation ( $5.6 \pm 0.492^\circ$ ).

**Conclusion:** Our findings suggest that shoulder active joint reposition sense in unstable subjects can be improved at close to maximal external rotation by wearing a shoulder brace.

## Measurement Of Upper Extremity Range Of Motion, Stability, And Isokinetic Strength In Collegiate Baseball Players

Ashley CS, Horodyski MB, Kaminski TW, Meister K, Buckley BD: University of Florida, Gainesville, FL

The purpose of this study was to examine peak torque, total work, agonist/antagonist ratios for shoulder external/internal rotator, abductor/adductor muscle strength of both the dominant and nondominant throwing arms, and to examine the range of motion and glenohumeral stability of both dominant (throwing) and nondominant arms. Thirty-eight Division I collegiate baseball players (age 18-23) participated in the study. Isokinetic tests were performed concentrically at 60, 180, and 300 deg/sec for both the dominant and nondominant arms on the Biodex Multi-Joint System (Biodex Medical Systems, Inc., Shirley, NY). Statistical analyses were performed using paired *t*-tests and a Wilcoxon-Signed Ranks Test with a level of significance set at  $p<.05$ . Test results for bilateral comparisons of mean peak torque and total work values demonstrated a significant difference in internal rotation peak torque and total work at all three test speeds. External-to-internal rotation peak torque ratios suggested a significantly greater ratio for the nondominant arm at speeds of 60 and 180 deg/sec. Adduction peak torque strength and adductor total work were significantly greater for the dominant arm at all three test speeds. Abductor-to-adductor peak torque ratios were evaluated and suggested a significantly greater ratio for the nondominant arm at speeds of 60 and 180 deg/sec. External rotation range of motion was significantly greater on the dominant arm when evaluated at both the  $30^\circ$  and  $90^\circ$  abducted position. Internal rotation range of motion was significantly greater on the nondominant arm when measured in neutral (highest vertebral level) and at  $90^\circ$  of abduction. Finally, inferior, anterior, and posterior laxity measurements indicated a significant difference in only posterior glenohumeral translation when compared bilaterally. This research helps to establish average values on shoulder strength, range of motion, and stability in collegiate baseball players. These values may assist in identification of deficits, the amelioration of which could assist injury prevention.

### Isokinetic Exercise: The Effects Of Training Specificity On Shoulder Strength Development

Quincy RI, Davies GJ, Kolbeck KJ, Szymanski JL: University of Wisconsin – La Crosse, WI

Evaluating the effects of specific rehabilitation techniques on shoulder strength development is very important to the rehabilitation process following injury. Determining those exercises that are the most effective at regaining the patient's strength is essential clinical information. The purpose of this study was to compare the effects of training specificity on shoulder strength as measured by peak torque production using an isokinetic dynamometer. Pre-test measurements of the dominant shoulder of 74 subjects (37 male, 37 female), mean age of 19.8 years, was performed at speeds of 60 deg/sec, 180 deg/sec and 300 deg/sec, in all three cardinal planes of shoulder motion; flexion/extension, abduction/adduction, internal/external rotation. Subjects were randomly divided into one of four groups; Control Group (C), Experimental (Exp.) Group 1 (flexion/extension), Exp. Group 2 (abduction/adduction), Exp. Group 3 (internal/external rotation). Experimental groups trained in one plane of motion three times a week for a period of six weeks. The training sessions consisted of ten concentric/concentric repetitions at angular velocities of 300 deg/sec, 180 deg/sec, 60 deg/sec, 180 deg/sec and 300 deg/sec with a ten-second rest between each speed. Post-test measurements were performed at the conclusion of the six week training period, using the format identical to the pre-test. An independent t-test ( $p \leq .05$ ) was used to compare the differences between pre and post-test measurements for each shoulder plane of motion. Bonferroni corrections were made for independent t-tests to eliminate statistical errors. An ANOVA was used to examine if differences existed between planes of motion. Pre and post-test measurements demonstrated a significant strength improvement as measured by peak torque production at all isokinetic speeds for all experimental subjects. Exp. Group 3 (internal/external rotation) demonstrated statistical significant strength development as measured by peak torque in the specified training plane and in all other cardinal planes of motion including flexion/extension and abduction/adduction.

### Evaluation Of Techniques To Measure The Effectiveness Of Plyometric Training On Shoulder Strength And Stability.

Navitskis L, Peterson CL, Ferrara MS, Courson R, Dillon M: University of Georgia, Athens, GA

There is a considerable amount of research, testing, and measurement information published concerning the use of plyometric training and the lower extremity. It is a common concept to include lower extremity plyometric training into a sport training program to increase overall lower extremity power and strength. Although upper body (shoulder) plyometrics have been introduced to the field and are increasing in popularity, there is a lack of research supporting effective ways to test and measure the effects of upper extremity plyometric training. The purpose of this study was to introduce and measure several upper extremity testing techniques to determine the overall effectiveness of a plyometric training program on strength and stability. **Methods:** Seventeen healthy male Division I athletes (mean age: 20.4, height 6'2", weight 242 lbs.) participated in the project. Athletes were assigned to experimental (7) or control (10) groups. The control group maintained a standard isotonic weightlifting regimen. The experimental group performed the same weightlifting program with the addition of a series of upper extremity plyometric exercises that were performed two times per week. Plyometric exercises consisted of several variations of push-ups, medicine ball tosses (various weights), and swiss ball stability exercises. Athletes were pre and post tested on a line shifting, rhythmic swiss ball shifting, and a shoulder press movement. Change scores were calculated from pre to post testing and a 2 (groups) X 4 (tests) MANOVA was conducted. **Results:** The overall model did not show statistical significance ( $p = .125$ ). However, post-hoc analysis found significant differences between the experimental and control groups on the line shifting test. All other tests were found to be not significant between groups. **Conclusion:** Upper extremity plyometric exercises are often incorporated into weightlifting regimens to augment strength gains and improve stability. Our results indicated this was the case on only one of the tests (line shifting) conducted. However, we felt this particular test was the best measure of both strength and stability. It is possible this test was significant because it incorporated a combination of strength and stability, whereas other tests were thought to be better measures of strength or stability. With differences in upper extremity plyometric training, the issue of strength vs. stability must be addressed when developing a technique for evaluation. We question whether specific testing protocols demonstrate an increase in strength or stability or both. Further research in this area needs to be done to develop a standard method of evaluating upper extremity plyometrics.

### The Effect Of Fatigue On Force Perception During Shoulder Internal Rotation

Vinson MT, Powers ME, Perrin DH, Gansneder BM: University of Virginia, Charlottesville, VA

Fatigue induced proprioception deficits may impair performance and possibly lead to injury in the overhead athlete. Thus, the purpose of this investigation was to assess the effect of fatigue on force perception during isometric shoulder internal rotation (IR). Twenty male subjects (age=21.15+/-2.81 yrs; ht=184.15+/-5.50 cm; wt=94.09+/-17.22 kg) were positioned supine with their shoulders in 90° of abduction and external rotation and their elbows in 90° of flexion. Subjects were then instructed to internally rotate the non-dominant (control) shoulder and produce a constant submaximal isometric force (50% MVIC). The force was recorded using a hand-grip dynamometer (Lafayette Instruments, Lafayette, IN) with a BioPac-DA100 (BioPac Inc., Goleta CA) physiological data analyzer. The subjects viewed their effort on a computer monitor to assist them in maintaining the desired force. The subjects then attempted to simultaneously produce an identical amount of force using the dominant (experimental) arm without visual feedback. Subjects were instructed to notify the investigator once they felt they had matched the force production of the control arm. Data from both arms were then recorded for 3-sec. Force perception was recorded as the absolute value of the difference in mean forces produced in the control and experimental arms during the 3-sec period. Three pre-test measurements were performed with a 1-min rest period between each measurement. Following the final pre-test measure, isotonic fatigue was induced in the experimental arm with the subjects in the same position used for the force perception measurement. Each subject performed an IR dumbbell exercise with a resistance equivalent to 60% of the MVIC. Each subject rotated the shoulder until the neutral position was achieved. Once this position was achieved the arm was returned to the starting position. This was continued until the neutral position could not be achieved. This was repeated two more times for a total of three sets with a 1-min rest in between. Using the same procedures previously described, the force perception data were then collected immediately after the final set of exercise and at one-minute intervals for five minutes following and again at ten minutes post for a total of seven post fatigue measures. A one-way repeated measures ANOVA revealed no significant differences [ $F(9,171) = .830, p > .05$ ] between any pre-test and/or post-test measures. This study suggests that isometric force perception is not affected by fatigue. However, it would be of benefit for future research to investigate these effects using a more objective measure of muscle fatigue.

## An Accelerated Rehabilitation Of A Hand Injury In A Collegiate Volleyball Player

James CB, Mattacola CG, Uhl TL, Lawton JN: University of Kentucky, Lexington, KY

### Personal Data/Medical History

A 22 year old, 6'3", 175 pound female Division I collegiate volleyball player (middle blocker) reported pain, limited ROM, and edema in the fifth digit of her right hand during a mid-semester practice. The athlete explained that pain began after competing a block and was unable to complete her next play.

### Physical signs and symptoms

Upon examination the athlete presented with edema, ecchymosis, no obvious deformity, and point tenderness along the proximal phalanx of the 5th digit with snapping occurring along the posteromedial border just proximal to the PIP joint. ROM was significantly limited; the athlete was unable to make a fist or a lumbrical grip. Manual muscle tests of both the flexors and extensors were weak and painful. Both a tap test and longitudinal loading test were positive. Sensation was intact and capillary refill was normal.

### Differential Diagnosis

Fracture

Extensor Digitorum Communi injury

PIP joint collateral ligament injury

Results of Diagnostic Imaging

X-rays confirmed a spiral, oblique fracture of the 5th proximal phalanx neck with apex volar angulation.

### Clinical Course

Surgery included open-reduction internal fixation with interfragmentary screws. At 1.5 weeks post-surgery, the athlete presented with a 20° extensor lag of the PIP joint with flexion to within one-centimeter of the palm. At 2.5 weeks post-surgery, athlete presented with a 10° extensor lag at the PIP joint, however, this was passively correctable to neutral. Additionally, there was a 5° extensor lag of MP joint which could be passively hyperextended to 5°. At this time the physician approved AAROM. At 3.5 weeks post-surgery, athlete presented with approximately 10° of passive hyperextension of the MP joint and active extension of the PIP joint to 10° and passive extension to 0°. At 7.5 weeks post-surgery, PIP joint motion was 90° (active & passive) as compared to 100° on the opposite side. Additionally, x-rays revealed a healed fracture. Criteria to return to competition included full functional ROM and pain free participation while wearing an approved splint.

### Deviation from the expected

This case is unique due to the: (1) use of interfragmentary screws versus Kirschner wires to repair a comminuted fracture, (2) early return to participation in NCAA volleyball, and (3) introduction of a semi-rigid brace that meets the standards of the National Association of Women's

and Girl's Sports (NAWGS). Previous literature has demonstrated that unstable comminuted fractures may require percutaneous Kirschner wire fixation if alignment is not satisfactory following one to two weeks of closed reduction treatment. Our surgeon opted to secure the fracture with four interfragmentary screws. These screws provide stability, better skeletal pain control, and allowance of early intensive rehabilitation. A review of literature reports that following two weeks of immobilization post-surgery gentle exercises may begin. However, four days after surgery the athlete began AROM exercises of flexion, extension, abduction and adduction. The athlete wore a removable forearm-based orthoplast splint when not in rehabilitation. As indicated in the clinical course, the athlete's ROM progressed to allow her to begin limited sport specific drills (forearm passing) at 3.5 weeks post-surgery. At 4.5 weeks post-surgery, the athlete was participating in all drills at practice, including attacking. In addition the athlete was allowed to return to full competition at six weeks. By incorporating a circular cone design in the splint, the semi-rigid materials provided greater support while meeting the criteria of the NAWGS rules interpreter and the surgeon. The athlete was allowed to compete in NCAA varsity matches wearing a splint fabricated of 1/8" alliplast padding, 1/8" polyethylene plastic and 1/8" neoprene.

## Reoccurring Shoulder Pain In A Collegiate Crew Athlete

Cokeley KL, Taylor D: United States Military Academy, West Point, NY

**PERSONAL DATA/MEDICAL HISTORY.** A 21-year-old male crew athlete reported to the training room the day after performing a bench press and felt as if his shoulder "fell apart." The athlete was unable to participate in practice, due to pain in the left anterior shoulder. Symptoms were present mostly during the "pull phase" of rowing and pain was more intense in the morning. After initial pain management it was decided that the patient would be referred to Physical Therapy to be re-evaluated. Initial diagnosis of was an acromioclavicular (AC) sprain with possible rotator cuff (ROTC) impingement and the patient began ROTC rehabilitation. After conservative management failed to produce improvements in the patient's condition, he was referred to an Orthopedic Surgeon to be re-evaluated. The Orthopedic Surgeon diagnosed the possibility of labral tear and recommended further investigation through arthroscopic surgery. Findings during arthroscopic surgery lead to a Tenosynovectomy. After the third month of post-surgical rehabilitation, the patient began to experience a painful snapping over the biceps tendon and hand paresthesia. Due to these extreme secondary symptoms a second arthroscopic surgery was performed.

The athlete remarked he had been taking three over-the-counter supplements, which included Androplex 700, Vanadyl Ph, and Creatine Monohydrate prior to the injury and during the first post-surgical rehabilitation phase.

**PHYSICAL SIGNS AND SYMPTOMS.** Findings during the initial physical examination included full range of motion (ROM) but pain at end ranges of abduction, horizontal abduction and external rotation. Strength in all shoulder muscles was within normal limits (WNL). Special tests: patient presented with a positive Hawkin's-Kennedy, positive empty can, positive Neer's, positive cross-arm, negative Speed's and a negative apprehension. The load and shift was equal bilaterally (2+). Patient had no tenderness on palpation.

Findings of the second injury examination included full ROM and strength measurements were WNL. Special tests demonstrated a positive Neer's, Hawkins-Kennedy, Speeds, and O'Briens.

### DIFFERENTIAL DIAGNOSIS.

#### Initial injury

1. AC sprain
2. ROTC impingement
3. Labral tear

#### Second injury

1. Sublexing biceps tendon
2. Soft tissue impingement
3. ROTC tear

### DIAGNOSTIC IMAGING/LABORATORY TESTS.

#### Initial injury

The MRI showed mild spurring of the AC joint with an increased signal of the supraspinatus tendon.

#### Second injury

The MRI demonstrated an increased signal of the biceps tendon and possible rotator cuff tear.

### CLINICAL COURSE/FINAL DISPOSITION.

Initial arthroscopic surgery did not confirm suspicions of a labral tear but showed a prominent inflamed biceps tendon, therefore a Tenosynovectomy was performed. Postoperative rehabilitation included prescribed range of motion exercises, modalities and isometrics. A sling was to be worn at all times and limitations were dependent on tissue healing and individual functional readiness.

Findings during the second arthroscopic surgical procedure revealed a prominent anterolateral acromion, a partial supraspinatus tear, and soft tissue impingement. The snapping mechanism could not be recreated under anesthesia, but it was noted that there was a complete unroofing of the biceps tendon distal to the joint along with a prominent transverse humeral ligament. The unroofing was performed in first surgery yet appeared unhealed. An open acromioplasty and suturing of the rotator cuff tear was performed. Portions of the transverse humeral ligament were debrided and closed over the biceps tendon. Post-surgical rehabilitation followed the prescribed rotator cuff repair guidelines. Progression was based on the discretion of the surgical precautions and patient tolerance. Four months after the second procedure, the patient was released to full activity and has had no "snapping" sensations occur.

### UNIQUENESS/DEVIATION FROM THE EXPECTED.

This case is unique in three ways. First, the signs and symptoms of the initial injury examination all lead to ROTC pathology but resulted in an inflamed biceps tendon. Second, the post-surgical symptoms that began in the third month lead to a sublexing biceps tendon. The sublexing biceps was believed to be the main source of the problem but a partial ROTC tear was present as well. Lastly, the athlete was taking three supplements prior to the first surgery and during the post-rehabilitation phase. One could conclude that these supplements may have interfered with the tissue healing process or may have been the origin of initial injury.

## Triceps Injury In An Intercollegiate Gymnast

McGinn PA, Goodlett M: Auburn University, Auburn, AL

During preseason workouts an 18-year-old freshman, left hand dominant, female collegiate gymnast, sustained a triceps injury while attempting a skill on the high bar of the uneven parallel bars. The athlete was working a station drill, during the middle of practice, on the single high bar over a foam pit. She was attempting a release move called a Healey-twirl straddle-back to handstand and when she attempted to do the handstand onto a foam mat stack, representing the low bar, her arm buckled and she flew into the pit. She stated that she could not support her body weight and her momentum, which in turn caused her bent elbow to hyper-flex over her head. The athlete complained of soreness in her left upper arm, on the posterior medial side. Initially, the athlete stated that she was fine, refused treatment, and she continued to participate for the duration of the practice. The following day at practice the athlete approached the certified athletic trainer (ATC) and complained of a throbbing sensation in her left upper arm and stated that she was having a lot of pain raising her arm over her head during activities of daily living (ADL). Upon the ATC's evaluation the athlete presented with a significant amount of general edema in her left upper arm compared bilaterally, but no ecchymosis was noted at that time. Athlete had normal dermatomes, but presented with a large palpable mass on the posterior medial aspect of her left upper arm, inferior to the axilla. The triceps tendon at its insertion was palpable, but not as prominent compared to the unaffected side. Active range of motion (AROM) was pain-free in all ROM except while performing the following actions: forearm extension, abduction > 70 degrees, and forward flexion > 90 degrees. Resistive range of motion (RRROM) was abnormal with a 3.5/5 strength ratio for both forearm extension and adduction. The athlete presented with 5/5 strength ratio for the remaining shoulder and forearm motions. The athlete was treated with ice, elevation, and given a compression sleeve to wear through the night; she did not participate in any further activity. The athlete was seen by the team physician the following day and presented with ecchymosis on the posterior aspect of her upper arm along with the same signs and symptoms still present. The injury was clearly a muscular disruption of the triceps; upon physician evaluation the diagnosis was an acute medial head triceps tear (partial). The athlete had no prior history of an injury of this nature.

The injury was treated non-operatively and with an aggressive rehabilitation program supervised by the ATC. The first week of treatment consisted of rest, ice and compression in an attempt to keep the athlete from further tearing the soft tissue of her triceps. The next five weeks her rehabilitation consisted of strengthening exercises with increasing weights, proprioceptive activity and during the final two weeks she engaged in plyometric exercises. The exercises, per-

## Severe Focal Lumbar Pain In A High School Soccer Player: A Case Report

Norris WC, Hanley KF: DeMatha Catholic High School, Hyattsville, MD

formed bilaterally, incorporated all appropriate musculature of the shoulder girdle and upper arm. The standard treatment session would begin with an ice treatment of 20 minutes, range of motion exercises, strengthening, proprioception, plyometrics (when appropriate), and end with a 20-minute ice treatment and reapplication of a compression sleeve. The athlete reported to the athletic training room twice daily for treatment and rehabilitation. Throughout her rehabilitation the athlete still participated in aerobic conditioning with her teammates, but her weight lifting sessions were modified. The weight progression during rehabilitation sessions was about every fourth session, or second day of that level. The athlete's progression with tubing resistance activities was to increase one level at the start of the next week. About 3 weeks post injury the team physician cleared her to begin pain-free progression back into competitive gymnastics. The athlete maintained her rehabilitation schedule and participated more aggressively at practice-to her pain tolerance. When the athlete was 4 weeks out from her injury, she began tumbling pain-free. At this time she also began light plyometric activities and had been competing all events except bars. The progression protocol of the plyometric activity was to complete one week and then increase to the next level. After she progressed to the second level of plyometric activities, she began working out on bars. In addition, she also increased her workload in the weight room to 70 percent of her normal weight. By the fifth and sixth weeks, the athlete was feeling more confident in herself and was participating in all four events. She continued her rehab program at the same rate/intensity for an additional week to maintain her levels of strength, endurance and proprioception.

By the end of the rehabilitation sessions the athlete had returned to competitive gymnastics pain-free and without complications. It was noted that the palpable mass in her left upper arm had decreased significantly and was almost undistinguishable, and her triceps tendon at its insertion was more prominent. This case presents as unique because the incidence of triceps injury is rare in athletics, but the mechanism of injury in this case was almost inconceivable. The athlete was attempting a release move that is performed by numerous gymnasts, but somehow her arm weakened during the handstand, and she crumbled into the foam pit. Since this athlete had no prior history of a significant musculoskeletal injury, it is difficult to conclude what factors may have contributed to this injury. However, fatigue from practice and the weight training session from the day before probably lead to delayed onset muscle soreness (DOMS). The DOMS probably played a role in her weakened response to an eccentric load on her triceps, which might have been the primary contributor to this injury.

### PERSONAL DATA

A 17-year-old male soccer player was participating in a soccer regional training camp. During a game he reached with his left leg to clear a ball going out of bounds. He felt immediate sharp pain in his lower back and had to leave the game. After being evaluated by the camp trainer and initially icing the area he returned to the game with some discomfort but was able to play through the pain. The athlete continued through training camp experiencing intermittent pain and stiffness. The following week the athlete left for international competition. During the intense two-week schedule the athlete had a gradual increase of symptoms. He however continued to play. When he returned from his tour he reported to his high school team where he was unable to perform due to the pain. He then reported to his high school athletic trainer for evaluation, three weeks after initial injury.

### PHYSICAL SIGNS AND SYMPTOMS

Three weeks from initial injury the athlete presented focal localized lumbar pain and spasm in the left lumbar area. The athlete had pain with both passive and active range of motion all lumbar specific testing was negative. He had no radicular symptomatology.

### DIFFERENTIAL DIAGNOSES

The athlete was sent for an aggressive battery of testing to rule out numerous possible diagnoses since on exam no clear causes were identified possible diagnoses needed to be ruled out which included sprain, strain of the lumbar structures, spondylolisthesis, discitis, facet fracture or osteoid osteoma.

### RESULTS OF DIAGNOSTIC IMAGING

A battery of testing was performed to take an aggressive diagnostic approach to the injury. X-rays of the lumbar spine were ordered the x-rays were unremarkable. A bone scan was then ordered. The scan demonstrated uptake at the L5 region. For a clearer view of what was identified on the bone scan as a possible L5 fracture a thin sliced CT scan was performed which clearly identified a fracture of the left side of the pedicle of L5. An MRI was then ordered to rule out any disc association. The MRI was unremarkable.

### CLINICAL COURSE

The athlete was taken out of all activity for two weeks. He was treated with a course of ultrasound and antispasmodic medication as well as antiinflammatories. At week two a stretching program was initiated along with a lumbar program with the swiss ball. He gradually was weaned into a walking and a stationary bike program. With no symptomatology reported activity was increased to tolerance which included running and core lumbar stabilization programs. As his tolerance increased he was weaned into sport specific drills and then gradually into play with time limitations. He returned to play for the last half of his high school season with no limitations. He presently is completing a course of aggressive lumbar strengthening. He is scheduled to repeat

his CT scan of the injured area 6 months from the initial injury date to evaluate the bony healing of the vertebrae. The team physician felt that an earlier study would have had the sports medicine team focusing on treating the images and not the athlete. The athlete is presently training with the national team. He was given All-American honors again this year and has accepted a scholarship to a Division 1 program. The athlete has had no reported problems since his return except intermittent tightness in the lumbar region that subsides after warm-up.

### DEVIATED FROM THE EXPECTED

Due to the signs and symptoms present during the initial exam a more conservative diagnosis and approach to the injury might have been taken. However an aggressive approach to the diagnoses was taken which lead to an immediate cause and then treatment to the injury. Although a diagnoses of an acute fracture was made this did not dictate the course of treatment. The athlete after the initial symptoms were treated was weaned into activity as tolerated with no restrictions dictated by the results of imaging. The athlete was treated not the diagnoses which lead to a speedy return to play. The fact he returned to play at the level of competition he is accustomed to both on a local and international level within months is remarkable.

## Dorsal Foot Pain In A College Football Place Kicker

Fletcher R: University of Kentucky Sports Medicine Clinic, Lexington, KY

### Personal Data

A 20 years old place kicker was referred to the clinic with dorsal foot pain. He stated a 3-day history of distal/medial tibial and dorsal foot tenderness, swelling and periodic discoloration of the kicking foot. He has played soccer since the age of 4, and was 4 months into his first football season. He recalled no prior similar episode. Excluding an occasional migraine, he relates being healthy.

### Physical Signs and Symptoms

Physical exam of the right ankle/foot, revealed minimal swelling and discoloration of the medial surface. Upon palpation, a palpable cord anterior to his medial malleolus could be appreciated; there was no Homan's sign. The anterior and posterior tibial tendons were non-tender, nor did active ankle or foot range of motion cause pain. Tracking of the anterior and posterior tibial tendons was normal. Dorsiflexion and plantarflexion of the ankle were 5/5 and toe extension was 5/5. Sensation was intact to light touch on all surfaces of the foot. His DP and PT pulses were normal, and capillary refill was brisk.

### Differential Diagnosis

Subluxing posterior tibial tendon, posterior tibialis tendonitis, medial malleolus stress fracture, thrombosis of the greater saphenous vein

### Results of Diagnostic Imaging

Ultrasound of the entire left lower extremity demonstrated a fresh thrombus of the greater saphenous vein, which extended approximately 5 cm proximal to the ankle. No deep venous thrombus was identified.

### Clinical Course

He was treated symptomatically with warm compresses, elevation and NSAIDS. He was returned to participation once symptoms resolved approximately three weeks post injury.

### Deviation from Expected

Even though the mechanism and regional anatomy would suggest a more common injury in the kicking athlete. To our knowledge, however, superficial venous thrombosis of the saphenous vein below the knee in an otherwise healthy athlete has never been reported in the modern literature. An injury to this area can easily overlooked as a tendonitis injury, but symptoms warrant a further investigation.

## Posterior Foot Pain In A Collegiate Field Hockey Player

Mancuso JJ, Guskiewicz KM, Petschauer MA: University of North Carolina at Chapel Hill, Chapel Hill, NC

### Pertinent Data/Pertinent Medical History

A 17 year-old collegiate female field hockey player reported to the athletic training room complaining of diffuse posteromedial pain in her left ankle following a plantarflexion-eversion mechanism that occurred in practice when she stepped on a ball. She was assessed as having a first degree sprain of her left deltoid ligament, which she rehabilitated over a six-week period while continuing to play field hockey with her ankle taped. Approximately one month later, the athlete returned complaining of pain in the same area of her left posterior ankle. She reported two separate occasions in practice when her left foot planted and gave out, resulting in a pop and immediate sharp pain around the area of her achilles tendon.

### Physical Signs and Symptoms

The athlete was swollen and point tender along her left achilles tendon and within the joint space medial and lateral to the tendon. She was also tender on her posteroinferior calcaneus below the calcaneal tuberosity. Active range of motion was within normal limits but painful for all motions, especially plantarflexion-inversion. A deficit in calf strength was detected with the athlete non weight bearing. Resisted toe flexion produced significant pain. Thompson test was negative, but passive movement of her achilles tendon elicited pain. She had a negative anterior drawer sign, and there seemed to be no injury to the anterior and lateral ankle ligaments as they were not point tender or painful during any testing.

### Differential Diagnosis

1. first degree strain of the achilles tendon from eccentric loading
2. os trigonal fracture
3. posterior tibialis tendinitis
4. flexor hallucis longus tendinitis
5. talar stress fracture.

### Results of Diagnostic Imaging/Laboratory Tests

Plain radiographs taken 38 days after the initial injury showed no signs of os trigonal fracture. Bone scan taken 48 days post-injury revealed activity in the region of her posterior talus as well as some other areas across the dorsum of her left foot. MRI taken 55 days post-injury confirmed positive stress reaction in left posterior talus and increased fluid around the flexor hallucis longus, but the tendon itself appeared healthy.

### Clinical Course

Due to a stress fracture of her left posterior talus, the athlete was advised to discontinue playing field hockey as well as engaging in any heavy impact activities such as running. The athlete was permitted to remain fully weight bearing without protective splinting or crutches. Her anticipated return to participation was set at approximately 6 weeks. She is currently at week 6, and has been reevaluated by the orthopedist and cleared to begin light jogging.

### Deviation From the Expected

Stress fractures of the posterior talus are rare. Signs and symptoms mimic those of soft tissue injuries associated with the posterior foot and ankle, making them difficult to diagnose. In this particular case, the stress fracture may have arisen because of the weakened ankle, which was sprained and then never given appropriate time to rest and heal. The injury to the deltoid ligament may have caused the athlete to compensate and therefore overstress her posterior talus. Similarly, the tape designed to protect her deltoid ligament and add to her ankle stability may have caused excessive pressure to her posterior talus during the end range of plantarflexion. No correlation has ever been postulated between ankle sprains and stress fractures of the mid and hind foot. The pain with resisted toe flexion and passive dorsiflexion, as well as the decrease in calf strength may have arisen due to the close proximity of the flexor hallucis longus and achilles tendons to the posteromedial ankle. Thus these soft tissue symptoms occurred secondary to the stress fracture of the posterior talus as a result of the overall trauma to the area. Stress fractures of the posterior talus are rare in athletes, however, clinicians should be cautious when an athlete presents with posteroinferior foot pain.

## Acute Pain And Numbness In Lower Leg Following Injury In A High School Football Player

Welsh WE, Ullery LR, Selby JS:

University of Kentucky Sports Medicine Center, Lexington, KY

### Personal Data/ Pertinent Medical History:

An 18 year-old (ht. = 173 cm, wt. = 70.3 kg) high school football player (halfback and defensive back) noticed pain on the lateral aspect of his right lower leg after football practice. The pain decreased with rest. He denies any direct blow trauma to the area. Four days later, during the third quarter of a football game, he sustained a twisting injury (inversion injury) in which he felt a pop in his right ankle during a non-contact offensive play. He states there was a marked increase in pain in the distal lateral lower leg and was unable to continue to play. He was initially treated with ice, compression wrap, and an Aircast. He was told to report to the emergency room if symptoms worsened and to report to the training room for re-evaluation the following day. Two hours after the game the pain worsened making weight bearing difficult. There was also a marked decrease in sensation to the dorsum of the right foot. His parents immediately took him to the emergency room. Past medical history is otherwise unremarkable.

### Physical Signs and Symptoms:

On evaluation in the emergency room, he complained of intense pain on the lateral aspect of the lower leg. Inspection revealed a swollen leg as compared to the left without swelling of the ankle or ecchymosis. There was no bony tenderness, no medial tenderness, and minimal tenderness of lateral ligamentous structures. Active range of motion was measured at 10° dorsiflexion, 30° plantarflexion, 5° inversion with pain, and 5° eversion with pain. Manual muscle testing was 4-/5 in plantarflexion and dorsiflexion and 3/5 in inversion and eversion. Dorsalis pedis and posterior tibial pulses were palpable and normal. Sensation was decreased over the dorsum of his foot with intact sensation of the first web space.

### Differential Diagnosis:

- 1) Lateral ankle sprain
- 2) Fibula fracture
- 3) Acute Compartment Syndrome
- 4) Exertional Compartment Syndrome
- 5) Peroneal tendon avulsion
- 6) Acute Compartment Syndrome with peroneal avulsion

### Results of Diagnostic Imaging/ Laboratory Tests:

Radiographs of the right lower leg and ankle were normal. In addition, compartment pressures were obtained and recorded as follows: anterior = 54mmHg; posterior = 15mmHg;

### Clinical Course:

The patient was immediately taken to the operating room. Under normal sterile conditions, an incision was made by extending over the length of the fibula. The subcutaneous flaps were raised and the deep fascia was visualized over the anterior and lateral compartments. Care was taken not to damage the superficial peroneal nerve. The

fascia above the compartments was incised longitudinally along the entire length of the compartments. The musculature of the anterior compartment was bulging, but contracted with stimulation and appeared viable. The lateral compartment musculature was severely contused and a long, free floating muscle belly, the peroneus brevis, was lying free in the compartment. This was debrided and the remaining muscle did not contract actively with stimulation, but did appear to be well perfused. The compartments were thoroughly irrigated and a medial incision was made to examine the posterior compartments. A 12cm incision was made over the mid lower leg, posterior to the tibia. The superficial and deep compartments were confirmed to be soft and without any intracompartmental tension or swelling. The medial incision was closed with staples and the lateral incision was closed loosely with vessel loops for a return visit of irrigation and debridement. Two days later in the operating room, no necrotic muscle was found in the anterior or lateral compartments. The lateral incision was washed out and closed. No operative complications were noted. The patient was placed in a posterior splint and allowed toe-touch weight bearing for two weeks until staple removal. His peroneal strength at that time was 3/5 and he was allowed weight bearing as tolerated but restricted from all athletic activities for 2-3 months. A home rehabilitation program of pain control (NSAIDS, rest, ice), gradual range of motion exercises (towel stretches), strengthening exercises (Theraband, calf raises), and proprioception exercises (trampoline, medicine ball activities, etc) were instituted over the next three months with success. His peroneal strength at 6 weeks was 4/5 and he still had decreased sensation over the dorsum of his foot. He has progressed to be able to play competitive tennis in the upcoming spring season.

### Deviation from the Expected:

Acute compartment syndrome in the absence of a fracture requiring emergency fasciotomy is a rare injury in athletics. Usually there is a memorable blow to the limb with damage to the muscle causing a large hematoma that continues to enlarge within the compartment. In this case, the athlete did not remember any direct blow to his limb and there was no visible bruising of the skin overlying the lesion. The phenomenon of exertional compartment syndrome is described and is characterized by pain in the affected compartment during exercise and relieved by rest. This entity must be diagnosed by measuring compartment pressures during the activity because the pressures return to normal after a short period of time. If the compartment pressures are elevated, the patient requires fasciotomy. This type of compartment syndrome is an overuse type of injury and is not acute.

The patient in this case report presented a confusing picture. He may have had signs of exertional compartment syndrome for the five days preceding the game, but his compartment pressures were of course not measured at that time. Because he had necrotic muscle seen at fasciotomy, it is certainly possible that the inciting injury took place prior to the football game. It is also possible that he had muscle damage to the peroneal musculature prior to the game, which led to acute avulsion during his inversion injury. It is difficult to discern the causative factors in this particular compartment syndrome, but it is very likely that his injury could have led to devastating complications if he did not undergo emergency fasciotomy. It is important to remember to examine the limb compartment in all lower leg injuries and consider the diagnosis of either exertional or acute compartment syndrome.

## Anterior Thigh Pain In A Division I Football Player

Madaleno JA, Mattacola CG, Allen JR:  
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Health Professions, University of  
Kentucky, Lexington, KY

### Personal Data/Medical History

The athlete is a 6'1", 200 lb, 21 year old Division I collegiate football player who is an outside line-backer. The athlete reported the day after a game with anterior thigh pain which was exacerbated with knee joint flexion. The athlete reported no previous injury to the quadriceps.

### Physical signs and symptoms

The athlete reported the mechanism of injury as a direct contact to the left quadriceps that occurred during the athletic event but did not limit play. Symptoms 24 hours after the injury included moderate swelling of the lateral mid-third of the left thigh. Initial examination revealed 120 deg of flexion. No palpable mass was present and the athlete was placed on crutches (NWB).

### Differential diagnosis

Quadriceps contusion  
Femoral nerve injury  
Compartment syndrome  
Myositis ossificans  
Periosteal osteosarcoma  
Synovial sarcoma

### Results of diagnostic imaging/laboratory tests

X-rays 9 days post-injury confirmed no ossification within the anterior compartments. Twelve days post-injury, blood work revealed that serum calcium and CBC were normal. Twenty-three days post-injury knee joint ROM was 100 deg and x-ray revealed early appearance of ossification within the quadriceps and onset of myositis ossificans. At 2 months post-injury x-ray revealed advanced myositis ossificans.

### Clinical course

The athlete was diagnosed with a grade one quadriceps contusion. Treatment included cryotherapy with compression. Crutches were supplied and the athlete was instructed to maintain a position of knee flexion and ambulate in a non-weight bearing position. Over-the-counter NSAIDS were initiated 24 hours post-injury. At 48 hours post-injury the athlete was partial weight bearing and at 72 hours the athlete was full weight bearing. The athlete was evaluated by an orthopaedic surgeon at this time and allowed to progress and return to function as tolerated. Five days post-injury the athlete had 133 deg of knee flexion, minimal pain, decreased swelling and was able to participate in running drills. The athlete was returned to competition and played in the first quarter but was ineffective. The athlete suffered no direct trauma.

### Deviation from the expected

Two days following the competition and 9 days post-injury, motion was decreased to 120 deg knee flexion. X-ray examination revealed no ossification within the anterior compartment. NSAID (600 mg b.i.d.) were prescribed. The athlete was given a strict home program as he left for Thanksgiving weekend. The athlete was weight bearing and the physician prescribed no contact for 2

weeks in fear of the injury becoming a chronic problem. Upon return from thanksgiving, swelling had increased and ROM decreased (110 deg knee flexion). A review of the literature revealed that it is uncommon for myositis to develop when knee range of motion is greater than 120 deg at initial evaluation. Therefore, our study represents an occurrence whereas knee flexion of greater than or equal to 120 degrees resulted in a case of myositis ossificans. In addition, during compilation and verification of data for this abstract, it was brought to our attention by the athlete that he had received, unbeknownst to us, massage therapy to the affected area during Thanksgiving break by his girlfriend. Therefore, it is recommended that clinical staff proactively reinforce that no additional treatments should be performed prior to releasing an athlete for home therapy.

## Free Communications, Poster Session B: Head Injury

Thursday, June 29, 1:00PM-5:00PM, Presidential Lobby, authors present from 4:00PM-5:00PM

### The Effects Of Heading A Soccer Ball On Postural Stability In Male And Female College Soccer Players

Carmack B, DeLaney H, Hambrick R, Hart J, Robinson K, Voight M: Belmont University, Nashville, TN

**Background:** With the increasing popularity of soccer in the United States many researchers have begun to examine the possible effects of heading a soccer ball. However, rather than investigating the direct effects of heading, researchers have examined generalized findings, such as cognitive changes, in populations with a significant soccer history. These studies were not designed to establish a causative relationship between heading and these various changes. **Purpose:** The purpose of this study was to determine the effects of heading a soccer ball on postural stability. We hypothesized that there would be a decrease in postural stability following the completion of a routine heading drill. **Methods:** A sample of male and female college soccer players ( $n_{exp}=11$ ,  $n_{control}=10$ ) were recruited from area colleges. Using the Sensory Organization Test (SOT) on the Neurocom Equitest, postural stability was assessed immediately prior to and following a routine heading drill as well as 48 hours after the heading drill. **Results:** A 2-way repeated measures ANOVA revealed a significant difference within subjects difference from pretest to posttest 1 ( $F=4.24$ ,  $P=.054$ ), and posttest 1 and posttest 2 ( $F=8.665$ ,  $P=.009$ ). No significant difference was found between the experimental and control groups resulting from imposed methods ( $F=3.209$ ,  $P=.090$ ). **Conclusions and Discussion:** Results from this study do not reveal any acute changes in postural stability following a typical heading drill. Significant differences within subjects are believed to be attributed to a learning curve with the SOT test. Although our results did not support our hypothesis, research exists that suggests neurological damage from heading. Therefore, further research is needed that better controls for any learning effects on the SOT.

### Concussion Management Practices Of Athletic Healthcare Providers

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There are multiple injury classification scales and numerous return to play guidelines available to the health care provider charged with the management of concussion. Many of these scales and guidelines are based on subjective symptom reporting from the injured athlete. While many are similar and each has its strengths and weaknesses, no strong consensus exists among healthcare providers as to which one scale or guideline provides the best information. The purpose of this study was to identify the methods used by health care providers to assess concussions and how this information is then used for return to play decision making. **Methods:** A 21-item questionnaire was distributed to attendees of the "Use of Standardized Assessment for Concussion (SAC) in the Immediate Sideline Evaluation of Injured Athletes" mini-course at the 1999 NATA Annual Meeting and Clinical Symposia. This questionnaire was designed to address the methods used by athletic health care providers to assess and grade concussions, and how these methods then influence return to play decisions. A total of 339 valid surveys representing a variety of professional practice settings were returned and used for analysis. **Results:** Symptom check lists (75%) and clinical examination (70%) were the most common tools utilized in the evaluation of concussion. However, a fair percentage also utilized neuropsychological testing (32%), Standardized Assessment of Concussion (22%), and Balance Error Scoring System (11%). The most common grading system was the Colorado Consortium (28%), followed by Cantu (19%), and AAN (13%). Interestingly, 18% use no guidelines and 2.6% use multiple guidelines. Return to play decisions were based primarily on physician recommendation (28%), clinical examination (24%), return to play guidelines (18.6%) and symptom checklist (16%). **Discussion:** It appears that athletic healthcare providers continue to use a variety of assessment techniques, grading scales, and return to play criteria in the management of concussions. Recent advances in assessment techniques advocate the inclusion of neuropsychological testing, sophisticated balance assessment, and standardized assessment of concussion. Our findings suggest that roughly one third of the sample are using advanced testing in their concussion assessments. We recommend continued educational efforts to increase the utilization of advanced assessment methods which ultimately will result in improved concussion management.

### Effect Of Pain On Standard Assessment Of Concussion And Trail Making Test Scores

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**Objective:** Cognitive tests have recently become tools used by athletic trainers on the playing field both to evaluate head injuries and to determine when an athlete is ready to return to their sport. The purpose of this study was to determine the effect of experimentally induced pain on two cognitive tests, the Standardized Assessment of Concussion (SAC) Test and Trail Making Test (TMT). **Design and Setting:** Each subject was seated at a table in a quiet room and given the SAC Test and TMT once with the Cold Pressor Test (CPT) and once without the CPT. The Cold Pressor Test requires the subject to place their foot into a bucket of ice water maintained at 0°C in order to elicit pain. The cognitive tests were administered in a counterbalanced order. **Subjects:** 24 healthy division I athletes (12 females, age = 20.7 +/- 0.4 yr, ht = 67.5 +/- 0.8 cm, wt = 68.5 +/- 2.8 kg; 12 males, age = 21.5 +/- 0.7 yr, ht = 72.5 +/- 0.5 cm, wt = 83.3 +/- 2.2 kg) with no previous head injuries volunteered to participate in this study. **Measurements:** The SAC Test measures orientation, immediate memory, concentration, and delayed recall on a 30 point scale. The TMT is a timed test measuring letter and number recognition, mental flexibility, visual scanning, and motor function. Scores are assigned based on the time to completion. **Results:** Separate 1 between (gender) x 1 within (test condition) mixed model ANOVAs were used to compare the control and experimental conditions for the SAC Test and TMT, respectively. The ANOVA for the SAC Test revealed no significant between subject [ $F(1,22) = 1.23$ ,  $p = .278$ ] or within subject [ $F(1,22) = 2.52$ ,  $p = .556$ ] main effects or interactions [ $F(1,22) = 1.06$ ,  $p = .313$ ]. The ANOVA for the TMT revealed no significant between subject [ $F(1,22) = 3.19$ ,  $p = .088$ ] or within subject main effects [ $F(1,22) = .028$ ,  $p = .868$ ] or interactions [ $F(1,22) = 1.42$ ,  $p = .246$ ]. **Conclusions:** Experimentally induced pain elicited by the CPT did not effect scores for the TMT or the SAC Test. No studies were found to validate the SAC Test with athletes other than male football players, however our results demonstrated that male and female athletes from a variety of sports did not score differently on the SAC Test. Further research is needed to examine other aspects of injury including anxiety, fear, and distraction to determine if they will affect cognitive test scores.

## Do Soccer Players Exhibit Impaired Neuropsychological and Balance Function Compared To Other Sports?

Casto SR, Ferrara MS, Peterson CL, Mrazik M, Klinger R, Courson R: The University of Georgia, Athens, GA

Recent research has suggested that amateur soccer players are at increased risk for developing mild traumatic brain injury (MTBI) as a consequence of repetitive primary and secondary blows to the head. A concussion incidence rate of 0.96 per team, per season has been identified in soccer. Previous research on soccer players has shown that neuropsychological tests of memory, planning, and attention have significantly diminished scores. The purpose of this study was to examine if neuropsychological tests, in addition to static and dynamic balance, were different between college-level soccer, football, and softball players. Twenty soccer, twenty eight football, and fourteen softball players were tested on eleven neuropsychological variables: Hopkins Verbal Learning Test, Trail-Making A and B; Symbol Digit Modality Test; Digit Span Forward and Backward; and Controlled Oral Word Association Test (COWAT). Balance was assessed on the Smart Balance Master (Neurocom International) during static and dynamic conditions. Neuropsychological results were analyzed controlling for SAT score and number of previous concussions. An analysis of covariance revealed three statistically significant neuropsychological variables between the three sports: Hopkins Verbal Learning Test ( $p=.026$ ); Digit Span Backward ( $p=.024$ ); and COWAT ( $p=.025$ ). Univariate contrasts found statistically significant differences with soccer athletes scoring better than football and softball when controlling for SAT score and history of previous concussions. A sport by previous history of MTBI interaction was found for the Hopkins Verbal Learning Test ( $p=.042$ ). In all cases, football scores were found to be lower for all neuropsychological variables. No statistically significant differences between sports were found for any of the balance testing conditions. Soccer players did not exhibit any impaired neuropsychological deficits when compared to a group of football and softball players. We found no statistically significant evidence to suggest that soccer players are different in their neuropsychological and balance profiles when compared to other sports. Thus, the recent suggestions that soccer may be associated with impaired neuropsychological function is not supported in this study.

## Transient Hemiparesis in a Collegiate Basketball Player

Gunnoe AJ: Bethune-Cookman College, Daytona Beach, FL

### Personal Data/Pertinent Medical History

During a Division I collegiate men's basketball game, a 21 year-old athlete with no documented history of head or neck injury, was struck above his right eye by an elbow. As he was falling he was struck on the left, posterior temporal region by another player's knee, and again on the floor. When the certified athletic trainer (ATC) arrived on the court, the athlete was prone with his head in a large puddle of blood from a 2.5-cm laceration above his right eye. The athlete was unable to recall the mechanism of injury, but exhibited no other signs of amnesia. He complained of pain above his eye and in his neck.

### Physical Signs and Symptoms

During questioning the athlete was sluggish but responsive, and while answering questions lost consciousness for approximately 15-20 seconds. Pulse and respiration remained strong. Palpation revealed a large hematoma in the left temporal region with no apparent bony deformity, and no palpable deformity in the cervical spine. However, because the athlete complained of tenderness at levels C3-C7 EMS was activated. The ATC's on the court continued to monitor consciousness and amnesia while maintaining the athlete prone with in-line stabilization. The athlete remained lethargic and responsive, and continued to display no amnesia besides mechanism of injury. Cranial nerves were intact and within normal limits. The athlete complained of abnormal sensation bilaterally in the upper and lower extremities. He stated that both sides "felt strange", and sensory testing revealed decreased sensation on the right as compared to the left. The athlete was unable to move his right foot or grip with his right hand. By the time the ambulance arrived, the athlete had suffered two spasms of his neck and back. Respiration had been normal, but became labored after the second spasm. The athlete stopped breathing and pulse became weak. The athlete was rolled in-line onto his back. The athlete was apneic for approximately 30 seconds when he responded to pain from sternal rub. When he regained consciousness he was sluggish to respond to questions, but still exhibited no amnesia beyond mechanism of injury. Respiration again became labored and then stopped while strapping the athlete to the spine board, but his pulse remained strong. The athlete was apneic for 20-30 seconds but responded to an ammonia capsule from the EMT as an ATC was preparing to perform rescue breathing. During transport the athlete became increasingly lethargic, and exhibited complete absence of sensory and motor function in his right upper and lower extremities. Upon arriving at the hospital, the athlete had marked weakness and decreased sensation on the right side of the body involving the upper and lower extremities, but not the chest or abdomen.

### Differential Diagnosis

Due to the mechanism of injury and complaints of head and neck pain, both cerebral and cervical pathologies had to be considered. Differential diagnosis included subdural and epidural hematoma, cerebral hemorrhage, skull fracture, cervical fracture, spinal cord injury, and brachial plexus injury. The immediate suspicion was a cervical injury due to the decreased sensation and motor function. The fact that the deficit was restricted to the right side reduced the likelihood of spinal cord disruption. Brachial plexus injuries produce unilateral changes in sensation and decreases in strength, but would not account for the symptoms in the lower extremity. Possible cerebral pathologies were also assessed for this injury. As with any severe head injury, epidural and subdural hematomas were a serious concern. This athlete's progression was similar to the normal sequela for an epidural injury. Epidural injuries are frequently associated with a skull fracture, and the possibility was consistent with this athlete's mechanism of injury.

### Results of Diagnostic Imaging/Laboratory Tests

Portable cervical spine radiographs and a CT scan were obtained at approximately one-hour post injury. All views were negative for fracture, hemorrhage, or edema. Approximately three hours after injury, the athlete had regained some sensation and motor function in his right upper and lower extremities. The athlete received flexion/extension radiographs of the cervical spine at four hours post injury, which were negative for evidence of ligamentous instability. The athlete was taken to ICU approximately five hours after the initial injury. The next morning, a cervical MRI was obtained and was within normal limits.

### Clinical Course

He was released from the hospital 24 hours after the injury with a diagnosis of concussion and cervical cord contusion/concussion. The emergency room physician suspected that the blow to the left side of the head produced a type of "stroke effect", resulting in the hemiparesis on the opposite side of the body. When the athlete was moved to ICU he had near normal sensation and strength bilaterally. This injury occurred on a road trip, so he was released to the care of the ATC with instructions to follow up with the team physician. The team general physician and orthopedic physician examined him five days after the injury. At that time he exhibited full, pain-free range of motion in his neck, normal neurological function in all extremities, and no signs of post-concussion syndrome. The athlete was restricted from participation for one month post-injury in accordance with agreed upon concussion guidelines. This injury ended his season, as only two weeks remained. During this time he had no complaints of neck pain or post-concussion syndrome, and neurological function was within normal limits. He

### Linear Skull Fracture Of The Temporal Lobe And Extradural Hematoma In An Intercollegiate Field Hockey Athlete: A Case Report

Little CH, Vanic KA, Hauth JM, Thatcher JR: East Stroudsburg University, East Stroudsburg, PA

quickly resumed normal function and returned to participation once cleared. The athlete is currently 18 months post-injury. He played the following season with no injuries or complaints, and continues to do well.

#### Deviation from the Expected

Hemiparesis, a paralysis of one half of the body, is an uncommon condition resulting from athletic injury. This case is unique due to the hemiparesis experienced by this athlete for two to three hours. Although the mechanical cause was determined, advanced testing was unable to identify the pathology associated with the symptoms. Additionally, the athlete was hit in the right jaw by an elbow during a pick-up game six weeks post-injury. He presented the next morning with swelling in the jaw, weakness of the muscles in the right side of the face, tearing eyes, and complaints of difficulty speaking and moving the right side of the face. He was referred to a physician who diagnosed Bell's Palsy, and subsequently was referred to a neurologist. A CT scan was performed to assess if there were any differences as compared to the CT scan taken post-injury. This second scan indicated no remarkable changes. The neurologist's impression was that the Bell's Palsy was not likely related to the original trauma.

**Personal Data/Medical History:** While attempting to ring a free hit, a 19-year-old female intercollegiate field hockey player was struck on the left side of the head by a chipped drive. Patient denied any past medical history of head trauma.

**Physical Signs and Symptoms:** An immediate on-field evaluation was conducted and the athlete presented no signs or symptoms of traumatic head injury. While eating dinner in the cafeteria (approx. 20-min. s/p), the athlete complained of head pain, feeling of lethargy and confusion, and developed blurred and distorted vision.

**Differential Diagnosis:** contusion, subdural hematoma, epidural hematoma, intra-cranial hemorrhage, concussion.

**Results of Diagnostic Imaging/Laboratory Tests:** Computerized Tomography Scans (CT-scan) revealed a 3mm linear skull fracture in the vicinity of the left superior-lateral temporal lobe and a hemorrhagic contusion and/or extradural hematoma. The brain was normal in size and configuration and the lateral third ventricles were normal in size and position. No other lesions were detected.

**Clinical Course:** Immediate treatment consisted of ice application to the left temporal lobe. Upon examination, the athlete denied and displayed no significant signs or symptoms of head trauma. Subsequently, the athlete was dismissed from practice with instructions to seek medical assistance if symptoms occurred. Twenty minutes post-injury, the athlete developed concussive symptoms and was taken to the emergency room. Radiographic findings were unremarkable for an underlying fracture, however, CT-scans revealed evidence of a linear skull fracture. The athlete was transported via Med-Evac helicopter (3 hours s/p) to the nearby trauma center for observation and admitted to the Intensive Care Unit until her condition stabilized.

**Deviation from the Expected:** This athlete was discharged from practice appearing lucid and in charge of her faculties. She was devoid of any traumatic signs or symptoms which may have indicated an underlying head injury. In addition, she was given explicit instruction to seek further medical attention if symptoms manifested. This case report described a classic head injury situation involving a deteriorating level of consciousness. Due to the quality instruction given by the athletic training staff and the responsible actions of her teammates, this athlete avoided a potentially life-threatening situation.

### Use Of Mouthpieces In Collegiate Soccer Players Within 8 Division I Conferences

Miller MM, Deivert RG: Ohio University, Athens, OH

Mouthguard protection reduces the amount of concussions and injuries to the head and neck. Soccer players are at risk for concussions and orofacial injuries due to heading the ball, collision with other players, and no protective equipment. The purpose of this study was to survey head certified soccer athletic trainers about the number of Division I varsity soccer players who wear mouthpieces, the type of mouthpiece worn, and the number of orofacial injuries in the Fall 1999 season. The subjects were eighty-two certified athletic trainers from Division I institutions. The conferences in the study include the Atlantic Coast, Big Twelve, Big East, Big Ten, Mid-American, Southeastern, Pacific Ten, and Western Athletic. The subjects were sent a one-page survey with thirteen questions. The survey included three demographic questions, five questions regarding mouthpieces, three questions pertaining to concussions, and two questions on orofacial injuries. Descriptive statistics and correlation were used to analyze the data. Fifty-seven surveys were returned. These surveys represented fifty-three women's teams and twenty-eight men's teams. None of the men's teams were required to wear mouthpieces, 2 of the women's teams (3.8%) were required to wear mouthpieces. The total number of concussions to men was 34, 88% grade one and 12% grade two. The total number for women was 80, 81.25% grade one, 17.5% grade two, and 1.25% grade three. The mechanism for concussion was 76.5% collision with another player for men, 67.5% women; ground 5.9% men, 12.5% women; ball 11.9% men, 20% women; goalpost 5.9% men, 0% women. The women had seven players that were wearing mouthpieces at the time of concussion (8.75%); none of the men were wearing a mouthpiece. The total number of orofacial injuries to men and women were 93 and 117, respectively. For men and women, respectively, nosebleeds accounted for 34.4%, 37.6%; lacerations 24.7%, 17.9%; teeth 11.8%, 3.4%; jaw 10.8%, 10.3%; neck 8.6%, 12%; eye 6.5%, 12.8%; and fractures 3.2%, 3.4%. The men had one player wearing a mouthpiece at the time of injury (1.1%); the women had six players (5.1%). If certified athletic trainer and coaches encourage soccer athletes to wear a mouthpiece during play, the number of concussions and orofacial injuries can be reduced.

## Lacrosse Helmet Designs And The Effects Of Impact Forces

Caswell SV, Deivert RG, Miller MG, Berry DC: Ohio University, Athens, OH

The National Operating Committee on Standards for Athletic Equipment (NOCSAE) has not changed lacrosse helmet standards since July 10, 1990. Since 1990, newly shaped and lighter helmet designs by Sport Helmets™ have become popular and are currently worn by the vast majority of National Collegiate Athletic Association (NCAA) men's lacrosse players. It has been reported that these new lighter models may be linked to an increased rate of cerebral concussions in men's lacrosse. The purpose of this study was to examine four NOCSAE certified lacrosse helmet designs; Sport Helmets™ Cascade, Cascade Air, Ultralite and Bacharach™ Ultralite, and compare the impact forces commonly experienced during competition. Helmets were tested at a NOCSAE re-certification facility using a guided free fall drop test. Impact testing was performed by raising the helmet on a carriage assembly to a height of 152 cm (60 in), then dropped onto a flat rigid anvil padded with 1.27-cm (.5 in) thick rubber modular elastomer programmer (MEP). Each helmet was dropped 10 times using front drop site (FDS), which mimics a head on collision, and a right rear boss drop site (RRBDS) to represent a "blind-sided" impact. A triaxial accelerometer mounted within the headform measured the force impact. Impact testing data was then integrated into the Gadd Severity Index (SI) which is a standard measure to determine the chance of sustaining a cerebral injury. Standard criterion for helmet certification is a SI less than 1500. The mean SI scores for the FDS were 1166.1, 1117.6, 857, and 1222.8 and the RRBDS were 974.5, 1022.1, 1376.3, and 1496.5 for Sport Helmets™ Cascade, Cascade Air, Ultralite and Bacharach™ Ultralite, respectively. A one-way ANOVA revealed a statistically significant difference in FDS SI between helmet types,  $F(3,36) = 9.680, p < .05$ , and in the RRBDS SI,  $F(3,36) = 28.140, p < .05$ . With repetitive drops, the SI increased, indicating a greater chance for developing cerebral injury. The percent increase in the SI from drop one to ten on the FDS increased by 48.8, 54.3, 45.6, and 18.8, and RRBDS increased by 22.6, 35.9, 71.7, and 57.4 for the helmets listed above. These findings indicate there are potential differences between the helmets at the two drop sites and that no one helmet is suited to reduce impact force. Furthermore, research that is more extensive is needed to determine force impact and SI at multiple drop sites on the helmet.

## The Influence Of A Football Helmet On Postural Sway

Joyce CJ, Kleiner DM, Quisenberry KC: University of North Florida, Jacksonville, FL

When standing on a stable base of support the ankle acts upon the body as an inverted pendulum. An increase in mass at the distal end of the inverted pendulum, such as a football helmet, might influence postural sway. The helmet may also interfere with the visual and vestibular systems which are also essential for balance control. However, these effects might be lessened when the football helmet is worn for a period of time. The purpose of this preliminary investigation was to determine if a properly fitted football helmet would increase postural sway, and whether subjects who have worn a helmet over a football season had better postural control than subjects who had not. Thirty-nine male volunteers (mean age = 22.8 yr, ht = 177.0 cm, wt = 63.6 kg) served as subjects. Thirteen of the subjects were in season collegiate football players experienced in wearing a helmet. All subjects were tested twice for static and dynamic postural sway on the Chattecx balance system for 15 seconds during; static (ST), linear anterior/posterior (LA), and linear lateral (LL) conditions. One trial was performed while wearing a properly fitted football helmet, and the other with no helmet. Both trials were conducted on the same day with the sequence of trials counterbalanced. Postural sway measures are reported as; anterior/posterior sway (AP), medial/lateral sway (ML), and sway index (SI) in centimeters. Data were analyzed by three separate 1 between (group) x 2 within (platform condition, test) mixed model ANOVAs for AP, ML, and SI, respectively. Results demonstrated a significant main effect for test condition for AP [ $F(2, 74) = 69.52, p < .001$ ], ML [ $F(2, 74) = 124.67, p < .001$ ], and SI [ $F(2, 74) = 62.89, p < .001$ ]. Tukey's HSD test revealed significantly greater AP during LA (5.65) and LL (5.02) than the ST (2.84) condition, and greater SI during LA (1.38) and LL (1.19) conditions than ST (.80). Furthermore, ML was greater during LL (4.11) than the LA (2.82) and ST (2.44) conditions. There was also a significant test x group interaction [ $F(1,37) = 7.70, p = .01$ ] for ML. Post hoc testing revealed the experienced group was significantly better than the inexperienced group (2.99 to 3.37) during the helmet wearing condition. These preliminary data suggest that postural sway is not effected in subjects with and without experience wearing a football helmet. Future research should investigate the effects of a helmet on alternative measures of balance and postural control.

## Free Communications, Poster Session C: Issues in Athletic Training

Friday, June 30, 8:30AM-12:00PM, Presidential Lobby; authors present from 11:00AM-12:00PM

### What Is The Relationship Between The MOS SF-36 And The Athletic Training Outcomes Assessment?

Andersen JC, Sands S, Spence J, Stringer A, McGlynn E: Armstrong Atlantic State University, Savannah, GA

Research literature exists for this assessment tool while the SF-36 is a generic instrument with well established reliability and validity for measuring health status. The purpose of this study was to examine the relationship between health status obtained with the ATOA and the SF-36 in college athletes. **Subjects.** Sixty-one student athletes from a southeastern university volunteered to participate in the study. Thirty-five of the subjects were male and 26 were female. Of the 61 subjects, 50 were classified as Caucasian and 11 were classified as Non-Caucasian. The subjects ranged in age from 18-26. The overall mean age was 20.26 years. The mean age for males was 20.97 years, and the mean age for female participants was 19.31 years of age. **Methods.** The subjects completed the ATOA, the SF-36, and a demographic questionnaire. Means, standard deviations, and correlational analysis (Spearman's rank order) were used to determine the relationship between measures obtained with the ATOA and the SF-36. **Results.** Meaningful correlations ( $r_s \geq 0.50$ ) were observed between the ATOA domains of ADLs, work, movement, strength, body structure, overall score, physical outcome score (POS), functional outcome score (FOS) and the SF-36 domains of role physical (RP), bodily pain (BP), and physical component score (PCS). The SF-36 social function item also had a meaningful correlation with the activities of daily living (ADL) domain of the ATOA. The greatest correlation ( $r_s = 0.66$ ) was between the PCS of the SF-36 and the overall outcome of the ATOA. There were no meaningful correlations between the ATOA domains of endurance and motor ability and any SF-36 dimension. With respect to ceiling effects, at least 50% of the subjects responded "no problem" on the ATOA items regardless of gender or race. **Discussion.** Meaningful correlations exist primarily between the physical dimensions of the two questionnaires. Likely ceiling effects were also demonstrated. Future research is needed comparing the ATOA to disease specific or physical functioning questionnaires. This study acts as a preliminary step in establishing the ATOA as a physical function outcome measure.

### The Perceived Incidence Of Sexual Harassment Among Student Athletic Trainers In NATA District One And Two

Hauth JM, Vanic KA, Menon, S: East Stroudsburg University, East Stroudsburg, PA

**Purpose:** The purpose of this study was to determine the incidence of sexual harassment among student athletic trainers (SAT) in selected Commission on Accreditation of Allied Health Education Programs (CAAHEP) accredited athletic training education programs in NATA Districts One and Two. A second purpose was to investigate the correlates associated with the occurrence of specific sexually harassing behaviors (SHB's).

**Methodology:** One hundred-seventy nine undergraduate students (70 males, 109 females) enrolled in nine CAAHEP-accredited athletic training education programs in NATA District One (n= 82) and Two (n= 97) served as subjects for the study. Subjects from each intercollegiate level (Division IA = 32, Division IAA = 19, Division II = 37, Division III = 91) volunteered to complete the Student Athletic Trainer - Sexual Experiences Questionnaire (SAT-SEQ). The SAT-SEQ is a 35-item Likert-type questionnaire developed by the researchers to assess a student athletic trainers' perception of various physical and non-physical SHB's. The questionnaires were analyzed using SPSS for Windows, Version 9.0. **Results:** Results indicated that the percentage of SAT's who reported experiencing at least one behavior of a sexually harassing nature in their relationships with student-athletes, coaches, and certified athletic trainers were 88%, 49%, and 47% respectively. However, only twenty-one percent of the SAT's (n=37) classified such encounters as sexual harassment. A One-way Analysis of Variance revealed a significant difference ( $p < .05$ ) in the occurrence and severity of selected non-physical SHB's. SAT's encounter SHB's more frequently with male coaches (91%) compared with female coaches (9%). These behaviors occur most frequently (69%) in a field experience involving male sports. This study also revealed that 45 SAT's (25%) perceive they have been discriminated against or treated differently during an athletic training field experience because of their gender. Ninety-seven subjects (54%) indicated that their institution has a formal written sexual harassment policy, however, 61% reported that they do not understand the steps that should be taken in the event that they encounter SHB's on their campus. Additionally, only 28 SAT's (16%) reported that they had received formal training or education on how to cope with SHB's. In conclusion, sixty-eight percent of the SAT's in this study believe that formal training should be included in their athletic training education. **Recommendations:** Previous research (Hauth & Vanic, 1998) indicated comparable and alarming results regarding the perceived incidence of these SHB's. Because this study focused on NATA District One and Two, further research is warranted to include CAAHEP-accredited athletic training education programs from the remaining NATA districts.

### Use Of Standard Precautions By Certified Athletic Trainers In The State Of Ohio

Berry D, Deivert RG: Ohio University, Athens, OH

As health care providers, certified athletic trainers (ATC) are responsible for taking the necessary steps to provide for a safe and clean health care facility, while limiting the potential spread of infectious diseases within the athletic and physically active population. The most common forms of transmitting infectious diseases in the healthcare setting are a result of improper use of SHARPS, needle sticks, and the lack of personal barrier protection (gloves, face mask and face shields). The risk of exposure to health care workers is due in part to the increase in SHARPS usage and the lack of compliance with Standard Precautions (SP). Standard precautions incorporate the major features of both Universal and Body Substance Isolation Precautions. The purpose of this study was to examine the use of standard precautions in the profession of athletic training, specifically in the State of Ohio. Surveys were mailed to 647 licensed ATC members of the Ohio Athletic Trainers' Association. The survey consisted of 29 yes-no and Likert-type questions to assess an ATC's use of SP. Two hundred and seventy two surveys were analyzed for a total response rate of 42%. Of those ATCs exposed to blood and bodily fluid in a twelve month period, 64.7% (n = 176) reported using rubber gloves "always" when treating an individual with exposed blood and bodily fluid. When disposing of biohazardous material after the treatment of exposed blood or bodily fluid, 49.4% (n= 134) of ATCs reported "always" disposing of waste in the appropriate container. Those engaged in treating athletes during on field/court traumas reported wearing rubber gloves "always" 72.6% (n = 183) of the time. Ninety-nine percent (n = 267) reported washing their hands after treating an individual with a potential blood-borne pathogen. A little less than half (49%, n = 131) of the facilities where ATCs are employed post the Occupational Safety and Health Administration Guidelines regarding the handling of blood borne pathogens. Athletic trainers reported that 73.9% (n = 193) of their employers offer in-service training regarding the use of SP. Ninety-four percent (n = 256) of ATC surveyed were immunized against the hepatitis B virus. The data suggests that athletic trainers in the State of Ohio are making concerted efforts to be compliant with SP. In order to achieve 100% compliance, educational programs and infection control policies are essential component to provide ATCs with the necessary information regarding the handling of potential blood-borne pathogens.

## **A Certified Athletic Therapist's Questionnaire: Entering The Twenty-First Century In Canada**

Paris DL: Concordia University, Montreal, Quebec, Canada

Many changes have been seen in the profession of athletic therapy in Canada over recent years. Earlier questionnaires (Paris 1986, Paris 1991) not only reported demographic and employment information, but disclosed the inequities of athletic therapists' salaries in comparison to other health care professionals. The outcome of the past studies helped to set a standard for entry level salaries of newly certified athletic therapists {CAT(C)}, as well as to legitimize salary increases due to the procurement of further professional experiences. The present questionnaire examined many issues pertinent to the status of the Canadian CAT(C)s. All members of the Canadian Athletic Therapists Association who were certified on or before August 31, 1999 were sent the questionnaire. With a return deadline four months after they were delivered, 256 out of 369 questionnaires were completed and returned for a response of 69.4%. Basic demographic data showed more than half of CAT(C)s (57.8%) lived in Ontario. Of all respondents, 46.1 % were female and 53.9% male, with 64% being between 25 and 34 years of age. 69.1% of certified members had earned a Bachelor's degree, with 16.7 % having a college diploma as their highest academic level. Of the 9.3 % and 4.6% of members holding Master's or Doctorate degrees respectively, 91.4% of them had received their highest graduate education in Canada. Full time employment in athletic therapy was held by 36.5% of CAT(C)s, while a further 29.4% were fully employed in both athletic therapy and an other related field. 30.5% of CAT(C)s worked full-time in a clinic setting. While 16.8% of CAT(C)s earned less than \$20,000 gross per year, 54% earned between \$20,000 and \$45,000. Fall was the busiest season for 45.3 % of CAT(C)s with winter (32.1%) the next busiest. Eighty percent of the membership reported working between 40 and over 60 hours per week during their respective busy seasons. Much of the data focuses on demographics, employment, teaching, continuing education, and research activities. Many questionnaire responses will be cross-tabulated by gender and province for national and regional interest.

## **Perceived Competency of Certified Athletic Trainers In The Psychology Of Injury And Rehabilitation**

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The purpose of this study was to determine whether Certified Athletic Trainers perceive themselves as competent in the psychology of injury and rehabilitation. While many athletic trainers report that counseling and the utilization of sport psychology techniques have become common aspects of their jobs, the question remains as to whether ATC's have the training necessary to prepare them to fulfill this facet of their employment. Surveys were mailed to 500 randomly selected Certified Athletic Trainers who were certified in either 1997 or 1998 as these ATC's would have been required to complete competencies in the area of the psychology of injury. The surveys included demographic information and questions rated on a 7 point Likert scale regarding their use and perceived competence in different aspects of the psychology of injury. Of the 500 surveys, 139 were returned and included in the data analysis for a 28% response rate. Of the respondents, 60% had completed a formal sport psychology class while 80% had received some instruction in sport psychology techniques in a formal class (sport psychology or athletic training), at a workshop, or at a conference. Eighty-three percent of the respondents also indicated that they neither employ nor refer athletes to a sport psychologist. In addition, the respondents indicated that they believe that injured athletes frequently encounter adjustment problems when they sustain an injury: 60% become depressed, 70% experience anxiety, 67% have injury adjustment problems, 69% experience injury related stress, and 65% experience general life stress. The ATC's expressed that they felt the most comfortable setting short, long, and daily rehabilitation goals, and providing positive reinforcement and injury education, while they felt the least comfortable utilizing imagery, self talk, and concentration skills. Furthermore, 90% counsel athletes regarding injury related problems, 77% counsel athletes regarding sport related problems, and 65% counsel athletes regarding personal problems. Sixty percent of the respondents felt that they were not adequately trained in either counseling or sport psychology techniques. The results suggest that ATC's frequently utilize a number of sport psychology techniques and regularly counsel athletes in a variety of areas however, 60% of the ATC's felt that they were not adequately trained to perform these responsibilities. In addition, while the vast majority of ATC's are receiving training in this area, the results still indicate that 20% of the ATC's are utilizing these techniques without any formal instruction or training.

## **A Survey Of Athletic Training Employers Hiring Criteria**

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Athletic trainer employment rates have risen from an average of 38% in past years to 50% in 1999. However, given the estimated increase (68%) for allied health care personnel by the year 2005, the low hiring rate of athletic trainers may demonstrate that they are not competitive with other allied health care professionals. The purpose of this study was to identify athletic trainer employer hiring criteria and determine if these criteria vary by setting. The Athletic Training Employer Needs Assessment Survey (ATENAS) was mailed to athletic training employers in three NATA Districts advertising in the NATA employment bulletin between October 1996 and 1998. Means and standard deviations were calculated to ascertain hiring criteria importance. A factor analysis was calculated for hiring criteria responses to determine salient factors. Eighty two (74%) of the 111 target population responded to the survey. Four hiring criteria factors emerged as desirable characteristics for athletic training employers; personal characteristics, educational experience, professional experience and professional attributes. Each of the four factors consists of interrelated hiring criteria or attributes that must be viewed as a whole unit. A lack of strength in one attribute within a factor can diminish an employers overall evaluation. For example, a lack of self-confidence during an interview may impart an overall lower impression of one's personal characteristics. Data from this study suggest that employers surveyed, regardless of setting, rate personal characteristics highly important. Thus, athletic trainers should pay particular attention to their personal and academic attributes and must possess a minimum of a Bachelor's degree for all settings and a Master's degree at the university/collegiate setting to successfully attain a position. With few exceptions, the hiring criteria across all athletic training work settings were fairly consistent; however, it may be that attention to the slight difference in hiring criteria of various settings may improve marketability. A comparison of this study's results and those found in the literature regarding hiring criteria practice make it clear that students should be introduced to employment hiring practices during their educational preparation. These findings propose that a better understanding of employer hiring criteria and the specific requirements of each setting may enhance athletic trainer marketability and increase employment rates. As a result, it is suggested that athletic training educators include workshops, inservices, time devoted to self marketing issues such as resume writing, interview techniques, self-marketing techniques, and professional correspondence.

## Factors Identified By Collegiate Student-Athletes As Important For Receiving Quality Athletic Training Care

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The purpose of this study was to identify factors that collegiate student-athletes perceived were important for them to receive quality athletic training services. Responses to the Athlete Satisfaction Questionnaire (ASQ) were used to identify factors common among the responses identified by student-athletes participating in the study. The ASQ consisted of 40 statements that represented a variety of athletic training services provided to collegiate student-athletes. Participants were asked to offer responses that ranged from Very Important to Not Important. Responses were compared by gender as well as by high profile and low profile sports. Responses were also examined across each domain of the NATABOC Role Delineation Study. Subjects were systematically selected from 30 NCAA Division I & II institutions. Fourteen of the 30 institutions asked to participate responded, yielding an institutional participation rate of 47%. One hundred forty-five athletes of the 618 selected participated yielding a 23% individual participation rate. A Kruskal Wallis One Way ANOVA was used to determine if there was a significant difference between male and female student-athletes for responses to all questions and the domains of the Role Delineation Study. A Mann-Whitney U-Wilcoxon Rank Sum Test was used to determine the significant difference between sport profiles for all questions and each of the domains. Data analysis demonstrated some significant findings. Alpha for all tests was set at .05. Both men and women agreed that the athletic training room should be equipped with the necessary tools as the most important component for them to receive quality athletic training care. Other factors both men and women identified as pre-requisites for quality care were that an athletic trainer should tell student-athletes what to expect during treatments and rehabilitation, and if the athlete has a question about rehabilitation, the athlete should have the freedom to ask questions of the ATC concerning the process. Similar responses were found when comparing responses across the sample. Male and female athletes of high profile and of low profile sports agree that the training room should be well equipped, the ATC should be able to answer athletes' questions and to fully explain the nature of their injury, and that the ATC should be thorough in the injury evaluation process. When the responses to statements were grouped into subject matter that reflected each aspect of the Role Delineation Study, the only area that did not demonstrate any significant results was that of Health Care Administration. The results of this study demonstrate that athletes are concerned most with the direct medical services provided to them as individuals. Results suggest that the way in which the ATC provides the services that directly affect the athlete as a person or result in the athlete's treatment protocol are most important. Although an important aspect to health care, administrative issues did not appear to be as important perhaps because the athlete does not directly observe or feel the results.

## Sensitivity Training In The Athletic Training Department

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**Objective:** The purpose of this research was to determine the perception of sensitivity training by athletic trainers in selected National Collegiate Athletic Association (NCAA) Division I athletic training departments. **Design and Setting:** A survey was developed based on the purpose and delivered to 50 participants, completed, and returned for data analysis. The participants in this study consisted of NCAA Division I male and female athletic trainers (i.e. certified athletic trainers by the National Athletic Trainers' Association). The 25 athletic trainers who responded were from the following conferences: 1) The Atlantic Coastal Conference (ACC), 2) The Big Ten, 3) The Pacific Ten Conference (PAC Ten) and, 4) Southeastern Conference (SEC). **Measurements and Results:** The demographic information revealed that the majority of the participants were White/Caucasian, males, from the SEC between the ages of 36-45 years old. The study revealed that the majority of the participants reported that sensitivity training did not exist within their athletic department (80%). Of the minority that stated sensitivity training did exist a large amount of the participants stated that it was required (80%). Of the majority who stated that sensitivity training did not exist within their athletic department, it was revealed that most felt sensitivity training was not needed in both the athletic training (70%) and athletic departments (75%). Does sensitivity training exist in selected athletic training programs? This answer was overwhelmingly no. The findings of this survey revealed that the level of sensitivity training that existed is considerably low. **Conclusions:** The conclusions that were drawn from this research are as follows: 1) the majority of the athletic trainers surveyed were not required to go through sensitivity training (80%), 2) the majority of the athletic trainers who were not required to go through sensitivity training did not see a need for such training (75%), 3) the majority of those who had not gone through sensitivity training were willing to attend sessions if they were offered (85%), 4) the majority of those who had sensitivity training, felt they gained something or realized some biases (60%), 5) a majority of the participants were most willing to discuss gender issues within sensitivity training sessions (n=15), and 6) a majority of the participants have had to deal with gender issues that could be viewed as negative (n=9).

**Effects Of An OA Knee Brace On Subjective Pain And Function In Athletes With Medial Compartment Osteoarthritis**

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**Objective:** Osteoarthritis, or degenerative joint disease (DJD), is a common problem in the elderly population. However, it is becoming more prevalent in younger recreational athletes. Surveys have indicated that 80 percent of persons over age 50 have detectable DJD in weight-bearing joints (1). The cumulative effects of decades of use, compounded by decreased ability to repair inter-articular cartilage, often results in pain, thus restricting mobility, and overall loss of function. We studied a brace designed to decrease loads on the medial tibiofemoral compartment in knees with DJD to determine if pain symptoms decreased and functioned improved.

**Methods:** Thirty-two (M = 26; F = 6; average age = 57.4,  $\pm 10.2$  years) patients with symptomatic medial compartment osteoarthritis (OA) were fitted with a pneumatic, off-the-shelf, adjustable OA brace. All patients have had documented symptoms for less than 10 years and were otherwise healthy subjects. Fourteen had undergone at least one video arthroscopy and all were involved in recreational activity for at least two times per week, but were limited by pain. The Cincinnati Knee Rating System (CKRS) (2,3) was used to assess symptoms and functional limitations before patients being fitted with the brace according to the manufacturer's specifications (Smith Nephew DonJoy, Carlsbad, CA). Patients were instructed in proper brace fit and use for activities of daily living. Follow up evaluations were at one week, four weeks, and four months after initial fitting. During each evaluation, brace adjustments were made as necessary, patients again completed the CKRS, and documented the hours of brace wear per day. Statistical means and standard of errors for all patients were calculated and values with and without bracing were compared using a paired, two-tailed T-test. The level of significance was at  $P \geq 0.05$ .

**Results:** At the first follow up, patients wore the brace an average of 5.6 hours per day, 9.1 hours on the second follow up, and 12.7 hours for the third evaluation. Eight patients suffered complications due to either brace fit, advanced DJD, or somatotype, and thus did not receive any perceived decrease in pain. Statistically significant improvements were found using the CKRS on the remaining 24 patients for activities such as ascending/descending stairs, walking, and overall activity level. There is also a corresponding decrease in swelling, decrease in pain, and increase in joint stability by the four month follow up. Fourteen patients were able to return to their recreational activities with decreased pain. The remaining ten returned to activities of daily living with the brace.

**Conclusions:** Our results support other authors who have conducted a similar study on a different brace (1). There are several bracing companies that are currently marketing OA braces. For some patients, these braces provide significant relief from subjective pain with weight-bearing activity. The implication for athletic trainers is to be aware of this option, as many of us are now working with these physically active recreational athletes.

(1) Hewett TE, Noyes FR, Barber-Westin SD, Heckmann TP. Decrease in knee joint pain and increase in function in patients with medial compartment arthrosis: a prospective analysis of valgus bracing. *Orthopedics*. 1998; 21: 131-138.

(2) Noyes FR, Barber SD, Mooar LA. A rationale for assessing sports activity levels and limitations in knee disorders. *Clin Orthop*. 1989; 246:238-249.

(3) Noyes FR, Mooar LA, Barber SD. The assessment of work-related activities and limitations in knee disorders. *Am J Sports Med*. 1991; 19: 178-188.

**Subjective Analyses Of Functional Knee Bracing On Muscle Endurance And Functional Ability**

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**Objective:** Functional knee brace studies on ACL reconstructed knees have compared functional knee brace performance only and have not considered subjectively assessing performance during functional activity. The purpose of this investigation was to use the Cincinnati Knee Ligament scoring system to subjectively assess performance with and without a functional knee brace while doing a one-legged hop and an agility running course. **Design and Setting:** This study took place at Indiana State University Sports Injury Research Laboratory and incorporated a 1x2 factorial design. The independent variables were the condition of braced and unbraced. The dependent variable was the modified Cincinnati Knee Ligament scoring system. The control variables of the study were functional tests, which had two levels, the one-legged hop and an agility running course. **Subjects:** Ten physically active males and females (3 males, 7 females) volunteered to participate in this study. Each subject had undergone ACL reconstructive surgery using a semitendinosus graft, participated in a full rehabilitation program, and had clearance from his/her physician to regain full activity. The Health and Human Performance Human Subjects Committee at Indiana State University approved the study. **Measurements:** Each subject participated in two functional tests, the one-legged hop test and the agility running course on two separate days. These two tests were performed braced and unbraced, resulting in a total of four functional tests completed by each subject. After the completion of each test, the subject was given the modified Cincinnati Knee Ligament scoring system questionnaire to fill out. **Results:** Two paired t-tests were used to determine if differences existed using the probability level of  $p < .025$  following the Bonferroni correction factor. No significant differences were seen when comparing the agility running course questionnaires, braced and unbraced ( $t(1,9)=2.65, p=.0260$ ), and when comparing the one-legged hop test questionnaires, braced and unbraced ( $t(1,9)=1.49, p=.168$ ). **Conclusions:** This study indicated that functional bracing does not subjectively affect the role of knee function and endurance on subjects with reconstructed ACL injuries. By combining functional activity followed by subjective assessment, the athlete's apprehension of a brace slowing them down, or that one is needed to provide stability and increase overall confidence that was lost following surgery will be eliminated.

## Prognostic Factors For Recovery From Anterior Cruciate Ligament Reconstruction Surgery

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Few protocols have examined the psychological aspects of the recovery from knee surgery (Laubach, Brewer, Van Raalte, & Petitpas, 1996; Sharma et al., 1996; Wise, Jackson, & Rocchio, 1979) despite the fact that substantial variability in recovery can exist in some procedures (Glasgow, Gabriel, Sapega, Glasgow, & Torg, 1993). This 12-month prospective study explored the ability of demographic, medical, and psychological factors to explain variability in the outcome of anterior cruciate ligament (ACL) reconstruction surgery on 64 participants. The medical predictor variables were the sum of the percentage of the medial and lateral menisci removed, presence of stable meniscal tears, number of compartments with osteochondral damage, and preoperative range of motion and ligamentous laxity deficits between the injured and uninjured knees. The demographic predictor variables were age, sex, and marital status. The psychological predictor variables were neuroticism, extraversion, openness, agreeableness, conscientiousness (Costa & McCrae, 1992), optimism, pessimism (Scheier, Carver, & Bridges, 1994), and a measure of specific expectations (Scheier et al., 1989). Criterion variables were instrumented measures of deficits between the injured and uninjured knees (ligamentous laxity, range of motion, and isokinetic strength) and the participants' subjective assessment. The number of participants who returned to the clinic for their 3-month, 6-month, and 12-month follow-up appointments were 62 (dropout of 3%), 44 (dropout of 30%), and 15 (dropout of 77%) respectively. Due to the significant dropout at the 12-month follow-up appointment, stepwise regression analyses were conducted only on the 3-month and 6-month data. Optimism and the number stable meniscal tears accounted for 26% of the variance in 3-month ligamentous laxity. Percentage of the menisci removed and marital status explained 22% of the variance 3-month strength deficit. Preoperative range of motion deficit and agreeableness accounted for 20% of the variance in 3-month range of deficit. Total percentage of the menisci removed, age, and neuroticism explained 42% of the variance in 6-month strength deficit. Sex accounted for 12% and 15% of the variance in ligamentous laxity and range of motion deficit, respectively. Agreeableness and preoperative ligamentous laxity explained 35% of the variance in participants' 6-month subjective assessments. These findings can be interpreted as partial support for the biopsychosocial model of health and illness, but they suggest that additional research is required to explain more of the variance in recovery from ACL reconstruction surgery.

## Correlation Of Isokinetic Closed And Open Kinetic Chain Strength Measurements With Functional Performance

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Isokinetic strength and functional performance testing are often used to assess recovery following knee ligament surgery. Closed kinetic chain (CKC) strength testing has become popular partly due to the belief that it is more closely related to functional activities than open kinetic chain (OKC) strength testing. Recently another mode of isokinetic muscle testing has become available that allows for CKC strength testing. No studies investigating the relationship between isokinetic CKC strength and functional performance could be identified. This study's purpose was to investigate the relationship between isokinetic CKC and isokinetic OKC concentric strength of the dominate lower limb extensors with functional performance. Thirty (age=20.9±2.4 yrs, weight=68.50±15.3 kg, height=170.25±9.1 cm) uninjured males (N=15) and females (N=15) performed isokinetic strength (peak force) tests for the knee extensors in the OKC (60°∞s<sup>-1</sup>) and for the hip knee, and ankle extensors in the CKC leg press exercise at 25 cm∞s<sup>-1</sup> (10 inches/second). Closed chain strength testing was conducted using the Closed Chain Rider System (Mettler Electronics, Anaheim, CA) and open chain strength testing was conducted using the Lido Active (Chatanooga Group, Inc., Hixson, TN) dynamometer. Functional testing involved each subject performing three trials of the 25.5 m shuttle run for time, single leg vertical jump, and single leg hop for distance. Pearson product-moment correlation analysis showed that isokinetic CKC strength scores were significant, but moderately correlated with the single leg hop (r=.448, p=.013) and shuttle run time (r=-.494, p=.006). The vertical jump did not correlate significantly (r=.260, p=.166). Isokinetic OKC strength demonstrated slightly higher correlations with the single leg hop (r=.623, p=.0001) and shuttle run time (r=-.510, p=.004), but not the vertical jump (r=.327, p=.078). We conclude that neither lower limb CKC nor OKC isokinetic strength correlate highly with the functional tasks of jumping, hopping, and sprinting. While the basis of both CKC and OKC isokinetic strength testing must be appreciated, it may not be an appropriate determinant of functional abilities. Future studies need to investigate the relationship between CKC isokinetic testing at higher speeds and functional performance.

### The Effects Of Open Versus Closed Kinetic Chain Ankle Exercises On Dynamic Stability: Single Subject Design

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The purpose of this study was to examine the effects of a strength and proprioception program consisting of open and closed kinetic chain exercises on dynamic stability. A single subject multiple baseline design across subjects was used to assess the effects of the intervention. Three subjects (age =  $20.6 \pm 2.3$  yr, height =  $178.65 \pm 8.1$  cm, weight =  $78.33 \pm 18.7$  kg) who had complained of a feeling of the ankle "giving way" in the past six months, but with no ankle sprain over the past six months volunteered to participate in this study. Each participant began baseline testing on the SMART Balance Master and Balance Master (NeuroCom International, Inc., Clackamas, OR), and upon attaining baseline, were assigned to one of three treatments which included exercises in the open kinetic chain, closed kinetic chain, and open and closed kinetic chain group, respectively. All participants performed various strength and proprioception exercises with the involved limb. Participants were tested between three and five times a week and exercises were performed at least three times a week. Each subject was tested on the SMART Balance for single leg rhythmic stability (front/back) on the involved extremity, and a forward lunge test for each lower extremity on the Balance Master. The dependent variables were directional control, on-axis velocity, distance lunged in percent body height, impact index in percent body weight, contact time in seconds, and force impulse measured in percent body weight and seconds. Inter-observer agreement was performed periodically throughout baseline and treatment. Visual inspection was used to evaluate whether the treatment resulted in a change of performance. No significant changes were noted for change in means, level, trend, and latency of change upon visual inspection. The results revealed that the strength and proprioception training program produced no improvements on dynamic stability as assessed on the SMART Balance and Balance Master systems. This research provides framework for future studies investigating the significance of open and closed kinetic chain exercises, and encourages the use of single subject design in athletic training research. Recommendations include the use of functional activities, a longer exercise schedule, an ABA design, and the continued exploration of testing procedures used on the SMART and Balance Master systems.

### The Influence Of Knee Bracing And Taping On Balance

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It is believed that orthopedic bracing and taping may work, in part, by enhancing proprioception. The purpose of this preliminary study was to determine the influence that orthopedic braces and tape have on proprioception, as measured by balance. Eleven male and ten female subjects (mean age 24.1 y, height 172.9 cm, weight 77.1 kg) with no previous injury participated in this study. The subjects' ability to balance was assessed using the Chattecx balance system. Each subject was tested under the following five conditions; (1) a control with no intervention [CTL], (2) a prophylactic knee guard [PKG], (3) a functional (ACL) brace [FTL], (4) a closed patella neoprene sleeve [SLV], and (5) with one 12.7 cm (5 inch) strip of athletic tape applied in a distal-proximal direction over the patella [TAP] to improve cutaneous sensory feedback. In a previous study, it was reported that a similar application of tape improved joint position sense and kinesthesia at the ankle in non-weight-bearing conditions. The subjects' ability to balance for ten seconds was assessed using the Chattecx balance system during; static, plantar flexion/dorsiflexion, inversion/eversion, and linear (anterior/posterior) conditions. Each subject performed all trials on the same day. The sequence of trials was randomly selected by each subject. Balance measures were reported as sway index in centimeters, and were used for analysis. The data were analyzed by ANOVA and are presented as means ( $\pm$  S.D.). There was no significant difference ( $p > 0.05$ ) in the sway index across the static and dynamic trials, so the data were collapsed. There was no significant difference ( $p > 0.05$ ) in balance measures between the five conditions. Postural sway was; 1.15 cm ( $\pm .13$ ), 1.11 cm ( $\pm .11$ ), 1.10 cm ( $\pm .16$ ), 1.10 cm ( $\pm .16$ ), and 1.05 cm ( $\pm .13$ ) for CTL, PKG, FTL, SLV, and TAP, respectively. These data indicate that knee braces and tape do not have a significant affect on balance, as measured by postural sway, in healthy, uninjured subjects. Additional research with other populations and with other taping techniques is indicated.

### The Effects Of Leg Dominance On Joint Position Sense Of The Lower Extremity

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Previous research in our laboratory has evaluated the influence of leg dominance on various motor skills, including those which involve proprioception. Proprioception has many components, including joint position sense. The purpose of this study was to determine any influence that leg dominance may have on proprioception. Fourteen male and sixteen female subjects (mean age 23.2 y, height 172.9 cm, weight 71.4 kg) with no previous injury to the lower extremity participated in this study. Twenty-seven subjects reported their right leg to be their dominant leg. Each subject had both legs evaluated for joint position sense during plantar flexion/dorsiflexion (P/D) and inversion/eversion (I/E) at the ankle, and flexion/extension (F/E) at the knee. Each subject performed all trials the same day. The sequence of trials was randomly selected by each subject. The subjects' ability to reposition their knee and ankle joints were assessed using the electronic goniometer on the Biodex isokinetic testing apparatus. Subjects were asked to actively reposition their lower leg to a previously demonstrated point and stop the lever arm with a hand held switch. The predetermined position in the range of motion was changed with each trial to negate any learning effect. The difference between the predetermined point in the range of motion and the subject's approximation is referred to as the error score and was used for analysis. The data were analyzed by *t*-tests and are presented as means ( $\pm$  S.D.). There were no significant differences ( $p > 0.05$ ) in error scores between the right and left legs for any of the conditions. The error scores for the dominant side were;  $3.0^\circ$  ( $\pm 2.1$ ),  $3.3^\circ$  ( $\pm 2.3$ ), and  $5.7^\circ$  ( $\pm 4.0$ ), for P/D, I/E, and F/E, respectively, and for the non-dominant side were;  $3.3^\circ$  ( $\pm 2.2$ ),  $3.7^\circ$  ( $\pm 2.5$ ), and  $5.1^\circ$  ( $\pm 4.6$ ), for P/D, I/E, and F/E, respectively. It was interesting to note that more reposition error occurred at the knee than at the ankle. These preliminary data indicate that leg dominance does not have a significant effect on the ability to actively reposition the knee in healthy, uninjured subjects.

## Effects Of Shoe Sole Thickness On Joint Position Sense

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**Objective:** Increased thickness of the running shoe sole places the foot in a higher position, thereby increasing the distance from the support surface to the foot. As a result, deficits in estimating joint position may occur. The purpose of this study was to determine the effects of shoe sole thickness and movement direction on joint position sense. **Design and Setting:** A 3 x 4 factorial design was used. The dependent variable was mean estimate angle error. The independent variables were movements (plantar flexion, dorsiflexion, inversion, eversion) and shod conditions (barefoot, thick sole, thin sole). The study took place at the Indiana State University Sports Injury Research Laboratory. **Subjects:** Twenty male volunteers (ht=174.2±8.7cm, wt=73.0±3.7 kg) between the ages of 22 and 33 were recruited for this study. All subjects had no history of ankle and foot injury within the past 6 months, no neurological abnormality and were not taking any medication. The range of subjects' shoe size was from US 8 to 10. **Measurement:** Joint position sense was measured by using a slope surface board (30cm x 30cm x 1.5cm). The slope surface angles were made by sandwiching angle blocks with pre-determined angles (0° to 25°) between the slope surface boards. The slope surfaces were manipulated to allow dorsiflexion, plantar flexion, inversion and eversion. The subjects were asked to estimate the angle and direction during the shod and movement conditions while standing on the slope surface board. The angle of slope surface was randomized within the planes. **Results:** There was significant interaction between shod condition and movement on angle error ( $F_{(6,117)}=3.5, P=.003$ ). Simple main effects indicated that for all shod conditions, joint position error was the greatest for plantar flexion and inversion compared to dorsiflexion and eversion ( $P < 0.05$ ). Shod conditions were not different for each of the movements ( $P > 0.05$ ), except dorsiflexion where thick-soled error was greater than barefoot error ( $P < 0.05$ ). **Conclusion:** Based on the results, it appears that shoe sole thickness does affect joint position sense, but only in dorsiflexion. In addition, since the joint position error was greatest for plantar flexion and inversion, the possibility to sustain lateral sprains may be increased with shoe sole thickness due to the proprioceptive deficit in plantar flexion and the prolonged stimulation for muscle contraction. This factor should be considered when designing new shoes.

## Effects Of Feldenkrais Awareness Through Movement® On Balance During Standing

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**Objective** Athletes and performing artists have used the Feldenkrais Method of somatic education to improve performance and recover from injury. Feldenkrais proposes to improve function by enhancing perceptual abilities that relate to balance and control of movement during static and dynamic tasks. This holds possibilities for injury prevention and rehabilitation. Control of balance in dynamic tasks may be a useful intervention against the continuing problem of ACL injury among female athletes. This study examined the effects of a series of 8 Feldenkrais lessons over 4 weeks on measures of balance while standing. **Subjects** 20 adult female participants were recruited for this study from the Bloomington community. All women reported being generally healthy and injury free at the time of the study. Researchers asked them not to alter their usual activities during the course of the study. **Methods and Materials** Researchers used a multivariate repeated measures design (2 groups—Feldenkrais or control, 2 times—pre and post). An AMTI force plate was used to gather data on several balance related measures as participants did 7 randomized standing tasks (30 sec. trials, 3 repetitions each of quiet standing in natural stance, standardized stance, standardized stance with vision blocked, single stance on right leg, single stance on left leg, medial-lateral sway, and anterior-posterior sway). The measures of balance we used were center of pressure (COP) related parameters (e.g., sway area, sway path, ML and AP excursions). **Results** Our preliminary results indicate that the 2 dimensional shape of the center of pressure distribution during the static tasks for the Feldenkrais group changed from elliptical to circular. This was achieved by a decrease in the extreme excursions in the ML and AP directions, thus enhancing the stability of this group due to the Feldenkrais intervention. **Conclusions** These early results suggest that the Feldenkrais Method can facilitate changes in standing behavior that allow individuals to improve their balance and postural control. This may decrease their risk of injury and aid the rehabilitation process. Further studies are planned to compare Feldenkrais with other interventions (e.g., traditional stretching, relaxation), and to document other changes in balance and posture (e.g., the relationship between center of pressure and center of mass).

## The Relationship Between Active And Passive Assessments Of Knee Proprioception

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Traditionally, proprioception of the knee has been assessed through the evaluation of threshold to detection of passive motion (TTDPM) and both active and passive replication of specific joint angles. The purpose of this investigation was to examine the relationship between TTDPM, reproduction of passive joint position sense (RPP) and reproduction of active joint position sense (RAP). Knee proprioception of 20 healthy subjects (10 males, 10 females, age=23.5 ± 2.3 yrs, ht= 172.8 ± 9.9 cm, wt=71.4 ± 16.5 kg) was assessed during a single testing session. A proprioceptive testing device was utilized to assess TTDPM and RPP. For the assessment of TTDPM, seated subjects indicated when knee motion was perceived for flexion or extension from two separate starting flexion angles (15° and 45°). For the assessment of RPP, subjects passively replicated one of four target angles (5° and 15° from a starting angle of 25°; and 35° and 55° from a starting angle of 45°). RAP was assessed under both open and closed kinetic chain conditions using The Motion Monitor electromagnetic tracking device (IST, Inc., Chicago IL). Subjects were asked to replicate one of two target angles (15° or 45°) that was presented to them. In all conditions, absolute angular error was calculated. Pearson Bivariate correlation coefficients were calculated between all pertinent variables. The results revealed significant ( $p < .05$ ) correlation coefficients between several of the TTDPM and RPP angles tested with values ranging from  $r=.51$  to  $r=.60$ . In addition, significant moderate correlation coefficients existed between several RPP angles tested ( $r=.52$  to  $r=.58$ ), and significant strong correlation coefficients were present between several TTDPM angles tested ( $r=.65$  to  $r=.81$ ). However, no significant relationship existed between the active and passive assessments under any condition or joint angle. These results suggest that cutaneous, joint and muscle mechanoreceptors may act independently in transmitting proprioceptive information to the central nervous system. Cutaneous and joint mechanoreceptors (Ruffini endings, Pacinian corpuscles, and golgi tendon organs) have been linked to the posterior dorsal pathway and may have had greater input during the passive tests. Muscle mechanoreceptors (muscle spindles and golgi tendon organs) have been linked to the spinocerebellar pathway and may have had greater input during the active tests. The controversy of whether cutaneous, joint, or muscle mechanoreceptors provide the predominant input is still ongoing. These results seem to suggest that each type of mechanoreceptors should be taken into account in order to make a thorough assessment of knee proprioception.

## A Single Subject Clinical Study: The Effects Of Core-Stability Training Using A Foam-Roller On Pelvic Inclination, Abdominal Muscle Strength And Center Of Balance

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The objective of this study was to assess whether a core-stability training program would improve pelvic inclination, abdominal muscle strength and center of balance (COB). The subject was a female (28 years, 177.8 cm, 88.63 kg) with complaints of chronic back, hip, and knee pain of ten-years duration. The subject performed core-stability exercises using a foam roller 3-times per week over a 6-week period. Pelvic inclination was measured as the angle of inclination between the anterior superior iliac spine (ASIS) and the posterior superior iliac spine (PSIS) using a universal protractor with an attached inclinometer while subject assumed a relaxed stance position. Abdominal muscle strength was measured through manual muscle testing protocols (Kendall, McCreary & Provance, 1993). Rectus abdominis strength was measured with the subject in a supine position on a firm surface. Subject's knees were kept in full extension as their legs were raised to 90° hip flexion. The subject positioned the pelvis into a posterior tilt and maintained this position as she slowly lowered her legs moving into hip extension. Hip range of motion (ROM) was measured through the use of a goniometer at the point where the subject was unable able to maintain posterior pelvic tilt. Oblique abdominal muscle strength was measured bilaterally with the subject in supine, hips flexed to 45°, knees flexed to 110°, and feet flat on the floor. The subject flexed their trunk and rotated towards the opposite knee. Resistance was applied on the shoulder leading towards the opposite knee. The amount of resistive force was measured through the use of a hand held dynamometer. Center of Balance (COB) was assessed using the Chattecx Dynamic Balance System. A single-case experimental design was used during the course of this study. Baseline test measurements were collected over 3-testing sessions within a 1-week period prior to initiation of core-stability training. Baseline test measures served as the comparison to post-training test measures. During the 6-week training period test measures were repeated 3-times per week. In comparison to baseline levels there were stable improvements in pelvic inclination, abdominal muscle strength, and COB after 6-weeks of core-stability training program performed on the foam roller. Anterior pelvic inclination decreased from baseline measures of 14° and 16° to 6° and 6°, left and right respectively. Rectus abdominis strength improved as baseline total hip ROM increased from 20° to 55°. Oblique abdominal strength improved from resistive force baseline measures of 20-lbs and 7-lbs to 37-lbs and 43-lbs, left and right respectively. COB measures improved as the subject's COB was altered from baseline measures of 1-cm anterior to a more centralized posi-

tion of 1.5-cm posterior. These results suggest that core-stability training on a foam roller may be able to improve abdominal muscle strength, pelvic inclination and COB.

## Joint Reposition Sense And Functional Performance In Athletes And Non-Athletes

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**Objective:** To determine the relationship between weight bearing (WB) and non-weight bearing (NWB) active joint reposition sense (JRS) and a functional hop (FH) test, and to determine if differences existed in performance on these parameters in athletes and non-athletes. Test-retest reliability was also determined for the JRS tests. **Subjects:** 40 male university students (age=20.8 +/-1.7 yrs; ht=176.9 +/-5.8 cm; wt=82.6 +/-9.5 kg) free from lower extremity injury participated. 20 were inseason lacrosse players and 20 were age matched non-athletes. **Methods and Materials:** Subjects first completed the two JRS tests in a counterbalanced order, followed by the hop test. For both JRS tests, the blindfolded subjects actively attempted to reproduce the target angle of 30 deg. An electrogoniometer (Penny and Giles, Gwent, UK) measured absolute knee joint angular error in degrees. For the WB testing, subjects squatted to the target angle and for the NWB testing, were seated in a semireclined position. Functional performance was measured in cm using a single leg cross over hop for distance test. For all testing, the average of 3 trials represented the subjects score. A Pearson correlation was used to determine the relationship between JRS and FH. A group x JRS test condition ANOVA was computed to examine for differences between athletes and non-athletes and WB and NWB JRS. **Results:** No significant correlations were found between WB and NWB JRS and the FH in either athletes or non-athletes. The ANOVA found no group x condition interaction, and no group main effect. A main effect was found for JRS test condition. Subjects were more accurate with the WB than NWB tests. Test-retest reliability coefficients (ICC 2,k) and standard errors of measurement (SEM) for WB and NWB were R=.57 (SEM=1.3 deg) and R=.59 (SEM=2.68 deg), respectively. **Conclusions:** There appears to be no relationship between active weight bearing and non-weight bearing joint reposition sense and functional performance in either athletes or non-athletes. Additional research should explore the potential mechanisms responsible for the observed differences in performance on the weight bearing and non-weight bearing joint reposition sense tests.

## The Effects Of Sports Massage Upon Subsequent Quadricep Force Output, Power, And Total Work

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The purpose of this study was to determine the effects of sports massage on subsequent muscular force output, power, and total work of the quadricep muscles. This study evaluated 13 healthy male subjects from a high school varsity football team. The Kinetic Communicator (Kin-Com) was utilized to assess mean peak force, power, and total work. The application of the 10 minutes sports massage was performed by a licensed massage therapist. The experimental design of this study was a single group with repeated measures. The subjects participated in both the massage and no massage treatment conditions. All subjects performed 3 sets of 10 repetitions, maximally, with a three minute rest between each set. Subjects then rested for 10 minutes (control condition) or received a 10 minute sports massage (experimental condition). Results of the paired t-tests revealed no significant differences in pre-post mean peak force, power, and total work within both the sports massage and no massage treatment conditions. Results also revealed no significant differences in mean pre-post changes in mean peak force, power, and total work between the no massage and massage treatment conditions.

## The Effect Of Interferential Current On Delayed Onset Muscle Soreness

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The purpose of this investigation was to assess the effect of interferential current (IFC) on the signs and symptoms associated with delayed onset muscle soreness (DOMS). Twenty-four subjects (12 male: age=25.75 $\pm$ 9.68 yrs; ht=178.01 $\pm$ 17.99 cm; wt=75.87 $\pm$ 23.93 kg, 12 female: age=24.00 $\pm$ 6.46 yrs; ht=165.52 $\pm$ 12.28 cm; wt=61.80 $\pm$ 22.12 kg) were assessed for upper extremity volume, elbow flexion and extension range of motion, and perceived pain scale rating for the non-dominant arm. DOMS was then induced in the non-dominant elbow flexors using an eccentric exercise protocol. Each subject performed elbow flexion through a full range of motion with an initial resistance equivalent to 80% of the MVIC. Each repetition consisted of a 3-sec eccentric phase while the examiner performed the concentric phase. The exercise set was continued until the 3-sec eccentric phase could not be maintained. This was repeated two more times for a total of three sets with the resistance decreased 2.3-kg after each set. Following the exercise protocol, each subject was randomly assigned to one of three treatment groups; IFC, IFC and ice, and control. The IFC current was delivered using a Forte CPS Series 400 Combo Unit ( Chattanooga Group, Inc., Hixson, TN) set to sweep between 80- and 150-Hz with a carrier frequency of 4000-Hz. The IFC and ice group also received an ice pack applied directly over the biceps area. Subjects in all three groups received treatment while in the supine position with the arm elevated and the elbow in a comfortably extended position. All treatment sessions were 20-min in duration and each subject reported for treatment 48-, 96-, and 120-hrs following the exercise protocol. Subjects were reassessed for all measures immediately before and after each treatment session. Two mixed model ANOVAs with two between (group, gender) and two within (day, test session) factors revealed significant test session main effects for both range of motion [F(1,18)=22.30, p=.000] and upper extremity volume [F(1,18)=10.22, p=.005]. All three groups also experienced a significant decrease in upper extremity volume at 96-hrs and a significant increase in range of motion at 48-, 96-, and 120-hrs following treatment. No other significant main effects or interactions were observed. These results suggest that IFC, with or without ice, is not an effective treatment for exercise induced muscle damage. These results also suggest that elevation of the extremity with the elbow in a comfortably extended position is effective for reducing swelling and improving range of motion over a short period of time.

## The Effect Of Training With NMES On Elbow Flexion Strength

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Neuromuscular electrical stimulation (NMES) may be used to prevent atrophy and strength loss associated with post-surgical immobilization. A number of studies have tested the effectiveness of NMES using primarily the knee extensors. The purpose of this investigation was to test the effectiveness NMES when training the elbow flexors by comparing NMES to voluntary training. Twenty-four university students (age 23.5  $\pm$  3.9 yr, height 1.73  $\pm$  .12 m, weight 73.1  $\pm$  16.7 kg) were randomly assigned to one of three groups: NMES training, voluntary training or a control that did not train. Testing and training sessions were completed using a Biodex™ dynamometer. After a standard warm-up, subjects were positioned on the Biodex™ with the shoulder in the anatomical neutral position, elbow flexed to 90° and forearm supinated. Subjects performed three maximum isometric muscle actions of 5 seconds duration, with 1 minute of recovery between repetitions. Average peak torque during three repetitions was used in the analysis. Subjects then trained on three days per week for four weeks. Each training session included 15 maximum isometric muscle actions of 10 seconds duration with 50 seconds recovery between repetitions. NMES was provided by a Forte 400 Combo ( Chattanooga Group, Inc., Hixson, TN). Russian current was delivered via two carbon rubber electrodes placed over the proximal and distal ends of the left biceps brachii. A maximum tolerable ramped intensity was delivered with a frequency of 90 burst per second and a duty cycle of 10:50. After four weeks of training, subjects were post-tested in a manner identical to the pretest. Mean normalized strength data were analyzed using a 3 (Group) x 2 (Test) analysis of variance with repeated measures on the last factor. The analysis revealed a significant main effect for Test [F(1,21)=15.14, p<0.001] with means of .48 and .59 for the pre and post-test, respectively. The main effect for Group was not significant [F(2,21)=1.30, p>0.2)]. The Group x Test interaction was significant [F(2,21)=4.62, p<0.02)]. Post-hoc analyses revealed that the voluntary training group had a significantly greater increase than the other two groups, which were not significantly different from each other. The lack of significant strength gains with NMES was likely due to the low average training intensity, which was only 20.4 % of the MVIC. Based on the results of this study, NMES training under these conditions may not be an effective alternative to voluntary training.

### Microcurrent Electrical Nerve Stimulation and Cryotherapy Do Not Affect Perceived Muscle Pain From Delayed Onset Muscle Soreness

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Experimental clinical studies have demonstrated no significant effect of microcurrent electrical nerve stimulation (MENS) on the perceived muscle pain from delayed onset muscle soreness (DOMS). However, the effect of MENS combined with cryotherapy (ICE) on the perceived muscle pain from DOMS has not been investigated. This study measured the effects of MENS, ICE, and MENS+ICE combined on perceived muscle pain derived from DOMS. Forty college age students, none involved in a weight lifting program, were randomly assigned to a control, MENS, ICE, or MENS+ICE group. DOMS was induced in the wrist flexors of the non-dominant arm using a programmed bout of eccentric exercise. At 24 hour (h) intervals, MENS, ICE, or MENS+ICE were administered using a standard procedure. Perceived pain was assessed on a verbal descriptive scale immediately following, and at 24h, 48h, 72h, and 96h post exercise. A three-way mixed factor ANOVA was used to evaluate the interactive effects of ICE, MENS and time on pain rating ( $\mu = 0.05$ ). Results indicated no statistically significant interactions among ICE, MENS and time. In addition, there was no statistically significant main effect for MENS ( $F_{1,36} = 0.71, p = 0.404$ ) nor for ICE ( $F_{1,36} = 0.18, p = 0.673$ ). There was, however, a significant main effect of time ( $F_{2,144} = 6.64, p = 0.002$ ). The peak pain rating was provided at 48h and declined at 72h and 96h post exercise. This study does not support the use of MENS or ICE to reduce perceived muscle pain derived from DOMS.

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### The Clinical Effects Of Cold Application On The Production Of Electrically Induced Involuntary Isometric Muscle Contractions

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The purpose of this study was to determine if cryotherapy affected an individual's ability to tolerate the painful stimulus associated with electrical stimulation as measured by peak force and output intensity over time. Twenty males (age =  $26 \pm 5.6$  yrs) and eighteen females (age =  $23.9 \pm 4.8$  yrs) volunteered to participate in this study. All subjects had no prior history of injury to the quadriceps muscle group for the past twelve months and were asked to refrain from exercising for 24 hours prior to testing. The subjects were randomly assigned to an experimental (ice bag) or control (no ice bag) group, and reported to the testing site once for the familiarization and testing session. Motor points were determined for the quadriceps at the vastus medialis oblique and rectus femoris. The Forte CPS series electrical stimulation unit was connected to the two motor points by two self adhesive electrodes. The subject was positioned in the Kin Com Isokinetic Dynamometer with the knee locked out at 60 degrees of flexion. The neuromuscular electrical stimulation was gradually increased, causing an involuntary muscle contraction until the subjects could no longer tolerate the noxious sensation. The subjects were asked to read from a list of verbal cues that described the noxious sensation so that the examiner could monitor the level of pain. The peak force and output intensity values were then recorded for the pretest and at four-minute intervals for twenty minutes. Separate, two between, one within repeated measures ANOVAs revealed an interaction for gender and time for output intensity [ $F(5,227) = 2.29, p < .05$ ] and an interaction for group and time for output intensity [ $F(5,227) = 14.28, p < .05$ ]. Main effects were also found for gender [ $F(1,227) = 7.53, p < .05$ ] and time [ $F(5,227) = 53.41, p < .05$ ] for the measure of output intensity, and for gender [ $F(1,227) = 42.67, p < .05$ ] and time [ $F(5,227) = 8.76, p < .05$ ] for the measure of peak force. The use of cryotherapy in a 20-minute time frame will allow the patient to tolerate greater output intensities, and does not adversely affect peak force. This increase in output intensity increases the training effect and muscle fiber recruitment associated with NMES. The relevance is shown in the increased level of patient comfort with the application of neuromuscular electrical stimulation. Future research should examine alternate forms of cryotherapy, and the exploration of measuring the effects of different time intervals.

### The Immediate Effects Of Heat, Ice And Jogging On Passive Knee Extension Before And After Stretching

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Various modalities are used to enhance the effectiveness of stretching prior to athletic competition. Little information is available investigating the effectiveness of these modalities in combination with stretching. **Purpose:** The purpose of this study was to determine the immediate effects of selected treatments on passive extension of the knee (PKE), after treatment and stretching. The treatments were: moist heat (MH), ice pack (IP) and jogging (J). Immediately following each treatment, passive stretching was performed. **Subjects:** Twenty healthy male college students between 18 and 25 years of age participated in this study. **Procedures:** The HP and IP treatments were twenty minutes in duration, the one-mile of jogging was performed within 10-12 minutes. MH was applied with a hydrocollater pack placed over the hamstring. The IP was applied to the hamstring in a similar fashion. The jogging was performed around an indoor track. All subjects completed each of the treatments during separate sessions. Using an apparatus designed to position the subject for stretching and knee angle measurements, the researcher passively extended the subject's knee while the hip was held in 90° of flexion. The stretch was held for 30 seconds and repeated for three repetitions. Consistent pressure (100mmHg) was applied to the heel using a blood pressure cuff when obtaining knee angle measurements. Hip, knee and ankle joints were marked, videotaped and digitized to obtain knee angles. Knee angle measurements were obtained prior to and following the treatment, and following stretching. **Results:** Through two-way ANOVA with repeated measures, the results indicate that HP, IP, and J had no significant effect on increasing PKE, nor was one modality more effective than the other. However, following these treatments static stretching had a tendency (although not significantly) to increase PKE except for IP. HP and stretching combined produced the greatest increase in PKE (1.75°). All test-retest measurements except one ( $r = 0.86$ ) were above  $r = 0.93$ . **Conclusion:** The results suggest that neither HP, IP or J in conjunction with stretching is more beneficial in improving PKE measures, although stretching seemed to be a potential contributor to improving ROM at the knee. Future studies should focus on other modalities and duration of treatment.

### Clinical Efficacy Of Selected Pivot Shift Tests For Assessing Anteriolateral Rotatory Instability Of The Knee

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Anteriolateral rotatory subluxation of the tibia is believed to occur when the anterior cruciate ligament (ACL) deficient knee gives way during pivoting maneuvers. The pivot shift test evolved as an attempt to demonstrate this phenomenon during the clinical examination of the patient. The purpose of this study was to determine the clinical efficacy of four variations of the MacIntosh pivot shift test for assessing anterior lateral rotatory instability (ALRI) in the ACL deficient knee. Forty-five male and female subjects (average age = 24.4 +/- 8.00 years) who were 21 or more days post unilateral ACL injury and undergoing elective reconstruction participated in the study. The independent variables were four variations of the MacIntosh pivot shift test, anesthetic condition, time period between initial injury and surgery, and structural injury group. The pivot shift tests consisted of four treatment levels: hip neutral and tibial internal rotation (NIR), hip neutral with tibial external rotation (NER), hip abduction and tibial internal rotation (ABDIR), and hip abduction with tibial external rotation (ABDER). Anesthetic condition consisted of anesthetized and unanesthetized. Time period between initial injury and surgery consisted of two levels: sub-acute (21 to 90 days between initial injury and surgery) and chronic (90 days or more between initial injury and surgery). Structural injury group consisted of three levels: group 1 (ACL tear only), group 2 (ACL and meniscus tear), and group 3 (ACL and other non-ligamentous intra-articular knee injuries). The dependent variables were subjective apprehension, objective apprehension, pain, and degree of pivot shift. All of the dependent variables were assessed pre-anesthesia with the addition of pivot shift also assessed post-anesthesia. Results revealed that pre-anesthesia affirmative subjective apprehension was present in cleared to begin light jogging  $\leq 37\%$  of the subjects in the sub-acute group and in  $\leq 61\%$  of the subjects in the chronic group. The ABDER pivot shift test resulted in the lowest percentage (27%) of affirmative responses for the sub-acute group and the highest percentage (61%) of affirmative responses for the chronic group. Pre-anesthesia affirmative objective apprehension results were dependent on injury group. All four pivot shift tests resulted in  $\leq 45\%$  affirmative responses in the sub-acute group. In the chronic group, the NIR, NER, ABDER pivot shift tests resulted in  $>50\%$  affirmative responses. The ABDER pivot shift test resulted in 75 and 77% affirmative responses in groups 1 and 2, respectively, for the chronic group. Pre-anesthesia affirmative pain responses were

$\leq 30\%$  for all four pivot shift tests. This was true for both the sub-acute and chronic groups. The ABDER pivot shift test produced a lower percentage of negative and grade 1 pivot shifts and a higher percentage of grade 2 pivot shifts pre-anesthesia compared to the other three pivot shift tests. This was true for both the sub-acute and chronic groups. Post-anesthesia the ABDER test resulted in the highest percentage of grade 2 pivot shifts in the sub-acute and chronic groups. In conclusion, subjective and objective apprehensions and pain were not generally efficacious clinical signs for diagnosing ALRI for any of the four pivot shift tests. The exception was the ABDER test for subjective and objective apprehensions which was effective for chronic subjects only. Of the four variations of the MacIntosh pivot shift test assessed, the ABDER was the most effective test for assessing ALRI in the ACL deficient knee pre- and post- anesthesia.

### Assessing The Nutrition Knowledge Of High School Basketball Players

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This study was performed to determine the extent of knowledge about nutrition that high school varsity basketball players possess. A survey consisting of twenty questions that asked for responses pertaining to subjects ranging from carbohydrate/protein/fat intake to breakfast consumption to fluid consumption to pre-event meals was used. Three hundred thirty-six surveys were distributed accordingly to the certified athletic trainer at each of the seventeen area high schools serviced by the university's Graduate Athletic Training program. The certified athletic trainer administered the surveys to each member of his/her school's boys and girls varsity basketball teams. Each survey was collected and checked as correct, incorrect, or simply for the content of its answers. Three hundred twenty-eight of the surveys were deemed complete for a return rate of 97.6%. One hundred fifty-four males and one hundred seventy-four females completed a survey. A total score of fifteen was possible for each survey. Females had a mean score of 7.97 and males had a mean score of 7.07. An independent t-test was conducted with a level of significance of .05 and it was determined that there was a significant difference between the mean scores (and nutrition knowledge) of females and males. In addition to the mean scores evaluation, a few select questions were examined for their content to determine if any alterations in dietary patterns based on nutrition knowledge could be suggested to assist in the optimization of athletic performance. Close to 77% (76.6%) of males and 65% (64.9%) of females reported consuming breakfast on a daily basis. Also, forty-six percent of males and 61% of females marked that they drank eight 8-ounce glasses of water per day. Finally, while 83.1% of the males and 87.4% of the females indicated that they ate a pre-event meal, only 11.7% and 7.0%, respectively, indicated that they ate the meal at the suggested 3-4 hours prior to competition. Although no specific nutrition counseling was offered to alert the athlete to deficiencies or misinformation that he/she may have had, it is an optimistic view of the presenter that the survey highlighted the importance of basic nutrition for optimal performance. Based on these findings, we conclude that athletes understand the importance of nutrition, but not necessarily as it relates to performance optimization on the basketball court.

### The Fluctuation Of Body Weight In Elite Collegiate Wrestlers Throughout The Competitive Season: An Implication For The New NCAA Wrestling Weight Certification

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The real danger from a rapid loss of weight by competitive wrestlers is to become dehydrated. The NCAA mandated a wrestling weight certification in 1998 to establish permanent weight classes for each wrestler and thus attempted to eliminate any incentive for detrimental weight loss. The purpose of this study was to determine daily fluctuation of total body weight of the elite collegiate wrestler during the competitive season. Forty-two male subjects ( $21.3 \pm 1.5$ yr,  $154.1 \pm 0.5$ cm) were used in this investigation from the top 3 finishing schools at the 1999 NCAA Division I National Wrestling Championships. The subjects in this investigation were considered elite athletes based on each teams finishing place and the fact that 15 of the participating subjects obtained All-American or National Champion status. All subjects reported no previous history of dehydration or heat illness as determined by the injury history questionnaire and subjects confidentiality was maintained at all times. The study period lasted from September 1998 to the end of the competitive season in March 1999. Each subject was asked to report to the testing area 24 hrs prior to ( $74.95 \pm 14.22$ kg), 1-hour prior ( $73.4 \pm 18.6$ kg) and 24 hrs following ( $75.6 \pm 13.66$ kg) a competitive wrestling match. Total body weight was recorded at this time to the nearest tenth of a pound. In addition, body composition for percent body fat was determined using skinfolds within normal urine specific gravity ranges to ensure hydration every two months ( $11.4 \pm 3.4$ ,  $9.39 \pm 2.1$ ,  $8.28 \pm 1.9$ ,  $8.77 \pm 2.6$ ,  $9.11 \pm 3.1\%$ ) throughout the competitive season. Comparisons between the pre-,match and post-match weights were made using a randomized one group repeated measure factorial analysis of covariance using an alpha level of .05. A significant difference ( $F=24.96$ ,  $p<.0001$ ) existed in subjects weight 24 hrs before a competitive match and a significant difference ( $F=18.93$ ,  $p<.0001$ ) existed in subjects weight 24 hrs following the competitive match. It has been suggested that novice wrestlers lose the greatest amounts of weight prior to competition and the elite athlete maintain a consistent body weight throughout the season. Based on the results of this investigation, elite collegiate wrestlers, like novice wrestlers, do significantly lose weight prior to competition and gain weight following the competition. In addition, the NCAA wrestling weight certification program has not deterred these subjects from losing and gaining significant amounts of body weight throughout the wrestling season.

### The Effects Of Caffeine On Short Distance High Intensity Running In Male Collegiate Cross-Country Runners

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The purpose of this study was to determine the effect of 9 mg/kg body weight of caffeine on male, college age, division II and III cross-country athletes ( $N=10$ ). The effect was measured through the athletes' performance of the 800-M and 1600-M dashes. The athletes were also rated on their perceived exertion during each trial. Ten male cross-country runners from division II and III university programs underwent six days of testing over a three week period. Baseline 800-M measures were taken on day one followed by rating of perceived exertion. On day two (48 hours later) a baseline 1600-M was tested with perceived exertion of that run. On the third and fourth days of testing the 800-M was tested after taking either a placebo or 9mg/kg body weight of caffeine. This was taken 60 minutes prior to the run and was done in a double blind fashion. Again the perceived exertion was tested after the runs. The fifth and sixth days of testing followed the same methods except the distance of the run was 1600-M. Data was analyzed by t-tests. Based on the data collected it was concluded that caffeine at 9mg/kg body weight did not have a strong significant effect on the athletes' times in the 800-M dash. But, it did significantly decrease the time taken to run the 1600-M dash. Also, there was a significant decrease in perception of effort at both distances.

### Effects Of Creatine Supplementation On The Incidence Of Cramping/ Injury During A College Football Season

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Anecdotal reports suggest that creatine supplementation during intense training may increase the incidence of muscle cramping and/or injury. The purpose of this study was to examine the effects of creatine supplementation on cramping/injury rates during the college football season. Seventy-two Division IA football players participated in this season long safety study. Before and/or during the first week of training, 38 (53%) of the seventy-two athletes reported ingesting 20 to 30 g/d of creatine for 5 to 7-d followed by 5 to 10 g/d of creatine during the competitive season. All athletes (creatine users/non-users) also had access to a carbohydrate supplement containing no creatine during the training/competitive seasons. Subjects practiced or played in environmental conditions ranging from 57 to 97° F, 30 to 86% RH ( $79.9 + 9.8^\circ$  F,  $47.8 + 11.2\%$  RH). During the season, 27/38 (71%) creatine users were first team starters at some point. Injuries treated by the athletic training staff were recorded and categorized as cramping, heat/dehydration, muscle tightness, muscle strains/pulls, non-contact joint injuries, contact injuries, and illness. The number of practices missed due to injury/illness were also recorded. Data are presented as the total number of treated injuries for creatine users/total injuries and percentage occurrence rate for in-season practice/competitive phases. Results revealed that the incidence of cramping (5/11, 45%), heat/dehydration (0/1, 0%), muscle tightness (6/18, 33%), muscle pulls/strains (21/40, 53%), non-contact joint injuries (19/46, 41%), contact injuries (81/154, 53%), illness (23/57, 40%), number of missed practices due to injury (41/96, 43%), players lost for the season (1/1, 100%), and total injuries/missed practices (197/424, 47%) were generally lower or proportional to the creatine use rate among players. These findings indicate that creatine supplementation during a Division I college football season does not increase the incidence of injury or cramping.

## Creatine Supplementation Patterns And Perceived Effects Among Division I Athletes

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There is limited information in the literature regarding the dosages and schedules of creatine use with athletes outside of controlled research settings. The purpose of this study was to investigate the patterns of creatine supplementation and its perceived effects among Division I athletes. Two hundred and nineteen Division I athletes (male  $n=156$ , female  $n=63$ ) participated in a study designed to determine the patterns of creatine use among varsity intercollegiate athletes. Subjects voluntarily completed an anonymous questionnaire regarding creatine use and perceived side effects attributed to creatine use. Ninety athletes (41%) indicated previous, or current creatine use (male  $n=88$ , female  $n=2$ ). These athletes represented six varsity sports and were considered creatine users (CrU) in the analysis of the survey. Based on literature reviews, recommended dosage guidelines used in this study were 0.3 g/kg/d for five to seven days in the loading phase and 0.03 g/kg/d during training in the maintenance phase. Eighty-three (92%) CrU considered creatine supplementation safe, while six did not, and one respondent did not know. CrU reported taking dosages of 0.03 (.24g/kg (mean (SD) of creatine during loading phases for 6.6 (10.2 days. CrU reported taking maintenance dosages of 0.15 +/- 0.14g/kg for 101 +/- 195 days. Regarding perceived positive effects of creatine use, 80 CrU (89%) noticed weight gains, 73 (81%) indicated quicker recovery from intense workouts, and 42 (47%) had strength increases. These CrU were above, at, or below recommended dosage levels for loading ( $0.31 \pm 0.25$ g/kg/d) and maintenance ( $0.16 \pm 0.15$ g/kg/d) phases. Thirty-four (38%) CrU reported GI distress and/or muscle cramping which they related to creatine use (load =  $0.35 \pm 0.30$ g/kg/d; maintenance =  $0.19 \pm 0.17$ g/kg/d). Ironically, the 34 CrU that noted perceived negative side effects also noted perceived positive effects. Overall, 10 CrU (11%) reported no ergogenic effects with creatine supplementation in either the loading ( $0.25 \pm 0.19$ g/kg/d) and/or maintenance ( $0.09 \pm 0.06$ g/kg/d) phases. Results from this study indicated that there were highly variable methods of creatine use according to dosages and days based on body weight. While positive effects were noted, improper use also appeared to influence perceived negative effects. Based on the information attained in this study, athletes are in need of education regarding proper use of creatine supplementation as part of their overall nutritional regimen.

## The Effect Of Exercising In A Hot Environment On Power Output Following Short-Term Creatine Supplementation In Collegiate Football Players

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**Objective:** Creatine monohydrate supplementation has increased due to a suggested positive correlation with anaerobic activity. However, creatine use has been anecdotally associated with muscle cramping and dehydration, especially in hot environments. The purpose of this study was to determine the effects of exercising under thermal stress on power output following short-term creatine supplementation. **Design and Setting:** A 3x3 repeated measures design was used. One independent variable was supplementation treatment (creatine, placebo, and no supplementation) and the second was test session (I, II, and III). The dependent variable was power output (kg. m. s-1). **Subjects:** Nine healthy male volunteers (age =  $24.1 \pm 1.2$  yrs, ht =  $182.6 \pm 4.8$  cm, wt =  $95.0 \pm 19.6$  kg) participated in this study. All subjects were either present collegiate football players ( $n=7$ ) or had been removed from participation for less than 1 year ( $n=2$ ) and had not supplemented with creatine within a 1-month period. **Measurements:** Supplementation groups were randomly assigned. Both the creatine and placebo groups performed the same regimen. The supplementation period consisted of a loading phase (20g/day . 5 days), followed by a maintenance phase (5g/day) for two days with testing performed following the final dosage. Urinary creatinine levels were studied to determine subjects' compliance with treatment allocation. Prior to warm-up, subjects were dressed in football shoulder pads, jersey, and pants with pads. Helmets were not used due to visual impairment. A modified Margaria Power test was then performed outside the environmental chamber. In an environmental chamber set at an ambient temperature of 90°F (31.6°C), a work-rest (10:20 seconds) interval was performed on a cycle ergometer at 50% of a pre-determined work load at 120 rpm. Subjects' repeated the procedure 3 times. Power output was then calculated. **Results:** A difference was observed between session II and III for power output ( $F_{(1,4)} = 8.0, P = .05$ ). However, no difference was observed between the creatine, placebo, and control groups ( $F_{(2,4)} = 6.3, P = .17$ ). Mean total power output increased from session I to session III with the placebo group demonstrating the greatest increase. **Conclusions:** Short-term creatine supplementation has no significant effect on power output after exercising in a hot environment.

## Creatine Does Not Enhance Strength Development In Male College Students During A 10-Week Weight Lifting Program

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**Objective:** to test the effects of creatine monohydrate on male college students (non-collegiate athletes) during a ten-week weight lifting program **Design and Setting:** a double blind 2 X 3 factorial with repeated measures on one factor. Independent variables included a liquid supplement (placebo or creatine) and time (pre, mid, and posttest). Training weight, 1 repetition maximum (1RM), and Dynamic Strength were measured as dependent variables.

**Subjects:** 42 male college students from 3 beginning weight training classes. **Measurements:** We pre-tested, weight trained 3 days per week for 5 weeks, mid-tested, weight trained 3 days per week for 5 more weeks, and post-tested. We tested subjects leg press 1RM strength and Dynamic Strength (the number of times they could lift 160% of their pre-test body weight). Body weight was recorded each week.

**Results:** Both groups increased significantly in strength: Training weights increased approximately 100%, 1RM increased 45%, and Dynamic Strength increased in excess of 300%. There were, however, no differences between groups for Training weights, 1RM, or Dynamic Strength. The creatine group gained weight (2.6%) while the placebo group essentially stayed the same (-.01%) during the training program. The difference between groups was significant. There was little to no correlation between strength measures: for 1RM vs. Dynamic Strength,  $r = .13$ ; for 1RM vs. training weights,  $r = .44$ ; for Dynamic Strength vs. training weights,  $r = .29$ .

**Conclusion:** Creatine does not appear to enhance leg press strength development in male college students during a 10-week weight training program associated with beginning weight training classes.

**Frequency Of Specific Entities Of The Female Athlete Triad Among Female Collegiate Athletes At An NCAA Division I Institution**

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**Purpose:** Our purpose was to describe the frequency of specific entities of the female athlete triad as self-reported among collegiate athletes at an NCAA Division I institution.

**Methods:** Over a three year period 450 female intercollegiate athletes completed a self-report questionnaire containing questions regarding menstrual health, eating patterns, and history of stress fractures. The questionnaire was given to all freshmen, transfer, and senior female athletes as part of their pre-participation physical examinations. The team physician reviewed completed questionnaires with each athlete.

**Analysis:** Descriptive statistics were calculated and reported as valid percentages after the removal of individual cases for missing values.

**Results:** The average age at menarche of subjects was  $13.07 \pm 1.38$  yrs and athletes reported having  $10.90 \pm 2.51$  cycles in the most recent year. Eighty percent ( $n=359$ ) reported that they experienced cramping with menstruation, while 60% ( $n=268$ ) indicated having irregular periods. Thirty percent ( $n=134$  athletes) indicated that at some point they stopped having their period regularly. Of these, absence of menstruation was reported for less than 3 months by 39% ( $n=43$ ), 3 to 6 months by 43% ( $n=47$ ), 6 to 12 months by 9% ( $n=10$ ), and greater than 12 months by 8% ( $n=9$ ). Nineteen percent ( $n=25$ ) of those reporting an absence of menstruation did not specify the length of this absence. A prior abnormal pelvic exam was report by 8.7% ( $n=33$ ) of the total sample. Oral contraceptives were being used by 33% ( $n=145$ ) of the athletes. Sixteen percent ( $n=69$ ) indicated that at some point they were diagnosed by a physician as being anemic. Fifteen athletes (3.4%) reported having had an eating disorder, 59 (13.4%) reported feeling out of control with eating patterns, and 201(45.4%) were not happy with their present weight. Reported methods of weight control included: dieting or fasting (16.8%), excessive exercise (12.6%), diet pills (4.1%), vomiting (3.6%), laxatives (2.9%), and diuretics (0.3%). Sixteen percent ( $n=69$ ) reported having suffered a stress fracture. Of these, 74% ( $n=51$ ) were in the lower extremity, 10% ( $n=7$ ) in the spine, 7% ( $n=5$ ) in the upper extremity, and 9% ( $n=6$ ) were unspecified.

**Conclusion:** Our results suggest that within the athletic population studied, risk factors for each of the three entities of the female athlete triad are present. The frequency of these risk factors are likely to be underestimated in this study due to the self-report method of survey data collection.

Further research is needed to explore the relationships between the risk factors of three components of the female athlete triad and the actual incidence of female athletes who have all components of the triad.

**Response Of Bone Mineral Density And Serum Hormone Levels Following Exercise Modifications In Two Amenorrheic Athletes**

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One of the greatest challenges facing athletic trainers and team physicians involves the management of the amenorrheic athlete with a history of stress fractures. The purpose of this study was three-fold. The first was to determine the effect of a modified exercise program, over a five month period, on the menstrual cycle, bone mineral density, and blood serum hormone levels in an amenorrheic athlete presenting with a history of stress reaction in bone. The second purpose was to determine if changes would result, in a relatively short period of time (five months), in the menstrual cycle, bone mineral density, and blood serum hormone levels of an amenorrheic athlete with a modified exercise program. Finally, the third purpose was to investigate a different approach to the treatment of decreased bone mineral density, serum hormone levels, and amenorrhea. The two subjects that participated in this study were highly competitive field hockey players at the University of North Carolina at Chapel Hill. Both subjects had a history of amenorrhea and of stress reactions in bone. Testing involved dual-energy x-ray absorptiometry (DEXA) scans of the lumbar spine (L1-L4) and proximal femur utilizing the Hologic 4500W densiometer. Maximal treadmill tests were performed to assess the maximal oxygen uptake of each subject. These tests were performed at baseline and at six week intervals. Blood samples were drawn at baseline and every three weeks thereafter. The samples were assessed for estradiol and progesterone levels. During the first half of the study period both subjects increased the duration their exercise program by 10 percent every three weeks. During the second half of the study period subject 1 decreased her exercise duration in 10 percent increments every three weeks to pre-study level. Subject 2 continued to increase her exercise duration by 5 percent every three weeks. Analysis of the data revealed no significant changes in bone mineral density, blood serum hormone levels, or menstrual cycle status. Interestingly, the DEXA scans indicated that both subjects have bone mineral density levels that fall within normal ranges. Fluctuations in blood serum hormone levels were revealed during the study period. These fluctuations were not indicative of a normal menstrual cycle however; they lead us to believe that normal menstrual function would return, had the study been extended five or six months. The results of this study indicate that it may be possible to stimulate normal menstrual function through exercise modifications, and could potentially be used as a means for treatment of amenorrhea.

### The Incidents And Severity Of Injuries In The Extrinsic Risk Factors Associated With Injuries That Occurred In Elite Women Field Hockey Players

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The prospective cohort study was undertaken to determine the incident and severity of injuries in the extrinsic risk factors associated with injuries that occurred during the Canadian women national field hockey team operations for the 1999 Pan American games. The incident of injury was 0.034 injuries per hour. Each phase of centralization had peak of injury frequency near the midpoint of the training section. Chronic injuries caused by overused, including fatigue, cramps and non-specific joint trauma, muscle strains, tendinitis postural mechanical dysfunction, occurred most frequently during skill training in practices. Acute injuries caused by contact and mechanical stress, such as contusion, sprains and traumatic mechanical dysfunction, occurred more frequently in games than in practice, and more frequently in the second half. The majority of injuries were of moderate severity. The lower extremities and spine comprised 81.7 percent of the total injuries. History of previous injuries, playing position, left or right side of the body, weather conditions and temperature, protective equipment and bracing had no effect on the frequency or severity of injuries.

Potential areas of injury prevention relate to chronic injuries, injuries due to mechanical stress, injuries due to from our mechanical stress and injuries due to contact. The lack of effect of extrinsic risk factors on injury and the theoretical basis for the cause of chronic and mechanical stress injuries suggest that further research should be directed toward intrinsic causes of injury.

### Tubing And Free Weight Strengthening Exercises Do Not Improve Shoulder Internal Rotation Acceleration

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**Objective:** The shoulder internal rotators play a role on the acceleration phase of throwing activities as well as stabilization of the shoulder. Both traditional free weight and tubing exercises have been used to strengthen the internal rotators to improve performance. However, there have been no studies comparing these methods to improve shoulder internal rotator activity during a functional movement. The purpose of this study was to compare tubing exercise and free weight exercise on shoulder internal rotation acceleration. **Design and Setting:** A 2 x 3 factorial design was used for this study. The dependent variable was shoulder internal angular acceleration. The two independent variables are test (pre and post) and exercise (tubing training, free weight training, and control). **Subjects:** Sixteen male and 11 female volunteers (ht=168.0cm, wt=71.9kg) between the ages of 20 and 32 were recruited for this study. All subjects had no history of shoulder injuries within the last three months. **Measurement:** Acceleration of shoulder internal rotation was measured by a motion analysis system before and after the 4 week training session. Four retro-reflective markers were used to capture shoulder internal rotation. Two markers were placed on subjects: one was attached to the ulnar styloid process and the other to the olecranon process. The two other markers were attached to the lateral surface of the table. The subjects were tested in the seated position with 90° of shoulder abduction and 90° of elbow flexion, and then performed 7 maximal contractions of shoulder internal rotation. The subjects were randomly assigned to one of three groups which included tubing training, free weight training, and the control (no training) group. **Results:** There were no differences among the levels of training group (tubing, free weights, or control) or tests (pre or post) for shoulder internal rotation acceleration. **Conclusion:** None of the exercises were effective for increasing shoulder internal rotation acceleration. Although these exercises may increase internal rotation force production, this does not appear to improve functional internal rotation acceleration.

### Range Of Motion, Glenohumeral Laxity And Isokinetic Tests As Indices For Shoulder Pain And Pathology In Swimmers

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Shoulder pathologies are common in swimmers. Swimmers have been reported as having altered ranges of motion and strength ratios, in comparison to non-swimmers. The purpose of this study was to investigate the relationships of shoulder range of motion (ROM), strength ratios, glenohumeral laxity and pain experienced over the course of a swimming season. Thirty-five (19 female and 16 male; age = 19.6±13.1, years competing = 9.5±3.2 years) collegiate swimmers volunteered as subjects for this study. Data were collected at the pre-season physical examination for all athletes who served as participants. Each subject underwent a clinical examination to measure internal and external rotation ranges of motion and glenohumeral laxity. Strength ratios for abduction/adduction and internal/external rotation were also measured. Wilcoxon rank-sum tests were used to analyze data. It was determined that no significant relationships existed between ROM, glenohumeral laxity, isokinetic strength and pain. There were no differences noted between range of motion and glenohumeral laxity in subjects without or with shoulder pathology. There were significant differences noted in peak torque between injured and non-injured swimmers. The results suggest that ROM and glenohumeral instability results had no relation to either shoulder pain or shoulder pathology in collegiate swimmers. There were also no differences noted in ROM, glenohumeral laxity and pain levels between male and female swimmers. The results suggest that ROM and glenohumeral laxity can not be used as indices for general shoulder pathology in collegiate swimmers. However, differences in isokinetic peak torque between injured and non-injured swimmers suggest that further research is necessary to investigate strength parameters in swimmers.

### Pharmaceutical Prophylaxis For Tinea Gladiatorum

Kohl TD, Martin DC, Nemeth R, Moyer J, Giesen D, Bartley T, Thompson G, Ganter J, Ventresca T, Motze J, Blimline M: Reading Hospital and Medical Center, Reading, PA

Tinea gladiatorum is a common entity in competitive wrestling. It impacts on a wrestler's ability to compete. Several methods have been advocated to prevent these infections; however, no well designed study of pharmaceutical prophylaxis has been conducted. A double blind placebo controlled trial was undertaken during the 1998-99 regular wrestling season. Wrestlers were randomized to receive 100mg of fluconazole weekly or placebo. Those not involved in the study were treated as a control group. The effects of prophylaxis were also examined by assessing treatment of clinical infections that did develop with fluconazole 200mg weekly for four weeks. A total of 131 wrestlers from eight different high schools in Berks County, PA were included in the prophylaxis phase of the trial. The incidence of infection in the placebo group was 22%, in the control group 18%, and in the fluconazole group it was 6%. Fluconazole significantly reduced the incidence of tinea corporis infections when compared with placebo and control  $X^2(3, N=131)=9.057, p<.05$ . There was also a significant reduction in the total number of infections in the fluconazole group ( $p<.05$ ). There were 21 wrestlers that incurred 23 cases of tinea corporis during the 1998-99 wrestling season in the eight study schools. Seven of the eight study schools had at least one case (range one to five cases). Prophylaxis with fluconazole did not impact upon the severity of disease, if contracted, when compared with the placebo prophylaxis. All isolates of tinea infections were *Trichophyton tonsurans*. We have shown that fluconazole is effective and safe for primary prevention of tinea gladiatorum. This could have amazing effects on the wrestling season by decreasing the number of wrestlers that miss time practicing or competing because of tinea infections. We must now define when and in what population would prophylaxis be warranted.

### Wrestling Mats: Are They A Source Of Ringworm Infections?

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In order to determine if the fungal molds (dermatophytes) responsible for causing tinea corporis (ringworm) can be isolated from wrestling mats a two-part study was conducted. The first phase involved a culture evaluation of material taken from wrestling mats at eight local high schools on a monthly basis. The second phase was a bench laboratory study to determine if the fungus/molds could be grown from a wrestling mat in an optimal setting. Material obtained from an area of the practice mats of eight high school wrestling teams at monthly intervals during the wrestling season. A two by one foot area of mat from one of the schools was used for the laboratory phase of the study. The endpoint sought was isolation of dermatophytes on culture media from specimens taken from wrestling mats. The ability to isolate dermatophytes from mat material in an optimal environment was the goal of the bench laboratory experiment. The mat cleaning habits of the eight schools were defined. No dermatophytes were grown from the swab specimens taken at the eight schools even though seven of the eight had at least one culture-confirmed case of tinea corporis in a wrestler during the season. Dermatophytes were not isolated from a section of mat evaluated in optimal laboratory conditions. It is unlikely that wrestling mats are a source of ringworm infections in wrestlers.

### Effectiveness Of Glenohumeral Joint Stability Braces On Restricting Active Shoulder Range Of Motion During Physiological Loading

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Glenohumeral joint stability braces are purported to be effective for restricting movements that predispose the shoulder to anterior dislocation. The purpose of this study was to determine the effectiveness of three commercially available glenohumeral joint stability braces on restricting active shoulder range of motion (ROM) during physiological loading. Fifteen males (age range 18 to 30 years) were tested on a Biodex Isokinetic Dynamometer in the concentric mode at an angular velocity of 180 deg/s. The independent variables were brace condition (Denison and Duke Wyre Vest, SAWA Shoulder Brace, and Simple Stable Shoulder Stabilizer), physiological movement (shoulder abduction and external rotation), and abduction angle (45 and 90 deg). All three independent variables were tested as within subject variables and were randomized. The dependent variable was ROM. The dependent variable ROM measure for abduction was based on the difference between the pre-set ROM limit (i.e., abduction limit = 45 or 90 deg) and actual abduction ROM attained. The dependent variable ROM measure for external rotation was based on the difference in ROM attained and 90 deg of external rotation at the 45 and 90 deg abduction angles. Testing was conducted on five different days (1 pretest and 4 tests for record) with a minimum of 7 days and a maximum of 10 days between sessions. Each brace condition treatment level was tested during a separate session. Results revealed that the three braces, on average, allowed an increase of 69.07 (+/- 21.78) deg of abduction at the 45 deg abduction limit, 40.62 (+/- 14.60) deg of abduction at the 90 deg abduction limit, 28.53 (+/- 7.40) deg of external rotation at the 45 deg abduction angle, and 29.35 (+/- 7.51) deg of external rotation at the 90 deg abduction angle. A 3 X 2 X 2 ANOVA with repeated measures revealed a significant ( $p<.01$ ) brace condition by physiological movement interaction. The Simply Stable Shoulder Stabilizer (64.83 +/-19.91 deg) and Denison and Duke Wyre Vest (57.97 +/-25.87 deg) allowed significantly greater abduction ROM than the SAWA Shoulder Brace (41.40 +/- 14.26 deg). The increase in external rotation ROM was similar for all three braces (28.93 +/- 10.12 deg). In conclusion, all three glenohumeral joint stability braces failed to restrict active abduction and external rotation to pre-set range limits during physiological loading. Without specificity to restrict ROM during physiological loading the braces' clinical effectiveness for preventing anterior glenohumeral shoulder dislocation is limited.

### Normative Isokinetic Shoulder Strength Values In Division I Softball Players

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The implementation of Title IX requirements at educational institutions across the country has made a tremendous impact on women's sports, especially at the intercollegiate level. One such sport to be impacted is that of women's softball. Objective shoulder strength measurements are important in the comprehensive evaluation and rehabilitation of the throwing athlete and offer the clinician baseline for comparison following injury. The purpose of this study was to develop a database of normative isokinetic strength measurements for a group of Division I softball players for the shoulder motions of external rotation (ER)/internal rotation (IR) and abduction (ABD)/adduction (ADD). Isokinetic strength data on twenty-five players (age=19.3±1.4 yr., wt=67.8±9.7 kg, ht=168.0±7.6 cm) were entered into the database over the course of three playing seasons. A Biodex System 2 (Biodex Medical Systems, Inc., Shirley, NY) isokinetic dynamometer was used to evaluate shoulder strength in each of the athletes. Strength was assessed at speeds of 60°, 180°, and 300° per second. Following a brief warm-up consisting of shoulder flexibility exercises, subjects were tested for bilateral shoulder ER, IR, ABD and ADD strength while seated and appropriately secured to the dynamometer chair. Six submaximal repetitions were allowed as a warm-up at each speed tested. Ten maximal repetitions were recorded at 60°/sec and 180°/sec, while 15 repetitions were recorded at 300°/sec. Normative peak torque (Ft•lb) values for ER ranged from 14.0±2.9 to 17.4±3.1 Ft•lb, IR ranged from 20.7±4.4 to 24.7±5.5 Ft•lb, ABD ranged from 36.3±7.3 to 57.0±10.8 Ft•lb, and ADD ranged from 39.9±9.1 to 62.9±16.4 Ft•lb. Subsequently, the ER:IR ratios and ABD:ADD ratio data for all players were derived for both the dominant and non-dominant arms. ER:IR ratios ranged from .61 to .77, while AB:AD ratios ranged from .85 to 1.0. Most normative isokinetic data available for comparison involves male athletes, however the results of this study indicate that the normative parameters for males should not be used to evaluate female throwing athletes. The data described in this report will prove useful to the clinician working with female athletes in the sport of softball and will allow for the application and interpretation of isokinetic data on these athletes. The use of population-specific normative data is particularly important when dealing with prevention and rehabilitation issues related to athletes with shoulder dysfunction.

### Reliability Of Inversion And Eversion Peak Torque Measurements From The Biodex System 3 Isokinetic Dynamometer

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Reliable and valid measurements are crucial to most clinical experiments. Isokinetic dynamometry is considered the standard for assessing strength in various muscle groups within the human body. In recent years, numerous articles have been published using measures of ankle strength, however few studies have assessed the reliability of those measurements. The purpose of this study was to determine the reliability of isokinetic strength measurements produced from the ankle motions of inversion and eversion on the Biodex System 3 (Biodex Medical Systems, Inc., Shirley, NY) isokinetic dynamometer. Thirty-five male (19) and female (16) subjects (age=21.4±2.1 yr., wt=72.6±15.2 kg, ht=172.6±9.5 cm) volunteered to participate in this study. Each subject was tested on two different occasions, with a minimum of 7 days between sessions. Subjects were allowed a brief stationary bicycle warm-up followed by a series of lower extremity flexibility exercises prior to testing. Inversion (INV) and eversion (EV) isokinetic strength measurements from both ankles were derived from a Biodex System 3 isokinetic dynamometer at speeds of 30°/sec (5 max reps.) and 120°/sec (10 max reps.). Subjects were tested through a full range-of-motion from inversion to eversion and were provided maximal visual feedback and verbal encouragement. Peak torque (PT) values were taken and used in the data analysis. An ANOVA with repeated measures was executed to determine differences between the pre and post test PT values. Reliability was assessed by calculating separate intraclass correlation coefficients (ICC's) for each leg (right and left), motion (inversion and eversion), and speed (30°/sec and 120°/sec). In addition, standard error of measurement (SEM) values were calculated to determine the precision of measurement. PT values ranged from 25.1 Nm to 59.0 Nm. ICC (2,1) values ranged from .54 (fair) to .92 (excellent). The results of this study establish the reliability of the Biodex System 3 isokinetic dynamometer in assessing inversion and eversion strength in the ankle at speeds of 30°/sec and 120°/sec. This reliability information should prove useful to clinicians and researchers who study and assess ankle strength measurements on a regular basis. Future research should look to examine the reliability of average torque measurements for these same two ankle motions.

### Force Requirements To Perform Exercises With A Weight-And-Pulley Circuit And With Elastic Tubing

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**PURPOSE:** The purpose of this study was to determine (1) if there is a significant difference between actual force requirements and predicted resistance during weight-and-pulley exercises, and (2) if there is a significant difference in force between the concentric and eccentric phases of both weight-and-pulley and elastic tubing resistive exercise. **METHODS:** Force requirements to lift three different resistances (1.5, 2.0, and 2.5 kg) were measured using the Lojer™ Mobile Pulley System, both concentrically (gravity resisted) and eccentrically (gravity assisted). The concentric (lengthening) and eccentric (shortening) force requirements for elongation of three, 45.7 cm samples (red, green, and blue) of Thera-Band® elastic tubing were then measured. Force requirements were measured using an ITC v2.0 force transducer. One tester pulled the resistance modality attached to the force transducer through a range of 91.5 cm with a constant speed of 30.5 cm/s, while another recorded the force measurements from the force transducer at 7 distances. Ten trials were performed for each sample. **DATA ANALYSIS:** Paired t-tests were used to evaluate significant differences between the predicted and actual force requirements for the weight-and-pulley circuit, and to determine if concentric and eccentric force requirements differed significantly at each elongation of both the pulley and elastic resistance. **RESULTS:** The force requirements to move each pulley resistance level were significantly different ( $p < .01$ ) than the predicted amount of resistance for both concentric and eccentric phases, except at the 2 kg, 30.4 cm and 76.2 cm eccentric phases. The concentric actual force was generally twice the predicted resistance, while the eccentric actual force was slightly less than predicted. There was also a significant difference ( $p = .000$ ) in force between the concentric and eccentric phases of the pulley resistances at each elongation. For the elastic tubing, there was no significant difference ( $p > .01$ ) between the concentric or eccentric force measurements, except at 30.4 and 61 cm elongation for green and blue, and at 91.4 cm for red and blue. **CONCLUSION:** Concentrically, approximately twice as much force is required to overcome the initial resistance of the pulley. This may be due to inertia, momentum and acceleration of the weight. Pulley concentric and eccentric force productions are also significantly different at similar elongations. Therefore, direction of motion has a significant impact on the amount of resistance provided with pulley exercise. Elastic tubing produced resistance that was not significantly different between concentric and eccentric phases at similar elongations.

### The Effect Of Strengthening External Hip Rotators On Abnormal Pronation of the Subtalar Joint

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The purpose of this study was to determine if a six-week functional exercise training program of the hip external rotator muscles would decrease the calcaneal eversion angle of subtalar joint pronation. A secondary focus of the study was to determine if tibial internal rotation angle and hip anteversion were also decreased following training. Twenty healthy college students between the ages of 18-40 years of age who demonstrated greater or equal to five degrees of rearfoot angle and a medial longitudinal arch angle of less than 130 degrees were selected for participation in this study. Twenty normal subjects (10 control group, 10 exercise group) were pre-tested to measure isokinetic hip external rotator strength on the Lido Multi-Joint II Active Dynamometer and kinematic motion on the Peak Performance Technologies motion analysis system. Following the pre-test, the exercise group underwent a six-week strengthening program for the posterior gluteal muscle. At the end of the six-week period, both the control and exercise groups were post-tested to measure isokinetic hip external rotator strength and kinematic motion. It was determined there was no increase in isokinetic strength of the hip external rotator at post-test for the exercise group. The varus angle at the knee increased at post-test for the exercise group. The maximum eversion angle at the subtalar joint was greater at post-test for both groups tested. The results of this study indicate that the exercises used to strengthen the hip external rotators had no effect on the calcaneal eversion angle. However the subjects reached a greater degree of calcaneal eversion and a greater degree of tibial external rotation at about the same time in the stance phase of gait from pre- to post test. Instead of excessive pronation causing an obligatory internal rotation of the tibia, perhaps the tibiofemoral joint controls the actions of the tibia to a greater degree. The increase in knee varus angle exhibited at post-test by the exercise group may have prevented the tibia from being fully influenced by the extreme amount of calcaneal eversion demonstrated by the subtalar joint. A possible reason for the increase in knee varus angle for the exercise group may be that the exercises strengthened or activated a muscle crossing both the hip and knee joint. Clinically, more research is needed to investigate the issue of closed chain strengthening exercises versus open chain assessment.

### Can An Educational Booklet Change Behavior And Pain In Chronic Low Back Pain Patients?

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**INTRODUCTION:** Patient education is considered valuable in treating low back pain (LBP) yet educational booklets have been ineffective in outcome studies. This investigation examined the impact of reading a specific booklet on the LBP and self-treatment behavior of volunteer chronic symptomatic subjects.

**METHODS:** 62 recruited volunteers with current chronic LBP read a low back educational booklet. A 50 question written survey was completed one-week later. 48 subjects (81%) were available for a follow-up telephone survey at 9 months. Besides descriptive statistics, AVOVA was used to analyze the dependent measures at  $p < 0.05$ .

**RESULTS:** Those patients with 9-month follow-up had a mean age of 42.4 years, mean pain duration of 10.4 years, and mean number of episodes/year of 4.1. The average pain intensity was 1.3 on a 0-4 scale (0 = none to 4 = severe). One-week after reading the book, 86% felt confident they could effectively self-treat their back pain. 95% stated they would use the book both as a reference to self-treat an acute episode and to prevent future pain. 52% reported they had already decreased their pain during the first week, 94% using specific directional spinal exercises described in the book, and 92% stated they were now more aware of correct posture. At 9-months, 87% were still exercising regularly. 91% were still focusing on using good posture. 82% noted less LBP since reading the book and 60% were pain free. 95% attributed their improvement to the exercises and posture changes learned from the book. Mean pain severity dropped from 1.3 to .44 and number of episodes from 4.1 to 1.0 annum ( $p < .0001$ ). Worst case scenario for those lost to follow-up was still significant at  $p < .01$ .

**DISCUSSION:** With 10.4 years duration of LBP being far beyond any expectation of any improvement by natural history, this chronic sample served as its own control. Such a high rate of change in exercise and postural behavior maintained over 9 months as a result of reading an educational booklet matches the high rate of improvement in pain and decreases in number of episodes.

**CONCLUSION:** In chronic LBP volunteers, a significant decrease in pain intensity (60% pain free) and number of painful episodes occurred after reading a specific educational booklet focused on the self-treatment of LBP. Such improvement may be related to the long-term changes in patient self-treatment efforts and strategies.

### Delayed Onset Muscle Soreness Does Not Affect Squat Lifting Mechanics

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**Objective:** It has been found that factors such as fatigue, balance, and pre-lifting preparations can affect the lift and lifting style. However, little research has been done evaluating the effects of muscle soreness on a lifting task. Thus, the objective of this study was to examine the effects of Delayed Onset Muscle Soreness (DOMS) in the leg musculature on lifting. **Design & Setting:** A 1 X 2 factorial design with repeated measures was used for this study. The independent variable was muscle soreness (with DOMS and without DOMS) in the leg musculature. Seven dependent variables were measured: shear force, torque and compression at L5/S1, and range of motion and torque at the knee and hip. **Subjects:** Twenty healthy college students, (age =  $23.45 \pm 1$  yr., height =  $169.67 \pm 8.15$  cm, and mass =  $71.94 \pm 12.6$  kg) from Indiana State University volunteered for this study. **Measurements:** Subjects were video taped lifting a 157N crate pre and post DOMS inducement. Six retro-reflective markers were placed at the following landmarks to model the lumbar spine, hip and knee: lateral border of the acromion process, lateral epicondyle of the elbow, greater trochanter, lateral epicondyle of the knee, and lateral malleolus. The x and y coordinates of each marker were digitized with the aid of a video processor, and LiftTrak software was used to calculate the kinematic and kinetic variables. **Results:** There was no significant effect of DOMS on L5/S1 torque, compression, and shear during lifting (Hotelling's T<sup>2</sup>:  $F_{(3,17)} = 1.55, p = .239$ ). There was no significant effect of DOMS on hip torque and range of motion during lifting (Hotelling's T<sup>2</sup>:  $F_{(2,18)} = .011, P = .989$ ). Additionally, DOMS had no significant effect on knee torque and range of motion during lifting (Hotelling's T<sup>2</sup>:  $F_{(2,18)} = 1.896, P = .179$ ). **Conclusions:** Delayed onset muscle soreness does not affect kinematic and kinetic variables associated with the squat lifting technique.

### The Effect Of Modified PNF Trunk Strengthening On Functional Performance In Female Rowers

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The sport of rowing often provides a unique challenge for athletic trainers and strength training specialists when attempting to isolate and strengthen the trunk musculature. The purpose of this study was to determine the effects of modified proprioceptive neuromuscular facilitation (PNF) strengthening patterns on improvement of functional performance in female rowers. A second focus of this study was to compare multi-planar strength training patterns to traditional uni-planar strength training patterns. This study focused on strength training the trunk musculature using sport-specific movements. The subjects were all members of the University of North Carolina Rowing Team (ages 18-22) with varying degrees of rowing experience. Thirty-seven subjects participated in either traditional uni-planar strength training (control group) or the modified PNF trunk training (experimental group) over a seven-week period. All participants performed a 2000 meter pretest and post-test on the Concept II Model C Ergometer (Morrisville, VT). Means and standard deviations were calculated for both the control and experimental groups for scores of power and time splits (dependant variables). A series of 2x2 repeated measures analysis of variances (ANOVAs) were used to compare the changes of each dependant variable between the treatment groups. It was determined that both types of trunk strengthening resulted in an increase in functional performance, as measured in average watts and total time. However, there was no significant difference in the total increase in performance between the two groups. Thus either method of strength training should result in an increase in functional performance as measured on an ergometer.

### Aquatic Therapy Patient Populations At The Orthopedic Specialty Hospital

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Our aquatic therapy program is supported by 2 clinics. Some of the physical therapists work in a team format along with athletic trainers, physical therapy assistants (PTA) and aides, whereas other therapists work independently, with the help of either 1 aide, or 1 PTA. Patients are routinely sent to the pool for functional conditioning, gait training, and cardiovascular conditioning by each of the therapists. Each team or individual therapist, regardless of pool usage, is responsible for equal amounts of the pool budget, including the salaries of 2 PTAs, 1 ATC, and 1 aide. The purpose of this study was to describe our patient population based on diagnosis and number of visits, and to determine whether referral patterns exist between therapists for various diagnoses. Patients were identified retrospectively, through patient scheduling records for a period of 6 months (April 1998 - September 1998). All patients were included whose records were complete (including diagnosis, date, number of visits, and physical therapist). Diagnoses and Therapists were coded and entered into SPSS 7.5. Seventeen different therapists referred patients to our aquatic program over the 6 months studied. There were a total of 799 new referrals in the duration of this study, (April = 138, May = 122, June = 129, July = 148, August = 130, and September = 132). There were no significant differences between number of new referrals within this time period. Our total new referral population during this time included: 41.3% backs, 39.9% knees, 6.9% shoulders, 5.5% hips, 3.6% feet/ankles, 1.9% global, .6% necks, and .3% wrists/hands. Specifically, the 5 most frequent (out of 156) diagnoses and mean number of visits referred were: ACL reconstruction (11.9%, M visits = 3.56), Low Back Pain (11.1%, M visits = 5.31), Herniated Disk (8.5%, M visits = 5.04), Total Knee Replacement (8.3%, M visits = 8.05), and Back Fusion (5.8%, M visits = 8.54). Our mean number of visits per patient for the 6 months studied was 5.3 (range 1 - 35, SD = 4.97). There was a significant interaction effect between therapist and diagnosis for number of visits, however the interaction was not significant for the 5 most frequent diagnoses. The aquatic program described in this study has been successful in maintaining productivity while serving a variety of orthopedic patients. This program may serve as a model for other aquatic therapy programs, employing ATC's, and PTA's under the direction of physical therapists.

### Static Innominate Position Asymmetry In Asymptomatic Male And Female Athletes

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Our purposes were to document the presence of static innominate position asymmetry in the sagittal plane and assess the relationship between innominate position asymmetry and true leg length discrepancy (LLD). Twenty-four male (age = 19.73 +/- 1.24 yrs, ht = 185.10 +/- 7.30 cm, mass = 81.40 +/- 9.95 kg) and twenty female (age = 19.39 +/- 1.19 yrs, ht = 168.63 +/- 6.98 cm, mass = 64.19 +/- 6.19 kg) asymptomatic intercollegiate athletes participated in this study. LLD was determined by measuring both legs with a plastic tape measure in the supine position. Three repeated measurements of length were made from the anterior superior iliac spine (ASIS) to the medial malleolus (MM), as well as from the ASIS to the lateral malleolus (LM). The Palpation Meter (Performance Attainment Associates, St. Paul, MN) was used to measure sagittal plane innominate position asymmetry on the right and left sides by measuring the angular deviation from the transverse plane of a line connecting the ipsilateral ASIS and PSIS in the standing position. Positive angular measurements indicated anterior innominate rotation, while negative values indicated posterior rotation. The mean for each measurement was calculated across the subject population, and frequency distributions were determined. Pearson r correlations were calculated between LLD and innominate position measures. A one way ANOVA was used to compare the male and female innominate position asymmetry findings. Ninety-five percent (n = 42) of subjects had some degree of innominate position asymmetry and in 73 percent (n = 32) of the subjects, the right innominate was in a more anteriorly rotated position (1.91° +/- 2.63°). Nearly all subjects (n=42) were determined to have unequal leg lengths with a majority showing a longer left leg (MM = -0.22 cm +/- 0.73 cm; LM = -0.14 cm +/- 0.62 cm). Statistically significant correlations were found between the two measures of LLD and innominate position asymmetry (MM: r = -0.336, p = 0.026; LM: r = -0.434, p = 0.003). A non-significant (F = 1.18, p = 0.283) difference in innominate position was found between males and females with females demonstrating a slightly greater (0.9°) right anterior innominate rotation. The results reveal a frequent occurrence of innominate position asymmetry in a healthy athletic population, and suggest a trend toward a more anteriorly rotated innominate on the right side associated with a long left leg.





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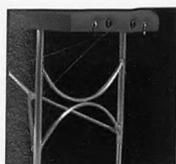


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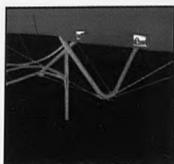
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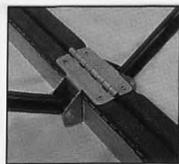
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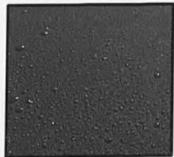
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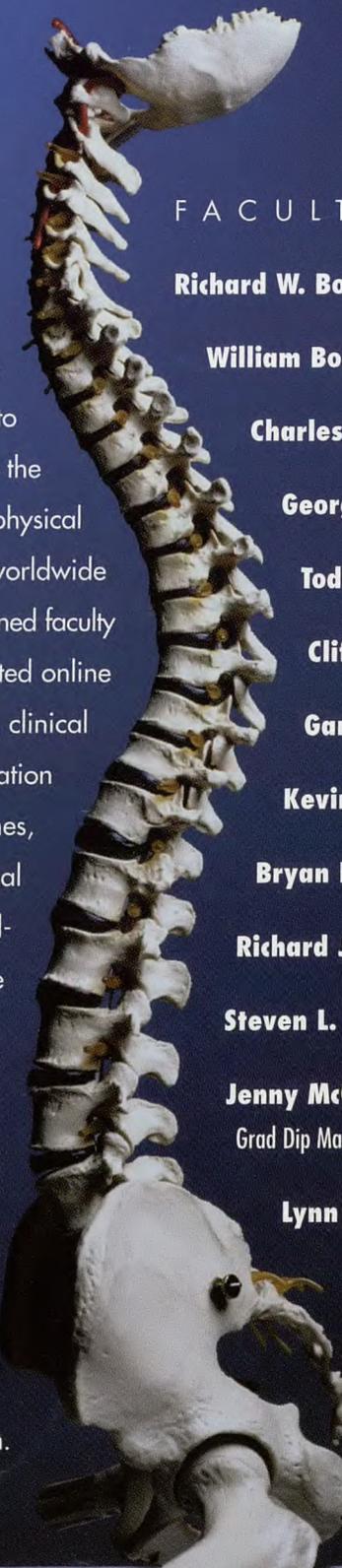
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