

SUPPLEMENT TO

# JOURNAL OF ATHLETIC TRAINING

VOLUME 33 • NUMBER 2 • APRIL-JUNE 1998



N A T A

*Official Publication of The National Athletic Trainers' Association*

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# JOURNAL OF ATHLETIC TRAINING

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Volume 33, Number 2, Supplement, 1998

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# Take this Supplement to Baltimore with you and use it as a guide to the Free Communications Sessions.

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 and held at the NATA Annual Meeting.

The Free Communications Sessions allow 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.

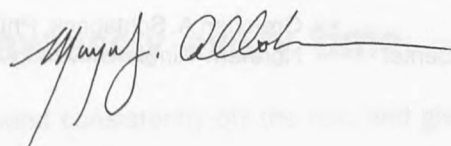
Free Communications presentations are divided into categories: basic science, clinical studies, educational research, sports injury epidemiology, and observational studies. In addition, the Clinical Case Reports sessions allow you to test your clinical assessment skills. We encourage you to attend these 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, a Professional Educators' Conference, the District Lecture Series, and summits on issues critical to athletic training, as well as 50 scholarships annually to students of athletic training.

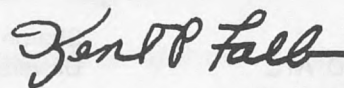
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NATA and its Foundation are happy to offer this supplement as a service to NATA members. We hope that it provides you with theoretical and practical information you can use to improve your effectiveness as an athletic trainer. Thank you for your support!

Sincerely,



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



Kent P. Falb, ATC, PT  
President, NATA



# JOURNAL OF ATHLETIC TRAINING

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## Abstracts of Research

### Free Communications, Oral Presentations (Room 327, Baltimore Convention Center)

<b>Funded Research I</b> .....	S-7
Moderator: Rod A. Harter, PhD, ATC	
<b>Sports Injury Epidemiology</b> .....	S-9
Moderator: Susanne Graner, MS, ATC	
<b>Basic Science Studies</b> .....	S-11
Moderator: Carl Mattacola, PhD, ATC	
<b>Funded Research II</b> .....	S-15
Moderator: Michael Sitler, EdD, ATC	
<b>Clinical Studies</b> .....	S-17
Moderator: Mike Hanley, MS, ATC	
<b>Sports Injury Epidemiology</b> .....	S-21
Moderator: Todd Evans, MA, ATC	

### Free Communications, Thematic Poster Session (Pratt Street Lobby, Baltimore Convention Center)

<b>Current Trends in Proprioception Research</b> .....	S-23
Moderator: Craig Denegar, PhD, ATC, PT	

### Clinical Case Reports I (Room 327) .....

Moderator: John McChesney, PhD, ATC  
Discussant: Gary Horsman, MS, ATC  
Discussant: Edward McFarland, MD

### Clinical Case Reports II (Room 327) .....

Moderator: Katie Walsh, EdD, ATC  
Discussant: Terry O'Brien, MS, ATC  
Discussant: Leigh Ann Curl, MD

### Free Communications, Poster Presentations (Location: Pratt Street Lobby, Baltimore Convention Center)

<b>Session A</b> .....	S-35
<b>Session B</b> .....	S-41
<b>Session C</b> .....	S-47
<b>Session D</b> .....	S-59
<b>Session E</b> .....	S-65
<b>Session F</b> .....	S-71

## Research Business

<b>Letter from Marjorie J. Albohm and Kent P. Falb</b> .....	S-2
<b>Thank You to Reviewers</b> .....	S-4, 5
<b>Call for Abstracts</b> .....	S-78
<b>Call for Reviewers</b> .....	S-79
<b>Subject Index</b> .....	S-80
<b>Author Index</b> .....	S-84

The abstracts on these pages were prepared by the authors and are printed here without correction. The accuracy, nomenclature, form, and style all remain the responsibility of the authors. Readers should note that the appearance of an abstract does not imply future publication of a regular scientific manuscript.

# Thank You!

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Wednesday, June 17, 8:15 AM - 9:30 AM, Room 327, Moscone South, San Francisco, CA

The Effects Of Knee Joint ROM And Load  
On EMG And Joint Reaction Force  
Characteristics During A Selected Closed  
Chain Exercise

Christopher W. Voth, J. Graham Y. Bell  
State University, Marquette, PA; Yale University,  
New Haven, CT

The purpose of this study was to document  
the effects of knee joint ROM and load on  
the EMG and joint reaction force characteristics  
of the ROM.

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Seminarator Evaluation Of Post-Operative  
Anterior Cruciate Ligament Repair  
Patients

William M. Pringle, Jr., Robert D. Old,  
William J. Schmitt, Robert J. Schmitt, Jr.

Knee surgery, specifically, repair of the an-  
terior cruciate ligament (ACL), is one of the most  
commonly performed orthopedic operations. In the  
recent past, however, it has been found that

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Kent Timm, PhD, PT, ATC  
St. Luke's Hospital

20 cases and female athletes with no history  
of significant orthopedic injuries to the lower  
extremities. There were significant differ-  
ences between the ACL group and the con-

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## Free Communications, Oral Presentations: Funded Research 1

Wednesday, June 17, 8:15 AM - 9:30 AM; Room 327; Moderator: Rod A. Harter, PhD, ATC

### The Effects Of Knee Joint ROM And Load On EMG And Joint Reaction Force Characteristics During A Selected Closed Chain Exercise

Gehlsen G, Weidner T, Graham V: Ball State University, Muncie, IN; Yale University, New Haven, CT

The purpose of this study was to determine the effects of knee joint ROM and load on the EMG and joint reaction force characteristics during the squat exercise. The ROM experimental conditions were 135 degrees, 90 degrees and 75 degrees of knee flexion. The load experimental conditions were 0 lbs. (no load), 50% of maximum lift (5R max.), and 75% of maximum lift (5R max.). Twenty female student athletes were asked to participate in this study. EMG surface electrodes were applied to the belly of biceps femoris, vastus lateralis, vastus medialis and rectus femoris muscles of the subject's dominant leg. The ground reaction forces were appraised by a Kistler multicomponent measuring platform, EMG data indicated significant differences between the load and depth for the quadricep muscles. The biceps femoris %MVC data ANOVA analysis did not reach significance. Anterior shear forces tended to increase from 45 to 90 degrees and then remain constant. The evidence presented here would indicate that the limitation of ROM and resistance is a necessary precaution. The magnitude of co-contraction appears to decrease with depth and load. Therefore, this study indicates that knee joint muscular co-contraction are affected by squat load and ROM.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### Sensorimotor Evaluation Of Post-Operative Anterior Cruciate Ligament Rupture Patients

Hoffman MA, Schrader JW, Koceja DM: Indiana University, Bloomington, IN

Knee injuries, specifically rupture of the anterior cruciate ligament (ACL), in past years posed a serious threat to sport participation. In the recent past, advances in surgical procedures, rehabilitation protocols, and other areas have decreased the devastation of ACL rupture. The purpose of this study was to evaluate the sensorimotor, static postural sway, dynamic balance, and quadriceps strength ratio of post-operative ACL reconstruction patients. This study was unique because it evaluated the status of the sensorimotor system as well as the postural control system from two perspectives, static and dynamic. The independent variable was tested leg (dominant and non-dominant for the control group and reconstructed and uninvolved for the experimental group). The dependent variables were static sway path length, dynamic phase duration, H-max/M-max ratio, and strength deficit. The static balance trials consisted of the subjects assuming a comfortable single-leg stance on a Kistler force platform for 20 seconds. During the dynamic condition, subjects stood on the force platform in a single leg stance and at a random point between the 8th and 12th second an electrical perturbation was delivered to the tibial nerve which induced an involuntary contraction of the triceps surae resulting in a posterior displacement of the subject's center of gravity. Sensorimotor profile mapping involved measurement of the soleus Hoffmann reflex. Surface recording electrodes were placed over the muscle bellies of the soleus muscles and a stimulating electrode was placed in the popliteal fossa for current delivery. A ratio was calculated from the maximum H-reflex and M-wave values. A Cybex dynamometer was used in the concentric isokinetic testing of the quadriceps muscles at 60 degrees per second. A 2X2 mixed design ANOVA [Group X Leg] was applied to the static posture, dynamic balance, H-reflex, and strength data. In addition, a priori simple main effects (Legs Within the ACL Group) were calculated to investigate specific differences between legs in the ACL group for these measures. The experimental group was composed of 20 male and female subjects who had undergone ACL reconstruction with a patellar tendon autograft. The control group was comprised of

20 male and female subjects with no history of significant orthopedic injuries to the lower extremities. There were significant differences between the ACL group and the control groups on the measures of dynamic balance and peak torque. No other measures showed significant differences. Evaluation of the postural control system under two conditions, static and dynamic, showed differences between the ACL and control groups for the dynamic measures only. These results suggest the presence of independent control mechanisms for the control of static and dynamic postures. In addition, due to the fact that there were no differences between the injured and non-injured legs of the ACL group, the theory of a central postural control mechanism is supported.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### Effect of Mild Head Injury On Cognition And Postural Stability

Guskiewicz KM, Perrin DH: University of North Carolina, Chapel Hill, NC; University of Virginia, Charlottesville, VA

The diagnosis, management, and treatment of sports related mild head injury (MHI) continues to be a source of frustration for athletic trainers and team physicians. Decisions regarding an athlete's return to play following MHI are some of the most difficult ones facing clinicians because of the limited amount of quantitative information indicating injury severity. Several authors have published guidelines for return to play following MHI, although these guidelines are based on limited scientific data. This study examined the effects of MHI on two objective measures, cognitive function and postural stability, and determined their usefulness in the assessment of sports related concussion. Twenty-two collegiate and high school athletes who sustained a MHI and 22 matched control subjects were assessed for cognitive function and postural stability at four intervals following injury (1, 3, 5 and 10 days). Eleven of the injured athletes had also received preseason baseline testing. Cognitive function was measured with four neuropsychological tests: Stroop Test, Trail Making Test, Digits Span and Hopkins Verbal Learning Test. Postural stability was assessed using the Sensory Organization Test on the NeuroCom Smart Balance Master. Separate mixed model repeated measures ANOVAs were calculated for the composite score and the three ratio scores (vestibular, visual and somatosensory) from the Sensory Organization Test, and the scores from the neuropsychological tests to reveal significant differences between groups and across days postinjury. A significant group by day interaction for overall postural stability (composite score) revealed that MHI athletes displayed increased postural instability one day following the injury ( $p < .05$ ). Analysis of the ratio scores also revealed a significant interaction for both the visual and vestibular ratios ( $p < .05$ ). No significant group differences or interactions were revealed for any of the neuropsychological tests ( $p > .05$ ), although significant day differences revealed the presence of a learning curve ( $p < .05$ ). This study indicates that athletes demonstrate decreased stability during the initial days following a MHI. It appears this deficit is related to a sensory interaction problem, whereby the injured athletes fail to use their visual and/or vestibular systems effectively. The findings also question the efficacy of neuropsychological assessment in making return to play decisions. These findings are consistent with our previous research using the Chattecx Balance System for postural stability and the Paced Auditory Serial Addition Task (PASAT) for cognition. We recommend that measures of postural stability be considered when making return to play decisions for athletes recovering from mild head injury.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### Brachial Plexus Injury (Burners) Incidence And Risk Factors In Collegiate Football Players: A Prospective Study

O'Connor CE, Pekow PS, Klingensmith MT: Amherst College, Amherst, MA

During the 1996 football season, a prospective study of brachial plexus injuries was conducted at ten Division III programs in five states. Of 793 athletes eligible at the beginning of the season, 719 volunteered to participate in the study. Data was gathered on a weekly basis by the supervising athletic trainers and submitted to the principal investigators. Players were requested to report all burners regardless of the brevity of the injury. Athlete exposure data for noncontact practices, contact practices, and game situations was calculated to enable a direct comparison to other reported NCAA injury rates. Preseason demographics and history revealed that 37.5% of players recall experiencing a burner in 1995 and 61% have had a burner at some time in their football career. Of those 435 individuals, 71.5% have failed to report a burner to medical staff. There was no statistical difference across the ten schools in player ages, total years of football participation, or body mass index. The prospectively monitored season captured 173 burners in 114 players for a per player incidence of 15.9%. This confirms the pilot project data (17%) and shows again that historical recall (especially postseason) grossly overestimates the incidence of this injury. Injury rates across schools ranged from 5% to 31%, with an average of 16%. The rate of injury during noncontact practice was .46 per 1000 athlete exposures, 4.5/1000 AE for contact practices, and 14.4/1000 AE in game situations. No statistically significant associations of injury rates with weather or field conditions, or time of injury during practices and games were found. However, history of burner the previous year, upperclassmen, higher BMI, defensive line position, and the act of tackling another player were all statistically significant risk factors. Injury specific data regarding mechanism of injury, sensorimotor deficits, and duration of symptoms and physical findings was evaluated. Players who denied any history of burners had a 6% risk of injury, past history but not in the preceding year conferred a 15% risk, and injury during the previous season resulted in a 27% risk of injury. Hopefully this study will result in better identification of athletes at risk who would benefit from some form of intervention to prevent injury.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### A Study Of The Relationship Between Life Events And Incidence Of Injury In High School Football

Gunnore AG, Horodyski MB, Tennant LK, Murphey M, Kaminski TW: University of Florida, Gainesville, FL

The purpose of this prospective cohort study was to determine if a life-stress-injury relationship exists among high school football players. Life events, participation, and injury data were collected throughout the season by certified athletic trainers. Injury parameters included frequency, severity, injury nature, practice versus game, time of season, and time loss from football participation due to injury. A modified version of the Life Events Scale for College Athletes was used to obtain total, positive, and negative life events scores, which were utilized as a measure of life change. The life events scores and injury statuses were analyzed using the Wilcoxon Rank Sums W Test. Data was also analyzed by using Pearson's Chi-square test statistic and the iterative proportional fitting procedure to account for differences in athlete-exposures. The participants in the study were 331 male varsity football players from 13 high schools in Alachua, Marion, Gilchrist, and Bradford counties, Florida, who experienced 21,031 athlete-exposures during the 1995 and 1996 football seasons. During the two seasons, 165 injuries were sustained by 121 athletes. The incidence of injury was significantly different for practices and games, with games having an injury rate more than four times greater than that of practices. There was no significant difference between weeks during the season and frequency of injury. In addition, preseason, season, and postseason did not produce significantly different injury frequencies. Athletes reporting high levels of life change were significantly more likely to be injured than those with low levels of life change. Life events scores were grouped into high and low categories in relation to the median. Athletes in the high life events category were significantly more likely to sustain multiple injuries during the season. No significant differences were noted between high and low life change groups for severity of injury. The relationship between time loss due to an injury and life events category was analyzed and no significant differences were noted between high and low life change groups. The results of this study indicated that the total and negative life event scores produced significant differences in injury outcome. The positive life event scores did not appear to effect injury outcome. Due to the unique relationship that exists between certified athletic trainers and athletes, these results suggest that ATC's should be aware of this relationship in order to identify athletes that may be at greater risk of injury.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.



## **An Investigation Of Gender Equity In The Medical Coverage And Injury Prevention Of Basketball Programs As Identified By Head Athletic Trainers At NCAA Division I Colleges And Universities**

Beckett JA: University of Charleston, Charleston, WV

The purpose of this study was to investigate gender equity in the medical coverage and injury prevention of basketball programs at NCAA Division I colleges and universities. The population for this study were 100 randomly sampled head athletic trainers at NCAA Division I colleges and universities that compete in both men's and women's basketball. Each participant was mailed a survey packet containing a cover letter and a researcher-designed questionnaire. The total return rate was 69%. The data were analyzed using the Statistical Analysis Systems. Analyses of Variance, Chi-Square, frequency distributions, and Duncan's Multiple Range Tests ( $p < .05$ ) were used to answer the two research questions. The independent variable in this study was gender and there were five dependent variables: 1) availability of medical personnel and assistance, 2) availability and qualifications of athletic trainers, 3) availability and quality of weight and training facilities, 4) availability and quality of conditioning facilities and equipment, and 5) health, accident, and injury insurance coverage. Significant differences were found in the interaction of gender with all of the dependent variables, with the exception of insurance coverage. Specifically, analyses resulted in a strong correlation between gender and the provision of medical coverage. Numerous significant differences were found which indicated that the men's basketball program was afforded better medical care, including more extensive physician and EMS coverage at home and away games, when compared to the women's basketball program. Moreover, a strong correlation between gender and the provision of injury prevention practices was also found. Numerous significant differences were found indicating that the men's basketball program had more frequent access to weight and training facilities, in addition to conditioning facilities and equipment, as compared to the women's basketball program. This study will add to the paucity of research on issues of gender equity regarding the medical coverage and injury prevention practices of female intercollegiate athletes. Furthermore, the results of this study do establish baseline data concerning the inequity of medical coverage and injury prevention practices that currently exists at NCAA Division I colleges and universities for their men's and women's basketball programs.

## **Adolescent Perceptions Of Drug Use And Drug Testing Differ By Gender And Grade**

Welsh WE, Nyland J, Sumida K: Section of Sports Medicine, Division of Orthopaedic Surgery, University of Kentucky, Lexington, KY

**PURPOSE:** Improving our understanding of adolescent perceptions of drug use and drug testing can only help improve efforts to deter this epidemic problem. This study assessed the opinions of teenagers on the topic of drug use and drug testing at the high school level. **METHODS:** A 21 question survey which questioned drug use origin, where and when drugs are being used, related causes of drug use, and related topics including who should receive mandatory drug testing, the kinds of drugs that should be tested for, how much the drug testing process was perceived as an invasion of privacy, and the need or benefit of high school drug testing was developed and pilot tested prior to use. Subjects responded to each survey question by shading in a 5 dot categorical continuum ranging from strongly disagree to strongly agree. Five sample statements were provided at the beginning of the survey for clarification of responses. All subjects were junior and senior high school student-athlete volunteers completed the survey following their pre-participation athletic physical examination. All subjects were assured that their responses would remain confidential. Chi-square tests (SAS Institute, Cary, NC) were performed following data collection to assess gender differences and differences by grade level in response to survey items ( $p < .05$ ). **RESULTS:** The survey was completed by 430 student-athletes (193 males, 232 females). No overall gender differences to survey questions were evident ( $p > .05$ ). The subject population was further divided into 4 groups for comparison by grade (6th, 7th, and 8th grades formed Group 1,  $n = 80$ ), (9th grade formed Group 2,  $n = 127$ ), (10th grade formed Group 3,  $n = 122$ ) and (11th grade formed Group 4,  $n = 101$ ). Group 2 males agreed more strongly than females that students start using drugs to "fit in" or "be cool" (Chi-square = 11.2,  $p = .02$ ). Group 2 males agreed more strongly than females that drugs are usually used at home (Chi-square = 9.8,  $p = .045$ ). Group 3 males agreed more strongly than females that drug testing should be required at their school (Chi-square = 9.6,  $p = .048$ ). **CONCLUSIONS:** Perceptions and peer pressure play a large role in the development of an adolescent. The results of this study indicate that during 9th and 10th grades, adolescent males perceived greater drug use behaviors and a greater need for drug testing than adolescent females.

## **Magnetic Resonance Imaging Of Hamstring Strains And Correlation With Biodex Strength Measures In Intercollegiate Athletes**

Hart CH, Perez-Guerra E, DeSmet A, Jensen KA, Bernhardt DT, Best TM: University of Wisconsin Hospitals and Clinics Sports Medicine Center, Madison, WI

Hamstring injuries can be very debilitating to athletes. In addition, these injuries are often frustrating for both certified athletic trainers and physicians to treat because of the length of time required for treatment and the frequency with which they recur. The purpose of this study was to correlate the pathology of a hamstring strain, as evaluated by magnetic resonance imaging (MRI), with functional strength data. This was part of a larger, ongoing investigation to determine if MRI can be used to predict recovery from muscle strain injuries. The population sampled for this study was track and field and football athletes at a NCAA Division I institution who reported a hamstring injury. The subjects were evaluated initially by a certified athletic trainer and/or physician. When it was determined that the athlete had suffered a hamstring strain injury and informed consent was obtained, they were evaluated by MRI within 2-3 days of the injury. The MRI was read by a radiologist (AD) who was blinded to the subject's clinical history and physical exam. As well, the certified athletic trainers were blinded to the MRI findings. Subjects underwent a standard rehabilitation program and completed a sport specific functional evaluation prior to their clearance for full participation. At this time, a second MRI was obtained and subjects were also evaluated on a Biodex isokinetic dynamometer (Biodex Medical Systems, Inc, Shirley, NY 11967) for concentric quadriceps and hamstring torque production at 60 deg/sec and 180 deg/sec. To date, five subjects have completed all phases of the investigation. All participants were males; 3 were sprinters or jumpers and 2 were football players. The initial MRI showed typical findings of an acute muscle strain injury with involvement of the biceps femoris muscle in all cases. Average rehabilitation time was 24 +/- 4 days. In all cases, the follow-up MRI was interpreted as abnormal with both T1 and T2 signal changes. In addition, there was an average hamstring strength deficit (injured/uninjured) of 16.2 +/- 4.5 % and 17.8 +/- 4.2% at 60 deg/sec and 180 deg/sec respectively. These results suggest that despite a typical rehabilitation program and length of time for recovery that the MRI can remain abnormal for some time. Furthermore, the MRI changes and strength deficit suggest a possible reason for why these injuries recur so frequently.

### Selected Psychological Correlates Of Deceptive Athletic Injuries

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Certified Athletic Trainers are often presented with the challenge of dealing with athletes who fake injury and/or exaggerate a mild injury for a variety of reasons. This study evaluated whether measures of psychological health differ between athletes who commonly malingering or intentionally fake injury, athletes who may occasionally malingering or fake injury, and athletes who never malingering or fake injury. The 37-item Weinberger Adjustment Inventory Short Form (WAI-SF) was used as the psychological assessment tool. This instrument describes psychological health using three constructs: distress, restraint, and defensiveness. The distress construct consists of four subscales: anxiety, depression, low self-esteem, and low well-being. The restraint construct also consists of four subscales: suppression of aggression, impulse control, consideration of others, and responsibility, while the defensiveness construct groups items related to denial of distress. Subjects ( $n = 129$ ) from two Division I universities completed the WAI-SF and a 12-item questionnaire on feigning injuries (i.e. faking and malingering), which was used to discriminate the subjects into one of three groups. Group 1 consisted of athletes who never malingering or fake injury. Group 2 consisted of athletes who may occasionally malingering or fake injury, and Group 3 consisted of athletes who commonly malingering or intentionally fake injury. A MANOVA revealed an overall significant difference between the three groups ( $p < 0.05$ ) on the WAI-SF profile. Upon further examination, using individual univariate ANOVAs, significant differences were reported between the three groups on the Distress [ $F(2,126) = 4.65$ ;  $p < 0.02$ ] and Restraint [ $F(2,126) = 3.80$ ;  $p < 0.03$ ] constructs. The Defensiveness construct did not reveal any significant differences between the groups. Classification of the data into the Weinberger Adjustment Typology Chart, labeled Groups 1 (non-malingers) and 2 (occasional malingers) as "self-assured" individuals, whereas Group 3 (high malingers) was labeled as "reactive". Reactive individuals generally display low emotional control, high impulse gratification, high proneness to personality disorders, and low self-concept; whereas self-assured individuals demonstrate high self-expression, low physical illness, high self-concept, and low neurotic symptoms. It was concluded that psychological health can distinguish between malingering and non-malingering athletes. This study identifies a new area of research and may provide Certified Athletic Trainers with a tool for identifying deceptive athletic injuries. It is recommended that further research be conducted to evaluate the validity of the WAI-SF in an athletic population.

### The Incidence Of ACL Injury In Female Intercollegiate Soccer Players

Kaiser DK: Central Michigan University, Mt. Pleasant, MI

The purpose of this study was to investigate the incidence of anterior cruciate ligament injury among female intercollegiate soccer players compared to male soccer players. The analysis was designed to be a large-scale investigation of females' ACL injury rates, as well as to collect data from a sport other than basketball where most of the data regarding females and ACL injury has been focused. The research was a four year retrospective survey study. The investigation surveyed the NCAA Division I institutions which sponsor both men's and women's intercollegiate soccer teams. The survey consisted of closed-ended questions regarding the incidence of ACL injuries and the associated circumstances of the injuries. Certified athletic trainers from the selected institutions were asked to complete the survey instrument using the injury records of the intercollegiate soccer players. During the four years surveyed, female intercollegiate soccer players had an ACL injury rate 1.8 times higher than male soccer players. Even though there were significantly more ACL injuries occurring to female soccer players, most of the other collected data were fairly consistent among the males and females. Noteworthy exceptions were that female soccer players tended to be injured at a younger chronological age, as well as earlier in their eligibility, than were the males. Also female soccer players incurred more ACL injuries from a non-contact mechanism, whereas male soccer players were more commonly injured as a result of a contact mechanism. The results of this study indicate that female intercollegiate soccer players are at a greater risk of ACL injury than their male counterparts, particularly early in their careers.

### A Comparison Of Single Limb Balance Between Male And Female High School Basketball Players

McGuine TA, Best TM, Greene JJ: University of Wisconsin Hospitals and Clinics Sports Medicine Center, Madison, WI

Previous epidemiologic studies have suggested an increase in susceptibility to lower extremity injuries in female basketball players. The purpose of this study was to assess single limb balance in a cohort of high school basketball players. Forty four males (age =  $16.1 \pm 1.1$  yr; height =  $182.98 \pm 6.95$  cm; weight =  $78.35 \pm 13.11$  kg) and forty seven females (age =  $16.3 \pm 1.1$  yr, height =  $171.45 \pm 8.38$  cm; weight =  $65.22 \pm 9.16$  kg) who did not sustain an ankle injury within the last year, volunteered to undergo balance assessment with the NeuroCom New Balance Master™ (NeuroCom International, Clackamas, OR). Testing consisted of having subjects stand on their left leg, for three trials of ten seconds, with their eyes open (EO) and again with their eyes closed (EC). Subjects then performed the same assessment on their right leg. Balance was assessed by recording the average degrees of sway per second ( $^{\circ}/S$ ) for the three trials with both EO and EC as well as a compilation (COMP) score for both conditions. In addition, a ratio of EC/EO was calculated. A t-test was used to compare the mean scores for all measures between the males and females with a level of  $p < .05$  used to detect significant differences. The mean  $^{\circ}/S$  for males EO ( $0.88 \pm 0.17$ ) was significantly less than females EO ( $0.95 \pm 0.23$ ),  $p = 0.010$ . There was no difference in  $^{\circ}/S$  between the males EC ( $2.15 \pm 0.61$ ) and females EC ( $2.37 \pm 0.82$ ),  $p = 0.063$ . The  $^{\circ}/S$  for COMP scores for males ( $1.51 \pm 0.29$ ) was not significantly less than females ( $1.68 \pm 0.39$ ),  $p = 0.051$ . There was no difference in the ratio of EC/EO between the males ( $2.48 \pm 0.77$ ) and females ( $2.58 \pm 0.94$ ),  $p = 0.079$ . In conclusion, for all conditions, females had slightly higher  $^{\circ}/S$  scores than their male cohorts, but only the EC condition resulted in a significant difference ( $p = 0.01$ ). Further study is necessary to determine if this increase in postural sway plays a role in susceptibility to lower extremity injury.

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### The Role Of Hyperbaric Oxygen And Naprosin On Rat Skeletal Muscle Following Acute Blunt Trauma

Fisher BD, Baracos VE, Young M, Richardson TB: University of Alberta, Edmonton, Alberta, Canada

There has been interest recently in the use of hyperbaric oxygen (HBO) therapy to reduce swelling and enhance healing time in athletic injuries such as sprains, ligamentous injuries and muscle contusion. Comparisons between HBO and other methods of maintaining muscle protein levels have not been made to date. The major objective of this study was to characterize the recovery of rat skeletal muscle following acute blunt trauma and to observe the therapeutic effects of HBO therapy and a non-steroidal anti-inflammatory drug (Naprosin). All procedures described were carried out in accordance with the guiding principles for the care and use of laboratory animals of the Canadian Council on Animal Care. An acute blunt device approximating the clinical lesion of a muscle contusion of moderate severity was used ( $n=60$ ). The amount of protein, within rat gastrocnemius traumatized muscle following acute blunt trauma, at 48 hours post trauma, varied according to the type of treatment administered. There was a significant increase ( $p<.05$ ) in the protein content of the traumatized medial gastrocnemius muscles which were treated with HBO for three 90 minute treatments at 2.2 atmospheres absolute ( $n=10$ ) in comparison with untreated trauma controls. The muscles treated with Naprosin following trauma ( $n=10$ ) showed increases in protein content when compared to trauma controls ( $n=10$ ). There was no significant difference between the traumatized animals treated with HBO or with Naproxen. These results suggest that when treating an acute muscle injury (soft tissue contusion) HBO treatment (2.2ATA) is no more effective than treatment with the non-steroidal anti-inflammatory drug Naprosin.

### Muscle Temperature Rise During 1 Mhz Ultrasound Treatments Of Two And Six Times The Effective Radiating Area Of The Transducer

Chudleigh D, Schulthies SS, Draper DO, Myrer JW: Brigham Young University, Provo, UT

**Objective:** Therapeutic ultrasound is commonly used as a deep heating modality, yet research on the optimal treatment size to provide therapeutic heating is limited. The purpose of this study was to determine the difference of muscle temperature rise between 1 MHz ultrasound treatments of two and six times the effective radiating area (ERA) of the transducer and see if we could lessen the temperature rise difference by increasing the ultrasound intensity.

**Design and Setting:** The dependent variable was temperature rise. The independent variables were treatment size (2 and 6 ERA) and intensity (1.5 W/cm<sup>2</sup> and 2.0 W/cm<sup>2</sup>). Treatment size was a within treatments factor and intensity was a between treatments factor.

**Subjects:** Twenty ( $M = 15$ ,  $F = 5$ ) healthy subjects (age =  $24.7 \pm 2.1$  yr) volunteered to participate in the investigation. All subjects signed an institutionally approved informed consent form.

**Measurements:** Subjects were randomly assigned to one of the two intensity groups (1.5 W/cm<sup>2</sup> and 2.0 W/cm<sup>2</sup>). All subjects received treatments of 2 and 6 times the ERA in a randomized order. We measured temperature using intramuscular thermocouples 4 cm beneath the skin of the posterior aspect of the calf, during 10 minute 1 MHz ultrasound treatments. We computed temperature rise by subtracting the baseline temperature from the peak temperature recorded during the treatment. Statistical difference was determined using a 2 X 2 factorial ANOVA.

**Results:** The mean temperature change of the 2 ERA treatments (3.5° C) was significantly ( $F = 76.601$ ,  $p = .0001$ ) greater than the 6 ERA treatments (1.3° C). There was no significant difference between the two intensities ( $F = .319$ ,  $p = .579$ ) and no interaction between independent variables ( $F = 1.397$ ;  $p = .2527$ ).

**Conclusions:** We recommend the treatment size of 2 times the effective radiating area of the sound head if moderate to vigorous heating is the desired effect when using 1 MHz ultrasound. Some clinicians may increase the ultrasound intensity in an attempt to heat large treatment sizes. Our data show this to be an ineffective practice. For a 10 minute treatment at 1 MHz, 6 ERA is simply too large to insonate if vigorous heating is the desired result. Extrapolating from our data, to obtain the amount of heating in 6 ERA as obtained in 2 ERA, a treatment intensity of 3.6 W/cm<sup>2</sup> would be required. This is impractical because patients could not tolerate the treatment and most ultrasound machines do not produce this intensity.

### Select Anthropometric And Conditioning Variables Are Not Predictive Of Patellar Tendon Thickness

Fletcher R, Nyland J, Maitra R: Section of Sports Medicine, Division of Orthopaedic Surgery, University of Kentucky, Lexington, KY

**PURPOSE:** The thicker the patella tendon, the better suited it is believed to be as an autograft ACL substitute. High intensity eccentric training is believed to produce a stronger and perhaps thicker patellar tendon. This study assessed correlational relationships between select anthropometric (thigh circumference, height, and weight) and strength (grip, single repetition maximum squat) variables and patellar tendon thickness. Comparisons were also made based on handedness. **METHODS:** Twelve, healthy NCAA Division II football players participated in this study. Bilateral thigh circumference was measured at 20 cm proximal to the tibial tubercle. Bilateral grip strength was assessed using a hand dynamometer and a 1.85 inch grip space interval. Handedness, height, weight, and single repetition maximum squat data were provided by subjects when they completed a demographic information survey. Bilateral patellar tendon thickness measurements were performed using diagnostic ultrasound by a single investigator at proximal (inferior patellar pole) and distal (tibial tubercle) insertions, and at 1 cm intervals distal or proximal to these sites, respectively. Paired t-tests compared bilateral differences, Pearson product moment correlations with Bonferroni adjustments determined relationships between anthropometric and strength variables and patellar tendon thickness ( $p < .05$ ). **RESULTS:** Select anthropometric and strength variables: (mean  $\pm$  SEM) Height =  $70.9 \pm .46$  inches, Weight =  $194 \pm 6.8$  lbs, Grip Strength (Right) =  $55.9 \pm 2.5$  kg, (Left) =  $54.8 \pm 2.1$  kg, Thigh Circumference (Right) =  $55.9 \pm .9$  cm, (Left) =  $55.7 \pm .8$  cm, Single Repetition Maximum Squat =  $430 \pm 15$  lbs. Patellar Tendon Thickness variables: (mean  $\pm$  SEM) Proximal Insertion (Right) =  $5.64 \pm .26$  mm, (Left) =  $5.28 \pm .23$  mm, Distal Insertion (Right) =  $5.25 \pm .16$  mm, (Left) =  $5.13 \pm .15$  mm, 1 cm distal to Proximal Insertion (Right) =  $4.58 \pm .15$  mm, (Left) =  $4.53 \pm .13$  mm, 1 cm proximal to Distal Insertion (Right) =  $4.63 \pm .11$  mm, (Left) =  $4.46 \pm .14$  mm. Significant correlations ( $p < .05$ ) did not exist between select variables (height, weight, grip strength, thigh circumference and single repetition maximum squat) and patellar tendon thickness. Single repetition maximum squat demonstrated a moderately strong positive correlation with right ( $r = .82$ ,  $p = .02$ ) and left ( $r = .85$ ,  $p = .009$ ) thigh circumference, but did not even remotely correlate with patellar tendon thickness ( $p > .05$ ). **CONCLUSIONS:** Although conditioning programs can be designed to increase thigh muscle strength and size, they do not appear to effect patellar tendon thickness. Further studies using other populations and on the effects of training on histological and biomechanical tendon factors are in progress.



### EMG Analysis Of A Modified Closed Chain Isometric Knee Extension Exercise

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Lexington, KY

**Introduction:** Closed chain exercises have become preferred mode of strengthening lower extremity musculature following ACL reconstructive surgery due to the decreased shear on the ACL. Others favor open kinetic chain exercises to isolate the quadriceps during rehabilitation. The addition of a footplate apparatus to Eagle (CYBEX, Lumex Inc. Lake Ronkonkoma, NY) knee extension rehabilitation equipment will allow for this compressive load and muscle coactivation at the knee during rehabilitation. The purpose of this study was to introduce this new method of lower extremity strengthening combining the benefits of both open and closed kinetic chain exercises.

**Methods:** Sixteen female graduate students were instrumented with surface electromyography (EMG) electrodes to the following right lower extremity muscles: vastus medialis, rectus femoris, medial hamstring, lateral hamstring, medial gastrocnemius, lateral gastrocnemius, tensor fascia lata (TFL) and gluteus maximus. The knee angle was goniometrically positioned at 60 degrees and aligned with the machine's axis of rotation. The subjects' hips were strapped to the seat and instructed to extend maximally once data collection was initiated. A load cell measured the load between the arm and a mechanical block. Integrated EMG was measured one second following peak torque. Isometric muscle activation allows within subject EMG evaluation under these two conditions.

**Results:** All muscles were more active ( $p < 0.05$ ) in the closed versus the open kinetic chain, except for the TFL and the rectus femoris. The VMO was on average 156% more active, the medial hamstrings and lateral hamstrings were 149% and 166% more active respectively. The medial gastrocnemius and lateral gastrocnemius were 177% and 176% more active respectively, and the gluteus maximus was 268 % more active. The rectus femoris was 75% less active ( $p < 0.05$ ) in the closed chain versus the open kinetic chain.

**Discussion:** Compressive load at the tibiofemoral joint in addition to muscle coactivation is what is thought to decrease shear force on the ACL. The EMG results from this study suggests this modified approach to lower extremity strengthening utilizes muscle coactivation of lower extremity musculature. Muscle coactivation of the medial and lateral hamstrings and medial and lateral gastrocnemius is thought to decrease shear on the ACL. This modified closed kinetic chain exercise can provide the benefits of both open and closed kinetic chain exercises. The decrease in rectus femoris activation in the closed kinetic chain coupled with increased VMO activation could suggest this modification could provide benefit for subjects with patellofemoral dysfunction.

### Effects Of Corrective Orthotics On Plantar Pressure Measures In Males With Forefoot Varus

Tis LL, Higbie EJ, Lichty DM, Dupont LA:  
Georgia State University, Atlanta, GA

The purpose of this study was to determine the effects of custom-molded, semi-rigid orthotics on plantar pressures obtained on a group of 18 males ( $29.2 \pm 6.6$  yrs) with forefoot varus greater than five degrees. Subjects were assessed for static forefoot varus of the left and right feet (left =  $7 \pm 1.5$  deg; right =  $6.3 \pm 1.6$  deg) using a standard goniometric procedure. Maximum force (MF), peak pressure (PP) and pressure-time integral (PTI) were assessed using the EMED Pedar In-shoe Pressure Measurement System (Novel Electronics Inc., St. Paul, MN) in three regions of the forefoot: first metatarsal head (medial forefoot), second and third metatarsal heads (middle forefoot), and fourth and fifth metatarsal heads (lateral forefoot). All subjects were assessed during ambulation in a shoe-only condition, followed by a shoe plus corrective orthotic condition. Paired t-tests revealed a significant reduction in the PP and PTI in the left lateral forefoot with a corrective orthotic ( $p < 0.05$ ). Paired t-tests also revealed a significant reduction in MF, PP and PTI in the right middle forefoot with a corrective orthotic ( $p < 0.05$ ). Similarly, a significant reduction in PP and PTI in the right lateral forefoot was observed ( $p < 0.05$ ). The findings of this study indicate that custom-molded, semi-rigid orthotics are effective in reducing dynamic plantar pressures in the forefoot, particularly pressures exerted in the lateral aspect of the forefoot.

### Pilot Study: Effects Of Viral Upper Respiratory Illness On Physical Performance

Weidner T, Gehlsen G, Schurr T, Steele B:  
Ball State University, Muncie, IN

Upper respiratory illness (URI) causes more disability among athletes than all other diseases combined. The purpose of this study was to assess the impact of a URI on physical performance. Seven young adult subjects (mean age = 19.9) with naturally-acquired moderate/severe colds were screened and selected into the illness group (ILL). Subjects met the following criteria: all were currently suffering from a moderate/severe upper respiratory illness (2-3 days of onset); none reported symptoms of fever, nausea/vomiting or diarrhea; all were moderate exercisers (five, 30 minute aerobic exercise sessions/week) and non-smokers with no history of alcohol or drug abuse; subjects were afebrile and were not currently using medications or suffering from hypertension, heart murmur, hepatitis, kidney disease, hay fever/allergies, asthma, lung disease, chronic respiratory illnesses, or diabetes. A control group (CRL) of 7 subjects was also examined. Aerobic performance was measured by assessing the subjects' treadmill running time to exhaustion. Prior to the exhaustion run, the subjects completed five bouts of ten minute interval treadmill running. The treadmill work loads were adjusted for each runner to achieve a heart rate response of approximately 80% of age-predicted maximal heart rate (PMHR). The subject's run to exhaustion work load was 90% of PMHR. During the running tests (five running bouts of ten minutes each and one run to exhaustion), Heart Rate Monitors were utilized to record the subjects' heart rates. In addition, the subjects' perceived exertion was recorded. Anaerobic performance was measured through mechanical power as the subjects performed intermittent vertical jumps (selected because they require explosive total body movement). A force plate was used to measure the reaction forces. The vertical jumps were performed prior to and between the five running bouts. A shuttered video camera recorded the segment movement during the five running bouts. Differences between time to exhaustion were evaluated with a t-test. A MANOVA with repeated measures was used to identify differences between stride length and stride frequency data. Perceived exertion differences were analyzed using Chi-square procedures. No alterations in physical performance during a URI were identified as compared to controls. This study supports many physicians' current practice of allowing athletes to train/compete under certain conditions during a URI. Other viral upper respiratory illness studies have revealed minimal changes in running gait and shown that physiological responses to pulmonary function testing and submaximal and maximal exercise do not appear to be altered by a URI.



**NOTES:**



## Free Communications, Oral Presentations: Funded Research II

Thursday, June 20, 3:00 PM - 4:00 PM; Room 327; Moderator: Michael Sitler, EdD, ATC

### The Effects Of Neuromuscular Control Exercises On Functional Stability In The Unstable Shoulder

Lephart SM, Henry TJ, Riemann BL, Giannantonio FP, Fu FH: Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA

The purpose of this study was to evaluate the effects of two rehabilitation protocols on functional stability in subjects with anterior shoulder instability. 38 subjects participated in the study consisting of three groups (Experimental (15), Core (8), Control (15)). Subjects with anterior instability of the shoulder were assigned to either the Experimental (E) or Core (CO) rehabilitation exercise group. Age matched healthy shoulder subjects were assigned to the Control (CL) group. All subjects were pre and post tested on the following dependent variables of neuromuscular control: shoulder proprioception and kinesthesia, isokinetic shoulder diagonal and protraction/retraction peak torque, static and dynamic stabilization on a kinesthetic ability trainer (K.A.T.) testing device, and a functional rating scale. Subjects in the E and CO groups were assigned to a 6 week, 3 session/week exercise program. Subjects in both groups perform a series of seven core strengthening exercises for the scapular and humeral muscles. In addition to the core exercises the E group performed a series of five neuromuscular control exercises that emphasized joint positioning, joint compression, shoulder muscle force couple strengthening, and reflex muscle co-activation of the shoulder joint. Results revealed significant ( $p < 0.05$ ) improvements in the E group on the kinesthetic ability test, scapular slide test at 120 degrees/ABD, isokinetic scapular protraction and retraction peak torque at 30, 60, and 120 degrees/sec., and isokinetic peak torque in the ABD/ER diagonal position at 60 degrees/sec. There were no significant pre-post differences in proprioception or on the functional rating scale revealed in the E group. There were no statistically significant difference revealed for any of the variables in either the CO or the CL group. These results suggest that neuromuscular control exercises combined with traditional humeral and scapular muscle strengthening exercises enhance selected characteristics that contribute to dynamic stabilization of the unstable shoulder. However, additional exercises to enhance performance in these subjects need to be validated.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### Effect Of Physical Activity And Leg Shape On Knee Brace Migration And EMG Activity Of The Leg

Miller J, Croce R, Confessore R, Vailas J, Catlaw K: University of New Hampshire, Durham, NH; Lahey-Hitchcock Clinic, Southern Region, Department of Orthopedic Medicine, Bedford, NH

The purpose of this study was twofold: to examine effect of physical activity and leg shape (thigh and calf circumference and the thigh/calf circumference ratio) on knee brace migration (BM) and to examine the effect of functional knee bracing on the root mean square EMG (rmsEMG) and the median frequency EMG (mfEMG) activity of muscles of the leg. Ten female college hockey players were fitted with two types of custom fitted functional knee braces. One was a primarily strap secured brace (SS) and the second was a knee brace which utilized a hard shell design with strapping (HS). The subjects performed three physical activities designed to simulate typical athletic movements. They were a treadmill run (linear movement), a side step maneuver (cutting) and an obstacle course which emphasized hopping and jumping. BM was measured for all three of the activities and EMG activity was collected for the treadmill run and the side step activity only. Repeated measures analysis of variance demonstrated that there was a significant difference in BM between the activities with the highest BM occurring during the obstacle course ( $p < .05$ ). There was however, no significant difference in BM between the two braces ( $p = .22$ ). Multiple regression analysis indicated that there was no relation between leg shape and the amount of BM observed for either the SS or the HS brace ( $R^2 = .031$  and  $.069$  respectively). For the EMG measurements, during the treadmill run there was no difference in the rmsEMG ( $P = .53$ ) or the mfEMG, ( $p = .77$ ) activity of the muscles of the leg between the braces or between the braced and non-braced conditions. For the side step activity again there was no difference in the rmsEMG ( $p = .89$ ) or the mfEMG ( $p = .91$ ) activity between the braces or between the braced and non-braced conditions. The results of this study suggest that 1) custom fitted functional knee braces do not migrate significantly during physical activity, 2) there is no significant difference between SS and HS custom fitted knee braces with regard to brace migration and 3) custom fitted functional knee braces do not significantly alter the EMG activity of the leg during physical activity.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

### Factors Affecting The Self-Perceived Continuing Education Needs Of Certified Athletic Trainers

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The purpose of this study was to determine the self-perceived continuing education needs of Certified Athletic Trainers, the factors that affect those needs, and continuing education participation. A survey was developed using the domains and tasks depicted by the NATABOC's Role Delineation Study. Respondents rated the importance of their need for continuing education for each task within the five domains: prevention of athletic injuries; recognition, evaluation and immediate care of athletic injuries; rehabilitation of athletic injuries; health care administration; and professional development and responsibility. The nationwide survey was sent to 2,000 randomly selected Certified Athletic Trainers. The return rate was 52% ( $n = 1040$ ). Statistical analysis included descriptive analysis of self-perceived continuing education needs of Athletic Trainers according to the five domains. Multiple regression and canonical correlation analysis were also performed to measure the relationship amongst factors and the self-perceived continuing education needs of Certified Athletic Trainers as well as their participation preferences. Certified Athletic Trainers in this study generally saw "some need" for continuing education amongst all of the domains. Rehabilitation of athletic injuries was indicated more often than other areas. Respondents indicated highest need for continuing education on the back and neck, followed by shoulder, head systemic illness and abdominal injuries. Higher need was indicated on all anatomical areas than on any of the tasks pertaining to administration or professional development. The results of the canonical correlation indicated that cost and convenience factors had a strong relationship ( $R_c = -.40$ ) with for athletic trainers with lower salaries, female athletic trainers and those athletic trainers employed in the high school and college settings and accounted for 16% of the variance in reasons to attend continuing education. An overriding importance of economic factors in decisions regarding attendance was also evident. Athletic trainers in this study preferred conferences and seminars as a mode of instruction despite the high cost of those activities.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

# Determination of Patellofemoral Joint Reaction Forces As A Function Of Cadence And Step Sequence During Low Impact Stepping Exercises

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The purpose of this study was to evaluate the effects of cadence rate on patellofemoral joint reaction (PFJR) force during two low impact step exercise movements. Fifteen female subjects (age range 25-40 years, height range 157-168 cm) performed both a frontal step and a lateral step each at three difference cadences (120, 132, and 145 beats per minute (bpm)) on to an instrumented force platform that was positioned 8 inches off the floor. The mean PFJR forces for the frontal step were 1.92, 1.85, and 1.84 times body weight at 120, 132, and 145 bpm, respectively. The mean PFJR forces for the lateral step were 3.08, 2.75, and 3.24 times body weight at 120, 132, and 145 bpm, respectively. The magnitude of the PFJR forces were significantly higher ( $p < .01$ ) for the lateral step compared to the frontal step. However, there was no significant difference in the magnitude of PFJR force between cadences of 120, 132, and 145 bpm for either step nor was there a significant interaction between step type and cadence. When considering variables that reduce the impact forces on the knee, specifically the patella and the PFJR forces, during low impact step exercises, the type of step (frontal vs. lateral) has more effect than the cadence rate.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.

# The Effects Of Acupressure Therapy On Exercise-Induced Delayed Onset Muscle Soreness And Muscle Function Following Eccentric Exercise

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The purpose of this investigation was two-fold: 1) to determine whether acupressure therapy is effective in alleviating delayed onset muscle soreness (DOMS), decreasing strength loss and swelling, and improving active (AROM) and passive (PROM) range of motion following eccentric exercise of the knee extensors; 2) to assess and record the acute inflammatory response which occurs following eccentric activity. 30 healthy subjects ( $21.3 \pm 1.7$  yr.) not currently participating in resistance training activity and with no previous history of acupressure or acupuncture exposure were randomly assigned to one of three treatment groups ( $n=10$ ): acupressure (ACU), placebo (PLA), or control (CON). All subjects engaged in 10 sets of 15 repetitions of non-dominant knee extension eccentric torque at 60 deg/sec on the Biodex isokinetic dynamometer. A visual analog scale (VAS) for soreness, maximal voluntary isometric torque, thigh circumference, AROM and PROM of the knee were assessed as indirect/functional indicators of muscle damage. Blood plasma samples of creatine kinase (CK), lactate dehydrogenase (LDH), interleukin-1 alpha (IL-1 $\alpha$ ), and tumor necrosis factor - alpha (TNF $\alpha$ ) were assessed and analyzed as direct indicators of muscle damage and acute inflammatory response. All dependent variables were assessed prior to engaging in exercise, immediately post-exercise, and at 24, 48, 72, and 96 hours post-exercise. Subjects assigned to ACU received 16 minutes of effleurage, petrissage, and acupressure to the focal point of muscle soreness on the exercised leg. Treatments were administered immediately following post-exercise assessments, at 24 hours, and at 48 hours. A 3x6 (treatment x time) two-way ANOVA revealed significant differences ( $p \leq 0.05$ ) in VAS within all three treatment groups over time. A one-way ANOVA of within group differences showed a significant increase ( $p \leq 0.05$ ) in VAS at 24, 48, and 72 hours post-exercise for ACU and PLA compared to pre- and post-exercise levels; CON exhibited significant increases in VAS at 48 and 72 hours post-exercise. VAS scores returned to pre-exercise levels by 72 hours for ACU, and by 96 hours for both PLA and CON. Significant main effects over time were found for maximal voluntary isometric torque, thigh circumference, AROM, and PROM.

However, variation and limited statistical power precluded identification of specific effects, and therefore, specific tests of hypotheses. In all treatment groups, LDH and CK appeared in the blood plasma at 48 hours post-exercise, and remained elevated through 96 hours post-exercise indicating that muscle breakdown and damage had occurred. Immune response markers of cell damage, IL-1 and TNF $\alpha$ , were not detectable in plasma at any time during the assessment period. It was concluded that acupressure therapy administered immediately post-exercise, and at 24, and 48 hours was effective in reducing the duration of perceived soreness compared to placebo or no treatment. The presence of CK and LDH in plasma suggest evidence of muscle breakdown following eccentric exercise.

This study was funded by a grant from the National Athletic Trainers' Association Research and Education Foundation.



## Instrumented Measurement Of Anterior-Posterior Laxity Of The Normal Ankle

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Although reproducible measurement of anterior-posterior knee laxity has been reported with the KT-1000 arthrometer, no such device exists for the ankle. Manual examination is currently the most common method for the evaluation of ankle anterior-posterior (A-P) "drawer" laxity. The need exists to prove objective assessment data of normal ankle laxity before comparison to an injured ankle can be made. The purpose of this study was to compare the A-P displacement of the talus with respect to the tibia at three force loads and to assess the test-retest reliability of a small, portable arthrometer (Blue Bay Research Inc., Milton, FL) in obtaining these measurements. The arthrometer consists of a frame fixed to the foot, a pad attached to the tibia, and a load measuring handle attached to the foot through which the load is applied. A measuring system that allows six degrees of freedom, which included the tibial pad and the foot frame, was used along with a spatial kinematic linkage system. We performed instrumented measurement testing of total A-P translation of both ankles in 41 (M=21;F=20) subjects (age =  $23.83 \pm 4.4$  yrs) without history of previous injury on two occasions. During the testing sessions subjects laid supine on a table with the secured leg extended and foot positioned at 0° neutral for A-P drawer testing. Laxity was measured as the total A-P translation (millimeters) after loading with 75, 100, and 125 Newtons of A-P force. Reliability was evaluated by calculating intraclass correlation coefficients [ICC (2,1)]. Mean differences between the dominant and nondominant ankles for total A-P translation were analyzed by dependent t tests. For both the dominant and nondominant ankles, respectively, the reliability values at 75 N (.83 vs. .87), 100 N (.83 vs. .89), and 125 N (.82 vs. .86) forces were clinically acceptable. The t test analyses showed no significant differences ( $p > .05$ ) for total A-P translation between the dominant and nondominant ankles at 75 N ( $11.10 \pm 3.4$  vs.  $10.47 \pm 3.6$ ), 100 N ( $14.94 \pm 4.5$  vs.  $14.21 \pm 4.7$ ), and 125 N ( $18.47 \pm 5.1$  vs.  $17.51 \pm 5.4$ ). The results are clinically useful in providing information about the reliability of measures at different A-P force loads. We believe the clinician can use the ankle ligament arthrometer to obtain reliable and quantitative measurements of A-P laxity of the ankle.

## Functional Performance Outcomes Following Two Types Of ACL Reconstruction

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The results of intraarticular anterior cruciate ligament reconstruction with either the patellar tendon or the semi-tendonosis/gracilis tendons (four strands) have been prospectively compared in numerous studies and advantages and disadvantages have been described. Traditionally, these studies have speculated that certain physical characteristics such as isokinetic muscular strength and joint laxity predict functional capacity. Recent research has suggests that the best assessment of functional capacity is achieved through the use of functional performance tests. Collectively these performance tests can provide the clinician with objective parameters by which to dynamically assess the athlete's function and provide a basis for determining readiness to return to sport activity. The purpose of this study was to determine whether or not there is a difference in functional performance outcome between these two ACL reconstruction techniques. We studied outcome data from 25 postoperative bone-patellar tendon-bone (PT) (N=15 males, N=10 females; mean age - 24) and 25 post-operative semi-tendonosis/gracilis tendon (STG) (N=12 males, N=13 females; mean age - 20.5 years). A single orthopedic surgeon performed the (PT) arthroscopic assisted reconstructions; likewise, another surgeon performed all of the (STG) techniques. After nine months of rehabilitation, patients were evaluated using six functional performance tests that have been well established in the literature. The functional tests (stair running, co-contraction arc, vertical jump, side jump test, twenty-foot speed hop, and triple jump test) were chosen as measures of daily life function and strength/stability function. All patients had these techniques incorporated into their rehab protocols and best scores were obtained only after learning effects had been compromised. There were no significant differences in the outcome measures between ACL reconstruction groups ( $P < .05$ ) as assessed by one-way between-subjects ANOVA for each test. The results suggest that despite having (PT) or (STG) tendons compromised for an ACL reconstruction, functional capacity returns to that of the uninvolved extremity. The only noticeable difference between groups was some patellofemoral crepitus developed more frequently in the (PT) group. We want to contribute to the understanding of each type of graft and aid the clinicians in providing a prognosis to their patients.

## Medial Patellar Taping Of Female Basketball Players Changes Peak Plantar Pressure Location And Timing

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**PURPOSE:** Subtle changes in patellofemoral joint biomechanics can have a dramatic impact on function. This study tested the hypothesis that medial patellar taping (McConnell Method) would change peak plantar pressure location, and timing during performance of a basketball lay-up. **METHODS:** Ten junior varsity female high school basketball players served as the subject group. Plantar pressure data were collected with an instrumented insole pressure monitoring system (50 Hz, 3 sec duration) from the preferred stance limb during the final deceleration step prior to performing a running basketball lay-up. Data were collected for 3 trials without medial patellar taping (single tape strip) and 3 trials following tape application (order effect controlled). A single investigator performed all tape applications. Paired t-tests compared mean differences between conditions,  $p < .05$ . **RESULTS:** Medial patellar tape application shifted the location of peak plantar pressure location anteriorly (distance from rear of sensor,  $93 \pm 17$  mm taped vs  $86.4 \pm 15$  mm untaped,  $p = .023$ ) and delayed the onset peak plantar pressure following running heelstrike ( $.148 \pm .02$  sec post-heelstrike taped vs.  $.136 \pm .03$  sec untaped,  $p = .035$ ). Medial patellar taping normal, athletic females, changed peak plantar pressure location (relative forefoot and supinatory bias) and timing (delayed peak pressure onset) during the final deceleration step prior to performing a running basketball lay-up. **CONCLUSIONS:** The peak plantar pressure location and timing differences observed following medial patellar taping suggest greater impact attenuation capability and potentially patellofemoral and anterior cruciate ligament injury preventative characteristics.



## Objective Mild Head Injury Evaluation Through A Battery Of Clinical Postural Stability Tests

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Mild head injury (MHI) represents one of the most challenging pathologies due to the limited amount of objective information often available at the time of injury. Postural stability has been reported to be one source of quantitative information concerning MHI through the use of complex and expensive forceplate systems. The purpose of this study was to develop a clinical balance test battery for use in MHI assessment without needing expensive equipment. Postural stability in 11 MHI subjects ( $18.6 \pm 2.5$  years,  $181.4 \pm 8.6$  cm,  $80.0 \pm 20.0$  kg) and 11 matched control subjects ( $21.3 \pm 2.0$  years,  $178.8 \pm 6.4$  cm,  $81.0 \pm 13.3$  kg) was tested at days 1, 3, and 5 postinjury. At each session subjects were evaluated using a clinical test battery consisting of 3 different stances (double, single and tandem) on 2 different surfaces (firm and foam) and the Sensory Organization Test (SOT) using the NeuroCom Smart Balance Master. During each clinical test, subjects were asked to maintain the stance position for 20 seconds with their eyes closed and hands resting on their iliac crests. An observer graded performance using a 6 criteria error scale system. Since none of the subjects in either group committed an error during the double stance-firm stance, this test was removed from the data analysis. The remaining clinical tests were analyzed using a repeated measures ANOVA (1 between, 2 within). Results revealed significant group by day ( $p < .05$ ) and group by test ( $p < .05$ ) interactions, as well as significant main effects for group, day and test. Post hoc analysis of the group by day interaction demonstrated significantly higher error scores by MHI subjects on days 1 and 3 postinjury. With respect to the purpose of this investigation, multiple paired t-tests were performed on the day 1 scores to identify those tests most sensitive to postural instability following MHI. Results of this analysis revealed significant differences for single leg and tandem stances on a firm surface and double and tandem stances on a foam surface. Additionally, a repeated measures ANOVA conducted on the NeuroCom SOT Composite Scores revealed a significant interaction for group by day ( $p < .05$ ) with post hoc analysis revealing significant differences at day 1 postinjury. In summary, our results suggest that the single leg and tandem stances on a firm surface and the double and tandem stances on a foam surface be used for identifying postural instabilities following MHI in the absence balance equipment. Clinicians should consider using these 4 tests either on the sideline or in clinical settings as objective adjuncts in MHI assessments.

## Intertester Reliability Of Concentric And Eccentric Isokinetic Peak Torque Values For Ankle Eversion Motion Obtained From The KIN COM 125 AP Isokinetic Dynamometer

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Isokinetic dynamometry has been the focus of many reliability studies. The majority of those studies have been conducted on the knee joint. There is little evidence available involving the reliability of isokinetic measurements of the ankle joint. The purpose of this study was to examine the intertester reliability for concentric and eccentric isokinetic peak torque values obtained from ankle eversion, using the Kin Com 125 AP (Chattanooga Group, Hixson, TN) isokinetic dynamometer. Sixteen male subjects (age =  $19.411 \pm 3$  yr., wt =  $82.711 \pm 0.6$  kg, ht =  $179.418 \pm 6$  cm) agreed to participate in this study. The subjects had no history of ankle pathology. Subjects were tested on two different occasions, separated by no more than 10 days between sessions. A different tester was used on each of these two occasions. The eversion motion started from a position of subtalar joint neutral and moved through  $25^\circ$  of eversion. Isokinetic tests were performed at 30, 60, 90, 120, 150 and 180 degrees per second. Three maximal concentric and eccentric repetitions were conducted at each velocity. Both ankles were tested. Separate ANOVA's with repeated measures were executed to determine mean differences between the two test sessions at each isokinetic velocity. Reliability was assessed by calculating separate intraclass correlation coefficients (ICC 2,1) at each velocity. In addition, standard error of measurement (SEM) values were calculated to determine the precision of measurement. Peak torque values ranged from 9.0 Nm to 62.0 Nm. Eccentric peak torque ICC values ranged from .20 to .77 (SEM 3.29 Nm to 5.95 Nm) for the right ankle and .15 to .58 (SEM 3.67 Nm to 4.52 Nm) for the left ankle. Concentric peak torque ICC values ranged from .24 to .71 (SEM 2.82 Nm to 3.92 Nm) for the right ankle and .10 to .78 (SEM 2.03 Nm to 4.84 Nm) for the left ankle. The results of this study indicate that a wide range of reliability estimates exist across the different velocities tested. Furthermore, the results show that at the slower velocities the associated ICC values were higher. Several factors can be targeted as potential sources for this variability, including: examiner experience with isokinetic

dynamometry, difficulty in determining the subtalar joint neutral position, different starting commands between examiners, and familiarity with the test protocol by both examiner and subject. This points to the need for clinicians to practice and familiarize themselves repeatedly, with the measurement techniques used to isokinetically assess ankle strength.







## Half Face-Shields May Not Prevent Facial Trauma In Junior "A" Hockey Players As Well As Previously Thought

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The purpose of this study was to determine the efficacy of hockey helmet half face-shields/visors (HFS) in the prevention of facial trauma. The United States Hockey League (USHL), a hockey league at the USA Hockey Junior "A" level, has athletes whose ages can run from the teen years to 21. The USHL requires all athletes under 18 years to use either a full face visor or cage with mouth guard to reduce the possibility of facial/dental injury. The Sioux City Musketeers, USHL affiliate team, enacted a mandatory HFS rule (MHFSR) for rate was compared to the previous four seasons for the same team. The documented facial trauma for all seasons were used to gather data. Facial trauma was defined as any injury to the face, eye, and/or nose. Concussions were not included. Dental injuries were not included in the study because mouth guard use is likewise optional for athletes over 18 in the USHL and there was no mandatory team rule enacted. The average facial trauma rate (FTR) for all seasons was 5.6 injuries/season ( $SD \pm 3.6$ ,  $SE \pm 1.6$ ). The average FTR for the MHFSR season was 7 injuries/season. Classical hypothesis testing using a standard T-test was used ( $p=0.05$ ) to determine if this noted difference shields/visors at this level of play did not reduce the facial injury rate. This may be due to the mechanisms of injury. 71% of the MHFSR year's injuries were caused by the use of sticks. 25% were caused by direct blows to the face. A HFS may not have afforded maximal protection in these instances given that sticks are usually poked under the HFS either by accident or intentionally, or the helmet-HFS complex may not be secure enough to the head to ward off blows from opposing players. The results of this study could also be attributed to other factors. Player compliance using the HFS in practices and the accuracy of documentation over the years may have skewed performed to more thoroughly determine the efficacy of the HFS in preventing facial injuries to Junior "A" level hockey players.

## Injury Mechanisms In A Mexican Soccer Team

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The purpose of this study was to explain the mechanisms of injury in the University soccer team from Mexico City. A prospective study in three seasons, 93-94, 94-95 and 95-96 was performed. All injuries which arose during training or in games and causes the absence for at least one day were registered. The total of injuries were 571, 53.4% during training and 45.2% during games. The localization of injuries were thigh 27.5%, ankle 22.1%, knee 19.1%, foot 5.6%, lower leg 4.7%, pelvis 3.9%, and in the rest of the body 17.1%. They were most frequent in grass 74.3% and in soil 19.3%, the field were irregular in 19.8%, hard in 12.6%, and in good conditions in 46.2%. The principal mechanisms were direct impact 37.5%, indirect trauma 19.4% and overuse 14.4%. Strains were more frequent in training and sprains in games, contusions and fractures were more frequent in games. Strains happened in running in 42%, kicking in 22%, at collision in 5.9%. Sprains happened in running in 29.9%, blocking in 17.7%, kicking in 14.6%, landing in 9%, collision in 8.5%, and slipping in 6%. Twenty one point six percent of the contusions happened kicking, 20.5% at collision, 15.9% running, and 17% blocking. The fractures happened 23.3% kicking, 23.3% landing, 13.3% running, 13.3% heading. This study show that the injuries were most frequent in the pelvic limb, in grass field in good conditions, for a direct impact and when the players were kicking. We think that the results reflex the kind of sport, and it is necessary to perform a study of the type of training and the moment of the season.

## Soccer Injuries: Study In Three Seasons

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The purpose of this study was to register the incidence of soccer injuries in three seasons 93-94, 94-95 and 95-96, in training and games in the soccer teams of Club Universidad Nacional. A prospective study of three seasons was performed. All the injuries during training and games that lead to an absence of at least one practice session were registered. All the information was collected on special forms elaborated by the medical staff. A total of 571 injuries were registered. 158 (27.7%) were on the first season, 204 (35.7%) in the second and 209 (36.6%) in the last, with an incidence of 1.01 for the professional players and 0.91 for the youth players. The most frequent injuries were strains 171 (29.9%), sprains 164 (28.7%) and contusions 88 (15.4%). As to their severity, 33% were mild, 53.23% were moderate and 13.48% were severe. We found that the backs were the most affected position with 31.7% and its most frequent injury was sprain. By other hand, the most frequent injury was strain 171 (29.9%). The injury rate for professionals were 16.6/1000 h during games and 1.6/1000 h in training. For the youths were 13/1000 h during games and 3.5/1000 h during training. The surgical treated injuries were 15 (2.62%). Soccer is a relatively secure sport for both professional and youth players. Only 13.48% of the injuries were severe and required more than four weeks of absence to games and training sessions. The importance of this study is to implement preventive regulations in relation to equipment and type of training to reduce the incidence of injuries.



## Return To Play Decisions Following A Mild Head Injury In Collegiate And High School Football Players

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Athletic trainers and team physicians are often faced with a dilemma when deciding whether to return an athlete to competition following a head related injury. It is often difficult to determine the severity of the initial injury, not to mention the status of post-concussive symptoms. Several guidelines for return to play following a concussion have been proposed, but none have been fully accepted and/or followed with any consistency. In an attempt to better understand sport related concussion, we examined the incidence of concussion and return to play decisions in collegiate and high school football. The study randomly surveyed certified athletic trainers from 50 Div. I, 28 Div. II, and 41 Div. III colleges, and 118 high schools over a three-year period (1995-1997). Of the 237 schools which responded, 915 football related concussions were reported. Our study revealed that 71.4% of all return to play decisions were made by both the team physician and the athletic trainer, however, 12.6% of the high school athletic trainers reported making the decisions independent of a team physician. The survey revealed that 30.4% of those players sustaining a concussion returned to participation on the same day of injury. The highest return rate on the same day of injury occurred with Div. I players (35%), followed by Div. III (30%), high school (29%), and Div. II (27%). Only 101 (11.0%) of the total injuries were classified as Grade II concussions, however, 12 (11.9%) returned to participation on the same day. The players who were released to play on the same day of injury were held out of participation for an average of 17.4 minutes following their injury. The survey revealed that 87 (30.3%) of those players returning on the same day did not report their injury until after they had returned to participation, and that they likely would have been removed had the athletic trainer known of the injury. The remaining 69.6% of the injured athletes who were not permitted to return to participation on the day of injury averaged 4.8 days before returning to participation. If analyzed by injury grade, the athletes sustaining a Grade I concussion averaged 4.5 days before returning, while those sustaining Grades II and III averaged 8.1 and 18.0 days respectively. Our findings suggest that none of the recommended guidelines are used with any consistency. With 16.5% of the injured players in the study sustaining multiple concussions in the same season, it is recommended that clinicians take more precaution in both identifying concussions and in returning athletes to competition following injury.

## Injury Incidence And Relative Risk Of Injury During Fall And Spring High School Football

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Football injury epidemiology has been the focus of many studies. Many of these studies have focused on the overall incidence of injury during the regular fall season. Recently the NCAA made changes to the spring practice schedule for collegiate football. These changes were made based upon research which established an increased incidence of injury for collegiate football players during the spring season. There is little information regarding the incidence of injury and relative risk of injury to high school football players during the spring season. The purpose of this study was to prospectively compare injury incidence between fall and spring football seasons. Thirteen high school football teams (3,640 football players) participated in the study over the course of three years (1994 through 1997). Each school employed a certified athletic trainer (ATC) who was responsible for recording injury information and athlete-exposures. Definitions for athlete-exposure and injury were defined prior to the beginning of the study. All ATCs were trained in the data collection process. Following data collection, descriptive statistics and the Fisher's Exact test were used to analyze the data. For the purposes of a more accurate comparison of the two seasons only practice data was compared. The fall season resulted in 416 injuries (71% - mild, 21.2% - moderate, 7.7% - severe) occurring during 84,486 athlete-exposures. The spring season resulted in 157 injuries (68.9% - mild, 20.7% - moderate, 10.4% - severe) occurring during 23,083 athlete-exposures. The injury rates per 1,000 athlete-exposures for the fall and spring seasons were 4.9 and 6.8, respectively. The Fisher's Exact test revealed that a significant difference ( $p < .001$ ) in incidence of injury existed between the two seasons. The relative risk calculation indicates that a high school football players is 1.38 times more likely to sustain an injury during spring practice sessions. This suggests the need for increased regulation of spring football at the high school level.

**The Assessment Of Leg Dominance By Motor Function, Proprioception And Strength**

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Many researchers use leg dominance to determine which leg will serve as the experimental leg, or to determine the order for testing. Leg dominance has typically been determined by the subject's perception. The subject is often asked with which leg they would prefer to kick a ball. It was hypothesized that leg dominance may differ depending on the task being evaluated. Therefore, the purpose of this study was to test the amount of agreement between perceived leg dominance and performance in motor function, proprioception and strength. Fifty-three volunteers (52.8 % male, mean age = 24.1 y) served as subjects. Motor skill (MS) was assessed by modified star tracing. Proprioception was evaluated from static and dynamic balance and by the ability to re-position the knee joint. Static balance (SB) and dynamic (anterior/posterior linear movement) balance (DB) were assessed with the Chattecx™ balance system. Joint position sense (PS) was determined by having the subjects passively return their lower leg to a previously noted position with their eyes closed. Measurements of PS were determined by electronic goniometry on the Biodex™ isokinetic dynamometer at 60°/s. These tests were each completed for the right and left legs with the order of testing randomly assigned. The data were analyzed by determining the percent of agreement between the subject's perceived dominance and actual leg dominance as determined by the subject's performance score. The percentages of agreement are as follows; MS (65.4%), SB (46.2%), DB (44.3%), PS (44.2%), FS (59.6%), and ES (84.6%). It can be concluded that with the exception of ES, one leg does not appear to be more dominant than the other. It is interesting to note that the movement of knee extension most resembles the skill of kicking which was used to determine perceived dominance. Additionally, there was greater agreement between perceived dominance and the variables of strength and motor function, than with the variables that involve proprioception. Based on these data, we recommend that the skill being performed should be considered when identifying the dominant leg.

**Hamstring Fatigue During Crossover Cutting Causes Dynamic Knee Control Deficits**

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**PURPOSE:** Non-contact anterior cruciate ligament injuries are commonly the result of sudden running directional changes. This study assessed the effect of eccentric work induced hamstring fatigue on knee and ankle biodynamics during a running crossover cut ("functional pivot shift"). **METHODS:** Twenty, normal, crossover cut trained (3 weeks), athletic females were test subjects. Data were sampled during 3 pre-fatigue and 3 fatigued (20% eccentric isokinetic knee flexor torque reduction) cutting trials. 3D kinematic, and ground reaction force data were sampled at 200 Hz and 1000 Hz, respectively and joint moments were calculated. Data were standardized to initial force plate heelstrike for trial mean comparisons between conditions (paired t-tests,  $p \leq .05$ ). **RESULTS:** Transverse plane (axial) knee internal rotation (IR) velocity ( $21.2^\circ/\text{sec}$ ,  $p = .04$ ) immediately following heelstrike and knee flexion velocity ( $19.9^\circ/\text{sec}$ ,  $p = .03$ ) were increased during hamstring fatigue. Likewise, peak knee IR immediately following heelstrike occurred earlier (8.4 msec,  $p = .019$ ). Total transverse plane rotation from peak impact IR through peak propulsion IR ( $2.7^\circ$ ,  $p = .045$ ) and peak knee IR at propulsion were decreased during hamstring fatigue ( $2.1^\circ$ ,  $p = .02$ ). Peak ankle plantar flexor (12.7 msec,  $p = .01$ ) and knee external rotator (5.1 msec,  $p = .045$ ) moments occurred earlier during hamstring fatigue. **CONCLUSIONS:** Knee IR and flexion velocity increases, and earlier peak knee IR immediately following heelstrike indicated dynamic knee control deficits during hamstring fatigue. Earlier peak ankle plantar flexor and knee external rotator moments and decreased knee IR at propulsion during hamstring fatigue are believed to represent compensatory attempts at dynamic knee stabilization. Knee rehabilitation programs should recognize the importance of hamstring muscle group endurance and the dynamic knee stabilizing contributions of lower leg musculature. Knee rehabilitation programs should recognize the importance of hamstring muscle group endurance and the dynamic knee stabilizing contributions of lower leg musculature.

**The Effect Of Achilles Tendon Stretching On Proprioception In Stable Versus Unstable Ankles**

Klein BM, Moore JH, Gansneder BM, Arnold BL: University of Virginia, Charlottesville, VA

The purpose of this study was to determine if stretching the Achilles tendon had an effect on proprioception in stable versus unstable ankles. Twenty male subjects (age = 20 yrs  $\pm 1.41$ , mass = 72.7 kg  $\pm 6.4$ , height = 175cm  $\pm 7.1$ ) completed this study. Subjects had one stable ankle (no previous injury) and one unstable ankle (4 or more ankle sprains with at least one being grade II or III). Subjects were randomly assigned to stretching or no stretching groups. The experimental group performed three 30 second static stretches of their gastrocnemius and soleus muscles. Range of motion (in degrees) and joint position sense (degrees of error) were collected in a counter balanced fashion for dorsiflexion, plantar flexion, inversion, and eversion. Data for both ankles were collected for each subject prior to and after the stretching protocol. An analysis of variance revealed that the pooled effects of plantar flexion and dorsiflexion produced a significant group by stability interaction for joint position sense [ $F(1,18)=11.08$ ,  $p<.05$ ] and a significant group by pre/post-test interaction for range of motion [ $F(1,18)=4.45$ ,  $p=.05$ ]. Post hoc testing revealed that in the no stretch group joint position sense was better for unstable ankles than for stable ankles and in the stretch group was similar between stable and unstable ankles. For range of motion, post hoc testing revealed a significant increase in range of motion for the stretch group after stretching. These results suggest that our stretching protocol was effective in increasing plantar flexion and dorsiflexion range of motion. Additionally, these results suggest that prior to stretching, unstable ankle joint position sense was better than stable ankle joint position sense and that this difference was eliminated with stretching.



### The Effects Of Muscular Fatigue On Shoulder Proprioception

Sterner RL, Pincivero DM, Swanik CB, Lephart SM: Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA

Proprioception is a neuromuscular mechanism responsible for monitoring joint position sense and movement during placement of joints. Proprioception also plays a role in the dynamic stability and modulation of muscle function. This neuromuscular mechanism relies on peripheral mechanoreceptors (e.g., cutaneous, articular, and muscular) imbedded in various tissues surrounding the joint to provide afferent messages to the central nervous system concerning limb position. Historically, the articular receptors have been viewed as the dominant receptor in joint proprioception; however, it now appears that few articular receptors are active in the midrange of rotation. Several studies have stated that the receptors most suited for proprioception in the midrange of motion are the muscle receptors. The purpose of this investigation was to assess the influence of muscular fatigue on active and passive shoulder proprioception within the midrange of rotation. Twenty recreationally active male subjects (mean age =  $23.81 \pm 2.77$  years) with no history of upper extremity injury or pathology, cardiovascular disease or disease affecting the sensory system were randomly assigned to either a control or fatigue group. Shoulder proprioception was assessed using: active reproduction of passive positioning (ARPP), active reproduction of active positioning (ARA-P), reproduction of passive positioning (RPP), and threshold to detect passive motion (TTDPM). For each test direction, the experimental group completed two bouts of maximal reciprocal concentric isokinetic internal and external contractions at 180 deg/s until peak torque declined to 50% of the established maximum voluntary contraction. Following these two bouts of the fatigue protocol, subjects were randomly assessed for proprioception values into either internal or external rotation. Subjects again completed the two bout fatigue protocol and were posttested in the remaining shoulder rotation. The absolute angular error (AA-E) for active proprioception was measured using the Biodex System 11 Isokinetic Dynamometer (Biodex Medical Inc., Shirley, N-Y) and for passive proprioception using a proprioception testing device. A two-factor analysis of variance with repeated measures revealed no significant interactions between the experimental and control groups

for ARPP, ARAP, RPP and TTDPM. This investigation demonstrated that the isokinetic fatigue protocol used did not impair shoulder proprioception within the midranges of external and internal rotation. The maximum voluntary contraction values observed between bouts suggest that the short duration, high intensity fatigue protocol used in this study did not provide an extensive recovery period for the accurate assessment of fatigue's effect on shoulder proprioception.

### The Effect Of Prophylactic Knee Bracing On Joint Position Sense As Measured In Both An Open And Closed Kinetic Chain

Bittner MB, Kaminski TW, Horodyski MB, Stopka CB, Connaughton D: University of Florida, Gainesville, FL

Knee joint proprioception has been studied extensively in an open kinetic chain. The primary purpose of this study was to determine if prophylactic knee bracing (PKB) enhances knee joint proprioception in healthy, uninjured knees. Furthermore, we were interested in determining if differences in joint position sense (JPS) exist when measured in an open (OKC) versus closed kinetic chain (CKC). Twenty male subjects (age =  $23.1 \pm 2.4$  yr., wt =  $81.0 \pm 10.7$  kg, ht =  $180.5 \pm 8.9$  cm) with no history of knee injury, volunteered to participate in this study. JPS selected target angles included 150, 450 and 750. Each angle was presented in random order. A total of two trials were performed at each target angle. JPS error scores were measured in an OKC using the internal goniometer of a Kin Com 125 AP (Chattanooga Group, Hixson, TN) isokinetic dynamometer under both a braced and unbraced condition. Subjects performed active knee extension from a 900 flexed position while lying supine on the dynamometer chair. JPS error scores were measured in a CKC using a Penny and Giles (P&G Co., Blackwood UK) electrogoniometer strapped to both a braced and unbraced knee. In the CKC, subjects performed knee extension while lying on a variable resistance leg press device with the knee flexed to 900. The McDavid Lateral Knee Guard (M-202; McDavid Knee Guard, Inc., Chicago, IL) was used for the braced condition. Data were analyzed using a repeated measures ANOVA to determine if differences existed between OKC and CKC scores and braced and unbraced scores. There was no significant interaction between the chain and bracing factors [ $F(1,19) = 0.92, p = .35$ ]. However, there was a significant main effect for chain [ $F(1,19) = 18.61, p < .001$ ]. CKC joint position sense error scores ( $3.5111.71$  degrees) were significantly lower (less error) than the OKC error scores ( $5.3212.46$  degrees). Bracing did not influence JPS error scores in either chain condition. The results suggest that JPS error scores measured in an CKC show less error than those taken in an OKC. Researchers and clinicians should consider assessing JPS in a CKC. The CKC test position appears to be a more functional position and may be a better reflection of JPS ability in those with healthy, uninjured knees. Furthermore, the data indicate that PKB's have no effect on JPS error scores in healthy, uninjured knees. Future studies should examine these factors using subjects who have suffered previous knee injuries.

## Muscle Injury And Its Effects On Knee Joint Proprioception, Strength, Range Of Motion And The Relationship To Pain

Nicholaides NK, Giannantonio FP, Lephart SM: Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA

Muscle injury resulting from unaccustomed exercise is a common occurrence among the athletic population. Soreness associated with this injury occurs 24-48 hours following unaccustomed eccentric exercise. Mechanical stress during eccentric exercise results in structural damage to myofibrils subsequently resulting in increased pain, decreased ROM and strength as well as neuromuscular dysfunction. The neuromuscular disruption associated with muscle injury may be attributable to disruption in tenomuscular mechanoreceptors. Proprioception is mediated by tenomuscular receptors which provide the CNS with sensory information regarding joint position sense and kinesthesia. These tenomuscular receptors lie parallel with myofibrils located in skeletal muscle. Therefore, probability exists that tenomuscular receptors may be implicated, thus altering proprioception, subsequently increasing risk of injury. The purpose of this study was to investigate the effects of muscle injury on: proprioception, strength, ROM, and to determine if there is a relationship to pain. Thirty subjects were randomly assigned to one of two groups (group 1 = experimental, age =  $22.5 \pm 2.0$ , group 2 = control, age  $23.0 \pm 2.5$ ). The experimental group was subjected to a baseline testing day followed by the muscle injury protocol consisting of 300 eccentric contractions on the Biodex II isokinetic dynamometer (Biodex Medical Systems Inc., Shirley, NY). Post-testing for proprioception, strength, ROM, and pain was conducted for the following three days. The control group participated in a baseline test followed by three post-test sessions. Proprioception was measured for threshold to detection of passive motion (TTDPM) and reproduction of passive positioning (RPP). Strength was measured on the Biodex II dynamometer for eccentric torque (ET), ROM was measured with a standard goniometer. Pain was assessed using the descriptive differential pain scale (DDS). A two way ANOVA (group x time) was conducted to determine significant differences between experimental and control groups ( $p < .05$ ). Pearson Product Moment Correlation analyses were conducted to determine the relationships between dependent variables and pain ( $p < .05$ ). Significant decreases

were found in ET, ROM and TTDPM between experimental and control groups ( $P < .05$ ). Significantly strong relationships were found between RPP and DDS ( $p < .05$ ). The results of this investigation suggest that muscle injury adversely effects proprioception, strength and ROM. The results also suggest strong relationships exist between pain and proprioception. This investigation provides evidence that muscle injury may lead to an increased risk of joint injury due to altered sensory pathways. Therefore, clinicians need to evaluate the status of muscle injury and recovery closely when determining the athletes ability for return to sport participation.

## The Effect Of Joint Hypermobility Syndrome On Knee Joint Proprioception And Its Relationship With Anterior Knee Joint Laxity

Moran MJ, Giannantonio FP, Lephart SM, Decoster LC, Bernier JN: Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA

Hypermobility syndrome is a term used to describe situations in which excessive joint laxity is present in the absence of other connective tissue disorders. The same joint ligaments and capsular structures which are responsible for this joint laxity also provide mechanical restraint to abnormal joint movement. In addition to this mechanical restraining function, these articular structures are thought to play an important neurological function in the maintenance of dynamic joint stability through reflexive muscular stabilization. The mechanism for dynamic restraint is mediated by articular mechanoreceptors and provides the individual with the proprioceptive sensations of kinesthesia and joint position sense. Since it is felt that the laxity observed in hypermobile joints is due to defects in the joint capsule and ligament, it is possible that hypermobility syndrome causes damage to joint mechanoreceptors and thus affects the proprioceptive ability of these individuals. The purpose of this investigation was to examine the effect of joint hypermobility syndrome on knee joint proprioception and its relationship to knee laxity. Subjects included 7 non-hypermobile (age =  $21 \pm 2$ ) and 8 hypermobile (age =  $22 \pm 3$ ) female intercollegiate soccer players. Hypermobility was determined utilizing the technique developed by Carter and Wilkinson. Subjects proprioception was measured with a proprioception testing device (PTD) for threshold to detection of passive motion (TTDPM) and reproduction of passive positioning (RPP). Anterior knee joint laxity was assessed using the MEDmetric KT-1000 at forces of 89N and 133N respectively. Multiple independent t-tests were conducted to detect significant group differences between hypermobile and non-hypermobile subjects. The Pearson Product moment correlation was performed to determine the relationship between joint hypermobility and knee joint laxity. The results demonstrated significant differences for TTDPM at  $15^\circ$  moving into extension and RPP at  $45^\circ$  moving into flexion ( $p < .05$ ). No significant relationships were found between joint hypermobility and anterior knee joint laxity. The results of this investigation suggest that knee joint hypermobility adversely effects knee joint proprioception. These results may be attributable to a lack of tension in knee joint capsular and ligamentous structures. This lack of tension may alter mechanoreceptor acuity via a reduced ability to sense knee motion. This investigation provides evidence that hypermobile individuals may be at an increased risk of injury due to a lack of proprioceptive acuity. Future research and clinical application should be directed towards the development of specific proprioceptive training programs for hypermobile individuals.



### Joint Reposition Sense Of The Healthy Shoulder Before And After Isotonic Exercise

Couper KL, Uhl TL, Perrin DH, Gansneder BM: University of Virginia, Charlottesville, VA

The importance of proprioceptive feedback in joint stability has been previously established. This study examined if there is an improvement in reproduction of active positioning (RAP) of the healthy shoulder immediately following submaximal isotonic exercise. 39 male varsity athletes (age =  $20.23 \pm 1.25$  years), with no history of shoulder subluxation or dislocation, were randomly divided into two groups. The experimental group performed three sets of ten of the following exercise: prone horizontal abduction with external rotation, internal rotation at  $0^\circ$  abduction, external rotation at  $0^\circ$  abduction, and scaption with internal rotation. The order of exercises was counterbalanced. The control group sat quietly for 12 minutes. Each group underwent an active repositioning test utilizing a Cybex® II+ Isokinetic Dynamometer for pre-testing and post-testing. Two angles were tested,  $30^\circ$  and  $80^\circ$ . The order of the angles was counterbalanced. Each subject was blindfolded and wore headphones emitting white noise to limit extraneous cues. The subject's forearm was placed in a pneumatic device throughout the testing to limit cutaneous cues. The absolute value of the difference between the trial angle and the given angle was calculated. The mean of the three absolute values was used for statistical analysis. A 1 between, 1 within repeated measures ANOVA was performed for each angle. A significant difference ( $F(1,37)=10.47$ ,  $p<.05$ ) in RAP was found from pre to post test within subjects at  $80^\circ$ . This difference was significant for both experimental and control groups, and was attributed to a learning effect. No statistical difference was found from pre to post test within subjects for the  $30^\circ$  angle, between subjects, and no interaction between experimental condition and pre and post test was found. This study suggests that submaximal isotonic exercise does not effect reproduction of active positioning. Further research is necessary to study RAP as a measure of proprioception. Future research suggestions include utilizing practice trials, a more varied population, an unstable population, and heavier weights.

### Acute Proprioceptive Measurements Following Resistive Ankle Exercises

Hawke RL, Van Lunen BL, Arnold BL, Gansneder BM: University of Virginia, Charlottesville, VA

There is a high incidence of ankle injuries in sports, especially ankle sprains occurring to the lateral structures. If these injuries occur frequently or are not treated properly, functional instability, or the feeling of the ankle "giving way", may result. The reasons for this condition include a proprioceptive deficit, muscular weakness and muscular dysfunction. Many exercises have shown to produce chronic strength and proprioceptive improvements. However, very little research reports any acute proprioceptive effects directly following the performance of exercise. Thus, the purpose of this study was to determine the acute proprioceptive benefits of open chain elastic resistive band ankle exercises. Twenty-six high school athletes (age =  $16.58 \pm 1.10$  yr, ht =  $173.94 \pm 11.05$  cm, wt =  $66.44 \pm 11.58$  kg) with a history of functional instability in one or both ankles and no occurrence of an ankle injury in the last six months were recruited for this study. Subjects were randomly assigned to an exercise or control group. The exercise group performed 30 repetitions of eversion, dorsiflexion, inversion and plantar flexion with a rubber resistive band stretched to 50% of its maximum length while the control group substituted this with no activity. Balance testing was assessed prior to the treatment, after the treatment, and again after a 30-minute period of non-weight bearing. All balance testing was performed on the Biodex Stability System (Biodex Medical, Shirley, NY) at level 2 for 30 seconds. A separate three way mixed design ANOVA with two between variables (group and gender) and one within variable (time) was performed for the overall stability index, and the medial/lateral stability index and the anterior/posterior stability index. No significant main effects or interactions were found. This suggests that these open chain isotonic resistive band exercises may have no effect on postural stability as measured by the Biodex Stability System. Further research should examine different proprioceptive protocols and their relationship to balance testing recorded at different levels.

### The Effects Of Neuromuscular Electrical Stimulation On Proprioceptive Acuity In The Shoulder

Pfeifer KE, Lephart SM, Gear WS: University of Pittsburgh, Pittsburgh, PA

The purpose of this study was to determine if two different neuromuscular electrical stimulation treatment protocols had any effect on shoulder proprioceptive acuity. Previous literature has provided evidence that electrical stimulation may positively or negatively affect proprioception, but the effect has not been tested directly. Twenty healthy college aged male subjects were divided equally into two different groups, a control and an experimental group, by following the counterbalancing model. The experimental group received the two different electrical stimulation protocols, an interferential sensory electrical stimulation protocol for pain control and a biphasic electrical stimulation protocol for muscle re-education. Subjects underwent passive proprioception testing on the University of Pittsburgh Proprioception Testing Device (PTD) and active proprioception testing on the Biodex II Isokinetic Dynamometer. These measures were tested in a pre-test/post-test manner. The experimental group received a twelve minute electrical stimulation treatment following the pre-test, while the control group rested during the twelve minute treatment time. Three days after the initial testing session, the experimental group subjects returned and repeated the testing procedures, substituting the other electrical stimulation protocol. The order of electrical stimulation protocols was determined by the counterbalanced model. Testing order was randomized. Data analysis involved the use of a 3X2 Multifactorial ANOVA. The results of the study indicated that the interferential sensory electrical stimulation treatment protocol had a significant effect on two of the dependent variables. A significant improvement was demonstrated in the sensory interferential portion of the experimental group, when the subjects performed reproduction of passive positioning (RPP) ( $p=.0379$ ) and active reproduction of passive positioning (ARPP) ( $p=.0180$ ) from a starting position of neutral rotation and movement into external rotation of the shoulder. The muscle re-education protocol had no effect on proprioceptive acuity. The results may indicate that the afferent nerve fibers associated with the mechanoreceptors responsible for proprioceptive feedback from the joint capsule to the Central Nervous System (CNS) were stimulated by the interferential electrical stimulation protocol. Therefore, the proprioceptive information received by the CNS increased, resulting in a more accurate efferent response. The electrical stimulation affected joint position sense under these two conditions but not joint kinesthesia. Further research needs to be conducted to further explore these findings to determine if this treatment should be added to proprioception rehabilitation programs.





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## Free Communications, Oral Presentations, Clinical Case Reports I

Saturday, June 20; 1:00 PM - 2:20 PM; Location: Room 327; Moderators: John McChesney, PhD, ATC; Gary Horsman, MS, ATC; Edward McFarland, MD

### Anterior Hip Pain In A Recreational Athlete

Keskula DR, Lott J, Duncan JB: Medical College of Georgia, Augusta, GA

**Personal Data/Pertinent Medical History.** A 31-year old female reported a chronic history of popping in the left hip that became painful approximately one month prior to seeking medical intervention. There were no apparent etiological factors consistent with the onset of pain. Her primary complaints were pain, popping and decreased functional abilities. An increase in symptoms was noted with the hip in certain positions and with motions involving hip flexion and extension. Specific examples included jumping, crossing the left lower extremity over the right, getting in and out of a car, and running. These restrictions did not significantly limit her work as a teacher. However, limitations were imposed on her participation in running and training for a road race. Relevant past medical history included a left anterior cruciate reconstruction in 1991. The primary goal of the patient was to return to pain free functional activities.

**Physical Signs And Symptoms.** Upon physical examination, active and passive range of motion of bilateral lower extremities were within normal limits and pain free with the following exception: passive extension of the left hip was painful. When the left hip was actively moved from a flexed, externally rotated, and abducted position toward extension, a painful, popping sound was present and reproducible. Strength of bilateral extremities was within normal limits with the following exception; increased pain with resisted contraction of the left hip flexors. Neurovascular status was within normal limits. Gait was within normal limits with no significant deviations noted. However, with increased symptoms, the patient reported she would limp.

**Differential Diagnosis.** The diagnosis was made of left snapping hip syndrome involving the iliopsoas tendon. The clinical signs and symptoms typically included in this syndrome include anterior hip pain, reduced function, and audible clicking.

**Results Of Diagnostic Imaging/Laboratory Tests.** Additional information to support the diagnosis includes standard radiographs to rule out intrarticular problems. X rays of the hip revealed no bony abnormality.

**Clinical Course.** The initial recommendation was a conservative course of treatment that included anti-inflammatory medication, therapeutic exercise, and home exercise program. A progressive array of range of motion / stretching exercises were implemented as a component of a daily home exercise program. The primary focus of the program was stretching the left hip flexors. The patient appeared to comply with the program and demonstrated good tolerance to activity. Following 4-weeks of intervention, there was significant improvement in the status of the left hip. The patient reported minimal pain and clicking with functional activities and was able to run 12 miles per week. Six months following the initiation of treatment she is symptom free and participates in a variety of exercises to include running, stair master, and stretching exercises.

**Deviation From The Expected.** Snapping hip syndrome is a clinical entity that may be described as hip pain associated with an audible snap of the hip during motion. The most common and well-known cause of this syndrome involves the snapping of the iliotibial band over the greater trochanter. A less common cause is the iliopsoas tendon snapping over the iliopectineal eminence. Enhanced understanding of the anatomy and function of the iliopsoas tendon and related structures provide a basis for evaluation and treatment of this unique problem. Accurate diagnosis will facilitate effective treatment and result in a satisfactory outcome. Conservative management focuses on appropriate stretching exercises and nonsteroidal anti-inflammatory medication.

### Unusual Forearm Pain In A High School Baseball Player

Greene JJ, Bernhardt DT: University of Wisconsin Hospitals and Clinics Sports Medicine Center, Madison, WI

**Personal Data/Pertinent Medical History :** A 17 year old right arm dominant male high school baseball athlete reported to his high school athletic training room for evaluation of right forearm pain that had been worsening for approximately one month. He initially developed pain in early November, 1996, when he increased resistance for bicep curls which he was performing as part of his off-season conditioning program. The athlete continued his strength training program following the initial onset of symptoms. He denied any complaint of pain with forearm and rotator cuff strengthening, but had significant discomfort with bicep curl and bench press activity. In addition, he was able to maintain his throwing program and only developed mild discomfort after throwing.

**Physical Signs And Symptoms :** The athlete initially presented to the athletic training room with a chief complaint of discomfort over the midshaft of the ulna and in the muscle tissue surrounding this area. On physical examination, the athlete had a discrete, focal area of tenderness in the middle third of his ulna on the flexor side. Generalized muscle tenderness was present throughout the region of discomfort but no edema or ecchymosis was present. The athlete exhibited no increase in symptoms with resisted or passive wrist extension, wrist flexion, pronation, supination, radial deviation, ulnar deviation, or with flexion or extension of the PIP's and DIP's. His reflexes were normal and symmetric in the upper extremity. Additionally, there was no evidence of numbness, tingling, or neck pain.

**Differential Diagnosis :** 1) Flexor Digitorum Profundus Tendinitis; 2) Anterior Interosseous Syndrome; 3) Ulnar Stress Fracture; 4) Myofascial Pain.

**Results of Diagnostic Imaging/Laboratory Tests :** Plain films taken approximately four weeks after the onset of symptoms were within normal limits and indicated no abnormalities. An MRI was then ordered and a sagittal series was obtained. Findings included considerable high signal through the entire length of the ulna. There was also a small amount of high signal in the periosteal area of the ulna on its volar surface. No definite cortical break was seen. The impression of the radiology technician was that the findings were most consistent with a stress fracture of the ulna.

**Clinical Course :** The athlete was seen again one week after his MRI was performed. He reported that symptoms had not improved and that he continued to have discomfort with palpation and with light lifting activity. He had been resting from throwing and weight training for one week. He was placed on anti-inflammatory medication (Naprosyn, 500 mg b.i.d.) and instructed to continue icing three times daily. In addition, he was placed on a comprehensive forearm and wrist flexibility program at this time and instructed to rest from all activity involving his right arm for two weeks. The patient was seen again approximately eight weeks later by his physician in early February, 1997. At this time, physical examination revealed no tenderness of his right ulna and very minimal discomfort in the surrounding muscle tissue. He had progressed to throwing at approximately three-quarter speed. He was placed on a graded throwing program to prepare himself for baseball season and went on to have a successful baseball season without further incident of injury.

**Deviation From The Expected :** This case provided a unique example of a stress fracture in a male high school athlete of the upper extremity most likely resulting from overtraining. Stress fractures are obviously much more common in the lower extremity due to the effects of weight-bearing. However, this case demonstrated that a stress fracture can also develop via the application of repeated progressive resistance and overtraining in non-weightbearing activities. The site of the injury was also interesting in that it is not a site usually associated with common athletic injuries and required very careful evaluation and management in order to achieve a satisfactory result.



## Acute Onset Of Neck Pain In A Novice Wrestler

Cameron KL, Austin MC, Arciero R: United States Military Academy, West Point, NY

**Personal Data:** A 175 pound, 19-year-old male cadet attending the United States Military Academy, reported to the athletic training room after completing a wrestling bout in a physical education course. The athlete complained of neck pain and stiffness. A thorough history revealed that the injury had occurred at the end of the first period. However, the athlete completed the final 90 seconds of the bout following the injury before reporting for evaluation. The injury occurred as the athlete was attempting to take down his opponent. The injured athlete's head was driven into the mat as his opponent tried to fight off the attack. The athlete reported severe pain upon impact with the mat but was able to complete the final period of the bout by keeping his neck "stiff".

**Physical Signs And Symptoms:** Physical examination was relatively unremarkable and revealed pain in the lower cervical region with moderate point tenderness along the lower cervical spine and paraspinal musculature. Muscle spasm and guarding were also noted about the lower cervical spine. Cervical and brachial plexus motor and sensory function were intact, however, the athlete did complain of some paresthesia bilaterally, about the lateral aspect of the shoulders.

**Differential Diagnosis:** Differential diagnosis included cervical strain, cervical sprain, and cervical fracture.

**Results Of Diagnostic Imaging Laboratory Tests:** Plain film radiographs revealed a burst or "tear drop" fracture to the fifth cervical vertebrae. Magnetic Resonance Imaging and CT Scans confirmed the diagnosis and were utilized to determine the extent of soft tissue injury and resulting edema.

**Clinical Course:** Surgical and non-surgical options were initially discussed with the patient. Due to the commissioning requirements of the United States Army, the patient chose to forgo surgical treatment opting for conservative management. The patient was fitted and placed in a halo orthosis. Throughout the immobilization phase, the patient underwent radiographic evaluation weekly, to assess healing of the cervical fracture. Four weeks post injury, lateral radiographs revealed retropulsion of the C5 vertebral body and widening of the interspinous distance with subluxation of the facet joints. Due to the increased angulation, treatment options were once again discussed with the patient. Subsequently, anterior arthrodesis with associated discectomy at the C4-C5 and C5-C6 levels were performed.

**Deviation From Expected:** It is very unusual for someone with a cervical spine fracture to walk into the athletic training room, especially after wrestling another round following the onset of injury. Most importantly, not all cervical spine fractures present as they are described in assessment texts. When the physical examination is relatively unremarkable, the sports medicine professional must rely on a thorough history. The results of this case study stress the importance of taking a conservative approach when making management decisions if a cervical spine fracture may be present.

## Scapular Fracture In A Collegiate Football Player

Smith AN: Department of Sports Medicine and Exercise Sciences, Canisius College, Buffalo, NY

**Personal Data/Medical History:** A 22 year old healthy male, wide receiver/kick returner, sustained a direct blow to the left shoulder while being tackled as a punt returner in a collegiate football contest. He was able to remove himself immediately from the field by self-splinting his shoulder to his abdomen. He presented on the sideline with complaints of significant pain in the left deltoid and lateral upper arm with tingling and numbness in the C5-T1 dermatomes. The patient denied history of injury in either shoulder.

**Physical Signs and Symptoms:** The patient was unable to actively move his arm in any plane due to pain. He was unable to describe a specific mechanism of injury other than a shoulder tackle. Later review of game films revealed a direct frontal blow by an opponents helmet to the anterior shoulder stopping forward progress. Anesthesia subsided completely in approximately 5 minutes, at which time he was neurovascularly intact. He reported no cervical pain, had full neck range of motion and no point tenderness to the cervical spine, humerus, coracoid process or posterior scapula. There was a positive "shrug sign" with deltoid cap and posterior shoulder musculature spasm. He was treated conservatively with a shoulder sling and ice. At 24 hours post-injury, he presented with severe, diffuse shoulder pain and spasm with gross swelling of the entire shoulder girdle without sign of ecchymosis. He remained neurovascularly intact. He reported no point tenderness upon bony palpation but complained of pain on palpation on the Anterior and Middle Deltoid muscles. He was kept in a sling and referred for radiographs and orthopedic evaluation.

### Differential Diagnosis:

- 1) Deltoid Contusion
- 2) Brachial Plexus Stretch
- 3) Acute Rotator Cuff Strain
- 4) Traumatic Fracture

**Results of Diagnostic Imaging:** Anterior to posterior, lateral and oblique radiograph views revealed a minimally displaced, longitudinal fracture of the left scapula. The fracture line extended between the coracoid process and the glenoid fossa migrating inferiorly into the body of the scapula. Passive range of motion revealed increased pain and spasm in shoulder flexion and external rotation at 45 degrees, respectively. He had minimal point tenderness in the anterior shoulder. NSAID's were prescribed along with use of a shoulder immobilizer. Passive range of motion exercises to pain tolerance were prescribed below 90 degrees of abduction, avoiding external rotation. At 2 1/2 weeks, radiographs revealed cancellous bone growth at the fracture site. Active range of motion exercises and isometric exercises to pain tolerance were utilized with sling use for daily activities. At one month, he exhibited full active range of motion, although a palpable "click" was present at 110 degrees of shoulder flexion and 80 degrees of scaption, producing a brief instance of discomfort. Manual muscle tests were within normal limits except at the point of "click" in shoulder flexion and scaption. At 2 months radiographs revealed a healed fracture site and he exhibited strength within normal limits with full range of motion. Due to completion of his eligibility he returned to his job as a laborer and normal activities of daily living including a gradual re-introduction of weight lifting.

**Deviation from the Expected:** What makes this case remarkable is the low incidence of scapular fractures, with trauma, reported in "traditional" athletics, as well as it's acute presentation. Scapular fractures represent 1% of all skeletal fractures and are generally associated with massive blunt trauma from motor vehicle accidents, falls and crushing injuries in persons aged 40 to 60 years (Banerjee and Field). Approximately 87% are related to multiple injuries with a mortality rate reported as high as 14.3% (Cain and Hamilton). This case is unique when compared to other reported scapular fractures in it's lack of an apparent, high impact injury mechanism. Lack of bony point tenderness deviates from traditional signs associated with athletic injury evaluation of musculoskeletal trauma and makes an often overlooked injury, difficult to diagnose as with this case in the initial differential diagnosis.

## Free Communications, Oral Presentations, Clinical Case Reports II

Saturday, June 20, 2:40 PM - 4:00 PM; Room 327; Moderator: Katie Walsh, EdD, ATC; Discussants: Terry O'Brien, MS, ATC; Leigh Ann Curl, MD

### An Open Ankle Injury In A Collegiate Woman Gymnast

Curtis N, Jimenez C: West Chester University, West Chester, PA

**Personal Data/Medical History:** A 19 year old sophomore female NCAA Division 2 gymnast (height: 167.6 cm, weight: 62.6 kg) sustained a right ankle injury landing from a vault in practice. She had suffered a moderate left ankle sprain the previous season and reported sustaining two or three minor to moderate right ankle sprains during her high school years. The athlete was attempting a "handspring one and one half twist" vault and landed with her right foot half on and half off an eight inch skill cushion landing mat. She sustained a severe weight bearing inversion and plantarflexion torsional injury. She reported feeling a pop and tearing sensation and fell to the mat on her back crying out in pain.

**Physical Signs And Symptoms:** Observation showed an open wound where the fibula punched through the skin. The distal 4 cm of the fibula was exposed with a flap of skin tucked beneath it. There was minimal bleeding and there was no other obvious deformity about the ankle joint. The athlete was conscious, alert and remarkably calm. Vital signs were within acceptable limits. The neurovascular status of the foot was normal. The foot was warm and pink, with intact dorsalis pedis pulse, sensation and motor function of the toes.

**Differential Diagnosis:** ankle dislocation; third degree ankle sprain; distal tibiofibular syndesmosis separation; avulsion fractures; malleolar fractures; talar dome fracture; fibula fracture; tibia fracture; other tarsal fractures; fifth metatarsal fracture.

**Diagnostic Imaging/Laboratory Tests:** X-rays revealed an asymmetric ankle mortise showing a widening of the lateral in comparison to the medial joint space indicating a tilting of the talus within the mortise. Ossific densities were noted adjacent to the tip of the medial malleolus and also adjacent to the lateral border of the talar dome. These may have represented fracture fragments or old trauma. Surgical inspection revealed gross ankle instability to inversion stress. The entire 1.5 cm of fibula was protruding through a skin rent with a segment of the calcaneofibular ligament attached to the distal fibula. There was a 1 cm square full thickness articular cartilage fragment missing from the superior lateral dome of the talus which was floating freely within the joint. The anterior talofibular ligament was ruptured. The stump incorporated a rounded ossific density appearing to be old trauma. The calcaneofibular ligament avulsed off the calcaneus. The ankle joint capsule was torn at the anterolateral aspect. The distal tibiofibular syndesmosis was intact.

**Clinical Course:** The injury was treated immediately by covering the open wound with a sterile non stick dressing applied loosely with elastic tape. The ankle and foot were splinted and the athlete was transported via ambulance to a local hospital where intravenous antibiotics were administered. Arrangements were made by the orthopedic surgeon to take her to the Operating Room. The talar dome fragment was removed. The rounded ossific density was removed from the anterior talofibular ligament stump and the ligament was then reapproximated and repaired using nonabsorbable sutures. The calcaneofibular ligament was tacked down in its anatomic position. The tear in the joint capsule was sutured. The wound was closed, cleaned, covered and the ankle was immobilized in cast for four weeks and then placed in a removable short leg walker, after which aggressive rehabilitation was initiated. The athlete returned to regular gymnastics activity 10 months after the initial injury and is expected to compete on the bars and beam this season.

**Deviation From The Expected:** Although ankle injuries are the most common in sports, an open ankle dislocation without malleolar fracture is rare, with few cases reported in the literature. The management and rehabilitation of this athlete represent a unique challenge due to the nature and severity of the injury and the high impact demands of gymnastics.

### Traumatic Eye Injury Of A Collegiate Soccer Player

Stave ES, Canlas RL, Smith KJ, Weisman BP: Kalamazoo College, Kalamazoo, MI

**Personal Data/ Pertinent Information:** A 20-year-old female collegiate soccer player sustained a "vision threatening" eye injury after being struck in the right eye with a kicked ball during practice. The athletic trainer, who was covering football practice at the same site, was informed that an athlete was struck in the eye, which resulted in a "shiner." The injured athlete had no previous history of trauma to the eye or other visual deficiencies.

**Physical Signs And Symptoms:** On-field evaluation by the athletic trainer found 2+ ecchymosis surrounding the right eye. The swelling was so intense that the athlete could not fully open her eye. The athlete reported a "weird" feeling, but no pain. The athlete stated "her eye was open" when she was hit and reported a slight blurring of her vision at the time of initial evaluation. The athlete was given an ice bag, and then sent to the training room to be examined by the team physician who happened to be on site. Physician evaluation revealed no orbital step-offs upon palpation, both pupils were reactive to light, accommodative and there was a mild anterior chamber reaction in the right eye. An ophthalmological exam was unsuccessful at this time due to swelling and spasm. The athlete was informed of signs and symptoms of emergent need, and was told to report to the athletic trainer the following morning.

#### Differential Diagnosis:

1. Corneal Abrasions
2. Corneal Foreign Bodies
3. Perforation of the Globe
4. Hyphema
5. Blow-out Fracture of the Orbit
6. Intraocular Foreign Bodies
7. Retinal Complications from Blunt Trauma (retinal edema, retinal hemorrhage, retinal tear and detachment)

**Diagnostic Imaging/ Laboratory Tests:** At 9:00 AM the next morning, 16 hours after initial trauma, the athlete reported to the athletic trainer experiencing flashes of light and black floaters in her vision. The athlete was immediately referred to an ophthalmologist. Upon arrival at the ophthalmologist the athlete noticed a curtain or veil in the corner of her eye. Ophthalmologic evaluation showed negative fluorescein strip exam, negative slit-lamp, intraocular pressures at 9mmHg OD and 10mmHg OS, normal dilated fluorescein exam OS. Also, she had what appeared to be a large retinal tear supertemporally OD and a macula on retinal detachment.

**Clinical Course:** After the ophthalmologic exam, the athlete was referred to a retinal surgeon for emergent surgery, which was performed that afternoon. The athlete underwent a scleral buckle procedure to repair the detached and torn retina. Postoperatively, during subsequent check-ups, the athlete displayed a 100% recovery with no loss of vision. The athlete was unable to finish the season, but was allowed to play the following year, fall 1997, as long as no complications arose. She played wearing protective eye wear. The only set back from the scleral buckle surgical procedure is the athlete is now nearsighted. However, this is corrected by contact lenses.

**Deviation From The Expected:** This case study provides a vivid example of how quick and proper recognition of signs and symptoms regarding eye injuries can help alleviate loss of vision after sustaining a blunt force to the orbital region. The importance of quick diagnosis through ophthalmoscopic exam allows for the best surgical outcome. There is also little documented evidence of traumatic retinal detachment after direct contact. Proper knowledge and awareness of all eye injuries is a necessity for all athletic trainers, even if injury occurrence is rare.



## **Knee Effusion In An ACL Reconstructed (Hamstring Autograft) Basketball Player Following Accelerated Rehabilitation**

McNew S, Maitra R, Nyland J: Section of Sports Medicine, Division of Orthopaedic Surgery, University of Kentucky, Lexington, KY

**PERSONAL DATA/MEDICAL HISTORY:** A 16 year old male basketball player (ht. 73 inches, wt. 172 lbs), 8 months s/p right knee ACL reconstruction (quadrupled semitendinosus-gracilis (STG) autograft with bioabsorbable interference screw fixation) complained of increased knee effusion and warmth at his right knee. He did not recall a specific episode of trauma or "giving way", however he stated that he landed "funny" while playing a couple nights previously. The athlete had been returned to full basketball participation during the 4<sup>th</sup> post-operative month following demonstration of 90% functional and isokinetic capability compared to the uninvolved lower extremity.

**PHYSICAL SIGNS AND SYMPTOMS:** +2 suprapatellar effusion, no c/o knee pain. +2 medial laxity was present with valgus stress at 30° of flexion, no laxity was evident with valgus stress at 0° of flexion. Anterior Lachman's Test was negative. Pivot shift and Anterior Drawer tests were also negative.

### **DIFFERENTIAL DIAGNOSIS:**

- 1) Medial Collateral Ligament Tear
- 2) ACL Reconstruction Failure
- 3) Medial Collateral Ligament Tear and ACL Reconstruction Failure

**DIAGNOSTIC IMAGING/LABORATORY TESTS:** X-rays of the involved knee were negative for bony abnormalities. MRI results revealed intact and appropriate interference screw placement in their respective tibial and femoral tunnels. A well delineated graft between the 2 bone tunnels was not evident. Significant degeneration of the posterior horn of the lateral meniscus was also evident.

**CLINICAL COURSE:** Diagnostic arthroscopy was scheduled to fully evaluate the autograft and repair or debride the lateral meniscal tear. Previous to this, the athlete and his mother discussed with the surgeon and ATC his desire to play his senior year if at all possible. Arthroscopy confirmed a failure of the quadrupled STG autograft, with only 2 strands of the autograft present. A bucket-handle lateral meniscus tear was apparent, with a large portion wedged within the femoral notch (producing a false negative Anterior Lachman's Test). The meniscal lesion was considered degenerative in nature with a low probability of healing, therefore it was debrided leaving a stable rim. No other pathology was noted. Because of the athlete's desire to play his senior year of basketball, the remaining portion of the damaged autograft was left alone. After a short period of post-operative rehabilitation and functional testing, he returned to play with derotation knee brace protection.

**DEVIATION FROM THE EXPECTED:** This case was unique because no pain or giving way was ever noted. Autograft failure was not easily distinguishable based on functional deficiencies or clinical complaints. Upon arthroscopic evaluation, the autograft appeared to be "reabsorbed" as only a small portion of 2 out of the original 4 strands remained. The method of surgical fixation, and the type of graft used for reconstruction are vital rehabilitative concerns. MRI confirmation of proper interference screw location suggested that failure occurred within the substance of the quadrupled STG autograft. Although the functional capabilities of the athlete returned relatively quickly following quadrupled STG ACL reconstruction, limited data regarding graft healing characteristics, particularly within the bony tunnels may warrant a less aggressive rehabilitative timetable.

## **Pulmonary Emergency In A Collegiate Soccer Player**

Kersey RD, Mumaw C, Max J, Smedley B, Garza C: California State University, Fullerton, CA

**Personal Data:** This case involved a male 20 year old Hispanic student-athlete, in his second year of Division I collegiate soccer. He was 177.8 cm. tall and weighed 68.2 kg. He had no previous history of pulmonary or thoracic injury and/or illness. One month prior, the patient was cleared for intercollegiate athletics following a complete physical exam.

**Physical Signs and Symptoms:** While participating in an intra-squad scrimmage, the subject suddenly, but insidiously, developed deep right-sided thoracic pain. He presented with his right arm held tightly to his side. He described the pain as though "something was blocked", with each inspiration. Exaggerated inhalation increased the pain. His vital signs were within normal limits, although he suffered mild to moderate dyspnea. There was no point tenderness, swelling, or deformity.

**Differential Diagnosis:** Possible pathologies included: idiopathic rib fracture and/or contusions, idiopathic costochondral separation, exercise-induced intercostal strain, spontaneous pneumothorax, and spontaneous pneumomediastinum.

**Results of Diagnostic Imaging/Laboratory Tests:** The patient was taken to the University Health Center, where standard radiographic examination was performed. Results indicated a right-sided 25% spontaneous pneumothorax. He was then transported to a local hospital, where the diagnosis was confirmed.

**Clinical Course:** The patient was monitored for changes at the hospital. The signs and symptoms improved over the next few hours. Upon release, (after approximately four hours), he reported only mild discomfort with deep inspiration. He was instructed to return immediately if signs and symptoms reoccurred. The patient was referred to a thoracic specialist, and restricted from all activity. After two weeks, the pneumothorax had reduced to 10%. Twenty-four days after the initial onset, the student-athlete was released to full activity, with a warning of risk for recurrence. The athlete finished the soccer season without incident.

**Deviation from the Expected:** Serious injury to the thoracic region in sport is rare. Those that occur often involve blunt trauma in contact sports. The present case involved a pneumothorax, without any predisposition or related trauma. A thorough literature review indicated the rarity of this specific diagnosis in sport. Sports health care professionals must continually be aware of these potentially catastrophic situations.





**NOTES:**

## Free Communications, Poster Presentations: Session A

Wednesday, June 17, 1:00 PM - 4:30 PM; Location: Pratt Street Lobby; Authors present from 3:30 PM to 4:30 PM to answer questions

### The Effects Of Subtalar Pronation And Orthotics On Postural Sway

Elbe WM, Van Lunen BL, Perrin DH, Gansneder BM: University of Virginia, Charlottesville, VA

This study determined if orthotics limit postural sway in static, unilateral standing for varying degrees of subtalar pronation. Fifteen subtalar pronators (age = 18.3  $\pm$  2.0 yr, ht = 177.1  $\pm$  7.6 cm, wt = 82.7  $\pm$  23.3 kg, navicular drop = 15.9  $\pm$  4.03 mm) and 16 subtalar nonpronators (age = 20.8  $\pm$  3.5 yr, ht = 175.4  $\pm$  4.5 cm, wt = 78.1  $\pm$  9.96 kg, navicular drop = 5.9  $\pm$  2.6 mm) volunteered to participate for the study. Each subject reported for testing on two occasions. The first session consisted of navicular drop testing and orthotic casting. The second session consisted of two 25-second static, unilateral stances, with and without orthotics, on the Chattecx Dynamic Balance System (Chattecx Corporation, Chattanooga, TN). Testing order was counterbalanced. A repeated-measures one between (group), two within (orthotic and plane) ANOVA was performed. A separate repeated-measures ANOVA was performed for the X,Y coordinates. The ANOVA revealed main effects for orthotic [ $F(1,29)=4.03$ ,  $p<.040$ ] and for plane [ $F(1,29)=159.41$ ,  $p<.000$ ] and no interaction. No main effect was present for differences in X,Y coordinates. Postural sway (A/P, R/L) decreased for both groups when orthotics were worn, but no difference was found between groups. Further research should assess females under the same conditions, testing subjects with less than five millimeters and greater than 15 mm of navicular drop, testing neuromuscular function with orthotic intervention, and dynamic platform conditions.

### Reliability Of The Cybex Reactor In The Assessment Of An Agility Task

Hertel JN, Denegar CR, Buckley WE, Johnson PD: Pennsylvania State University, University Park, PA

The reliability of the Cybex Reactor in the assessment of an agility task was examined. This device quantifies performance of functional agility tasks and is interfaced with an IBM computer, a large screen monitor, and 14 pairs of target sensors. Thirteen (M=12; F=1) varsity and recreational college athletes (age=20.0  $\pm$  1.7 yr; height=183.0  $\pm$  5.2 cm; weight=82.5  $\pm$  10.7 kg) underwent identical testing on 2 days within the same week. Each day subjects performed 4 "Getback 2-1" trials separated by 1.5 minutes rest. This is a preprogrammed protocol in which subjects perform 25 consecutive moves about the 14 different ground targets. Subjects view the targets on the monitor and move to the appropriate ground targets. As subjects touch the appropriate targets, a new pair of targets appears. Subjects were instructed to perform each trial in the shortest possible time. Trial 1 was performed as a familiarization trial and data was not collected. Data was recorded for the next 3 trials. The total time (TOT) to perform a trial is calculated by summing the initial reaction time (IRT), transit time (TRT), and acceleration time (AT). RT is the time from initial cueing on the monitor until the onset of movement. TRT is the time it takes to move between targets. AT is the time weight is placed on the active targets. Reliability was measured using Intraclass Correlation Coefficients (ICC (2,1)). The reliability measures for TOT were better on Day 2 (ICC=.75, SEM=1.75 sec) than Day 1 (ICC=.47, SEM=1.92 sec). Reliability measures for IRT, TRT, and AT were less than TOT scores on both days (all ICC's <.52). Subjects completed the task faster on day 2 (TOT=20.4  $\pm$  2.9 s) than on day 1 (TOT=22.5  $\pm$  2.6 s) ( $p<.05$ ). We conclude that a learning effect is present with repetitive trials. The reliability of TOT was acceptable on Day 2, but not on Day 1. If this device is to be used experimentally, subjects must be given ample practice trials before baseline measurements are recorded. The reliability of IRT, TRT, and AT were not high, however these variables are probably of less interest than TOT to investigators. We attribute the low reliability of IRT, TRT, and AT to the subjects altering their strategies to execute the task with repeated trials. Future research should address the reliability of other preprogrammed protocols and the reliability of measures over longer test-retest intervals.

### Effect Of Breathe Right Nasal Strips (BRNS) On Measures Of Performance In Aerobically Trained Males

West SA, Perry AC, Signorile JL, Morgan RO, VanBemden AL: University of Miami, Miami, FL

Recent research has shown conflicting results regarding the effectiveness of BRNS (CNS, Inc.) on athletic performance. However, those studies have not been conducted using elite endurance athletes. Furthermore, the effects of changes in nasal cross-sectional area (NA) on aerobic performance have not been measured. Therefore, the purpose of this study was to assess the effects of BRNS on performance measures in aerobically trained males to determine whether increases in NA are related to performance improvements. Twenty-nine competitive male distance runners (age = 25.76  $\pm$  5.45 yrs., ht. = 69.43  $\pm$  2.52 in., wt. = 151.14  $\pm$  16.52 lbs.) performed three graded exercise tests on a treadmill under three randomly ordered conditions (BRNS, placebo, control). Subjects and researchers were blinded to the BRNS and placebo conditions. NA was determined by acoustic rhinometry before all three conditions and after application of both strips. Repeated measures ANOVA revealed significant increases in  $\dot{V}O_2$  at ventilatory threshold (VT) ( $p=.0001$ ; BRNS = 3.44  $\pm$  .37 L/min; placebo = 3.24  $\pm$  .35 L/min; control = 3.33  $\pm$  .43 L/min), percent of  $\dot{V}O_{2max}$  at VT ( $p=.002$ ; BRNS = 80.98  $\pm$  5.99; placebo = 77.57  $\pm$  6.83; control = 78.30  $\pm$  6.80), and HR at VT ( $p=.04$ ; BRNS = 165.61  $\pm$  8.91 bpm; placebo = 162.79  $\pm$  9.60 bpm; control = 163.76  $\pm$  8.42 bpm) while wearing the BRNS. No significant differences in peak HR ( $p=.761$ ), VE ( $p=.123$ ), or  $\dot{V}O_{2max}$  ( $p=.334$ ) were observed. When data from subjects under BRNS condition were analyzed, those who demonstrated a change in cross-sectional area  $\geq .15$  cm<sup>2</sup> ("responders") were separated from those who did not ("non-responders"). Responders (n=17) showed significant increases in  $\dot{V}O_2$  at VT ( $p=.0001$ ; BRNS = 3.44  $\pm$  .46 L/min; placebo = 3.18  $\pm$  .43; control = 3.25  $\pm$  .50) and percent of  $\dot{V}O_{2max}$  at VT ( $p=.04$ ; BRNS = 80.16  $\pm$  6.03; placebo = 76.87  $\pm$  7.40; control = 77.24  $\pm$  6.37). Responders also showed non-significant increases in  $\dot{V}O_{2max}$  ( $p=.08$ ), VE ( $p=.11$ ), and HR at VT ( $p=.15$ ) while wearing the active strip, in comparison to placebo and control conditions. Non-responders showed no significant differences in any variables across the three conditions. Our findings demonstrated that BRNS may enhance variables related to aerobic performance. Since responders showed significant improvements in VT variables using the BRNS, significant differences may be attributed to increases in NA. This research provides impetus for further study of individuals responsive to BRNS.



### Intravenous Versus Oral Rehydration During A Brief Period: Heat Illness Symptoms Responses To Subsequent Exercise In The Heat

Casa DJ, Maresh CM, Armstrong LE, Kavouras SA, Herrera-Soto JA, Keith NR, Elliott TA, Hacker FT: Berry College, Mount Berry, GA; University of Connecticut, Storrs, CT

The purpose of this study was to assess if intravenous fluid rehydration, versus oral rehydration, during a brief period (20 min) differentially effects the onset of heat illness symptoms as measured by an Environmental Symptoms Questionnaire (ESQ) following exhaustive exercise in the heat. The ESQ is a valued tool when evaluating for the onset of the signs and symptoms of heat illness. Following dehydration (-4% of body weight), eight heat-nonacclimated men (Age  $23.5 \pm 1.2$  years,  $\text{VO}_2\text{max} = 61.4 \pm 0.8 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ , % body fat  $13.5 \pm 0.6\%$ ) cycled at 70%  $\text{VO}_2\text{max}$  to exhaustion in 36°C. Testing (random, cross-over design) included: 1) CONTROL (C), no fluid during the rehydration period, 2) DRINK (D), oral rehydration (0.45% NaCl) equal to 50% of prior dehydration, and 3) IV (0.45% NaCl) equal to 50% of prior dehydration. Thus, in the D and IV treatments subjects began exercise at -2% of body weight. The ESQ was answered immediately following exhaustion in each trial. Exercise time to exhaustion was not different ( $p > .05$ ) between D ( $34.86 \pm 4.01$  min) and IV ( $29.48 \pm 3.50$  min), but both were significantly ( $p < .05$ ) longer than C ( $18.95 \pm 2.73$  min). ESQ scores were not different ( $p > .05$ ) among C ( $54 \pm 8$ ), D ( $49 \pm 6$ ), and IV ( $51 \pm 5$ ) trials. ESQ/Exercise Time was significantly ( $p < .05$ ) higher in the C ( $3.02 \pm 0.62$ ) trial as compared to D ( $1.36 \pm 0.20$ ) and IV ( $1.80 \pm 0.30$ ) trials. The similarity of scores on the ESQ indicates that the physiological strain associated with exercise to exhaustion is similar regardless of the exercise time, degree of dehydration, or mode of rehydration. The higher ESQ/Exercise Time score in C indicates a faster onset of symptoms with an increasing degree of dehydration. This may have important ramifications since many athletes often exercise to exhaustion during competition and begin exercise at various degrees of dehydration.

### Effects Of Menstrual Cycle On Volumetric Measurement Of The Ankles

Poust DL, Kleiner DM, Holcomb WR: University of North Florida, Jacksonville, FL

Several recent investigations have reported ankle volume, as measured by water displacement, as a dependent variable. However, some of these studies have reported unexplained variations in the data. Upon closer evaluation of the methods used, it was realized that pre-test and post-test measurements of ankle volume appeared to have been made without regard to the date of data collection. It was hypothesized that some of the variance observed in the female subjects could be accounted for by monthly variations in ankle size due to the female menstrual cycle. Therefore, the purpose of this study was to evaluate any influences that menstrual cycle may have on volumetric analysis of the ankles. The left and right ankle volumes of twenty-five female subjects (mean age = 23.8 y, height = 165.9 cm, weight = 61.4 kg) were simultaneously measured by water displacement using standard procedures. Measurements were obtained on four separate occasions each spaced one week apart. The data were then grouped according to the subject's menstrual cycle, beginning with the measurement obtained closest to the onset of menstruation. The reported average duration of the subject's menstrual cycle was  $27.9 \pm 1.1$  days. Sixty-eight percent ( $n = 17$ ) of the subjects had their menstrual cycles regulated by chemical contraceptives. An ANOVA with repeated measures was employed to detect statistical significance. Mean combined (left and right ankles) volumes were  $2162.1 \pm 249.5$ ,  $2157.1 \pm 254.9$ ,  $2172.0 \pm 254.0$ , &  $2161.3 \pm 248.8$  ml, for the 4 trials listed in order based on the onset of menstruation, respectively. The data revealed no significant difference ( $p = 0.226$ ) between trials. These preliminary data indicate that the menstrual cycle does not appear to affect ankle size in healthy young females. Therefore, researchers need not be concerned with the female menstrual cycle when conducting volumetric analysis of the ankle via the water displacement technique. However, more critical analysis of the water displacement technique is needed to account for the unexplained variance sometimes observed.

### Female Endurance Runners' Response To An Ergogenic Dose Of Caffeine

Cokeley KLT, Ball TE: Northern Illinois University, DeKalb, IL

The majority of the research on the ergogenic effects of caffeine has been conducted on males. Despite that the same doping standard applies to men and women, there has been little research on the effects of caffeine on performance in women. The purpose of this investigation was to examine the effects of a moderate caffeine dose on respiratory exchange ratio (RER), blood glucose, and blood triglyceride concentrations in trained female, endurance athletes. Twelve collegiate cross-country runners (age =  $20 \pm 2.4$ ;  $\text{VO}_2\text{max} = 56.4 \text{ ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1} \pm 6.1$ ) began the study and five completed it. Each runner performed two, ten-mile treadmill bouts at 70%  $\text{VO}_2\text{max}$  after ingestion of caffeine (CAF; 5 mg.kg bw<sup>-1</sup>) or a placebo (PLA; 2 mg.kg bw<sup>-1</sup>) solution. The caffeine and placebo were administered in a random, double blind design with at least seven days separating the two runs. The subject's diet was observed via a dietary recall for the three days prior to testing. Additionally, no subject was tested during menses nor was any subject taking oral contraceptives. Wilcoxon Matched-Pairs Signed-Ranks Test displayed no significant differences; RER percent change ( $6.60\% \pm 2.95$  vs.  $7.20\% \pm 5.17$ ,  $p > .1$ ), triglyceride concentrations ( $26.2 \text{ mg}\cdot\text{dL}^{-1} \pm 17.9$  vs.  $24.3 \text{ mg}\cdot\text{dL}^{-1} \pm 17.2$ ,  $p > .1$ ) or glucose concentrations ( $11.6 \text{ mg}\cdot\text{dL}^{-1} \pm 19.4$  vs.  $23.8 \text{ mg}\cdot\text{dL}^{-1} \pm 24.7$ ,  $p > .1$ ) between PLA or CAF trials respectively. These results illustrate that there are no ergogenic effects of a moderate dose of caffeine (5 mg.kg bw<sup>-1</sup>) on RER, blood glucose concentrations, or blood triglyceride concentrations in female collegiate, endurance runners. This is in contrast to the research on men. Ultimately, possible gender specific physiologic differences in response to caffeine should be considered in evaluating doping concentrations. Therefore, a separate women's caffeine doping standard may be warranted.

## Subjective And Objective Assessments Of Nasal Patency In Aerobically Trained Males Before And After Application Of A Breathe Right Nasal Strip

VanBemden AL, West SA, Perry AC, Signorile JL, Morgan RO:  
University of Miami, Miami, FL

Past research has shown that certain individuals may be responsive to Breathe Right Nasal Strips (BRNS) but few exercise studies exist that objectively assess nasal patency, measured by acoustic rhinometry, coupled with a subjective assessment of nasal patency, measured by a "nasal stuffiness" questionnaire. In fact, there are no studies reporting data using both methods of evaluation together. Therefore, the purpose of this study was to use both objective and subjective methods to determine whether subjects who show an increase in nasal cross-sectional area (N) also subjectively report a reduction in "nasal stuffiness" after applying the strip. Twenty-nine competitive male distance runners (age =  $25.76 \pm 5.45$  yrs., ht. =  $69.43 \pm 2.52$  in., wt. =  $151.14 \pm 16.52$  lbs.) completed questionnaires of "nasal stuffiness" with and without a BRNS and with and without a placebo strip on separate days. Subjects were asked to close one nostril while assessing the other on a 1-5 scale (1 being clear and open, 5 being completely blocked). NA was determined by acoustic rhinometry (provided by Kay Elemetrics, Lincoln Park, NJ) before and after application of the strips. When all 29 subjects were analyzed together, repeated measures ANOVA showed significant differences using BRNS in comparison to placebo when assessing changes in NA (left:  $p=.0001$ , right:  $p=.0001$ ). A significant difference ( $p=.012$ ) was also found in changes in right "nasal stuffiness" but no differences were found in changes ( $p=.293$ ) in left "nasal stuffiness." Subjects were then classified as "responders" ( $N=17$ ) if a change in NA  $>.15$  cm<sup>2</sup> was observed in each nasal passage. When subjects were separated (responders vs. non-responders), significant differences were observed in change in nasal cross-sectional area with the BRNS (responders; left:  $p=.0001$ , right:  $p=.0001$ ; non-responders; left:  $p=.032$ , right:  $p=.011$ ) However, no differences were observed in change in "nasal stuffiness" with the BRNS (responders; left:  $p=.096$ , right:  $p=.096$ ; non-responders; left:  $p=.674$ , right:  $p=.067$ ) This study supports previous research indicating that certain individuals are responsive to BRNS. Our research also supports the need for further modifications in the subjective evaluation of nasal patency. Therefore, current subjective assessments of nasal patency should not be used alone but rather in conjunction with objective measures such as acoustic rhinometry.

## The Effect Of Naloxone On Anaerobic Threshold Evaluation During Incremental Cycle Ergometry In A Fit Population

Sgherza A, Haas F, Fain R, Schwartz E, Hoffman R, Axen K:  
Department of Medicine, Division of Pulmonary and Critical Medicine, New York University, School of Medicine, New York, NY

On two separate days, eighteen adults (13 males, 5 females, mean age = 30.1, range 21-35) completed a 25 watts/min incremental bicycle ergometer test to exhaustion following an intravenous bolus of either naloxone (30 mg) or an equivalent amount of saline (placebo). The participants and investigator were blinded to the intravenous bolus administration and the session for which they received either the opiate blockade (naloxone) or placebo was determined randomly during these crossover trials. The parameters of maximal exercise capacity measured were peak oxygen consumption (VO<sub>2</sub> peak), maximum heart rate (HR max), maximum work rate (W max), maximum time (T max), maximum ventilation (V<sub>e</sub> max) and maximum lactate accumulation (La max). In addition, the participants subjectively rated their perceived effort (RPE) during the incremental bicycle ergometry tests according to the Borg rate of perceived exertion scale. Anaerobic threshold was derived from lactate (lactate anaerobic threshold) and ventilatory (ventilatory anaerobic threshold) data. Placebo versus naloxone data revealed that T max ( $740 \pm 37$  vs  $710 \pm 34$  sec, mean  $\pm$  SE), VO<sub>2</sub> peak ( $49.4 \pm 2.9$  vs  $46.8 \pm 2.7$  ml/kg/min), W max ( $324 \pm 15.5$  vs  $310 \pm 14.5$  watts), and HR max ( $171 \pm 2.1$  vs  $167 \pm 2.2$  bpm) were lower following naloxone infusion ( $p < .05$ ). V<sub>e</sub> max ( $126.5 \pm 6.1$  vs  $121 \pm 5.0$  l/min) and La max ( $8.1 \pm .5$  vs  $7.8 \pm .41$  mmol) appeared to be lower with naloxone; however, these were not statistically significant. LAT and VAT measures did not differ between placebo and naloxone. Conversely, RPE was elevated under the influence of naloxone compared to placebo indicating that effort perception was amplified despite the performance of less work in less time with a lower peak oxygen consumption and a lower maximum heart rate. These data suggest that exercise capacity is partly influenced by effort perception which can be modified by endorphins.



# Effect Of A Semi-Rigid Prophylactic Ankle Stabilizer On Performance In Post-Acute, Functionally Impaired Ankle Sprain Subjects

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The purpose of this study was to determine the effect of the Aircast Sportstirrup™, a semi-rigid prophylactic ankle stabilizer (PAS), and a non-braced control on performance involving agility and vertical jump in post-acute ankle sprain subjects. Eight males and 17 females (mean height 66.5 + 13 in., mean weight 134 + 65 lbs., and mean age 16.2 + 6 years) participated in the study. All subjects were post-acute grade I or II lateral or medial ankle sprains and were cleared medically by their attending physician to return to activities of daily living. Each subject's post-acute injured ankle was mechanically stable as determined by clinical examination (i.e., inversion and eversion talar tilt and anterior drawer tests) by the attending physician. In addition, each subject exhibited less than a 10% bilateral deficit in ankle plantarflexion/dorsiflexion and inversion/eversion range of motion and strength. However, subjects were functionally impaired (i.e., postural instability) in their post-acute injured ankle as determined via the modified Romberg Test. The performance testing phase of the study consisted of subjects completing one pre-test and two test sessions for record. The pre-test was completed to familiarize subjects with the testing protocol. During the two test sessions subjects completed one sub-maximal and two maximal 40-yard shuttle run and vertical jump tests while braced (post-acute injured ankle only) and non-braced. Brace condition and performance test order were randomized within each test session. Test session I was completed 3-5 days after the pre-test. Following test session I, subjects wore the PAS during activities of daily living for 5-7 continuous days and were then retested during test session II. Subjects were not verbally encouraged during testing and were required to use the same low-top sneakers during all testing. Results of the study revealed that shuttle run time was significantly faster ( $p < .01$ ) for the braced condition (mean = 9.43) than for the nonbraced control condition (mean = 9.57), regardless of test session. In addition, shuttle run time was significantly faster ( $p < .05$ ) for test session II (mean = 9.43) than for test session I (mean = 9.57), regardless of brace condition. No significant main or interaction effects occurred for vertical jump.

The results of this study indicate that use of the Aircast Sportstirrup™ significantly increased shuttle run performance, but not vertical jump performance, in post-acute ankle sprain subjects who are mechanically stable but functionally impaired. This effect was immediate and did not require PAS acclimation.

# Ankle Bracing And Lower Extremity Muscle EMG Activity During Inversion Loading

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The effect of external ankle support in restricting joint range of motion has been well documented; however, the specific role ankle bracing has on the electromyographic (EMG) activity of the leg musculature during dynamic movement has not been extensively studied. Thus, the objective of this study was to evaluate the effects of two commonly used ankle braces on the EMG activity of selected lower extremity muscles during dynamic foot inversion at three different loading points. Twenty-four healthy males performed five trials of a lateral shuffling movement at a rate between 80-90% of their maximal shuffle speed under three ankle brace conditions (no brace - control, Aircast Sportstirrup, Active Ankle). EMG activity of the peroneus longus (PL), tibialis anterior (TA), and medial gastrocnemius (MG) during foot contact on a force platform were digitally converted, processed, and analyzed using customized software to derive nine specific dependent measures: PL activity at lateral peak impact force (PLLPIF), PL activity at lateral maximum loading force (PLLMLF), PL activity at lateral peak propulsion force (PLLPPF), TA activity at lateral peak impact force (TALPIF), TA activity at lateral maximum loading force (TALMLF), TA activity at lateral peak propulsion force (TALPPF), MG activity at lateral peak impact force (MGLPIF), MG activity at lateral maximum loading force (MGLMLF), MG activity at lateral peak propulsion force (MGLPPF). A repeated measures analysis of variance revealed that ankle bracing reduced PLLPIF ( $P < 0.05$ ) compared to the control condition, although no differences were noted between braces. Ankle bracing did not affect PLLMLF ( $P > 0.05$ ), PLLPPF ( $P > 0.05$ ), TALPIF ( $P > 0.05$ ), TALMLF ( $P > 0.05$ ), TALPPF ( $P > 0.05$ ), MGLPIF ( $P > 0.05$ ), MGLMLF ( $P > 0.05$ ), and MGLPPF ( $P > 0.05$ ). The results of this study suggest that these ankle braces function to reduce the strain placed on the peroneus longus during initial peak impact force. During maximum loading and peak propulsion force, the braces tested do not alter PL, TA, and MG muscle function. Based on these data, it may be speculated that these braces may aid in absorbing external inversion force placed at the foot and ankle during initial contact as evidenced by reduced PL activity.

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### Comparison Of Three External Ankle Support Systems Utilized For Management Of Acute Lateral Ankle Sprains

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Lateral ankle sprains are one of the most common injuries incurred in athletics. Research suggests that prolonged instability may be related to specific treatment regimens, which focus solely on protection or edema reduction. Various external ankle support systems intended to provide protection against further ankle injury have been developed and studied. The purpose of this study was to examine three different types of external ankle support systems used in treating acute lateral ankle sprains. The research was conducted using 30 subjects who sustained acute Grade II lateral ankle sprains. Each subject was assessed for ankle volume, functional performance, and self-perception of symptoms during five post-injury assessments. Subjects were randomly placed into one of three groups within 24 hours post-injury, standard elastic wrap with horseshoe (10 males,  $21.7 \pm 3.4$  years, ht. =  $183.9 \pm 3.4$  cm, wt. =  $81.5$  kg), Aircast Sport Stirrup (9 males & 1 female,  $20.2 \pm 1.2$  years, ht. =  $178.6 \pm 7.4$  cm, wt. =  $75.7 \pm 11.5$  kg), and Omni Multiphase orthosis (8 males & 2 females,  $21.2 \pm 1.5$  years, ht. =  $179.1 \pm 9.4$  cm, wt. =  $78.2 \pm 14.2$  kg), and were tested on days 1, 2, 3, 5, and 7 post-injury. Subjects wore their respective ankle support systems during waking hours, while abstaining from anti-inflammatory medications and extraneous physical activity involving the lower extremities. Standardized rehabilitation instructions were followed for each of the three groups. Results revealed no significant differences among the three groups on measures of ankle volume, functional performance, and self-perception of symptoms ( $p > .05$ ). In addition, correlational analysis between level of function and volume revealed significant correlations for the elastic wrap group, but not for the Aircast and Omni groups. The standard elastic wrap with horseshoe revealed significant negative correlations between level of function and ankle volume on day 5 ( $r = -.79$ ,  $p < .01$ ) and day 7 ( $r = -.80$ ,  $p < .01$ ) postinjury. Various possibilities exist for this difference between rigid external ankle support systems and the elastic wrap, such as perceptual support confidence or volume swelling distribution patterns. Overall, the most important finding is that none of the methods used are superior to the others for reducing swelling, restoring functional performance, or relieving symptoms during the acute management of lateral ankle ligament sprains. These results would indicate that clinicians should base their management decision for lateral ankle sprains on budgetary constraints, availability, and patient comfort rather than on manufacturers' advertised testimonials.

### The Effects Of Short Term Ankle Bracing On Balance

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The effects of long term ankle bracing on balance have been studied and are being reported in a companion study. This investigation, which was designed to evaluate short term ankle bracing, was necessary to determine whether the changes observed in the long term study were due to chronic adaptations or to more acute factors. Thus, the purpose of this investigation was to determine any effects of short term ankle bracing on balance. Eleven male volunteers (mean age =  $22.3$  y) served as subjects in the experimental group by wearing bilateral ankle braces for one day. An additional eleven male subjects (mean age =  $22.7$  y) served in a control group and were not braced. All subjects were pre-tested for static and dynamic balance on a Chattecx™ balance system for ten seconds during: static (ST), plantar flexion/dorsiflexion (P/D) inversion/eversion (IN/EV, and anterior/posterior (A/P) conditions. Following the pre-test, subjects in the experimental group were fitted with commercially available lace-up ankle braces and instructed to wear the braces for 24 consecutive hours. All subjects were then post-tested in an identical fashion to the pre-test. Balance measures are reported as sway index in centimeters. Pre- to post-test changes in balance were analyzed by t-tests and are presented as mean changes. Significant changes ( $p < 0.05$ ) were found within the experimental group for all tests. The mean changes in postural sway for the experimental group were;  $0.670$ ,  $1.182$ ,  $1.053$ , and  $0.970$  cm for ST, P/D, IN/EV, and A/P, respectively. All values increased from pre-test to post-test indicating postural sway became worse with bracing. Postural sway for the control subjects did not significantly change ( $p > 0.05$ ) from pre-test to post-test, except for the A/P condition which did improve significantly ( $p = 0.0402$ ), indicating a potential learning effect. The mean changes in postural sway for the control group were;  $0.015$ ,  $0.058$ ,  $0.033$ , and  $0.099$  cm for ST, P/D, IN/EV, and A/P, respectively. These preliminary data suggest that short term ankle bracing does affect static and dynamic balance. Additional research to determine what other effects bracing may have on balance and proprioception is advised.

### The Effects Of Long Term Ankle Bracing On Balance

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University of North Florida, Jacksonville, FL

It is a common belief that long term prophylactic taping or bracing may lead to a general weakening of the ankles. However, this perception appears to be based on testimonials and not on scientific investigation. Other recent studies have suggested that ankle stability may include components of proprioception, as well as strength. Therefore, the purpose of this study was to determine any effects of long term ankle bracing on balance. Thirty-nine male and female volunteers (mean age =  $22.7$  y) served as subjects in the experimental group by wearing bilateral ankle braces for the duration of the study. An additional ten subjects (mean age =  $24.0$  y) served in a control group and were not braced. All subjects were pre-tested for static and dynamic balance on a Chattecx™ balance system for ten seconds during: static (ST), plantar flexion/dorsiflexion (P/D) inversion/eversion (IN/EV), and anterior/posterior (A/P) conditions. Following the pre-test, subjects in the experimental group were fitted with commercially available lace-up ankle braces and instructed to wear the braces daily for a duration of eight hours. Following a period of seven weeks, all subjects were post-tested in an identical fashion to the pre-test. Balance measures are reported as sway index in centimeters. Pre- to post-test changes in balance were analyzed by t-tests and are presented as mean changes. No significant changes ( $p > 0.05$ ) were found within the experimental group for any condition. The mean changes in postural sway for the experimental group were;  $0.006$ ,  $0.011$ ,  $0.025$ , and  $0.178$  cm for ST, P/D, IN/EV, and A/P, respectively. All values increased, or became worse, from pre-test to post-test, however, these increases in postural sway were not significant. No changes were observed in the control subjects for ST or P/D. However, the control subjects did exhibit a significant improvement in postural sway during the IN/EV ( $p = 0.0019$ ) and A/P ( $p = 0.0148$ ) conditions, from pre- to post-test which may indicate a learning effect. These preliminary data suggest that long term ankle bracing does not appear to have a significant affect on static or dynamic balance.



## NOTES:

## Free Communications, Poster Presentations: Session B

Thursday, June 18, 8:00 AM - 11:30 AM; Location: Pratt Street Lobby; Authors present from 10:30 AM to 11:30 AM to answer questions

### Intratester Reliability Assessing Postural Stability On The Biodex Stability System

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It is common to assess postural stability following injury. However, the effect of this measurement over time has not been determined. This study examined intratester reliability of postural stability on the Biodex Stability System during a 3 week period. Sixteen males and 13 females (mean age = 24.4 (3.1 yrs, wt = 77.3 (14.4 kg, ht = 174.8 (9.9 cm) with no history of lower extremity pathology within 1 year participated in this study. Subjects were tested three times a week for the following stances: right single-limb, left single-limb, and bilateral limb postural stability. Order of testing was counterbalanced to reduce any learning effects. Postural stability was assessed as the degrees of displacement in the anterior-posterior and medial-lateral directions. The Stability Index, as provided by the Biodex Stability system was used as the dependent measure. Subjects performed two, 20-second practice trials prior to each test for each stance. The test procedure consisted of the platform moving for a 20-second time period from the most stable position (level 8) to the least stable position (level 1). One test trial was performed in each of the three stances, three times a week for three weeks. A 1 x 3 repeated measures analysis of variance (ANOVA) with one between subject factor and three within subject factors (week, extremity, and plane) was used to examine differences in single-limb postural stability. A 1 x 2 repeated measures ANOVA with one between subject factor and two within subject factors (week and plane) was used to examine differences in bilateral postural stability. Repeated measure ANOVA's indicated a significant effect for single-limb anterior-posterior postural stability for extremity, week, and extremity/day ( $p < .05$ ). Tukey HSD tests determined that the only significant difference existed for week ( $F [1,28] = 3.78$ ,  $p < .05$ ). Repeated measure ANOVA's indicated a significant effect for bilateral medial-lateral postural stability for week. Subsequent tests for simple effects at the  $p < .05$  alpha level indicated no significant differences. Intraclass correlation coefficients (ICC) and standard error of measurement (SEM) for right single-limb stance in the medial-lateral direction ranged from .51 to .72,

and .71 to 1.33. ICC's for left single-limb stance in the medial lateral direction ranged from .49 to .78, and SEM's from .97 to 1.19. ICC's for bilateral stance in the medial-lateral direction ranged from .46 to .61, and SEM's from .76 to .87. ICC's for right single-limb stance in the anterior-posterior direction ranged from .49 to .67, and SEM's from .89 to 1.27. ICC's for left single-limb stance in the anterior-posterior direction ranged from .49 to .61, and SEM's from 1.03 to 1.21. ICC's for bilateral stance in the anterior-posterior direction ranged from .44 to .56, SEM's from .94 to 1.27. Results indicate ICC values ranged from fair to poor. More importantly, the lack of significant difference between weeks indicates that clinicians can be confident when comparing postural stability values from week to week on the Biodex Stability System. The significant difference between single-limb stance in the anterior-posterior direction suggests that further study is warranted to assess if these differences exist in an acute or chronically unstable population.

### A Comparison Of Spine Boarding Techniques: Log Roll Versus Lift And Slide

Martin L, Anderson K, Lansing K, Ingersoll CD, Sandrey MA: Athletic Training Department, Indiana State University, Terre Haute, IN

Objective: (1) To compare maximum movement in flexion/extension, lateral flexion, and rotation of the cervical spine during a log roll and lift and slide, and (2) to determine the importance of practicing these immobilization techniques, and to suggest which method should be used by groups that are practiced and those that have never performed either task as a group. Design and setting: This study used a 2x2x2 factorial design. The independent variables were spine boarding techniques (log roll and lift and slide), experience (practiced and unpracticed), and ordinal position (perform log roll or lift and slide first). The three dependant variables were peak maximum movement in the cervical spine during flexion/extension, lateral flexion, and rotation. Research was performed at the Athletic Training Research Laboratory at Indiana State University. Methods: Five Emergency Medical Technicians (EMTs), fifteen Certified Athletic Trainers (ATCs), and fifteen student athletic trainers. Two volunteers to act as athletes being immobilized during practice and data collection. Subjects were randomly placed into one of five groups. Each group was instructed via video in proper immobilization procedures then their first two trials were recorded as unpracticed trials using the PCReflex System. Each group then proceeded to practice eight times. The following week, the groups returned and performed two more trials to be recorded as practiced trials, then proceeded to follow the same protocol for the technique they had not yet performed. Results: There was no significant difference found in ordinal position or whether the groups were practiced or unpracticed. There was a significant difference between the log roll and lift and slide techniques in flexion/extension, lateral flexion, and rotation. Conclusions: The lift and slide was found to be the best method of these two spine boarding techniques in terms of least amount of cervical spine movement in flexion/extension, lateral flexion, and rotation. Further research should investigate the effects of practicing each spine boarding technique with less time between practice and recording trials, more practice trials, different types of equipment to record the trials, and performing the trials on an actual field of grass. Also, the study of cervical spine movement during the log roll when an athlete is in the prone position, and comparing these spine boarding techniques using the same methods we used to verify our findings is highly recommended.



### The Accuracy Of Magnetic Resonance Imaging In Diagnosing Meniscus Tears

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PA

Magnetic Resonance Imaging (MRI) plays a valuable role in the evaluation of the full range of meniscal pathology, including the primary diagnosis of a meniscal tear, the detection of a recurrent tear after resection or repair, and the demonstration of associated injuries such as anterior cruciate ligament disruption or other complications. The accuracy of MRI is dependent on the appropriate choice of MRI pulse sequences, imaging parameters, and diagnostic criteria. The purpose of our study was to categorize errors in interpretation of MRI of the knee and explain the discrepancy between MRI and diagnostic arthroscopic findings. Two hundred and thirty-one patients underwent arthroscopy and MRI of the knee over a two year period. Prospective and retrospective ratings were used to categorize tear type and location. These readings were conducted by four radiologists of similar background and experience. The MRI was conducted by the spin-echo technique, with four standard views taken (T2PD sagittal, PD coronal, T1 coronal, and flash 2D axial). The results of our study showed that the MRI and video arthroscopy concurred 71% of the time, with 29% having some discrepancy. The distribution of errors for those that did not concur are as follows: false negative medial meniscal tears - 15%; false negative lateral meniscal tears - 52%; false positive lateral meniscal tears - 10%; false positive medial meniscal tears - 6%; other - 17%. Many factors involved have been identified as potential sources of error: radiologists reading of the MRI, the MRI views taken, the time passed from the MRI to the time of the video arthroscopy, identifying a very small tear vs fraying, or occlusion by the popliteus tendon (especially in reading lateral meniscal tears). The MRI continues to be an effective diagnostic tool and as technology advances the percentage of error should decrease. It is the role of the athletic trainer to be aware that discrepancies do exist and may affect the outcome for the patient.

### Subtalar Joint Range Of Motion: Manual Goniometry Vs. Electronic Goniometry

Hoewischer PE, Holcomb WR, Kleiner DM, Ragatz AE: University of North Florida, Jacksonville, FL

The instruments used to measure range of motion (ROM) most accessible to athletic trainers are the hand held (manual) goniometer and the electronic goniometer that is a part of an isokinetic dynamometer. The purpose of this investigation was to compare ROM, from inversion to eversion, when measured with a manual goniometer versus when measured by the electronic goniometer within the Biodex™ multi-joint testing system. Seventy-one volunteers (mean age = 22.8 y, height = 174.3 cm, weight = 75.6 kg) served as subjects. Passive inversion/eversion ROM was assessed for each subject manually and electronically within minutes of each other. The data were analyzed with a paired t-test and are presented as means ( $\pm$  S.D.). The results from the t-test revealed a significant difference in ROM between the two assessment techniques ( $p = .0001$ ). Mean values for inversion/eversion ROM were  $31.9^\circ \pm 9.3^\circ$  by manual goniometry and  $80.7^\circ \pm 16.4^\circ$  by electronic goniometry. More detailed scrutiny of the techniques revealed the source of the significant difference in ROM. The manual technique appeared to limit movement to "true" inversion and eversion because the examiner was able to restrict movement to the subtalar joint. Whereas, the movement that occurred during measurement with the Biodex™ electronic goniometer did not appear to measure only inversion and eversion. Instead, it is thought that the movement on the Biodex™ more closely resembles supination (combined movement of plantar flexion, inversion and foot adduction) and pronation (combination of dorsiflexion, eversion and foot abduction, rather than true inversion and eversion at the subtalar joint. Based on our data and observations, we suggest that manual goniometry be used for assessing ROM of the ankle, particularly when attempting to isolate movement at the subtalar joint. In addition, when testing ROM or strength at the ankle with an electronic goniometer and isokinetic dynamometer, care should be taken in identifying movements traditionally described as inversion and eversion.

### Effects Of Estrogen And Progesterone On Female Knee Joint Laxity

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Female athletes have a high incidence of anterior cruciate ligament (ACL) injury compared to their male counterparts. A hormonal influence on knee joint laxity has been suggested, along with other gender-related factors as being associated with this increased injury rate. The purpose of this study was to determine if women experience significantly greater knee laxity in conjunction with estrogen and progesterone surges during a normal 28 - 30 day menstrual cycle. Subjects were 11 healthy, active females ages 18 - 35 years, with at least one apparently healthy knee (no known knee anomalies). Serial estrogen and progesterone levels were measured via radioimmunoassay procedures to identify the follicular and luteal phases of a subject menstrual cycle and to specify periods of peak hormonal surges. Concomitant knee laxity measures were taken using the KT-2000 (MEDmetric, San Diego). A within-subjects design repeated measures analysis of variance was applied to determine presence or absence of significant differences in knee laxity values over the course of a subject's menstrual cycle. Tests of within-subjects contrasts revealed statistically significant differences ( $p < .05$ ) in knee laxity between 1) baseline (day 1) and Day 21, 2) days 13 and 21, 3) days 20 and 21 and 4) days 21 and 23 of the subject's cycle. Day 1 corresponds to the menstrual phase when estrogen and progesterone levels are at their lowest. Day 13 corresponds to peak estrogen surge (follicular phase) and days 20, 21 and 23 correspond to peak progesterone surge (luteal phase). These results indicate that further investigation into the clinical significance of these findings is warranted.

### Comparative Analysis Of Lower Extremity Loading Forces During Exercise On The Excel Glider Exercise Device

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The purpose of this evaluation was to measure the vertical reaction forces associated with exercise on the Excel Glider exercise device developed by Fitness Quest Inc. Twelve subjects were recruited from the population of the University of Toledo. Mean ages for males and females were 26.75 and 21.30 years of age, respectively. Mean weights for males and females were 163.6 lbs and 129.5 lbs, respectively. The device was placed on two AMTI force platforms. The output of the platforms was analog to digital converted at a sampling rate of 240 Hz, and measured by a computer program custom written for this application. Each subject underwent a two phase testing process. The first phase was used to acclimate the subject to the device as well as to find the 70% of their age-adjusted maximum exercising heart rate. The second phase of the testing included a five minute bout of exercise which produced a heart rate of 60% of their age-adjusted max. During this period three samples of force platform data (each of five seconds) were recorded at approximately one minute intervals. This process was then repeated at cadences that produced heart rates of 70% and 80% of their age adjusted heart rate maximum. A single representative curve of the five second data samples were selected and analyzed which resulted in three force curves for each of the subject's conditions. Force values were normalized by dividing them by the subject's weight. Thus, the units for measurement of force were "body weights", and the units for loading rate are "body weight-seconds". Averages for the loading rates at the 60%, 70%, and 80% age adjusted maximums were 1.013 bw's, 1.077 bw's, and 1.168 bw's, respectively. These values are comparable to what would be seen in an activity such as walking at a comfortable speed. These values were low due to the lack of a single support phase as is found in walking and running. The design of the Excel Glider keeps an even body mass distribution between the lower extremities throughout the motion. The loading rates were also found to be low as compared to activities such as jogging and high impact aerobics. These values were due to the design of the device allowing more control for vertical and horizontal motion. The Excel Glider appears to be a safe and efficient device for those who wish to improve their aerobic capacity.

### The Effects Of Gender, Hand Size And Grip Strength On The Ability To Remove A Football Helmet Face Mask

Redden WW, Kleiner DM, Holcomb WR: University of North Florida, Jacksonville, FL

Several recent investigations have reported the time that it takes to remove the face mask for a football helmet. Many of these studies have cited difficulties, particularly with females, in cutting the straps that secure the face mask to the helmet when using the Trainers Angel™ (TA). However, previous studies failed to report significance, perhaps due to methodological constraints. The purpose of this study was to re-evaluate any influences that hand size or grip strength may have on the time that it takes to cut the face mask strap, with altered methods of data collection. Fifty-one student athletic trainers (36 males, 15 females) served as subjects. After receiving standard instructions, each subject cut through a single Surlyn ArmorGuard™ face mask strap with both the TA and an anvil pruner (AP). The order of testing was assigned and counterbalanced. Grip strength was assessed by hand grip dynamometry from the best of three trials. Hand size was measured for both length and width. The subjects also reported a rating of satisfaction with a 10-point scale. Data were analyzed by t-tests and correlation coefficients, and are presented as means ( $\pm$  S.D.). Time to cut the face mask strap was significantly ( $p < 0.05$ ) better with the AP 24.56 s ( $\pm 16.6$  s), than with the TA 103.55 s ( $\pm 113.1$  s). The ratings of satisfaction were also significantly different between the TA 3.06 ( $\pm 2.1$ ) and the AP 7.35 ( $\pm 1.6$ ). Hand width, hand length and grip strength had a greater affect on time with the TA ( $r = -.59, -.52, \& -.66$ , respectively), than it did with the AP ( $r = -.18, -.03, \& -.16$ , respectively). When analyzed by gender, time was significantly ( $p < 0.05$ ) different between males and females for the TA ( $M = 42.01 \pm 28.5$  s;  $F = 218.79 \pm 133.8$  s), but not for the AP ( $M = 23.43 \pm 10.7$  s;  $F = 31.16 \pm 22.8$  s). The present study found differences between the TA and AP, but unlike previous studies was able to attribute some of the differences between tools and gender to hand size or grip strength.

Face mask straps were provided by Schutt Manufacturing Co.

### Single Treatment Contrast Bath And Cold Whirlpool May Have No Effect On The Symptoms Associated With DOMS

Eastep C, Hayes E, Mochizuki M, Ingersoll CD, Edwards JE, Behnke RS: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** One of the primary goals during rehabilitation is to control pain which can limit range of motion (ROM) and function preventing an athlete from performing prescribed exercise or activity. Researchers often use DOMS as a model of injury for the purpose of studying various modalities and their effectiveness in controlling pain. The purpose of this study was to compare the effectiveness of cold whirlpool and contrast therapy on symptoms associated with delayed onset muscle soreness (DOMS). **Design and Setting:** ROM, maximum voluntary isometric contraction (MVIC) and I-EMG of submaximal contractions of the bicep brachii were all measured on day 1. DOMS was then induced. Forty-eight hours later ROM, pain, and I-EMG of submaximal contractions were measured. Subjects then received either a control treatment, contrast bath, or cold whirlpool treatment for twenty minutes. Measurements for all variables were then taken and one hour later taken again. **Subjects:** Twenty-seven college age students (15 male and 12 female) age  $21.5 \pm 4.4$  years with no history of pain or injury to the non-dominant arm in the past two months volunteered to participate in this study. **Measurements:** ROM of the elbow was measured using a plastic goniometer. Pain was measured using a McGill pain questionnaire. Neural inhibition was determined by using the line of best fit for force versus I-EMG and then calculating the slope and y-intercept for this line. ROM, slope and y-intercept were measured before DOMS was induced, before treatment, after treatment, and one hour after treatment. Pain was measured before and after treatment and one hour after treatment. **Results:** A repeated measures ANOVA found no significant difference between treatment groups among any of the variables. **Conclusions:** There does not appear to be any benefit to using cold whirlpool or contrast therapy to control the pain, loss of ROM, and strength associated with DOMS.



### Whirlpool Therapy In The Treatment Of The Signs And Symptoms Of Delayed Onset Muscle Soreness

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Muscular soreness resulting from physical activity may be classified as acute or delayed in onset (DOMS). Various clinicians and researchers have attempted to prevent and treat the signs and symptoms of DOMS, however results have been varied and inconsistent. Specifically, the use of superficial heat and cold application in the treatment of DOMS has had minimal investigation, and superior treatment has yet to be determined. Therefore the purpose of this investigation was to determine the efficacy of warm whirlpool, cold whirlpool, and contrast therapy in the treatment of delayed onset muscle soreness (DOMS). Subjects for this investigation included fifty-six gender-matched (age = 19-25 yr. (4.5 yr.) volunteers from the University of Pittsburgh. Subjects were randomly assigned to one of four treatment groups: warm whirlpool (WW), cold whirlpool (CW), contrast therapy (CT) or no treatment at all (CON). Induction of DOMS was performed with eccentric contractions of the elbow flexors, and four twenty-four minute treatments were administered with WW, CW, CT or CON. Measurements were taken for: degrees of resting elbow flexion (REF) and active elbow flexion (AEF) and extension (AEE); perceived soreness values on a graphic pain rating scale (PAIN); and maximal voluntary isometric contraction (MVIC). Measurements were taken pre-exercise, prior to administration of treatment at 24, 48, and 72 hours post-exercise, and at 96 hours post-exercise. A repeated measures ANOVA (group (time) was performed for each dependent variable, and Tukey post hoc analysis was utilized to determine which treatment groups differed significantly in returning subjects to pre-exercise values ( $p < .05$ ). Results indicated that CW and CT were found to return subjects to baseline values of REF and PAIN significantly more than WW or CON ( $p < .05$ ). Additionally, WW was found to be more effective than CON in the return of REF to baseline values ( $p < .05$ ). There was no significant difference found between CW or CT groups for any dependent variables. The results of this investigation suggest that cold whirlpool and contrast therapy are more effective than warm whirlpool or no treatment in alleviating DOMS in the elbow flexors. Further research and clinical application need to be made into the physiological effects of contrast therapy. Different ratios of warm to cold whirlpool immersions, as well as different temperature ranges may help to delineate the combined effects of whirlpools in contrast therapy.

### The Effects Of Ice Immersion On Concentric And Eccentric Isokinetic Muscle Performance In The Ankle

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The effects of cryotherapy on tissue healing have been extensively studied and documented. The extent to which cryotherapy effects muscle performance has not been examined with as much scrutiny, especially the effects on eccentric muscle activity. The purpose of this study was to determine the effect of cryotherapy on isokinetic ankle strength immediately after ice immersion treatment. Twenty college aged males (age =  $19.6 \pm 1.27$  yr., wt =  $80.5 \pm 12.2$  kg, ht =  $178.1 \pm 7.9$  cm) volunteered to participate in the study. Each participant was free from any lower extremity cold allergies and injuries at the time of the study. Concentric (CON) and eccentric (ECC) isokinetic ankle strength was measured using a Kin Com 125 AP (Chattanooga Group, Hixson, TN) isokinetic dynamometer. Plantar flexion, dorsiflexion, inversion and eversion motions were assessed at speeds of 60°/s and 120°/s before and immediately after an ice immersion treatment. Subjects submerged their lower leg up to the tibial plateau in a 100°C ice immersion bath for 20'. Maximal isokinetic test bouts were performed with encouragement and visual feedback. Peak torque (PT) values were extracted from the maximal torque curves and used in the data analysis. Data were analyzed using a repeated measures ANOVA to determine if any differences existed between pre (PRE) and post (POST) test strength values. A separate analysis was performed for each of the four motions tested and each type of muscle action. A total of eight ANOVA's were executed. The within subject factors included test (PRE vs. POST) and speed (60°/s vs. 120°/s). As expected, ECC PT was higher than CON PT at both speeds and was not affected by ice immersion treatment. The only notable finding was a significant main effect for test (PRE vs. POST) for CON dorsiflexion ankle strength [ $F(1,19) = 6.37, p = .021$ ]. The Tukey post hoc test determined that POST test PT values ( $39.72 \pm 12.69$  Nm) were significantly lower than PRE test scores ( $45.93 \pm 11.15$  Nm). This finding suggests that CON dorsiflexion strength in the ankle may be adversely affected immediately after ice immersion application. In support of previous research, this finding may have resulted from decreases in nerve conduction velocities and decreased speed of CON muscle contraction in the ankle dorsiflexors. Interestingly, ECC strength was not adversely affected. However, clinicians should still exercise caution when allowing athletes to return to competition immediately following ice immersion application to the lower leg.

### Cryotherapy Inhibits Secondary Injury In Skeletal Muscle

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The most common rationale for the acute use of cryotherapy involves retarding secondary hypoxic and secondary enzymatic injury. Although the secondary injury model has been widely accepted for over twenty years, secondary injury has not yet been documented or quantified. The purpose of this study was to document the presence of secondary injury, quantify it, and determine if it is altered by acute cryotherapy. Secondary injury following acute trauma to skeletal muscle was quantified using a spectrophotometric assay based on the reduction of triphenyltetrazolium chloride (TTC) to triphenylformazan (formazan red) by cytochrome oxidase, the terminal enzyme of oxidative phosphorylation. Crush injuries to the triceps surae of 19 adult male Sprague-Dawley rats were treated either continuously with ice for five hours ( $N=10$ ) or received no ice treatment ( $N=9$ ). Tissues were harvested and homogenized at five hours post-injury and assayed for cytochrome oxidase activity manifested as TTC reduction. Data were analyzed using a fixed model, 2 X 2 ANOVA with one between factor (treatment) and one within factor (limb), and for injured limbs, an ANCOVA comparing treated to non-treated. A significantly lower TTC reduction rate was seen in both cold treated injured tissue ( $6.59 \pm 1.01$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup>) and non-treated injured tissue ( $4.48 \pm 0.79$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup>) compared with uninjured controls ( $7.94 \pm 1.49$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup> for ice group and  $6.62 \pm 0.75$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup> for no-ice group). This indicates that crushing muscle tissue produces injury measurable with the TTC reduction assay. Additionally, in tissues receiving uniform crush injuries, a significantly lower TTC reduction rate was seen in untreated tissues ( $4.48 \pm 0.79$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup>) than in ice treated tissues ( $6.59 \pm 1.01$   $\mu\text{g}\cdot\text{mg}$  muscle protein<sup>-1</sup>·hr<sup>-1</sup>), indicating that cryotherapy reduces the magnitude of secondary injury. From these data it can be concluded that secondary injury occurs following primary crush injury and that this secondary injury is retarded by acute treatment with five hours of continuous cryotherapy.

### The Effects Of Muscle Trauma And Cold Application On Indicators Of Oxygen Free Radicals (OFR) And Protein Levels In Exercise-Trained Rat Skeletal Muscle

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The purpose of this study was to examine the effects of muscle trauma and of cold application on indicators of oxygen free radical (OFR) and protein levels in exercise-trained rat skeletal muscle. Seventy female Sprague-Dawley rats weighing 200-250 g. were housed in wire cages, provided with commercial rat chow and water ad libitum. Skeletal muscle analysis took place at 72 hr. post trauma. Fifty-six rats took part in a daily running program for eight weeks. After the training program, 28 rats were randomly assigned to one of the four groups to study indices of OFR levels after trauma and cold treatments. The remaining 28 rats were randomly assigned to one of four groups to study muscle protein content after trauma and cold treatment. Trauma groups were subjected to a single impact blunt trauma to the medial aspect of the gastrocnemius muscle of the left leg. Following the trauma procedure, groups that received cold had 6 cold applications for 10 minutes, twice per day, over a 72 hour period with 3x2 inch gel cold pack, stored at  $-4^{\circ}\text{C}$ . Medial gastrocnemius muscles were analyzed at 72 hours post-trauma for citrate synthase, indicators of OFR (malonaldehyde and lipofusion) and protein content. After the endurance training program, significant increases ( $p < 0.05$ ) in citrate synthase activity and protein levels were elicited, but the indices of lipid peroxidation (OFR indicators) were unaltered when the sedentary and exercised groups were compared. Following trauma, the net loss of pre-existing protein was statistically significant ( $p < 0.05$ ). Lipid peroxidation activity increased slightly, but not significantly. The application of cold prevented or delayed indicators of OFR activity and protein loss in traumatized rat medial gastrocnemius muscle. Thus cold treatment applied to traumatized muscle significantly decreased lipofusion content (an indicator of OFR) and offset the catabolic response in protein content during the inflammatory reaction that follows injury. The early application of cold immediately after trauma is recommended within the protocol guidelines.

### Cryotherapy, Sensation And Isometric Force Variability

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The effect of cryotherapy on isometric force variability (particularly targeting error), variance of sub-maximal isometric force, and sensation in the hand was investigated in this study. It is well established that cryotherapy affects the function of muscle in maximal isometric force production. The effects on sensation and sub-maximal force remains unclear. In this study, the investigators measured the effects of a 15-minute ice bath immersion on isometric force targeting error and variability as well as the sensation of pressure and two-point discrimination. Fifteen volunteer subjects ( $\text{age} = 22.5 \pm 2.47$ ) were tested on consecutive days. The testing protocol included assessing levels of sensitivity to deep pressure and two-point discrimination and establishing a maximal voluntary contraction (MVC) in a pinching task. One arm was randomly selected for a 15 minute ice bath immersion at  $10^{\circ}\text{C}$ . Sensation and performance of the pinching tasks performed at force targets of 10%, 25%, and 40% of MVC were measured. The protocol was repeated on the opposite arm using a control treatment of 15 minutes of rest. On the following day, the protocol was repeated with the opposite arm treated with cryotherapy. Target error and variability of force production were not significantly different as a result of the cryotherapy ( $p > .05$ ). Error and variability increased as force production increased from 10% to 40% ( $p < .05$ ). A four-way interaction between treatment, arm, digit, and test time was discovered in the measuring of pressure ( $p < .05$ ). Cold caused a greater decrease ( $p < .05$ ) in sensation in the right limb than the left. The thumbs were more affected by cold than the index fingers ( $p < .05$ ). Analysis of two-point discrimination revealed a difference between the digits ( $p < .05$ ) with the index finger being more accurate in all conditions. Significant differences in pressure sensation were found between testing immediately following cooling when compared to pre-tests and after 15 minutes of warming ( $p < .05$ ). The sensation of two points was not affected by the cold condition. The practical implications from this study address the issue of whether the use of cold bath immersion as a treatment modality is contraindicated if the patient will be required to continue to perform.

### The Effectiveness Of Ice Alone And Ice In Conjunction With Positive Polarity Galvanic Stimulation On Reducing Intra-Muscular Temperature

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The modalities of ice alone and ice in conjunction with positive polarity galvanic stimulation (PPGS) were compared to determine which treatment was more effective in reducing muscle temperature among healthy male and female adults. Informed consent was given by each subject in accordance with University IRB Standards. Twenty ( $25.1 \pm 2.3$  y/o) subjects, void of any muscle strains in their lower legs, had their muscle temperature measurements in response to the treatment of ice alone and the treatment of ice with PPGS for 15 minutes and throughout 105 minutes of rest. A temperature probe was inserted 5 cm into the lateral aspect of the left and right gastrocnemius muscle. Muscle temperature was recorded every minute during the 15 minutes of treatment and throughout the 105 minutes of rest. The baseline temperature reading for the ice alone treatment averaged  $35.01^{\circ}\text{C}$  ( $\pm 1.08^{\circ}\text{C}$ ) and the baseline temperature for the ice with PPGS averaged  $34.82^{\circ}\text{C}$  ( $\pm 0.87^{\circ}\text{C}$ ). After the treatment and rest period, the average ending temperature for ice alone was  $31.46^{\circ}\text{C}$  ( $\pm 1.20^{\circ}\text{C}$ ) and the average ending time for ice with PPGS was  $31.61^{\circ}\text{C}$  ( $\pm 1.08^{\circ}\text{C}$ ). Two-way ANOVAs revealed no significant difference ( $p > .05$ ) in muscle temperature between treatments. However, both treatments were effective in significantly ( $p < .05$ ) reducing muscle temperature across time. The treatment of ice alone initially decreases muscle temperature faster than ice in conjunction with PPGS. Fifteen minute treatments of ice alone or ice in conjunction with PPGS are effective in reducing muscle temperature. Two-way ANCOVA ( $p > .05$ ) covaring for skinfold thickness eliminated the gender difference in muscle temperature following the treatment of ice with PPGS. In addition, there was an inverse relationship between skinfold thickness and the effectiveness PPGS. The greater the skinfold, the less effective the treatment of PPGS in reducing muscle temperature. When treating acute muscle injuries, ice alone and ice in conjunction with PPGS are effective treatments in reducing muscle temperature. This study was partially funded by the Far West Athletic Trainers Association Research and Injury Committee and Staodyn, Inc.



# The Effect Of A Twenty Minute Ice Application To The Knee On Functional Performance

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The use of cryotherapy is a common practice prior to physical activity. Various studies have investigated the adverse effects of cold on such physiological functions as muscle strength and nerve conduction. Prior studies have investigated the effect on functional performance following cooling of the ankle and lower leg. To date, there are no published studies on the effect of cooling the knee on functional performance. The purpose of this study was to determine if a twenty minute icing of the knee significantly affected functional performance. Nineteen subjects (age =  $24.32 \pm 2.71$  yrs; ht =  $180.07 \pm 12.70$  cm; wt =  $79.19 \pm 10.13$  kg) with no prior knee injuries and no lower extremity injuries in the previous six months showed up for testing on three days, one week apart. The tests were the 6 m single leg hop test with the dominant leg, the 24.3 m carioca run, and the 24.4 m shuttle run. All subjects participated in both the experimental and control treatments. The experimental treatment consisted of an ice pack applied to both the anterior and posterior surfaces of the knee for twenty minutes. The control treatment consisted of sitting for twenty minutes. The first day was for familiarization with the tests. Days two and three the subjects performed the tests following the 20 minute icing or 20 minutes of rest. Immediately following treatment, the subjects reported to the gymnasium for the three tests. The tests were performed with one minute of rest in between tests and were timed using a hand-held stop watch to the nearest one-hundredth of a second. The results revealed that icing had no significant effect on the hop test ( $t = 1.995$   $p < .05$ ), but did produce significantly slower times on the carioca run ( $t = 2.247$   $p < .05$ ) and the shuttle run ( $t = 3.513$   $p < .05$ ). The results suggest that a twenty minute icing of the knee has an adverse affect on functional performance. Proper warm-up following icing may be needed so not to decrease performance following cryotherapy.

## Free Communications, Poster Presentations: Session C

Thursday, June 18, 1:00 PM-4:30 PM; Location: Pratt Street Lobby; Authors present from 3:30 PM to 4:30 PM to answer questions

### Acute Upper Arm Pain In A Collegiate Football Player

Ferullo K, Dailey SW: Miami University, Oxford, OH

**History:** A 21-year-old male football player presented at the end of practice with a progressively tender and swollen left arm. Two weeks previously, he had injured his biceps and was treated for a biceps contusion. Initially receiving ice and rest, he returned to play with protective padding following two days of treatment. The athlete was doing well until he hyperextended his elbow attempting to maintain his balance while falling. He felt an acute strain of his biceps and developed progressive symptoms over the next thirty minutes.

**Physical Exam:** His left biceps was extremely tense and tender to palpation. The girth of the unflexed left biceps was 18 inches versus 15 1/2 on the right. The distal biceps tendon was not well palpated. ROM of the elbow was significantly limited secondary to pain. Neurologically he was intact. He had 2+ brachial, 2+ radial, and 1+ ulnar pulses.

#### Differential Diagnosis:

- 1) Biceps tendon rupture
- 2) Biceps contusion
- 3) Humerus fracture
- 4) Acute upper extremity compartment syndrome

**Diagnostic Tests:** X-ray - normal; compartment pressures - 46 mm H<sub>2</sub>O; Arteriogram - pseudoaneurysm of a branch of the deep brachial artery;

**Clinical Course:** Diagnosis was acute biceps compartment syndrome. Patient was emergently taken to surgery for compartment release and fasciotomy. At the time of surgery, the short head of the biceps was white and showed signs of ischemia. There was a large tear in the biceps muscle with a 4 cm x 8 cm hematoma. The hematoma was evacuated, a drain placed and the skin closed. The drain was removed after 24 hours of minimal drainage and the athlete discharged. The athlete's staples were removed at 14 days, and he was able to return to full competition four weeks after surgery. He missed four games and competed in the remaining seven games without difficulty.

**Deviation from the expected:** The athlete was initially treated for a biceps contusion and was doing well. In contact sports deep muscle contusions are common and usually do well without long term morbidity. Occasionally an athlete may develop myositis ossificans or have prolonged difficulty attaining full range of motion. Our athlete suffered a muscle tear of the already contused tissue which inadvertently disrupted one of the deep arteries causing increased compartmental pressures. Fortunately the patient did well and has had no long term sequelae.

### Acute Onset Shoulder Pain In A High School Wrestler

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**PERSONAL DATA/MEDICAL HISTORY:** This case study presents an otherwise healthy 17 year old male high school wrestler that arrived at our clinic immediately after suffering an indirect trauma to the right upper extremity. The athlete was reportedly in an "arm bar" while being forced to the mat. He felt pain in his chest and the posterior aspect of his right shoulder immediately following impact. His initial complaint was severe pain with right shoulder movement.

**PHYSICAL SIGNS AND SYMPTOMS:** Initial examination revealed a guarded and awkward shoulder carry, swelling over the inferior aspect of the posterior scapula, and point tenderness to light palpation to the inferior angle of the right scapula. There were no neurological deficits. Strength was severely limited secondary to pain.

#### DIFFERENTIAL DIAGNOSIS:

- 1) Rib Fracture.
- 2) Serratus Anterior Strain/Tear.
- 3) Long Thoracic Nerve Injury.
- 4) Trapezius Strain/Tear.
- 5) Scapular Fracture.

**DIAGNOSTIC TESTS/SURGERY:** Initial AP radiograph revealed diffuse edema with possible evidence of a fracture at the inferior angle of the right scapula. The Scapular Y radiographs more clearly revealed a minimally displaced avulsion fracture at the inferior angle. The athlete was prescribed non-steroidal anti-inflammatory medication and was instructed in pain-free active upper extremity range of motion exercises and ice pack application. The athlete's goal was to participate at the regional level of the state wrestling tournament 3 weeks from injury onset.

**CLINICAL COURSE:** Initial evaluation revealed maximal active right shoulder abduction and flexion of 15 degrees. Significant scapular winging was noted with active shoulder flexion and abduction. No manual muscle testing was performed secondary to acute pain. The athlete was point tender near the inferior angle of the right scapular and along the origin of the serratus anterior muscle. Initial treatment consisted of ice pack application in conjunction with electrical stimulation to decrease pain, inflammation, and muscle guarding. Gentle active range of motion (AROM) was initiated with emphasis placed on scapular movements and Codman's pendulum exercises. The athlete was fitted with a sling for comfort, (instructed to only use it for 1-2 days) and was instructed in a home exercise program. Marked improvement in

pain-free right shoulder AROM was noticed each day following initial treatment. Over the initial week of treatment, the athlete's right shoulder flexion and abduction AROM improved to 90°. He still exhibited scapular winging with AROM. Tenderness remained with palpation along the inferior scapular border and along the serratus anterior muscle origin. After week 1, his exercise program was advanced to include progressive resistive exercises emphasizing scapular and combined scapulothoracic-glenohumeral joint movements. Modalities were utilized as needed for pain relief and swelling reduction. The athlete wrestled in the state meet 3 weeks following the initial injury. While he had no further complications from the original injury, he did experience chronic soreness and occasional pain during his quest for a state wrestling title. He finished 3<sup>rd</sup> in the state in his weight class despite the efforts of opposing wrestlers to "work on" his injured right shoulder. A 6 month follow-up evaluation revealed no further problems. At this time he experienced no tenderness to palpation, exhibited full right shoulder AROM, and normal right shoulder strength. Follow-up radiographs show evidence of a bony union at the fracture site. This athlete has continued his wrestling career at a local college.

**DEVIATION FROM THE EXPECTED:** The overall incidence of scapular fractures is low with the vast majority resulting from high velocity traumas such as motor vehicle accidents. Scapular fractures in sport are even more rare, usually resulting from blunt trauma. Indirect trauma leading to scapular fracture is extremely rare. This unique injury, along with the timetable for return to competition, challenged us in its management.



**Personal Data:** A 21 year-old right-hand dominant college student and athlete who is a high caliber pitcher presented a two to three week history of right shoulder pain. He reported that in 1989 he underwent an arthroscopic surgery on his right shoulder to remove bone spurs from his shoulder. Presently, he described having persistent pain and on a recent try out with a professional club was found to be throwing approximately 20 miles per hour slower than his normal 91 miles per hour. He noted a sense of weakness posteriorly and that sometimes his arm would go dead. Additionally, he reported intermittent night pain.

**Physical Signs and Symptoms:** Reveals total elevation of 185°, external rotation of 80° and internal rotation to T6. Strength of external and internal rotation is 5/5. There was a positive impingement sign and mildly painful arc of motion but a negative drop arm test. He exhibited full cervical spine range of motion and shows no signs of any cervical radiculopathy or peripheral neuropathy. The only tenderness was localized to the subacromial area anteriorly radiating down along the long head of the biceps and posteriorly in the region of the infraspinatus muscle. Further exams revealed inferior and anterior laxity as determined by sulcus sign and increased anterior glide in the horizontal position. A relocation test could not be performed, and he did not demonstrate a significant Apprehension sign.

**Differential Diagnosis:** Instability/Impingement overlap syndrome, rotator cuff tendinitis.

**Results of Diagnostic Imaging/Laboratory Tests:** AP, lateral radiographs reveal a type II right acromion with prominent anterior edge and large medial osteophyte formation at the inferior corner of the acromion at its junction with the clavicle. Ultrasound examination of the right shoulder reveals the rotator cuff to have normal thickness throughout. No evidence of either focal or full thickness tear was identified and no evidence of unusual fluid accumulation. An MRI in the axial and oblique coronal planes using T1 and T2 weighted sequences revealed some degenerative change of the acromioclavicular joint. The remaining joint surfaces appeared to be normal. There was minimally increased signal intensity in the region of insertion of the supraspinatus which is suggestive of a small degree of tendinitis. There is no evidence of a rotator cuff tear. On various images, a very large redundant inferior and anterior capsular notch was evident which is consistent with his diagnosis of multidirectional instability.

**Clinical Course:** 1. Naprosyn, 375 mg., TID. 2. Ice, relative rest from irritating activities. 3. Rehabilitation with emphasis on strengthening the adduction and internal rotation musculature. Progression to total upper quarter strengthening, trunk and lower extremity exercises, an overhead endurance and eventual throwing program with return to pitching.

**Deviation from the Expected:** Athlete had no previous history of shoulder instability. His symptoms were consistent with an Impingement. The Impingement is thought to be a precursor to the shoulder instability.

## Rehabilitation Of A College Baseball Pitcher Emphasizing Proprioception

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**Personal Data/Medical History:** A 21-year-old male college baseball pitcher experienced pain in his right (pitching) shoulder for over 1 year. The athlete had been red-shirted the previous season and was inactive over the past summer. He underwent right shoulder arthroscopy on 10-23-97 for debridement of small SLAP lesion and subacromial space as well as shaving of synovitis of supraspinatus tendon.

**Physical Signs And Symptoms:** The athlete experienced recurrent right shoulder pain while throwing. Following surgery, the athlete presented with near full and equal shoulder ROM bilaterally. Strength was 5/5 in all shoulder motions except extension and external rotation: 4+/5 for both motions. The only pain reported was during active and passive extension.

**Differential Diagnosis:** 1) Rotator cuff tendinitis 2) SLAP lesion 3) Synovitis 4) Shoulder impingement.

**Diagnostic Imaging/Laboratory Tests:** The athlete was referred to the athletic trainer two days post-surgery. Prior to surgery, the athlete had undergone a series of injections of Marcaine 4ccs at .5% into and around the AC joint and subacromial space. Following each injection, the athlete was instructed to throw for a few days in an attempt to localize the precise area of irritation. Injections located the problem to the subacromial space, however, medication was unable to halt pain associated with throwing. The athlete opted for an arthroscopic procedure.

**Clinical Course:** Upon surgical inspection, a small SLAP lesion was discovered as well as synovitis within the subacromial space. The athlete was referred to the athletic trainer for rehabilitation under the premise that throwing would not begin until January 1998 (approximately 2 months post-surgery). The athlete presented to us two days post-surgery lacking 10° active ROM as compared bilaterally in all shoulder motions, but possessing full passive ROM in all motions except external rotation. One week later, all deficits in ROM had been recovered and external rotation exceeded that of the uninvolved shoulder. Strength was 5/5 in all motions except extension and external rotation which caused mild pain and were graded as 4+/5. Codman's pendulum exercises and Jobe's exercises with tubing, including flexion, extension, internal rotation, external rotation, abduction, prone flexion, prone extension, prone rows and full-can, were prescribed for the first week. After one week, strength had continued to improve. Emphasis was now on scapulohumeral rhythm to prevent reoccurrence of the synovitis in the subacromial space. Push-ups with a plus were added for serratus anterior strengthening. Upper extremity D1 and D2 PNF patterns were incorporated for strengthening through a functional ROM for a baseball pitcher. One-arm stabilization on a BAPS Board for 30 seconds, hand-walk-overs on an aerobic step, one-arm stabilization on a stability ball, and other proprioception exercises were initiated. Four weeks later, functional throwing exercises were added as the athlete threw a four pound ball against an angled mini-trampoline. He was required to catch the ball on the rebound and eccentrically slow the ball down as it took him into a cocking motion. All rehabilitation took place three days/week. Prior to the semester break, the athlete reported feeling very strong with no pain associated with motion or activity. The athlete will begin tossing under 30 feet during the Christmas break. Upon returning to school in January, the athlete will follow-up with the team physician. He is projected to begin throwing and is anticipated to return to the line-up in the spring.

**Uniqueness/Deviation From The Expected:** Shoulder problems in baseball players, especially pitchers, are nothing new, nor are the accepted rehabilitation goals: achieve full ROM, achieve functional strength, progress through functional activities, begin a throwing program, and return to activity. In this case, however, ROM was not a problem; the athlete presented with almost full ROM post-surgery and had achieved full ROM 1 week post-surgery. Strength was within normal limits bilaterally when the athlete was presented to us. However, because of the nature of the injury, synovitis of the subacromial space and a probable Grade I SLAP lesion, we decided to emphasize more on the scapulohumeral rhythm and functional proprioception as soon as possible. We chose to put into practice closed-chain proprioception exercises that have been recently researched at the University of North Carolina at Chapel Hill. These exercises, such as hand-walk-overs and ball stability movements, emphasized balance, proprioception, and stability. It was our belief that because of the nature of the pitching motion, upper extremity D1 and D2 patterns and eccentric functional motions with the mini-trampoline would be ideal for progression of strength in a functional manner. We believe that for a baseball pitcher, this type of functional proprioceptive activity progression is an ideal type of rehabilitation before advancing to a throwing program.



# Chronic Proximal Deep Posterior Compartment Syndrome In A Collegiate Track And Field Athlete

Bateman W: James Madison University, Harrisonburg, VA

M.S., a twenty-one year old male track hurdler and sprinter competing in the 110 hurdles at a division IA university, complained of continually recurring pain and tightness bilaterally in his calves over a four year period, beginning during his junior year of high school. It should also be noted that this athlete showed bilateral signs and symptoms of chronic medial tibial stress syndrome ("shin splints") along the anterior tibial crest during this period. Early on, he was asymptomatic during competition followed by extreme tightness and deep muscular soreness in his calves the next day. Progressive problems began to surface the spring of his sophomore year in college when bilateral pain and cramping in his calves began to appear immediately after races, as well as during practice. After unsuccessful attempts to relieve the tightness with stretching and various modalities, the symptoms ultimately led to cessation of running for short periods of time. This athlete's junior year of college was marked by progressively worsening symptoms with the pain continuing and increasing in intensity and frequency, with an earlier onset of symptoms. At this point, activities of daily living were now affected by pain and stiffness during gait and the athlete was forced to cease all training.

On physical examination, the athlete was tender to palpation bilaterally only upon compression of the proximal deep compartment musculature deep to the gastrocnemius-soleus muscle group. His symptoms of tenderness extended from the level of the soleal bridge at the base of the popliteal fossa to a level at the base of the medial head of the gastrocnemius distally. Early in this scenario, range of motion for plantar flexion was restricted and painful; however, this progressed to include pain on active plantar flexion range of motion. The athlete had no complaints of tenderness to palpation in any of the other compartments. No swelling in the proximal calves, nor instep paresthesias were noted during this symptomatic period. Excellent pulses were present in both feet and did not diminish with plantar or dorsiflexion. Symptoms of constant, sharp pain and increasing muscular tightness in the calves bilaterally were absent at rest, but reappeared more rapidly with any activity, including normal activities of daily living. Rest completely re-

lieved the symptoms which were unaffected by time of day (i.e. no significant improvement or deterioration in symptoms upon arising in the morning or in the evening).

A history of exercise-induced pain in clearly demarcated leg muscles, marked by onset after shorter and shorter distances and consistently relieved by rest is typical of chronic compartment syndrome, but may be caused by other orthopedic disorders brought on by exertion, such as tendinitis, stress fractures, and chronic peristalgia. However, tendinitis and stress fractures typically cause lingering pain beyond that seen with a compartment syndrome. Other differential diagnoses to also be considered include medial tibial stress syndrome and popliteal artery entrapment. Although the overwhelming majority of cases of tibial stress syndrome are not complicated by a concomitant compartment problem, there will be occasions in which they coexist. This athlete suffered from chronic periostalgia concurrently with the deep compartment syndrome. Second, it must be noted that clinical differentiation between proximal deep posterior compartment syndrome and popliteal artery entrapment syndrome can be difficult because no physical findings may be present at rest and they are symptomatically similar. Typically, a significant dampening of the pulse volume recording is noted on dorsiflexion of the foot in popliteal artery entrapment.

Blood work and a MRI conducted to rule out a stress fracture and other vascular problems were found to be inconclusive. It should also be noted that a preoperative compartment pressure measurement was not taken on this athlete. Because of the anatomy of the proximal deep posterior compartment, "blind" needle placement for pressure measurements increase the chances of injuring major nerves and /or blood vessels. The athlete's history and physical findings formed the basis for recommending fasciotomy.

As the compartment syndrome worsened prior to arriving at a definitive diagnosis, a variety of conservative approaches were attempted without long-term success. These included cryotherapy, heat, whirlpools, contrast baths, ultrasound, orthotics, passive and active exercises to improve flexibility of the involved musculature, multidirectional ankle conditioning exercises, alternate car-

diovascular exercises, relative rest periods, and total rest. With the prototypic history and physical examination, a diagnosis of bilateral proximal deep posterior compartment syndrome was made, and the athlete underwent a bilateral proximal deep posterior compartment fasciotomy. Post operative recovery consisted of rest and elevation for the first 48-72 hours, and the use of elastic wraps when weightbearing for the first two weeks; daily activity was resumed as tolerated and the athlete was able to perform a slow jog by three months post operatively. He had no complaints of pain or deep tightness during activities of daily living, and pain associated with exercise at this time was characteristic of exercise-induced pain. Unfortunately, the athlete was unable to progress beyond the level of a daily low intensity jogging program of 30 minutes achieved by the four month marker due to continued deep pain, limiting the duration of the exercise session. However, his symptoms were not the same type of cramping or deep tightness experienced preoperatively. A recent return visit to the surgeon has suggested a possible popliteal artery involvement.

Regularly appearing exercise induced leg pain, relieved only by an absence from activity is an uncommon but not rare complaint among athletes, particularly with well conditioned athletes involved in aerobic sports. However, chronic compartment syndrome must be differentiated from acute injuries often resulting from stress overload due to poor training techniques ("the too fast, too hard, too soon" syndrome). An accurate diagnosis of compartment syndromes most often relies upon the clinician's awareness of the condition. A clear understanding of the anatomy of the lower leg is vital to correctly recognize and diagnose this syndrome. A lack of awareness of the clinical history contributes to the underdiagnosis of this problem. Indeed, many patients report they have seen several physicians over a period of 3-4 years before arriving at the correct diagnosis and intervention.

## Rehabilitation For An Achilles Tendon Rupture Of A College Basketball Player

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**Personal Data:** A 22 y/o male college basketball player complained of a feeling of "the floor falling out from beneath him" as he tried to walk after he attempted to "steal" the basketball from his opponent in a NCAA Division I intercollegiate basketball game on January 8, 1997. Diagnosed as an Achilles tendon rupture, the athlete's chief complaint was lack of plantar flexion with mild pain. The mechanism of injury occurred to the right foot during eccentric plantar flexion in preparation to accelerate forward. No external force was involved as the cause of the injury. The athlete's initial description of the injury was that he felt like he sprained his ankle. When the athlete stood, he found that he was unable to plantar flex his right foot. The athlete had no history of previous lower leg pathology.

**Physical Signs and Symptoms:** Physical examination revealed an abnormal muscle tone to his right gastroc/soleus complex. A "step-off" deformity was present at the distal insertion of the Achilles tendon. Manual muscle testing revealed the inability to plantar flex his foot and minimal discomfort accompanying dorsiflexion. A positive Thompson's test was evident revealing no plantar flexion indicating a possible third degree Achilles tendon tear.

### Differential Diagnosis:

Lateral ankle sprain with gastroc/soleus complex involvement

Non-complete Achilles tendon tear

Complete third degree Achilles tendon rupture

### Results of Diagnostic Imaging/Laboratory

**Tests:** No diagnostic tests were performed due to the physician's positive physical examination findings. His evaluation revealed what appeared to be a complete Achilles tendon rupture.

**Clinical Course:** Two days following the onset of this injury, surgery was performed. The surgeon described the injury as "a complete transverse rupture of the Achilles tendon with a medial and lateral separation with a longitudinal rupture." The surgeon reattached the two loose ends using a "Locking Kessler stitch." The athlete was immobilized in a slight plantar flexion position in a short leg plaster cast from the tibial tuberosity to the metatarsal phalangeal joints for two weeks with crutches used to assist ambulation. At the end of two weeks the

plaster cast was removed and a fiberglass cast was applied. This cast was bivalved for easier cast removal and for progression into early range of motion exercises. At this point in the rehab, variable muscle stimulation (10/10-second contract/relax time for fifteen minutes at 80/80 usec phases at 25 Hz) was used four times a week. A Cam-Walker, which allows variable degrees of ankle motion, replaced the fiberglass cast during the third week. The Cam-Walker's stops were set at unlimited plantar flexion with dorsiflexion limited to 5 degrees. In addition, a 1" heel wedge was also applied in conjunction with the Cam-Walker. Duoderm was used to cover the 7" surgical scar. Towards the end of the third week the crutches were eliminated and the patient was cleared to walk with the boot. He could remove the boot for walking only in a controlled rehabilitation environment under the supervision of a certified athletic trainer. Also during this time, the heel wedges in the walking boot were removed due to patient discomfort in the arch of the foot. During the fourth week of rehab, hydrotherapy in the SwimEx Pool was initiated allowing the athlete to jog in a swimming vest with body totally emerged except for his head making him approximately ninety percent unweighted. During these sessions he was instructed to increase his weight-bearing activities in the pool only if he was pain-free by changing the depth of water he was exercising in. In addition, walking in a controlled environment and riding the stationary bike (heel riding) were also introduced at this stage. This stage continued through the fifth week. The sixth week of the rehab marked the patient's clearance to initiate an increased rehab protocol focusing on increasing range of motion (primarily in dorsiflexion), increasing strength and endurance, and increasing proprioception of the entire lower body. In addition to this lower extremity rehab protocol, the athlete had been working on sport specific exercise for his upperbody. Sport specific activity included a minimum of 500 shots/day, ball handling for 20-30 minutes/day, and core workouts 4-5 times/week. At nine and a half weeks, use of the Cam-Walker was consummated. The twelfth week brought about another increase in the rehab protocol emphasizing bilateral comparisons in strength and endurance as well as ranges

of motion and girth measurements. Additional goals included bilateral increases in proprioception of the Achilles complex as well as the anterior musculature of the lower leg, increase in sport specific activities, increases in cardiovascular endurance, and increases in flexibility. During week fourteen, the patient began running progressions on the basketball court. During this same week the athlete claims to have played basketball two days over the weekend without complications. This was against the regulations designed in his rehab program and against the medical staff's orders. At the twenty-first week, the patient was cleared of all restrictions by the team physician after showing bilaterally equal girth measurements, 4+/5 muscle testing, normal gait, and no pain/discomfort with any of his rehab or workouts. The rehab at this point was continued emphasizing continuations in strength and endurance, increases in cardiovascular endurance and increases in flexibility. At this point in time the athlete continues to play intercollegiate basketball and remains asymptomatic through the eleventh month following his initial injury with no perceived decreases in speed, strength or endurance.

**Deviations from the Expected:** An extensive literature review of this topic presented an average time frame for the complete rehab of an Achilles tendon rupture to be approximately six months for a normal recreational individual of approximate age ranging from 18-50. This case presents a somewhat rare injury in a patient of such a young age (22 y/o), and a collegiate basketball player. This case also indicates, through patient non-compliance that at fourteen weeks post-op a completely ruptured Achilles tendon may possibly be able to withstand greater dynamic forces earlier than had been previously believed.



### Foot Pain In A Collegiate Football Player

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**History:** A nineteen year old football safety for a Division III football team injured his left great toe while playing. He jumped up to defend a pass and came down on the tip of his toe. He had immediate onset of mild pain in the toe but he continued to play. Over the next two days he continued to practice with no to little pain in the toe. However, he did notice some pain around the front of his ankle. He also noticed the inability to lift up his great toe. He had no previous injury to that ankle, foot or toe in the past. He did not have any parasthesias and was in good health otherwise. He presented to the training room four days after the injury.

**Physical Examination:** He was in no distress and could walk normally with and without footwear. He had no swelling or ecchymosis in his ankle, foot or toe. His great toe was held in a plantar-flexed position at the interphalangeal joint. He had tenderness over the interphalangeal joint (IP) and the proximal aspect of the distal phalanx dorsally. He had no tenderness proximally and there were no palpable lumps or crepitus over the dorsum of the foot. He had normal flexion of the great toe at the metatarso-phalangeal joint but not at the interphalangeal joint. The deformity at the IP joint was painlessly correctable by passive extension of the distal phalanx. Passive flexion of the ankle relaxed the flexion deformity at the IP joint whereas extension (dorsiflexion) increased the deformity. He was neurologically intact otherwise.

#### Differential Diagnosis

1. Rupture extensor hallucis longus tendon
2. Fracture or interphalangeal joint abnormality

**Test And Results:** Plain Radiographs: Volar angulation of the distal phalanx of the big toe with no fracture or subluxation of the joint.

**Clinical Course:** A diagnosis of traumatic rupture of the extensor hallucis longus tendon was made based upon clinical examination. Operative exploration was performed by an orthopaedic surgeon who found intrasubstance failure and elongation of the tendon at the IP joint level. Shortening and reattachment of the tendon to the distal phalanx was performed using suture anchors. He was placed in a fracture walking boot with rigid toe plate for six weeks, followed by a gradual return to activities with no recurrence of the deformity.

**Deviation From The Expected:** Traumatic rupture of the EHL tendon from the big toe has never been reported to our knowledge. The mechanism and presentation of this injury demonstrate the importance of assessment of tendon function when evaluating injuries to the foot. Intrasubstance tearing of the tendon without a bony or tendon avulsion from the phalanx is another unique feature of this injury.

### Cardiac Arrhythmia In A Collegiate Soccer Player

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**Personal Data/Pertinent Medical History:** The athlete is a 20 year old female intercollegiate soccer player. She initially approached the certified athletic trainer, during a practice in September of 1994, complaining of heart palpitations. She reported having previous episodes of palpitations that had occurred intermittently over the past seven years. Some of these had occurred at rest and while others occurred during exercise. The palpitations started and ended abruptly and never resulted in a loss of consciousness. There was no association with caffeine or exercise. The athlete had no history of prior cardiac disease. In addition, she had no history of asthma, endocrine disorders, seizure disorders, or musculoskeletal abnormalities. She had never sought medical attention for her palpitations.

**Physical Signs and Symptoms:** The onset of palpitations was associated with an initial feeling of lightheadedness and chest tightness at which time the athlete would stop her current activity. The episodes would usually last ten minutes, with the longest lasting approximately thirty minutes.

**Differential Diagnosis:** fever inducing arrhythmia; drug abuse; mitral valve prolapse; pre-excitation syndrome for example, Wolf-Parkinson White syndrome; cardiomyopathy; endocrine dysfunction; valvular stenosis; atrioventricular nodal reentrant tachycardia (AVNRT).

**Results of Diagnostic Imaging/Laboratory Tests:** An exercise stress test revealed excellent exercise tolerance with no significant EKG changes or arrhythmias. An echocardiogram revealed normal left ventricular systolic function and response to exercise, normal mitral and aortic valves, and was negative for mitral or aortic regurgitation. A 24 hour Holter recording and twelve lead electrocardiogram were normal. An event recorder captured a supraventricular tacharrhythmia with a heart rate of approximately 240 beats per minute. The athlete was diagnosed as having atrioventricular nodal reentrant tachycardia (AVNRT).

**Clinical Course:** The athlete had experienced one episode of palpitations during each of her final three years of collegiate soccer. Following the bout of tachycardia in September of 1994, the athlete was referred to a cardiologist who performed the exercise stress test and echocardiogram. The results of these tests were normal and the athlete was medically cleared to return to soccer. Following another bout of palpitations one year later the athlete was referred back to her cardiologist. A 24 hour Holter recording and twelve lead electrocardiogram were normal and the athlete was medically cleared to resume all activities. In 1996 the athlete again experienced palpitations and was referred back to her cardiologist who gave her an event recorder. In September of that year, this recorder captured a supraventricular tacharrhythmia with a heart rate of 240 beats per minute. Two treatment options were outlined for this athlete. First, she could take an anti-arrhythmic medication on a daily basis and abstain from competitive athletics. Second, she could undergo radiofrequency ablation of the accessory conductive pathway. The athlete elected to have the ablation. This is a nonsurgical procedure that is done under mild sedation with a local anesthesia. A catheter with an electrode at its tip is guided to the area of the heart where there is an accessory AV nodal pathway. Two pathways are needed to maintain AVNRT, a "slow" and a "fast" pathway. While either pathway can be ablated, destruction of the slow pathway yields better results. The slow pathway was ablated. After the ablation, there was no further evidence of the slow path and no further AVNRT. Following one week of rest the athlete was medically cleared to return to soccer. She has continued to compete in competitive soccer with no recurrence of tachyarrhythmia.

**Deviation from the Expected:** The presence of cardiac arrhythmias in an athlete is a rare but significant event. This warrants prompt referral for diagnosis and treatment. Although it took time to make a definitive diagnosis in this case, the athlete was ultimately treated and able to safely resume athletic competition in one week. While not all arrhythmias are suited for radiofrequency ablation those that depend on well defined pathways often involving re-entry pathways near the AV node are highly amenable to this technique. The reported success rate for ablation of the slow pathway of AVNRT is over 90%.

## Knee Injury - High School Soccer Player

Miller CA, Decoster LC, Vailas JC: HealthSouth/Lahey Hitchcock Clinic, Manchester, NH

**PERSONAL DATA/MEDICAL HISTORY:** A 16-year-old white male suffered a varus blow to his left knee during a high school soccer game. This injury occurred immediately after the athlete had scored a goal. The goalkeeper was charging the athlete in a tackle attempt when he collided with the athlete's left leg. At the time of impact, the athlete's leg was fully extended and his foot was planted. He reported hearing a "crunch" which was followed by immediate pain and disability, and a transient numbness in the leg and foot. There was no medical staff present at the time of injury. The athlete was assisted from the field to the team bench, after the coach attempted unsuccessfully to have him "walk it off." During evaluation by his family physician later the same day he reported tenderness at and just proximal to his fibular head. The doctor noted lateral deformity in the form of a "dent where the collateral ligament should be." His past medical history was unremarkable. **PHYSICAL SIGNS & SYMPTOMS:** Orthopedic evaluation of the athlete the next day revealed large effusion, tenderness over LCL and fibular head, good peroneal nerve function, and anterior (Grade II) and lateral (Grade II - III) laxity. There was no apparent posterior or medial laxity. **DIFFERENTIAL DIAGNOSIS:** Epiphyseal or regular fracture at distal femur and/or proximal tibia or fibula, anterior cruciate ligament tear or avulsion, lateral collateral ligament tear or avulsion, disruption or avulsion of other lateral structures, patella subluxation, osteochondral or meniscal pathology, knee dislocation. **DIAGNOSTIC IMAGING/LABORATORY TESTS:** Anterior-Posterior and Lateral X-rays revealed a small avulsion fragment on the lateral aspect of the knee, possibly off the fibula.

**CLINICAL COURSE:** A primary repair of the LCL was recommended. Findings at surgery included complete ACL tear at the tibial spine with small avulsion fracture, lateral capsular tear, lateral collateral ligament and biceps femoris tendon avulsion from fibular head, iliotibial band detachment from Gerdy's tubercle. In addition to the LCL repair, the ACL was reconstructed using a semitendinosus autograft, the fibular head avulsion was repaired with sutures through drill holes, the IT band was reattached using suture anchors, and the capsular tear was also closed and tightened with sutures. Following surgery and three weeks' immobilization, the athlete completed rehabilitation following an ACL reconstruction protocol. The athlete began jogging at four months postop. **DEVIATION FROM THE EXPECTED:** Our literature search did not reveal knee trauma of this magnitude in a soccer player. Further, we were unable to find any reference to the frequency of these injuries in sports - either individually or together. While unusual, significant trauma can occur in athletics, even in "less dangerous" contact sports. Education of the coaching public should continue to stress reconsideration of the "walk-it-off" attitude.

## A Stress Fracture Masquerading As Mechanical Lumbar Pain In A High School Lacrosse Player: A Case Report

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

**History:** The athlete was a 17 year old high school lacrosse player with no history of injury to the lumbar spine. He was involved in a post-season conditioning program where he began to experience lower back pain during activity. This pain gradually became worse during a time frame of six weeks. The pain became so intense he could not continue activity. He reported to the athletic trainer for evaluation at that time.

**Physical Signs and Symptoms:** Upon examination the athlete presented intense spasm on the left side of the lumbar region. He had significant bilateral hamstring tightness. The athlete had decreased pure lumbar motion. He had pain with both passive and active range of motion. All other muscular and skeletal testing presented negative findings.

**Differential Diagnosis:** Given the history of the athlete and the presence of such significant signs and symptoms, numerous diagnoses had to be ruled out. The following were: lumbar strain, spondylolisthesis, osteoma, and discitis. The following diagnostic imaging was obtained to rule out these diagnoses.

**Results of Diagnostic Imaging:** Normal x-ray views were obtained of the lumbar spine. The films showed open growth plates of the vertebrae. At the level of L5 there was some evidence of disc disease. A second set of x-rays were then taken of flexion and extension views. The x-rays demonstrated no movements of the spine at segments L4, L5, and S1. These films also presented some sclerosis at L3. A bone scan was then ordered which resulted in a positive reading showing evidence of a spondylolysis at the pars of L3. To evaluate the extent of the damage to L3 a thin sliced CT scan through the pars of L3 was performed. The CT scan showed evidence of bilateral pars of L3 involvement with sclerotic and bone reaction around the vertebrae confirming a healing spondylolysis of L3.

**Clinical Course:** The Athlete was treated with a TLSO jacket for eight weeks of immobilization. He was also given initially a course of anti-inflammatories and anti-spasmodics to help with the discomfort. Rehabilitation began at the eight week mark by progressively weaning him out of the TLSO jacket in hour increments. At that time he also began a brisk walking program. At week nine he wore the TLSO jacket only eight hours a day and began a flexibility/strength program. He also began bicycle and treadmill workouts. At week ten the TLSO was discontinued. The athlete began a more vigorous strength and conditioning program. The athlete began running to tolerance. At week 12 the athlete was pain-free. The CT scan was repeated. The films showed some healing at the pars of L3 compared to the first CT scan at week one. The athlete was, however, asymptomatic. Activity was increased to tolerance. At week 14 the athlete returned to full activity and contact sports. The athlete continued in a formal physical therapy program for extension activities and spinal stabilization for an eight week course. The athlete returned successfully to his Division I lacrosse program. The x-rays that were obtained at the seven month mark showed successful healing of L3. Presently, the athlete is healthy. He, however, still complains of occasional tightness in the lumbar region. This complaint is due to the congenital abnormality at L4, L5, and S1.

**Deviation from Expected:** What makes this case unique is the age of the athlete and the location of the injury. The more common site of a spondylolysis is at the level of L5. However, due to the evident disc disease at L5, which is highly uncommon at this age, and the decreased motion at segments L4, L5, and S1 abnormal stress was transmitted to the level of L3. These fixated segments of L4, L5, and S1 caused over time a stress reaction at L3 which ultimately caused the spondylolysis.



**Personal Data:** A 20 year old white female Division I-A field hockey player was initially assessed by the athletic training staff four weeks into the season of her junior year. The athlete's pre-season conditioning regimen consisted of running 3 to 4 times a week for 45 minutes on a rubberized track. Prior to visiting the athletic training staff the athlete had participated in 29 formal team practices in 31 days. The athlete had no previous history of stress fractures in her lower extremities. She had been a vegetarian for 2 years prior to the onset of symptoms and denied any menstrual irregularities at the time of her evaluation or six months prior to it.

**Physical Signs and Symptoms:** Upon initial evaluation the athlete's main complaint was of a feeling of weakness and an inability to perform at her maximal level. She especially felt weak in both legs and complained of a low-grade aching in both thighs and right knee. Physical examination revealed full range of motion and no obvious loss of strength in either her upper or lower extremities. The athletic training staff was unable to elicit any discomfort during the physical examination. A follow up evaluation was performed ten days following the initial evaluation. The athlete stated that symptoms had progressed to the point where she felt as though she had a chronic "muscle pull". At that time, her thigh discomfort had increased and become more localized to the proximal mid-thighs. The athlete had also developed visible muscle twitching, fasciculation, of the right quadriceps femoris muscle. The muscle twitching would occur spontaneously and last for approximately five seconds at a time. During physical examination pain was found during the combined hip movements of passive flexion, abduction and external rotation or the position known as FABER. In addition to focal thigh tenderness and pain during passive hip range of motion, a positive fulcrum test was also elicited.

**Differential Diagnosis:**

Initial evaluation

1. dehydration
2. bilateral quadriceps muscle strain

Second evaluation

1. femoral stress fracture
2. bilateral quadriceps muscle strain
3. iliopsoas muscle spasm
4. neurological disorders:
  - myokymia
  - poliomyelitis

**Results of Diagnostic Imaging/Laboratory Tests:** Radiographs of the right hip and femur revealed a small focal area of fuzzy periosteal elevation along the medial cortex of the proximal femoral shaft. A Technetium 99 bone scan performed the same day showed increased uptake in the focal area seen on the x-ray and an area of increased uptake in the medial cortex of the mid-shaft of the left femur. These studies were performed approximately three weeks following the initial evaluation and were indicative of bilateral femoral stress fractures. Radiographs performed six weeks following the initial evaluation revealed increased callus formation and consolidation of both fracture areas.

**Clinical Course:** Following the diagnosis of bilateral femoral stress fractures the athlete was restricted from all running, with walking limited to necessary daily activities only. Two weeks following the diagnosis of bilateral femoral stress fractures aquatic therapy was initiated three times weekly. The athlete noted that three weeks following her initial activity restriction symptoms began to subside. Ten weeks following the diagnosis of bilateral femoral stress fractures the athlete

began spring lacrosse. Despite a modified activity level the athlete continued to experience low grade symptoms during the entire season. Even though the athlete continued to experience low grade symptoms there was no increase in her symptoms during the lacrosse season. The athlete did not fully recover until all running activities were discontinued at the end of the lacrosse season.

**Deviation From The Expected:** To date muscle twitching or fasciculation of the quadriceps femoris has not been reported as a possible sign of an underlying femoral stress fracture. The muscle twitching is suggestive of muscle fatigue or irritability which may be a cause of increased stress in the underlying bone. While stress fractures are among the most common and significant overuse injury, femoral stress fractures have, until recently, received very little attention. The increasing incidence of femoral stress fractures has been attributed to the fact that they are being more accurately and earlier diagnosed. Early recognition of femoral stress fractures is imperative to limit the occurrence of more complicated injury (displaced fracture), permanent disability and increased time loss from athletic participation.

## Quadriceps Pain In A Female Soccer Player

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**Personal Data/Medical History.** A 20-year-old Division III varsity soccer player complained of a pulling sensation in her left quadriceps muscle group. At the time of injury, she had two games remaining in the regular season. She suffered a serious strain to her left quadriceps one year prior during preseason training and was held for 4 weeks. She was treated throughout the season and during the spring. She participated in one indoor tournament that off season. She also stated that she had difficulty running, turning, and sprinting until late in the summer and therefore was unable to do conditioning until just before preseason.

**Physical Signs And Symptoms.** On physical exam she presented with no atrophy of the quadriceps group. She was point tender to palpation over the mid aspect of her anterior left thigh. She noticed no muscle discomfort. No pain was elicited with resisted knee extension or with resisted knee flexion. She noticed mild pain with resisted hip abduction. Strength testing showed equal strength bilaterally for the quadriceps and hamstring muscle groups.

### Differential Diagnosis.

- Rectus Femoris strain
- Abductor muscle group strain
- Contusion to the Rectus Femoris or Vastus Lateralis
- Myositis Ossificans
- Femoral stress fracture

**Diagnostic Imaging/Laboratory Tests.** X-rays of the left thigh were taken one and one-half months prior to the 1997 season and showed no evidence of myositis ossificans or stress fracture. Ultrasound treatment elicited a significant increase in pain. AP and Lateral X-rays of the left femur revealed what appeared to be a cortical reaction to the proximal medial aspect of the left femur. The nuclear bone scan showed an intense focal uptake of the proximal one-third of the left femur in the posteromedial aspect of the cortex. The bone scan also showed a small focal uptake in the posteromedial aspect of the distal tibia in the left leg.

**Clinical Course/Final Disposition.** With two regular season games and postseason remaining, she was cleared to participate as tolerated, but her practices would be limited. The results of her X-ray of the left femur showed no identifiable stress fracture, but the impression of the physician was a healing stress fracture. Our initial goal of rehabilitation was to maintain her conditioning through the end of her season, yet limit the amount of force her leg was subjected to. We started her with a pool workout four days per week and functional workout on the field one day per week with pre-practice warm-up in the fitness center. The pool workout lasted 40-50 minutes and consisted of running in place at varying speeds for selected amounts of time. The pre-practice warm up consisted of riding 3 miles on a stationary bike and 3 miles on a stairmaster. The athlete participated in games and practices with her left quadriceps wrapped. She stated that the quad wrap provided support and helped control pain while playing. Pain management consisted of ice application, pre and post activity. NSAIDs were used for treatment of pain and inflammation. A TENS unit was used for 6-10 hours per day. A decrease in pain sensation was elicited using the gate control theory with the TENS unit.

**Uniqueness/Deviation From Expected.** When our patient first started complaining of pain in her quadriceps, she had all the signs and symptoms of reaggravating her old injury. As the season progressed and no sign of improvement was made, we were somewhat surprised with the pain elicited by the ultrasound. At that point we sent her for X-rays and were expecting the results to be myositis ossificans and not a femoral stress fracture. In researching this injury, we could find only a small amount of information on stress fractures of the femur. Unfortunately, most of this information was related to stress fractures occurring in the femoral neck. Femoral stress fractures are relatively uncommon, yet the number being diagnosed is steadily increasing possibly due to the popularity of jogging and the increased mileage covered by serious runners. Femoral stress fractures account for less than 5 percent of total stress fractures in the lower extremities. Stress fractures in the midshaft of the femur are even less common than those of the femoral neck, occurring in about 2 percent of all stress fractures.

## Low-Velocity Knee Dislocation In A High School Football Player

Fernandez JC: Barry University, Miami Shores, FL

**Personal data:** A 16 year old male defensive end varsity football player (height = 72", weight = 180 lbs.) sustained a posterior knee dislocation while jogging during a practice session. The athlete stepped in a hole resulting in immediate injury and was transported to a hospital emergency room.

**Physical signs and symptoms:** The athlete was in severe distress complaining of intense left knee pain. He reported an audible and palpable pop. Examination revealed an obvious bony deformity with the femur displaced anteriorly with respect to the tibia. Dorsalis pedis and posterior tibial pulses were normal, and there was no loss of motor or sensory function to the lower extremity. Upon stabilization for splinting the dislocation was spontaneously reduced. Prior to hospital discharge a neurovascular examination revealed an absence of the right pedis pulse.

**Differential diagnosis:** Differential diagnoses include complete tear of the anterior cruciate ligament, posterior cruciate ligament, and medial collateral ligament tear.

**Results of diagnostic imaging/laboratory tests:** X-rays were taken at the time of hospital arrival confirming a posterior knee dislocation. Due to the absence of the dorsalis pedis pulse, an arteriogram was performed. Results were positive for damage to the popliteal artery.

**Clinical course:** The athlete was diagnosed with a low-velocity posterior dislocation of the knee with popliteal artery damage, complete posterior cruciate ligament tear, and partial anterior cruciate ligament tear. Immediate treatments included stabilization and splinting in extension, ice, elevation, elastic wrap and transportation to the hospital by emergency medical services. At the hospital emergency neurovascular surgery was performed to repair the popliteal artery. Surgery to repair the ligaments was postponed for three weeks. As a result of the ligamentous repair surgery, the patient suffered permanent damage to the foot and is currently a candidate for amputation.

**Deviation from the expected:** The uniqueness of this violent injury is that it occurred while the athlete was stepping in a hole on the practice field in a non-contact and low-velocity situation. Upon arrival of the athletic trainer to the scene, the knee had spontaneously reduced itself cautioning that arterial damage might be present.



## Acute Knee Pain In A Collegiate Lacrosse Player

Horsman G, Curl LA, Yap J, McFarland EG: Section of Sports Medicine, Johns Hopkins University, Baltimore, MD

**History:** A nineteen year old Division I college lacrosse player sustained a direct blow to the anterolateral side of his left knee during competition. He was unable to continue to walk and was carried to the sideline for further evaluation. He had no history of previous injury to that knee and did not complain of any paresthesias. He did not feel or hear a pop but had significant pain in his knee.

**Physical Examination:** The player was in mild distally and held his knee in a flexed, protected position. He was neurologically intact for sensation and motor testing, and he had normal pulses. He had a tense effusion and range of motion was limited to 5 to 80 degrees. He was tender over the medial joint line, medial collateral ligament but also was tender over the lateral joint line and lateral proximal tibia. He had a negative Lachman's but guarding prevented a conclusive examination. He could actively extend the leg and his extensor mechanism was intact. To valgus stress in full extension he seemed to open up more than the contralateral knee, and at thirty degrees of flexion he had definite laxity with no firm endpoint. Anterior and posterior drawer testing could not be done due to pain and guarding. His knee was iced and placed in a knee immobilizer, and he was placed on crutches non-weight bearing.

### Differential Diagnosis

1. Medial collateral ligament injury
2. Possible posterior cruciate and posterior-medial oblique ligament injury
3. Fracture

**Tests And Results:** Plain Radiographs—Displaced lateral tibial plateau fracture, split-compression type (Schatzker type 2) with depression of the articular surface over one centimeter.

**Clinical Course:** Based upon the radiographs, a diagnosis of a lateral tibial plateau fracture with articular surface depression was made. He underwent operative treatment with open reduction and internal fixation, supplemented with iliac crest bone grafting. He was placed postoperatively in a hinged knee brace held at thirty degrees of flexion for ten days, non-weight bearing. He began active assisted range of motion at two weeks post-op, and progressed to active motion as tolerated. His fracture healed at three months with full range of motion, and he was allowed to return to full activity, including sports, at four months postoperatively.

**Deviation From The Expected:** Acute knee injuries are seen frequently and there is widespread awareness of the possibility of ligamentous injury. This case demonstrates that fracture should be considered in the differential diagnosis of the acutely injured knee. This is an unusual fracture infrequently reported in sports. Opening of the knee to valgus stress can occur due to this injury. Also, it is unique that this player was able to return to sport so rapidly after such a severe injury.

## Prolonged Muscle Aches And Fatigue In A Collegiate Football Player

McLendon M: Mississippi State University, Starkville, MS

**PERSONAL DATA/MEDICAL HISTORY:** A 24 year-old male, inside linebacker on a Division I football team had complaints of muscle aches, fatigue, and muscle weakness beginning in the fall semester and continuing into the spring. The only significant aspect of his medical history was a sister with lupus disease.

**PHYSICAL SIGNS AND SYMPTOMS:** The athlete complained of muscle aches, fatigue, and muscle weakness, especially in the upper body. The symptoms began in the fall during football season, but he continued to play. His symptoms worsened into the spring. During spring football practice, the weakness became so disabling that he would fall for no apparent reason. Upon examination, the athlete had visible atrophy, a rash on his chest, and periorbital edema.

### DIFFERENTIAL DIAGNOSIS:

- (1) Mononucleosis
- (2) Rhabdomyolysis
- (3) Polymyositis
- (4) Becker's Dystrophy
- (5) Thyroid Myopathy
- (6) Muscular Dystrophy
- (7) Polyneuropathy
- (8) Polymyalgia Rheumatica
- (9) Scleroderma
- (10) Systemic Lupus Erythematosus
- (11) Rheumatoid Arthritis
- (12) Occult Malignancy

**DIAGNOSTIC IMAGING/LABORATORY TESTS:** Decreased hematocrit, hemoglobin, white blood cell count, and red blood cell count. Elevated LDH, cholesterol, SGOT, SGPT, myoglobin (urine), aldolase, and TSH. Creatine kinase (CK) was increased from a normal level of 38-174 to 21,300. Hepatitis A and B tests were negative as were tests for HIV, mononucleosis, and Epstein-Barr.

**CLINICAL COURSE:** The athlete was admitted to the hospital because of his elevated CK level and to perform further diagnostic tests including a muscle biopsy. He was diagnosed with polymyositis. While in the hospital, he was placed on high doses of steroids to decrease his CK level. His long-term treatment has consisted of prednisone, methotrexate, and rest. For several months, his workouts were limited to 5 minutes of stationary bike each day, but his normal daily activities did return to normal. Once his medicines put the disease into remission, the athlete can gradually increase physical activity, but a return to football appears doubtful.

**DEVIATION FROM THE EXPECTED:** Athletic trainers and doctors often have athletes who report symptoms of fatigue and sometimes weakness, but rarely do these symptoms indicate a life-threatening disease. The incidence of polymyositis is only 1 in 25,000, and it usually occurs in people 40 to 60 years-old. This is a disease with no known cause. Interestingly, the CK level of this athlete still has not returned to normal after 7 months of treatment, and his level of activity is still very restricted.

## Viral Infection In A High School Varsity Field Hockey Player

Casey, KC: Casady School, Oklahoma City, OK

An 18 year old female varsity field hockey player complained of a sore back, headache, and "excessive" fatigue following a pre-season field hockey practice in a hot environment. The athlete was recovering from a grade II M.C.L. knee sprain which she suffered 1 month before. In pre-season of last year the athlete came down with infectious mononucleosis and recovered without complications. The athlete presented with a fever (99.4°F), tachypnea, headache, and back soreness. The soreness extended from the base of her skull into her lumbar region. Physical exam revealed a decrease in trunk flexion and an exacerbation of the headache upon combined lumbar and cervical spine flexion. That night the athlete became nauseated and began vomiting. Her headache increased significantly. Her parents took her to a medical physician the following morning. Based on the initial exam, possible diagnosis include a heat-related illness, delayed onset-muscle soreness, a strain to the paraspinal muscles, viral or bacterial infection or rheumatoid arthritis. The cytomegalovirus (CMV) serology test done the next morning revealed an increased CMV IgM antibody enzyme immunoassay (EIA) value of 40. The normal EIA value range is 0-20. Complete blood count showed low lymphocyte (326 cells/M.C.L.; range 1300-5200) and eosinophil (45 cells/M.C.L.; range 50-500) counts. The athlete was diagnosed with viral meningoencephalitis. Treatment included a continuation of NSAIDS that she had been using during her recovery from her knee injury. She was instructed to decrease all activity and to stay home from school. She returned to the doctor in 7 days with no headache or nausea and decreased back soreness. NSAIDS were discontinued and Tylenol was recommended for soreness or headache. She returned to school after 10 days with strict limitations on activity. Seven days following, she was cleared for exercise in a controlled environment. The athlete began with knee rehabilitation exercises and low intensity aerobic conditioning on a cycle ergometer. A heart rate monitor was used to monitor workout intensity. She was progressed daily as long as she remained asymptomatic. She advanced to outside conditioning and drills for agility and speed. Intensity was constantly monitored. Ten days after being cleared to start activity, she was full go and cleared to return to practice for 1 week of before competition. She played the rest of the season without incident. Meningoencephalitis is a very uncommon illness in young, healthy individuals. Young adults that do become infected are infected with some form of the herpes simplex virus, not CMV.

## Syncope In A Collegiate Wrestler Caused By An OTC Metabolic Stimulant

Myers JB, Guskiewicz KM, Padua DP, Riemann BL, Tuttle GH: University of North Carolina; Chapel Hill, NC

**Personal Data/Pertinent Medical History:** A 20-year-old African-American male collegiate wrestler suffered from sharp chest pains, tachycardia, and syncope during wrestling practice, following ingestion of a metabolic stimulant. The athlete had no previous history of chest pain, syncope, or tachycardia.

**Physical Signs and Symptoms:** The athlete experienced altered states of consciousness, intermittent, and sharp chest pain on the left side just deep to the sternum. He was in tachycardia with a pulse rate of 160 bpm, while hyperventilating. The athlete was able to respond to verbal stimuli but unable to respond verbally. The athlete experienced intermittent episodes of eye closure and cessation of breathing. With this altered state of consciousness, the athlete was able to describe the symptoms as chest pressure with no sensations referred to his upper extremities. He was transferred via EMS to the emergency room.

**Differential Diagnosis:** 1) Cardiac arrhythmia; 2) Hypertrophic myopathy; 3) Electrolyte imbalances; 4) Drug overdose; 5) Primary epileptic seizure; 6) Pulmonary embolus; 7) Traumatic head injury 8) Syncope

**Result of Diagnostic Imaging/Laboratory Tests:** The athlete was transported to the emergency room where his blood pressure was measured to be 120/80 and his pulse 90 bpm. The chest pains, tachycardia, and shortness of breath persisted for approximately 2 hours following the incident. While at the emergency room, the athlete revealed he had taken 2 tablets of an OTC medication containing both ephedrine and caffeine approximately 1 hour prior to practice. The athlete was admitted to the hospital for further testing. An electrocardiogram revealed normal cardiac intervals and normal sinus rhythm. A 24-hour Holter monitor was performed to rule out a cardiac arrhythmia. An echocardiogram was performed and ruled out hypertrophic myopathy. Urine analysis revealed levels of amphetamines due to the high intake of ephedrine. A urine analysis revealed increased levels of creatine possibly due to dehydration. One day following the incident the athlete performed a Cardiovascular Exercise Tolerance Study, which revealed chest pain 16 minutes into the test and lasting 15 seconds. Results revealed normal heart rate, rhythm and blood pressure. The final diagnosis was syncope.

**Clinical Course:** The subjective and objective information attained by the physician indicated that the syncope was caused by a combination of dehydration, a metabolic stimulant, and physical stress. The athlete was discharged from the hospital two days following the incident. The athlete followed up with the team physician 4 days later and was counseled on the dangers of metabolic stimulants. The team physician advised the athlete to refrain from taking OTC medications containing ephedrine or pseudoephedrine and was advised to screen all OTC medications with his physician and athletic trainer. The athlete was cleared for return to activity on that follow-up visit and experienced no further episodes. It is assumed that he discontinued his use of the metabolic stimulant.

**Deviation from the Expected:** This case study is unique in that it involves a collegiate wrestler taking an OTC metabolic stimulant in order to aid in weight loss. The medication was called Ripped Fuel (Twin Lab, Ronkonkoma, New York) and contained Ma-Hueng extract (6% ephedrine) and Guarana extract (22% caffeine). This OTC medication is available at most stores specializing in nutritional supplements. The athlete was taking 2 tablets twice a day for several months. His rationale for use was to increase his basal metabolism in order to aid in weight control. This athlete was fortunate that a certified athletic trainer was present and took the correct actions. If the incident had occurred during an unsupervised exercise session, the athlete could have died. The recent deaths of three collegiate wrestlers while attempting to lose weight reminds us that it is vital for athletic trainers and coaches to understand the dangers involved with the practice of "cutting weight." Taking metabolic stimulants like Ripped Fuel when dehydrated and under physical stress, can cause syncope and possibly death in normal healthy athletes.



## Acute Midfoot Pain In A Collegiate Football Player

Freeman ML, Klootwyk TE, Ingersoll CD: Athletic Training Department, Indiana State University, Terre Haute, IN

**Personal data:** The injured athlete (age: 22; ht: 6'4.4"; wt: 275 lbs) was a collegiate football player who played on the offensive line. The injury occurred during the 8th game of the season. He had no history of injury during preseason and throughout the first 7 games. While he was blocking an opponent, another player fell on his heel, causing an axial load through his mid-foot. He reported that he felt his toes being pushed down into hyperextension and his foot into plantar flexion. He came off of the field under his own volition for evaluation.

**Physical signs and symptoms:** The athlete presented initially with no swelling or discoloration. He was point tender between the 1st and 2nd metatarsals at their proximal articulation. He could walk pain-free; however, when he attempted functional activities, he could not push off without pain.

**Differential diagnosis:** 1) Mid-foot sprain, 2) Lisfranc fracture, 3) Lisfranc sprain, 4) metatarsal fracture, 5) intertarsal sprain, 6) cuneiform fracture.

**Results of diagnostic imaging/laboratory tests:** Bilateral, weight-bearing x-rays showed a 1 mm space between the 1st and 2nd metatarsal bases on the unaffected foot as compared to a 4mm spread on the injured side.

**Clinical course:** The injury was initially treated with cryotherapy and later with pulsed ultrasound. He was instructed in non-weight bearing crutch use and placed in an immobilizing boot. He was also instructed to self-treat using a Cryocuff when he was not in the athletic training room. He was diagnosed with a Lisfranc sprain by the head team orthopedic surgeon and referred on to a foot and ankle specialist for further evaluation. The specialist determined that surgery was necessary to stabilize the joint and an open-reduction internal fixation (ORIF) was performed. The surgery went well and the athlete was in minimal discomfort afterward. At 5 days post-op, the athlete presented with minimal swelling and his incision was healing well. He had moderate ecchymosis in his toes along with mild paresthesia. His early rehabilitation consisted of active range of motion at the ankle and toes, towel drags and desensitization massage of the incision. He tolerated these exercises/activities well. He was successfully weaned off crutches by week 4. He progressed to a steel-shank orthotic and progressively more challenging exercises.

**Deviation from the expected:** This injury would have likely been identified as a midfoot sprain had we not carefully examined x-rays and noted a 4mm spread between the 1st and 2nd metatarsal bases. Another football player had a Lisfranc's sprain earlier in the season, so we were attuned to the possibility. Had we treated this as a midfoot sprain we likely would have expected a 3 to 4 week recovery period, but would not have met with success. Because we identified the Lisfranc sprain early, we were able to get the metatarsals pinned, expediting recovery. Faulty foot alignment may have resulted from failing to pin the joint, possibly resulting in changed mechanics throughout the chain.

## Free Communications, Poster Presentations: Session D

Friday, June 19, 8:00 AM - 11:30 AM; Location: Pratt Street Lobby; Authors present from 10:30 AM to 11:30 AM to answer questions

### National Injury Patterns For High School Football

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The National High School Sports Injury Registry (NHSSIR) is a program that is sponsored by the National Athletic Trainers' Association. Its objectives are to identify the type, frequency and severity of injuries associated with selected high school sports. The injury data were recorded by certified athletic trainers that were on-site at least five days per week during the 1995, 1996 and 1997 football seasons. Participating schools represented varsity football programs in 45 states and included an average of 7,000 players per season. A reportable case included any injury that required the player to be removed from the current session. All fractures, dental injuries and concussions, regardless of time lost, were reportable. The accumulated data indicates that 39% of the varsity football players sustain at least one injury during the football season. Nearly 57% of the injuries occur during practice and 23% of the cases require the player to miss more than seven days of participation. The Hip/Thigh/Leg account for 17.5% of the injuries. The Ankle/Foot and Knee injuries both represent 15.3% of the injuries. Two percent of the injuries required surgery and 54% of the surgical cases involved the knee. Nearly 50% of the injuries resulted from direct impact. The three year data show an average of 92% of the injuries were initial injuries with only 8% of cases listed as re-injuries. For game-related injuries running backs have a 56% greater risk of injury than wide receivers, a 14% increase over the quarterbacks and over twice the risk of injury as other positions. These injury patterns describe the frequency and type of injuries that can be expected in high school football. The large proportion of practice-related injuries demonstrates the importance of the daily need for health care supervision. The low proportion of re-injuries reflects the value of early injury recognition and professional injury management as tools for injury prevention.

### An Epidemiological Survey Of Injuries In Boys And Girls High School Soccer

Hafner TL, Pfeiffer R: Boise State University, Boise, ID

The purpose of this study was to assess the injury type, location, mechanism, incidence rate, and severity during games for one complete season among high school soccer players of both genders. A secondary purpose was to compare genders as well as chronological age groups on the basis of injury severity. The sample included male ( $n=240$ ) and female ( $n=243$ ) varsity and junior varsity club soccer players in seven high schools. Subjects ranged in age from 14 to 18 years. Injury was defined as "any incident occurring during scheduled games and causing a player to miss the next game or practice" (Ekstrand et al., 1983). For the purposes of this study, only injuries occurring in games were included. Injury information was obtained from NATABOC certified athletic trainers employed at each high school and at two local clinics. Coaches provided information regarding rosters, playing positions, and time played by each athlete during each game. A total of 41 injuries were recorded for 10,948 game hours played yielding 22 injuries (4.04/1000 game hours) for boys and 19 (3.45/1000 game hours) for girls. With genders combined, the majority of injuries were to the lower extremities with sprains being the most common (29%) followed by contusions (24%) and strains (12%). The most common mechanism of injury was a direct blow (76%). Injury severity was differentiated using the Abbreviated Injury Scale (AIS). The data revealed that 74% of the injuries were minor, 26% were moderate and none were in the serious or maximum categories. Statistical analyses (Mann-Whitney U-test and Kruskal-Wallis One-Way ANOVA) revealed no significant differences between genders on injury severity ( $p<0.674$ ). In addition, no significant differences in injury severity between chronological age groupings was found ( $p<0.0708$ ). It is recommended that future studies be conducted over successive seasons in order to identify injury trends as well as intrinsic and extrinsic injury risk factors.

### Epidemiological Investigation Of Mild Head Injuries Sustained By Participants In Collegiate And High School Football

Padua DP, Guskiewicz KM, Myers JB: University of North Carolina, Chapel Hill, NC

Mild head injury (MHI) is estimated to occur at a rate of 250,000 per year in contact sports. Football is commonly used as the model sport for studying MHI in athletics. Quantitative information on football related concussions often relates to the professional level, with limited data specific to collegiate and high school levels. The purpose of the study was to investigate the incidence, setting, mechanism of injury, and symptoms associated with MHI at all levels of collegiate and high school football. Over a three-year period (1995-1997), a national study randomly surveyed certified athletic trainers (Div. I = 50; Div. II = 28; Div. III = 41; H.S. = 118). Of the 237 responses, 839 athletes sustained concussions producing a 5% MHI incidence rate. There were no significant differences between MHI incidence rates and level of competition (Div. I = 5%; Div. II = 5%; Div. III = 6%; H.S. = 6%). The survey revealed that Grade I concussions were most common (88%), with Grade II concussions (11%) and Grade III concussions (<1%) being significantly less frequent. Results of the study revealed game situations as the setting most commonly associated with MHI (60%). Additionally, the mechanisms of injury most common with MHI were contact with opponent (76%), followed by contact with ground (10%), contact with teammate (4%), and contact with equipment (4%). The positions at greatest risk for sustaining MHI were defensive backs (16%), offensive linemen (15%), linebackers (15%), defensive linemen (14%) and running backs (13%). The most common signs and symptoms reported with MHI were headache (86%), dizziness (68%), confusion (59%), disorientation (48%) and blurred vision (36%). Loss of consciousness (9%), amnesia (28%) and a positive Romberg test (29%) occurred less frequently. Twenty percent of the athletes experienced headache for at least two days, 15% for at least three days and 5% for at least five days. Confusion and disorientation greater than ten minutes were reported in 33% and 23% of the athletes respectively. If analyzed by injury grade, those athletes sustaining Grade II concussions revealed headache, confusion, disorientation, blurred vision, amnesia and loss of consciousness of longer duration. These findings suggest that while MHI is still very prevalent in football, the incidence of MHI is much lower than the 20% reported by Gerberich and others during the 1980's. The injury patterns such as mechanism, setting, and positions at risk are consistent with previously reported findings.



## Characteristics Of Anterior Cruciate Ligament Injuries: Preliminary Findings

Van Lunen BL, Perrin DH, Arnold BL, Gieck JH, Saliba EN, Gansneder BM, McCue FC: University of Virginia, Charlottesville, VA

The purpose of this study was to compare several anatomical reference points and knee laxity assessments for anterior cruciate ligament (ACL) injured males and females. Secondly, this study examined the anatomical and laxity differences between those injured through a noncontact or contact mechanism. Lastly, this study examined the intratester reliability of several of the measures. Thirty subjects with disruption of the ACL who gave informed consent (10 females, 20 males, age =  $25.53 \pm 9.54$  yrs, ht =  $176.50 \pm 9.39$  cm, wt =  $83.81 \pm 20.70$  kg) participated in this study. Subjects were classified as being injured due to contact or noncontact. Tunnel-view radiographs of both knees were taken and the notch dimensions of popliteal notch width index and half-height notch width index were determined. The subjects were measured for quadriceps angle, navicular drop, sagittal knee extension, tibial fibular varum, tibiofemoral angle and KT1000 measures at 15 and 30 pounds of force. If applicable, the subjects was asked to place their feet on a pre-made foot template. All measures were taken bilaterally. Separate one way analyses of variance were performed on each dependent measure. Intraclass correlation coefficients (ICC) (2,1) were used to determine intratester reliability. Results indicated that quadriceps angle was significantly greater for the males injured through a contact mechanism [ $F(2,29)=3.97$ ,  $p=.031$ ] than the males injured by noncontact. The injured popliteal notch width index was significantly greater for the contact males [ $F(2,27)=6.123$ ,  $p=.007$ ] than the noncontact males and females. The injured half-height notch width index was significantly greater for the contact males [ $F(2,27)=3.987$ ,  $p=.032$ ] than the noncontact males only. All other analyses of variance were not significantly different. Values for intratester reliability ranged from .57 - .94. The results of this study demonstrate that many of the dependent variables examined may not differ between males and females who are injured through contact or noncontact mechanisms. The values of popliteal notch width index support past research in classifying those individuals with a notch width index of less than .2000 as being susceptible to noncontact ACL injuries. Future research should examine notch dimensions utilizing a different method. The di-

mensions of the ACL in relationship to the dimensions of the notch should also be investigated in different populations. Further research should also examine the role of the dependent variables in a dynamic gait pattern.

## Injuries To Javelin Throwers: Gender Differences

Butcher M: Texas Woman's University, Denton, TX

The primary purpose of the study was to determine the incidence and types of injuries occurring to intercollegiate javelin throwers. The secondary purpose of the study was to determine the incidence and types of injuries occurring between male and female intercollegiate javelin throwers. In the fall of 1996, a questionnaire was mailed to the head athletic trainers of 500 college/universities in the United States that offered track and field as a competitive sport. The instrument was designed to generate the following information with regard to the 1995-96 academic year: (a) number of participating male and female javelin throwers including those red-shirted, (b) number of participating injured male and female javelin throwers including those red-shirted, and (c) type of injury per body part per injured male and female javelin thrower. Data were descriptively analyzed via BMDP2D. Based on 138 usable returned questionnaires (27.6%), a total of 191 athletes (36.3%) were injured, 99 males (35.9%) and 92 females (36.8), sustaining 285 injuries (140 to males, 145 to females). The largest number of injuries sustained by the total group was to the elbow and shoulder joints, 21.8% and 21.4%, respectively. Medial epicondylitis accounted for the most common specific elbow joint injury (38.1%), and rotator cuff injuries were the most common shoulder joint injury (83.8%). For the female group, the most common injured body part was the back (21.4%) with lumbar strains/sprains being the most prevalent back injury (58.1%). Elbow joint injuries were the most common in the male group (29.3%) with sprains comprising 41.5% of those injuries. Overall, females incurred more injuries to the lower extremities than did males, 40.7% vs. 27.1%. Differences may be a result of technique and/or strength and conditioning training differences between the two groups. Therefore, athletic trainers must be aware of the biomechanical and physiological demands that throwing the javelin places upon their athletes, and in particular upon female throwers, in order to improve injury prevention programs, rehabilitation and treatment protocols, and evaluation techniques.

### Sexual Activity And Condom Use In Female Collegiate Athletes Versus Non-athletes

Watson A, Martin M, Hunt H: University of South Carolina - Columbia, Columbia, SC

As research indicates, traditional-age college students are at a higher risk to contract a sexually transmitted disease. The objective of this study is to compare the sexual behavior and incidence of sexually transmitted diseases among collegiate female athletes versus their non-athlete peers. A 24 question survey was given to 100 female division I collegiate athletes and 100 non-athletes randomly selected, for convenience, from a Psychology, Biomechanics, and Human Movement class at the same university. Participation in this study was stressed as completely voluntary and all answers strictly confidential. The questionnaire contained questions regarding sexual behavior and knowledge of safe sex practices along with demographic information, such as the primary sport of participation, age, race, and year in school. After collecting all 200 surveys, the answers from each group were tallied and compared with sexual activity, condom use or some other safe sex practice, and the incidence of sexually transmitted diseases being the focus of the results. From the questionnaire, the number of lifetime partners and the age of the first sexual encounter as compared between athletes and non-athletes was similar; however, the incidence of sexually transmitted diseases were not as similar. The athletic population experienced twice the rate of sexually transmitted diseases as their non-athletic peers. Both groups reported condom use 44% of the time and over 70% have had more than one partner. In spite of the assumed intellectual level of these subjects, over 43% of both groups had engaged in sexual activity with someone other than a steady partner. Findings of this study have implications for improved methods of STD/AIDS education. Sexually transmitted diseases/Acquired Immunodeficiency Disease Syndrome education workshops should be included annually in each sport's pre-season, focusing on both social and physical aspects of safer sex practices.

### Attitudes About Football Helmet Removal Procedures From Students In A Paramedic Education Classroom

Vieson M, Wimer JW: Wilmington College, Wilmington, OH

Support for leaving the football helmet in place until cervical-spine fracture or dislocation are ruled out has been extensively documented. The purpose of our study was to investigate the attitudes of Emergency Medical Technicians (EMT) preparing for paramedic certification. We wanted to know whether EMTs (paramedic students) are knowledgeable about leaving the helmet in place in cases of suspected cervical injury. A survey was administered to 81 students enrolled in a community college paramedic program. The instrument consisted of a scenario portraying a downed football player with a possible cervical-spine injury and six statements regarding management and care for the athlete in the scenario. Responses to each question were made on a modified Likert scale (1 = strongly agree to 7 = strongly disagree). We hypothesized that the paramedic students would be knowledgeable about football helmet procedures for two reasons. First, we believed that the paramedic students would be more familiar about the topic of football helmet removal in cases of cervical-spine injury than entry-level EMTs due to training seminars and experience. Second, we believed that persistent educational efforts by groups such as NATA, ACSM and NCAA have influenced paramedic instruction. In other words, we thought the paramedic curriculum would reflect the views of most certified athletic trainers (ATCs) — that the football helmet should remain in place in cases of suspected cervical spine injury. Results of the survey showed that paramedic students were somewhat knowledgeable about football helmet procedures. Specifically, we found a marginally significant difference between the EMTs attained educational level and their knowledge about football helmet removal. Results from an independent samples t-test ( $p = 0.07$ ) indicate that EMT-A (advanced level) agreed that it was important to leave the football helmet on ( $4.80 \pm 2.07$ ), whereas EMT-B (basic level) thought it was less important to leave the helmet in place ( $3.75 \pm 2.01$ ). Despite these data, continuing efforts are necessary to educate EMTs and paramedics that football helmet removal requires specialized training because of problems posed by adjoining athletic equipment, primarily the shoulder pads.

### Collegiate Coaches' Knowledge Of Eating Disorders

Turk JC, Prentice WE: The University of North Carolina, Chapel Hill, NC

Exploratory research was conducted to assess collegiate coaches' knowledge of eating disorders. In addition to investigating knowledge, confidence in response correctness was analyzed as well as demographic data. Knowledge of eating disorders was computed overall and within five domains. These domains include: etiology; identifying signs and symptoms; management and treatment; risk factors; and education and prevention of eating disorders. One-hundred thirty-eight NCAA Division I-A coaches from five universities responded to the two-part questionnaire. Demographic data focused on educational programs attended by coaches and teams. The survey consisted of 30 true / false questions which tested knowledge in each of the five domains. Coaches indicated their level of certainty in their response by rating their confidence level on a four item Likert-type scale. Descriptive statistics were used to analyze all data. Results suggested a need for coaches to achieve a greater knowledge of eating disorders in all domains. Evidence showed that educational programs about eating disorders were not often sponsored by the athletic department for coaches or athletes. There seemed to be poor communication between athletic departments and coaches regarding the availability of eating disorder educational resources. Data suggested coaches could benefit from comprehensive education in all domains of eating disorders. Athletic departments are in a position to enforce such education of coaches, teams, and other department members that work closely with athletes. With proper education, athletic departments and coaches can play a primary role in enhancing the health and athletic experience of athletes.



### **A Comparison Of HIV/AIDS Knowledge And Attitudes Of Entry Level Athletic Training And Nursing Students**

Loriz LM, Miller MG: University of North Florida, Jacksonville, FL

Students entering the field of nursing are aware that at some point throughout their career they will be caring for individuals who are HIV infected. Entry level athletic training students may not be aware that they too might work with HIV infected individuals. Additionally, issues of confidentiality prevent the athletic trainer or nurse from knowing which individuals are HIV positive. A review of literature found numerous studies of HIV/AIDS knowledge and related attitudes in the nursing profession, however, only one study to date has examined this topic among athletic trainers. The purpose of this study was to compare the HIV/AIDS knowledge and attitudes of entry level athletic training (AT) and nursing (NU) students. A 20-question HIV/AIDS knowledge test (HKT) and an 18 item HIV/AIDS attitude questionnaire (HAQ) were administered to 72 entry level students. The subject population consisted of 41 AT and 31 NU students enrolled in the introductory courses of their specialties. The data were analyzed using SPSS 7.5 for Windows. T-tests were used to compare the HKT and HAQ results between the two groups. There was no significant difference between the general results for the HKT for the two groups. However, there was a significant difference ( $p < 0.05$ ) noted within responses to specific questions. The question regarding definition of AIDS showed a correct response in 84% of the NU students versus a 73% correct response for the AT students. Possibility of transmission from infected individuals with no visible signs or symptoms was correctly identified in 90% of NU students and in 97.5% of AT students. The identification of a common opportunistic infection was correct in 23% of NU and 34% of AT students. Results to the HAQ did not reveal any significant differences between the two groups. However, a significant difference was found to the question of whether attitudes had changed towards homosexuality since the beginning of the AIDS crisis. Only 39% of NU students and 24% of the AT students had a positive response. These findings indicate that there are no significant differences in the HIV/AIDS knowledge and attitudes of the entry-level students in both nursing and athletic training programs at this university. Future studies will examine the relationship between knowledge and attitudes. An extension of this study will include administering the HKT and the HAQ to students prior to their completion of the program to determine significant changes.

### **A Comparison Of Learning Styles Between Two CAAHEP Accredited Athletic Training Programs**

Harrelson GL, Leaver-Dunn D: DCH Regional Medical Center, Tuscaloosa, AL

An understanding of student athletic trainer learning styles will allow athletic training educators to enhance the quality of their instruction. By knowing the learning styles in a classroom the educator can modify their lesson to take advantage of these preferences. The purpose of this investigation was to compare the learning modes and styles of undergraduate athletic training students using the Learning Style Inventory (LSI) II-A. The LSI II-A assesses the learner's level of activity or reflectivity and of abstractness or concreteness. These four learning modes fall on two continuums: a horizontal axis represents the active-reflective learning mode, and a vertical axis represents the concrete-abstract learning mode. The learning mode scores translate into four learning styles that incorporate two characteristics. The accommodator is concrete and active, the diverger is concrete and reflective, the assimilator is abstract and reflective, and the converger is abstract and active. Seventy students enrolled in two CAAHEP-accredited undergraduate athletic training education programs (ATEPs) served as subjects. Thirty-six subjects were from School 1 and 34 were from School 2. The LSI II-A was administered to each subject before the beginning of a regularly scheduled athletic training class during the 1997 fall semester. Forty-seven percent of the subjects from School 1 were classified as assimilators while a majority (32%) of the School 2 students were accommodators. Collectively the subjects fell in the assimilator learning style quadrant. One-way ANOVA revealed significant differences ( $p < .05$ ) between the learning modes of concrete experience and reflective observation between the two schools. Students from School 2 were more concrete, while the School 2 students were more reflective. Both schools scored on the abstract side of the learning continuum. School 1 students scored more on the reflective side than did School 2 students whose data point was almost in the middle of the two axes. These results indicate there were differences between the learning modes and styles of students in these two ATEPs. Based on these data, athletic training educators are urged to assess the learning styles of each class and examine their instructional methods to ensure they are addressing the learning preferences of each class and helping students explore their non-preferred learning style(s).

### **Internet Resources That Enhance Student Athletic Trainer Knowledge Of Rehabilitation And Reconditioning Of Athletic Injuries For NATABOC Certification Examination**

Wright K, Elder C, Newman V, Wright V, Leaver-Dunn D: The University of Alabama, Tuscaloosa, AL

This presentation presents components of educational technology, specifically related to Internet usage, which assist student athletic trainers in studying and preparing for the National Athletic Trainer's Association's Board of Certification (NATABOC) certification examination. This presentation summarizes how The University of Alabama's Athletic Training Education program, in cooperation with the university's Instructional Technology department, implemented Webwhacker to develop an educational curriculum. This curriculum focuses on several skills the student athletic trainer must master before taking the NATABOC certification exam, specifically, the domain of rehabilitation and reconditioning of athletic injuries. A WWW search for viable pages related to the skills was accomplished and using WebWhacker software, the selected files were downloaded and organized into a study bank for students to utilize offline. For students and classroom instructors with or without network access, this is a fast, reliable and efficient way to deliver important lessons and related information. The primary advantages of this technological tool are learner flexibility, maximization of content, timeliness and availability, and content retention.

## Development And Validation Of A Computer-Assisted Learning Program Designed To Enhance Professional Preparation In Athletic Training

Castle RR, Gallaspy JB, Gangstead S, Thompson W, Knight C: The University of Southern Mississippi, Hattiesburg, MS

The primary purpose of this study was to develop a computer-assisted instructional (CAI) program designed to be utilized by the student athletic trainer in preparation for the National Athletic Trainers' Association Board of Certification, Inc., Certification Examination. A second purpose of this study was to determine the efficacy of this computer-assisted, self-paced instructional strategy among student athletic trainers. Subjects for the study were 22 undergraduate students enrolled in an NATA-approved Athletic Training Undergraduate Curriculum, and were randomly assigned to either the Experimental or Control Group. All students who participated in the study had taken or were currently enrolled in all of the following classes: 1) Care and Prevention of Athletic Injuries, 2) Therapeutic Modalities, 3) Evaluation of Athletic Injuries, and 4) Rehabilitation of Athletic Injuries. A quasi-experimental (pre-test, post-test with control group) design was utilized in this study in which the two groups were administered a pre-treatment and post-treatment assessment of a 150 question Knowledge Assessment Instrument (KAI). The Experimental Group received short-term, intensive treatment on a computer-assisted instructional program which contained 551 multiple-choice questions related to specific knowledge areas within the profession of Athletic Training. Statistical analysis involved independent t-tests that were conducted on both pre-treatment and post-treatment data. The pre-treatment analysis was used to determine initial equivalency of groups. A One-Way Analysis of Covariance (ANCOVA) was ultimately used to determine the influence of instructional strategy on subjects' knowledge of Athletic Training concepts and to control for pre-treatment variability of performance between the groups. These analyses were conducted on the KAI post-test data. Subjects' pre-test scores were used as the covariate in the analysis. This study yielded the following findings: 1) There is no significant differences in pre-test scores between the Experimental and Control Groups ( $t = -0.63$ ,  $p > .05$ ), and 2) There is a significant difference in post-test scores between the Experimental and Control Group after the Experimental Group received interaction with the treatment instrument ( $F_{1,19} = 49.87$ ,  $p < .001$ ). The Experimental Group improved their performance scores by approximately 15%. It can be concluded from this study that CAI can have a significant effect on knowledge gains.

## Reliability Of The Productivity Environmental Preferences Survey Among Undergraduate Athletic Training Students

Leaver-Dunn D, Harrelson GL: DCH Regional Medical Center, Tuscaloosa, AL

Recent investigations have examined the learning styles of undergraduate athletic training students using the Productivity Environmental Preferences Survey (PEPS). This instrument has been shown to be reliable among nursing and other allied health students, but its reliability among athletic training students has not been established. The purpose of this investigation was to assess the test-retest reliability of the PEPS among undergraduate athletic training students. Twenty-seven student athletic trainers enrolled in a CAAHEP-accredited undergraduate athletic training education program served as subjects. The subjects completed the PEPS during a regularly scheduled athletic training class at the start of the Spring semester and at the end of the following Fall semester. Standard scores and demographic data for each subject were coded and analyzed using the mainframe version of the SAS statistical software package (SAS Institute, Inc. Cary NC). Test-retest reliabilities of the majority of the 20 subscales ranged were low ( $r = -.060$  -  $r = .426$ ). The highest reliabilities were found for the Temperature Preferences ( $r = .66$ ), Design Preferences ( $r = .70$ ), Responsible/Conforming ( $r = .630$ ), and Tactile Preferences ( $r = .67$ ) subscales. These findings suggest that the PEPS may not be a reliable instrument when administered to undergraduate athletic training students. While some subscales were found to be reliable, the majority of the variables had poor reliability. Changes in learning preferences may have impacted these findings as well. Future research should assess the test-retest reliability of the PEPS on larger samples.



## NOTES:

Dr. J. J. Knapik, Jr., is a professor of physical education and health, and a member of the American College of Sports Medicine. He is also a member of the American Association of Health, Physical Education and Recreation. He is currently serving as the director of the physical education department at the University of North Carolina at Charlotte.

The purpose of this study was to determine the effect of a 12-week aerobic fitness program on the physical fitness of sedentary college students. The study was conducted at the University of North Carolina at Charlotte. The subjects were 30 college students who were sedentary and had no previous experience with exercise. They were divided into two groups: an experimental group and a control group. The experimental group participated in a 12-week aerobic fitness program, while the control group did not. The program consisted of three sessions per week, each lasting 30 minutes. The sessions included a warm-up, a cardiovascular workout, and a cool-down. The cardiovascular workout consisted of running on a treadmill at a speed of 3.0 mph for 20 minutes. The cool-down consisted of walking at a speed of 1.0 mph for 5 minutes. The control group did not participate in any exercise program. Physical fitness was measured at the beginning and end of the 12-week period. The measurements included heart rate, blood pressure, and body mass index (BMI). The results of the study showed that the experimental group had significantly higher heart rates and blood pressures at the end of the 12-week period compared to the control group. Additionally, the experimental group had a significantly lower BMI at the end of the 12-week period compared to the control group. These findings suggest that a 12-week aerobic fitness program can improve the physical fitness of sedentary college students.

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## Free Communications, Poster Presentations: Session E

Friday, June 19, 1:00 PM-4:30 PM; Location: Pratt Street Lobby; Authors present from 3:30 PM to 4:30 PM to answer questions

### Relationship Between Selected Static Foot/Ankle Range Of Motion And Posture Measurements And Mean Peak Heel Forces During Forward And Backward Walking (A Regression Analysis)

Albensi RJ, Nyland J, Hester P: Section of Sports Medicine, Division of Orthopaedic Surgery, University of Kentucky, Lexington, KY

**PURPOSE:** This study compared relationships between select static clinical measurements and the mean peak contact heel forces of forward walking and the mean peak propulsive heel forces of backward walking among normal high school athletes. **METHODS:** Seventeen (8 female, 9 male) healthy high school student-athletes volunteered to participate in this single group, cross-order controlled, repeated measures design study. All data were collected in a high school training room. Static clinical measurements of the foot and ankle were performed using hand held goniometers. A metric ruler was used to assess navicular drop. A standard physician's scale was used to measure bodyweight. Mean peak heel forces were measured using calibrated insole force sensors (F-Scan, TekScan, Boston, MA) inserted into the subject's right shoe. Data were sampled for 3, 5 sec trials (50 Hz sampling rate) of 3-5 consecutive right foot contacts while subjects walked forward and backward at 2.5 - 3 miles/hr. Subjects wore personal athletic shoes during testing and alternated their initial walking direction. Stepwise regression models were constructed to assess the predictive value of the selected static, clinical measurements ( $p < .05$ ). **RESULTS:** (mean  $\pm$  SD) Bodyweight  $154 \pm 28$  lbs, Standing Rearfoot Alignment in Subtalar Neutral Position  $1.7^\circ$  valgus  $\pm 5^\circ$ , Standing Rearfoot Alignment in Subtalar Relaxed Position  $4.8^\circ$  valgus  $\pm 5^\circ$ , Navicular Drop  $1.2 \pm .5$  cm, First Metatarsophalangeal Joint Extension  $56 \pm 13^\circ$ , Ankle Dorsiflexion  $5.4 \pm 3^\circ$ , Modified Thomas Test (Quadriceps Extensibility)  $102^\circ$  knee flexion  $\pm 10^\circ$ , Standing Foot Angle (Toeing Out)  $19.7 \pm 9^\circ$ , Contact Peak Heel Force  $124.7 \pm 28$  lbs, Propulsion Peak Heel Force  $120.1 \pm 25$  lbs. Regression analysis revealed that during forward walking, Mean Peak Contact Forces =  $(.47)$  Bodyweight +  $(23.7)$  Navicular Drop +  $(-1.65)$  Standing Foot Angle +  $55.8$ , (Adjusted  $R^2 = .71$ , Mallows C(p) =  $2.85$ , F value =  $10.1$ ,  $p = .001$ ). During backward walking, Mean Peak Propulsive Forces =  $(.38)$  Bodyweight +  $(18.1)$  Navicular Drop +  $(-1.38)$  Standing Foot Angle +  $66.2$ , (Adjusted  $R^2 = .57$ , Mallows C(p) =  $1.35$ , F value =  $5.74$ ,  $p = .01$ ). **CONCLUSIONS:** Increased Bodyweight and Navicular Drop increased heel forces during forward and backward walking. Increased Standing Foot Angle decreased heel forces during forward and backward walking. Subtle changes in any of these variables has a direct effect on peak heel pressure during forward or backward walking. Further studies are needed at greater gait velocities and during sport specific movements.

### Mood Disturbances Of Intercollegiate Athletes Following Athletic Injury

Miller WN: Springfield College, Springfield, MA

The prevention and care of athletic injuries has historically emphasized physical attributes (Wiese-Bjornstal, Smith, & LaMott, 1995). The assumption has been made that when an athlete is physically rehabilitated, he/she is fully prepared to safely return to physical activity. However, in addition to physical injury, athletes are at risk for suffering psychological consequences attributable to injury (Pero, 1995), and in fact, rehabilitation can be hampered by the emotional state of the athlete (Pearson & Jones, 1992). Larson, Starkey, and Zaichkowsky (1996) reported that 47% of 482 athletic trainers surveyed, postulated that every injured athlete suffers from psychological as well as physiological trauma. In a prospective study, mood disturbances of intercollegiate athletes were assessed both before and after injury. Among 244 male and 92 female intercollegiate athletes from the sports of lacrosse and track and field, 24 sustained injuries lasting a minimum of 2 days. The Profile of Mood States (POMS) (McNair, Lorr, & Droppleman, 1971) was utilized to determine postinjury mood disturbances. The participants completed an informed consent form, a demographic form, and the POMS during the first three weeks of their respective preseasons. Following injury of at least two days in length, the POMS was completed again by the injured athletes in addition to noninjured athletes randomly matched to serve as comparisons. A 2 x 2 mixed factorial MANOVA for the interaction between injury status (injured, noninjured) and time of assessment (pretest, posttest) was significant ( $p < .05$ ). Following a multiple comparison analysis, the significant interaction was found to be attributable to the subscales of 'Vigor' and 'Anger'. 'Vigor' was found to decrease between pretest and posttest for the injured group. At posttest, 'Vigor' was also lower for the injured group in comparison to the noninjured group. In addition, 'Anger' increased between pretest and posttest for the injured group. However, the noninjured group reported similar scores on these constructs from pretest to posttest assessments. In conclusion, 'Vigor' decreased and 'Anger' increased following the incidence of athletic injury in this investigation. A primary objective of the investigation was to provide additional insight to athletic trainers concerning the psychological consequences associated with athletic injury. For many athletes, optimal rehabilitation incorporates both physiological and psychological components. Therefore, by understanding and addressing the mood disturbances associated with athletic injury, athletic trainers can help enhance the overall effectiveness of each rehabilitation program.



### **Osteitis Pubis: Conservative Treatment**

Rodriguez C, Miguel A: Club Universidad Nacional and Facultad de Medicina, University of Mexico, Mexico City, Mexico

Osteitis Pubis is an inflammatory condition of the pubis symphysis and the adjacent muscular insertions. It is caused by repeated trauma to the fascia and joint. It was first described in 1932 by Spinelli as a syndrome of the straight muscles of the abdomen (rectus abdominis) and the adductors. Medical documentation describes it as a rare condition that accounts for only 3 to 5% of all sport injuries, and yet, it has been recognized as one of the most chronic syndromes limiting the athletes' performance. The purpose of this work was to describe the conservative treatment administered to all soccer players of the "Club Universidad Nacional, A.C." in Mexico City who presented with osteitis pubis between September, 1989 and March, 1997. They were all diagnosed by the medical staff of the Club based upon tests with special equipment and physical examination. According to clinical manifestations, patients were classified into 4 stages. Initially, they were all managed with conservative treatment, including NSAID's, physiotherapy and an aggressive program of stretching, flexion and rehabilitation. A total of 44 cases were observed, nine of which were excluded because they required surgical treatment. The 35 remaining cases were all  $18 \pm 2.89$  years old males on average (15-27 years old range) and they were classified as follows: 25 (71.4%) under GI; 9 (25.7%) under GII; and 1 (2.8%) under GIII. As to the player's position, there were 15 (42.8%) midfielders, 9 (25.7%) backs, 9 (25.7%) forwards and 2 (4.5%) goalkeepers. The average recovery time was 26.7 days for GI, 47.3 days for GII, and 72 days for GIII. It is known that while osteitis pubis is not a common condition in sports lesions it is often a disabling pathology that can even force players out of sport activities. This is why this condition has to be diagnosed and treated on a timely basis so that the player's career is not frustrated.

### **The Immediate Effects Of The ProStretch™ With Various Stretching Programs On The Gastrocnemius Muscle**

Namisanak SM, Grossman JM, Bernard A, Wilson B: University of Cincinnati, Cincinnati, OH

The purpose of this study was to research the immediate effectiveness of various stretching protocols using the ProStretch™, a therapeutic product developed by Prism Technologies in San Antonio, Texas. This study focused on the gastrocnemius muscle of active individuals, those participating in an exercise program on a continual basis at least three times per week. Different stretching protocols centered upon static stretching time were researched, as well as the effects of hydrotherapy. Each potential subject was asked to complete an informed consent form and a preparticipatory questionnaire. This study utilized four random experimental groups - a control group, a ProStretch™ group on land with an intermittent protocol, a ProStretch™ group in warm water with an intermittent protocol and a ProStretch™ group in warm water with a continuous protocol. Each group contained 12 subjects. The treatment for the intermittent protocol groups required three sets of stretching of the gastrocnemius muscle according to the guidelines suggested by Prism Technologies - 30 second stretch followed by a five second rest, repeated three times. Each subject was measured three times over the course of the study - (1) prior to any treatment, (2) immediately following a treatment, (3) 10 minutes post treatment. The results showed a statistical significance between pre testing scores and immediate post testing scores between the control group and each of the three experimental groups. A significant difference was also found between pre testing scores and 10 minute post testing scores between the control group and the ProStretch™ in warm water with a continuous protocol. No statistical significance was found between immediate post testing scores and 10 minute post testing scores, however the 10 minute post scores were greater than the pre scores in all cases. These results seem to support the hypothesis. The ProStretch™ product is effective on land and in the water. The more continuous stretch resulted in the greater flexibility retained over time. Therefore, the continuous stretch, combined with the heat modality, may offer greater flexibility over a longer duration of time.

### **Objectively Comparing The Immediate Extensibility Effects On Hamstring Musculature: PNF Versus Static Stretching**

Druse TL, Lee BW, Ostdiek DPG, Threlkeld AJ: Doctor of Physical Therapy Program, Creighton University, Omaha, NE

**PURPOSE:** The purpose of this study was to compare the immediate effects of two different stretching techniques intended to increase the extensibility of the hamstring musculature. **SUBJECTS:** Fifty-five subjects (26 male, 29 female), ranging in age from 22-49 (mean = 26.7) were screened and cleared for neuromuscular impairments of the lower quarter and lumbar region. **METHODS:** Randomly assigned stretching methods consisted of a control and two stretching techniques: hold-relax proprioceptive neuromuscular facilitation (PNF) and static. The stretches were administered with free weights suspended from a traction pulley system accommodating different body weights, leg lengths, and extensibility capacities. Bilateral pre- and post-treatment measurements of hamstring extensibility were recorded utilizing the active knee extension (AKE) test. **ANALYSIS:** Data were analyzed using a 1 (group) x 3 (test) repeated measures Analysis of Variance and subsequent Tukey post hoc test. **RESULTS:** Statistical analysis following the ANOVA revealed a statistically significant ( $p < .05$ ) difference between the control and the two stretching techniques. Subsequent Tukey post hoc tests revealed a statistically significant ( $p < .05$ ) difference between the hold-relax PNF technique (mean elongation increase =  $11.6^\circ$ ) compared to the static technique (mean elongation increase =  $5.4^\circ$ ). **CONCLUSION:** The results of this study suggest that a hold-relax PNF stretching technique is more effective than a static stretching technique for immediate increases in extensibility of the hamstring musculature. **RELEVANCE:** It is recommended that individuals stretch independently using a PNF technique rather than a static technique to increase extensibility. Maximizing hamstring extensibility by safely applying the PNF technique may reduce the possibility of injury while improving athletic performance.

### The Effect Of Active Versus Passive Warm-Up On Alleviating Musculoskeletal Injury After Exercise

Young AL, Lephart SM, Jenkinson DM, DeMont RG, Robertson R: University of Pittsburgh, Pittsburgh, PA

It is commonly recommended in literature that a proper warm-up prior to a bout of exercise will prevent musculoskeletal injury. One paramount domain of athletic training is prevention of athletic injuries. In this study, delayed onset muscle soreness (DOMS) served as a model for musculoskeletal injury. The purpose of this study was to determine the effects of active and passive warm-up on alleviating the signs and symptoms of DOMS. This study compared the effectiveness of these two modes of warm-up and a control prior to an exercise bout of eccentric contractions on the signs and symptoms of DOMS. DOMS was induced to the right hamstring muscle group of thirty recreationally active males and females via five sets of ten eccentric contractions above the subject's one repetition maximum. All subjects were randomly assigned to one of three groups (two warm-up and one control). Each subject performed one of the three activities prior to exercise: 1) active warm-up, rode a stationary bicycle for twenty minutes at a heart rate between 105-115 bpm, 2) passive warm-up, received a moist hot pack to their right hamstring muscle group for twenty minutes, 3) control, sat quietly on plinth for twenty minutes. Data was collected on four dependent variables: active flexion and extension of the knee, leg girth, and visual analogue pain scale. Data was collected on four occasions: pre-induced DOMS, 24, 48 and 72 hours post exercise. The mean and standard deviation were calculated for the age, height, weight, perceived soreness, range of motion angles, and girth measurements of each subject. A 3X4 ANOVA ( $p < .05$ ) with repeated measures on time was performed on each of the dependent variables. Significant main effects and interactions were found between the three groups and across the time periods for the dependent variable of perceived soreness. A Tukey post hoc test ( $p < .05$ ) revealed a significant difference between the perceived soreness measurement means of all three groups in the study: passive warm-up ( $4.8 \pm 2.1$ ), active warm-up ( $2.3 \pm 2.3$ ), control ( $3.5 \pm 1.7$ ). There were no significant effects found relating to the dependent variables of: active flexion and extension angles of the knee and leg girth across all time periods. The results suggest that performing active warm-up prior to exercise is effective in decreasing muscular soreness after activity and may aid in the prevention of muscular injury.

### Comparison Of PNF And Static Stretching Techniques With Superficial Application Of Thermal Modalities On Hip Extension Range Of Motion

Webster K, Yartym C, Reynolds C, Sandrey MA, Ingersoll CD: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** There are a number of different stretching methods employed by athletic trainers. Commonly, therapeutic modalities are combined with a stretching technique to increase its effectiveness. In the past, many of the studies examining the effects of stretching have utilized hip flexion range of motion (ROM). The purpose of this study was to determine the effectiveness of six different stretching and thermal modality protocols on hip extension ROM. **Design and Setting:** Subjects were randomly assigned to one of six different stretching and modality protocols (PNF alone, Static alone, PNF with heat, Static with heat, PNF with cold, Static with cold). Each group featured static or Proprioceptive Neuromuscular Facilitation stretching preceded by an ice application, moist heat application, or no modality application. Each subject completed five stretching sessions over a two week period. **Subjects:** 28 female and 22 male (mean age  $22.32 \pm 3.87$ ) college students with no prior history of hip pathology. **Measurement:** Subjects had their hip extension ROM assessed prior to the first stretching session. Each subject was strapped to a table in the prone position. The examiner lifted the subject's dominant leg to a point of discomfort, maximal resistance, or the onset of anterior hip rotation. An electric goniometer was used to record all measurements. The same procedure was followed for the posttest ROM measurement. ANCOVA analysis of posttest ROM with a covariate of pretest ROM was used. **Results:** ANCOVA analysis indicated that there were no significant differences between any of the six treatment groups ( $F = .298$ ,  $p < .05$ ). Mean posttest measurements by group: Group 1 =  $27.07 \pm 6.51$ , Group 2 =  $26.25 \pm 4.58$ , Group 3 =  $25.59 \pm 5.85$ , Group 4 =  $29.22 \pm 7.56$ , Group 5 =  $29.67 \pm 6.50$ , Group 6 =  $26.71 \pm 4.23$ . **Conclusions:** Each of the six groups was found equally effective. An increase of hip extension ROM can occur through simple stretching alone. Modality application may not be required to increase the effectiveness of the stretch.

### Effects Of Dexamethasone Iontophoresis On Symptomatic Tendinitis: A Double Blind Study Of Perceived Pain, Active Range Of Motion, And Isometric Force Production

Brown DJ, Kimura IF, Mattacola CG, Kendrick ZV: Temple University, Philadelphia, PA

We examined the effect of dexamethasone iontophoresis on perceived pain, active range of motion, and isometric force production on Division I collegiate athletes with symptomatic tendinitis. Twenty-four subjects were randomly assigned either to one of two groups. Group I which received dexamethasone iontophoresis treatment and Group II which received placebo iontophoresis treatment. Four consecutive double blind treatments were administered at 24 hour intervals. A visual perceived pain scale (VPPS) and a pain threshold gauge (PTG) were used to quantify perceived pain. A goniometer was used to measure active range of motion (AROM) and a MicroFET Hand Held Dynamometer (HHD) was used to measure isometric force production. Perceived pain data were collected on Days 1, 2, 3, 4, 5, and 7 and AROM and MicroFET HHD data were collected on Days 1, 3, 5, and 7. Two 2 x 6 analyses of variance (ANOVAs) were used to analyze VPPS and PTG raw data. Two 2 x 4 ANOVAs were used to analyze AROM and MicroFET HHD raw data. No significant ( $p < .05$ ) differences were found for perceived pain via VPPS and PTG between treatment groups. A Tukey post-hoc test for VPPS data indicated that regardless of group, there were significant decreases in perceived pain between Sessions 1 and 5 and Sessions 1 and 6. No significant ( $p < .05$ ) differences were found in AROM and isometric force production via MicroFET HHD between treatment groups. Tukey post-hoc tests for AROM data indicated significant increases in AROM between Sessions 1 and 4 and between Sessions 2 and 4, regardless of group. Similarly, Tukey post-hoc tests for MicroFET HHD data indicated significant increases in isometric force production between Sessions 2 and 4. It was concluded that perceived pain levels significantly decreased and AROM and isometric force production significantly increased after 4 to 7 days in athletes with symptomatic tendinitis regardless of whether dexamethasone or placebo iontophoresis was administered.



# Double Blind Clinical Efficacy Study Of Dexamethasone Iontophoresis On Perceived Pain And Decreased Function Associated With Symptomatic Tendinitis

Shorty MB, Kimura IF, Mattacola CG, Kendrick ZV: Temple University, Philadelphia, PA

We investigated the efficacy of dexamethasone sodium phosphate (DmNaP) iontophoresis on perceived pain and decreased function associated with symptomatic tendinitis of college athletes. Twenty-four subjects were randomly assigned to either a DmNaP iontophoresis (treatment) group or a placebo iontophoresis (control) group. The 7-day treatment period consisted of four, consecutive double-blind treatments of DmNaP or placebo iontophoresis and a 10-min ice massage separated by at least 24 hr. Perceived pain was assessed via a visual perceived pain scale (VPPS) and a punctate threshold gauge (PTG) on Days 1, 2, 3, 4, 5, and 7. Function was assessed via a functional index questionnaire (FIQ) and functional tests (FXN) specific to the location of tendinitis. Two 2 x 6 analysis of variance (ANOVA) with repeated measures were used to analyze VPPS and PTG data. No significant ( $p < .05$ ) differences were found for perceived pain via VPPS and PTG between treatment groups. Significant ( $p < .05$ ) differences were found among treatment sessions regardless of group for VPPS. Tukey tests for VPPS indicated significant decreases in perceived pain between treatment Sessions 1 and 5 and between Sessions 1 and 6. PTG F values indicated an interaction between treatment groups and sessions. However, subsequent F tests for simple effects indicated no significant ( $p < .05$ ) interactions. Two 2 x 4 ANOVAs with repeated measures were used to analyze FIQ and FXN data. No significant ( $p < .05$ ) differences were revealed in the functional index questionnaire results or functional ability tests between treatment groups. Significant ( $p < .05$ ) differences were found among treatment sessions, regardless of group, for FXN. Tukey tests for FXN indicated significant increases in functional ability between treatment Sessions 1 and 4 and between Sessions 2 and 4. Results indicated that both DmNaP and placebo iontophoresis may have positively influenced perceived pain and functional ability in the treatment of symptomatic tendinitis in college athletes. Although not statistically significant, subjects treated with DmNaP iontophoresis appeared to demonstrate greater improvements in VPPS and FXN (42% and 50%, respectively) than those subjects treated with

placebo iontophoresis (16% and 27%, respectively) between Session 2 (Day 3 of treatment period) and Session 4 (Day 7 of treatment period).

# The Effect Of Russian Stimulation Combined With Isotonic Exercise On Peak Muscular Force

Buckley T, Bleggi SD, Ingersoll CD, Ozmun JC: Athletic Training Department, Indiana State University, Terre Haute, IN

**Objective:** The purpose of this study was to compare the effects of Russian stimulation, isotonic exercise, and Russian stimulation combined with isotonic exercise on the peak muscle force of the subject's quadriceps. **Design and Setting:** The subjects were pre and post tested for peak muscular force on the Kin-Com II. The subjects performed five trials for peak concentric force of the quadriceps with the highest and lowest scores removed and the mean of the remaining three measurements was used as the peak force output. The subjects were divided into four groups: Russian stimulation only, isotonic exercise only, combination of Russian stimulation and isotonic exercise, and control. The subjects performed the prescribed treatment for 10 consecutive days. **Subjects:** 35 healthy physically active female subjects volunteers (age =  $21.6 \pm 2.4$ ) were screened for previous injury and contraindications to electrical therapy were used as subjects. **Measurements:** A one-way ANCOVA was used to determine if differences existed between the treatment groups. The pretest force measurement was the co-variate. **Results:** There were no differences found between any of the four treatment groups for force output. **Conclusions:** There are four probable reasons why there were no differences found. The DAPRE technique produced 62% and 71% strength gains, these gains were not seen in peak force measurements. The use of healthy, physically active subjects limited the potential gain in strength. 4 subjects reported muscle soreness on the day of the posttest and all decreased in peak force output as compared to their pretest. The statistical power ( $1 - \beta = .39$ ) was low leaving a 61% chance of failing to detect a true difference.

## A Pilot Study To Evaluate The Effectiveness Of Pulsed Low Intensity Ultrasound To Accelerate Tibial Stress Fracture Healing

Jacobs D, Nyland J, Brindle TJ, Brand J, Caborn DNM: Section of Sports Medicine, Division of Orthopaedic Surgery, University of Kentucky, Lexington, KY

**Introduction:** The tibia is the most common stress fracture site in the lower extremity as a direct result of overtraining where osteoclastic activity predominates osteoblastic activity. Traditional treatment consists of rest, symptomatic relief measures, and a gradual return to activity following approximately 3 months. The use of daily pulsed low intensity ultrasound (LIUS) has been shown to be effective in the treatment of non-union tibial fractures, but its use with tibial stress fractures has not been previously reported. This pilot study attempted to assess the effectiveness of using LIUS to accelerate tibial stress fracture healing as evidenced by decreased symptomatic complaints. **Methods:** Eight patients (2 male, 6 female) with radiographic and bone scan confirmed tibial stress fractures participated in this study. Prior to study initiation, subjects completed a 5 question, 10 cm visual analog scale (VAS) regarding pain level (10 = extreme pain, 1 = no pain) and were assessed for step down repetitions/1 min (4" step height) and standing single leg broad jump distance. VAS scales were also completed to assess the pain experienced during functional test performance. Subjects received daily 20 min LIUS treatments of operating frequency = 1.5 MHz, radiating area = 3.88 cm<sup>2</sup>, pulse width = 200  $\mu$ sec (Sonic Accelerated Fracture Healing System, Exogen Inc., West Caldwell, NJ). Subjects received 5 LIUS treatments / week for 4 weeks, and maintained all low impact functional activities during this time period. Subjects were re-tested after 4 weeks of treatment. Mann-Whitney U tests (VAS data) and paired t-tests (functional tests) assessed statistical significance ( $p < .05$ ). **Results:** Following 4 weeks of LIUS treatment, step down repetitions/1 min and standing single leg broad jump distance improved from 97.6% to 107.9% and from 85.8% to 105% respectively, compared to the uninvolved lower extremity, but these improvements were not significant ( $p > .05$ ). Pain during step downs/1 min decreased from 7.8 mm to 2.2 mm ( $p < 0.05$ ). Pain during the standing single leg broad jump decreased from 6.5 mm to 3.3 mm but was not significant ( $p > .05$ ). Responses to "How bad is your leg pain at its worst" decreased from 6.9 mm to 3.4 mm ( $p < .05$ ). Responses to pain during thumb-index finger palpation of the injured tibial shaft decreased from 7.6 mm to 3.3 mm ( $p < .05$ ). All subjects returned to full participation following 4 weeks of treatment. **Discussion:** The results of this pilot study are encouraging for the use of pulsed LIUS as a tibial stress fracture treatment modality. Limitations in study design however limit the conclusions that can be reported at this time. A randomized, double blind study comparing pulsed LIUS to other methods of treatment is presently underway.

## Pulsed Ultrasound Fails To Diminish Delayed Onset Muscle Soreness Symptoms Whether Delivered Once Or Twice Daily

Stay JC, Ricard MD, Schulthies SS, Durrant E, Draper DO: Brigham Young University, Provo, UT

**Objective:** We investigated the effects of pulsed ultrasound on swelling, muscle soreness perception, relaxed elbow extension angle, and muscular strength. **Subjects:** Thirty-six college age females volunteered for the study (age =  $21.5 \pm 2.0$  yrs., ht =  $164.5 \pm 6.2$  cm., wt. =  $127.2 \pm 14.4$  lb). **Design and Setting:** To induce delayed onset muscle soreness (DOMS) of the elbow flexors, subjects performed eight sets of ten reps of concentric and eccentric actions at 80-100% of their one repetition max. Group 1 received 20% pulsed ultrasound treatments (1-MHz, 7 minutes, 1.5 W/cm<sup>2</sup> temporal peak intensity) twice a day immediately following postexercise assessments, and at 3, 24, 27, 48, 51, 72, and 75 hours postexercise. Group 2 received sham treatments immediately following postexercise assessments, and at 3, 27, 51, and 75 hours postexercise; and true treatments of pulsed ultrasound at 24, 48, and 72 hours postexercise. Group 3 received sham treatments of no ultrasonic output immediately following postexercise assessments, and at 3, 24, 27, 48, 51, 72, and 75 hours postexercise. **Measurements:** We recorded upper arm circumference, relaxed elbow extension angle, elbow flexion strength and perceived soreness before (pretest), immediately postexercise, and at 24, 48, 72, and 96 hours postexercise. **Results:** A 3 X 6 repeated measures ANOVA ( $p < .05$ ) showed differences over time but did not indicate a treatment effect between groups or interactions between time and groups for upper arm circumference, perceived soreness, relaxed elbow extension angle, or elbow flexion strength. **Conclusions:** Pulsed ultrasound as used in this study did not significantly reduce soreness perception and swelling in the upper arm, nor was it effective in restoring relaxed elbow extension angle and strength decreases relating to DOMS compared to placebo.



## Rate Of Temperature Change In Human Fat During 3 Mhz Ultrasound: Implications For Allied Health

Castel JC, Draper DO, Abergel PA:  
Brigham Young University, Provo, UT

**Goals/Purpose:** Previous data have been published regarding the rate of ultrasound heating in muscle and tendon; however, this has not been recorded for fat tissue. This data would assist those who choose to use ultrasound prior to myofascial release, since the fat layer lies directly over the fascia. This information would also be valuable to cosmetic surgeons, who have recently been using ultrasound to soften fat prior to liposuction. We performed this study to determine if ultrasound could vigorously heat fat and to note the frequency, intensity and treatment duration required. **Subjects:** Ten females (mean age =  $38 \pm 1.4$  yrs) volunteered to participate in the investigation and signed an informed consent waiver. **Methods and materials:** The left tricep was cleansed with a Betadine scrub while the subject was supine. A 1cc injection of 1% lidocaine® (Xylocaine) buffered with sodium bicarbonate was administered subcutaneously to anesthetize the area. Next, a 23 gauge thermistor microprobe connected to a monitor was inserted into the adipose tissue covering the left tricep muscle belly. Ultrasound gel was applied to the area, then we administered ultrasound (Omnisound 3000™ Physio Technology Inc-Accelerated Care Plus, Topeka, KS) at the following parameters: continuous mode; 3MHz frequency; 1 W/cm<sup>2</sup>; 10 min duration, treatment size = 2 ERA. Temperature was recorded every 60 seconds. At the end of each 10 minute application, we recorded the rate at which the temperature dropped each minute for 10 minutes. **Results:** The mean baseline temperature was 33° C and the mean peak temperature was 41.4° C (ave increase from baseline to peak = 8.4° C). The fat temperature dropped 4.8° C, and 6.4° C respectively 5 and 10 minutes post insonation. **Conclusion:** Our protocol resulted in vigorous heating of adipose tissue (according to Lehman an increase of 4° C or a peak temperature of  $\geq 40^\circ$  C is considered vigorous heating). This information may assist cosmetic surgeons who use ultrasound prior to liposuction of small areas such as under the chin. Their rationale is that ultrasound selectively destroys the liquid fraction of adipocytes, accounting for 90% of the adipocyte volume thus softening or liquifying adipose tissue. Using these parameters may also decrease the visco elastic properties of collagen, thereby facilitating myofascial release.

## The Effect Of Pulsed Short-Wave Diathermy On Temperature Elevation In Adipose Tissue

Draper DO, Castel JC, Abergel PA:  
Brigham Young University, Provo, UT

**Goals/Purpose:** Previous data have been published regarding the heating rate of muscle via pulsed short-wave diathermy (PSWD) application, however this has not been recorded for fat tissue. This data would assist practitioners who choose to use diathermy prior to massage or myofascial release, since the fat layer lies directly over the fascia. This information would also be valuable to cosmetic surgeons, who use ultrasound to heat, thus soften fat prior to liposuction. We performed this study to determine if PSWD could vigorously heat and retain heat in fat.

**Subjects:** Six males (mean age =  $27.5 \pm 2.7$  yrs) volunteered to participate and gave informed consent. **Methods and materials:** The skin over the subcutaneous fat pocket of the left suprailiac was cleansed with a Betadine scrub while the subject was supine. A 1cc injection of 1% lidocaine® (Xylocaine) was administered subcutaneously to anesthetize the area. Next, a 23 gauge thermistor microprobe was inserted into the adipose tissue covering the left suprailiac area. The temperature was recorded at baseline, 5, 10, 15 and 20 minutes during PSWD application, and at 5, 10, 15 and 20 minutes post application. We administered PSWD (Curapulse™ Physio Technology Inc-Accelerated Care Plus, Topeka, KS) at the following parameters: 800 Hz; 125 watts peak power; pulse duration 400  $\mu$ sec; interpulse interval of 12.5 ms.

**Results:** The mean baseline temperature was 34.2° C and the mean peak temperature was 41.4° C (ave increase from baseline to peak = 7.16° C). At the end of the treatment, the fat temperature dropped as follows: 2.6° C (5 min); 3.7° C (10 min); 4.3° C (15 min); and 4.6° C (20 min).

**Conclusion:** Our protocol resulted in vigorous heating of adipose tissue (according to Lehman an increase of 4° C or a peak temperature of  $\geq 40^\circ$  C is considered vigorous heating). This information should interest cosmetic surgeons who use ultrasound prior to liposuction. Ultrasound heats small areas, whereas PSWD can heat much larger areas, and cause fat to retain heat longer. Using these parameters may also decrease the viscous elastic properties of collagen, thereby facilitating massage and myofascial release.

## Free Communications, Poster Presentations: Session F

Saturday, June 20, 8:00 AM-11:30 AM; Location: Pratt Street Lobby; Authors present from 10:30 AM to 11:30 AM to answer questions

### The Effect Of Hip Position And EMG Biofeedback Training On The VMO:VL Ratio

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Patellofemoral Pain Syndrome is a patellar tracking dysfunction usually associated with vastus medialis oblique (VMO) weakness which results in a small VMO: vastus lateralis (VL) ratio. Several electromyographic (EMG) studies have defined specific limb positions (such as external rotation of the hip) that preferentially activate the VMO. However, there has been no published evidence to suggest that preferential activation of the VMO successfully translates into increased VMO:VL ratios with training. The purpose of the current study was to investigate the effects of hip rotation on the mean VMO:VL EMG ratio using EMG biofeedback over a 5 day training period. Thirty-six healthy females (age =  $20.1 \pm 1.2$  yr, height =  $166 \pm 8.0$  cm, weight =  $59 \pm 11.5$  kg) performed isometric quadriceps contractions, in terminal extension, with one of three hip positions: anatomically neutral, external rotation, or internal rotation. An initial VMO:VL ratio was determined by recording muscle activity using an EMG. Subjects then completed 5 sets of 5 isometric quadriceps contractions in their assigned hip position on each of four consecutive days. Contractions were held for 10 sec with a 15 sec rest interval between repetitions. On the fifth day a post-test was completed that was identical to the pretest. Pretest to post-test data were analyzed using a 3 (group)  $\times$  2 (test) ANOVA with repeated measures on the last factor. Neither the Group by Test interaction [ $F(2,33) = 2.03, p = 0.1471$ ] nor the main effect for Group [ $F(2,33) = 2.19, p = 0.1278$ ] were significant. These results suggest that hip position during EMG biofeedback training has no effect on the VMO:VL ratio. However, the main effect for Test was significant [ $F(1,33) = 38.74, p = 0.0001$ ]. This main effect indicates an increase in the VMO:VL ratio resulting from practice regardless of hip position. Therefore, EMG biofeedback can be recommended for the facilitation of VMO strengthening.

### Functional Training Vs. Weight Training Effects On One-Legged Postural Sway And Evertor Strength

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Indiana State University, Terre Haute, IN

**Problem:** Ankle injuries are prevalent in athletic competition. Traditional weight training focuses on isolation of the muscle group, but not on proprioception or balance. Functional training focuses on multi-planar movements which incorporate proprioception and balance. This study compared functional training and traditional weight training and their effects on postural sway and evertor muscle strength. **Design:** A 2X3 factorial was used. The dependent variables were postural sway and strength of the evertors. The independent variables were test (pre and post) and exercise (functional training, weight training and control). **Methods:** Twenty-one college students with no current ankle injuries participated. They were given a questionnaire and subjectively tested for stability of the ankle. Some subjects had stable ankles while others presented with instability. A pre-test measuring postural sway and evertor strength was administered. The two exercise groups performed approximately 45 minutes of designated exercises three times a week for 4 weeks. A post-test followed the exercise sessions. **Results:** There was no difference between groups for postural sway. The weight training group did show increased evertor strength compared to the control group. **Conclusion:** To correct isolated strength differences clinicians should use closed chain isotonic exercises before progressing into functional activities. Further research should investigate a longer duration exercise protocol along with a more efficient way to adjust weight and time increments for functional training activities.

### Reactive Muscle Firing Of ACL-D, ACL-R, And Normal Females During Dynamic Activities

Swanik CB, Lephart SM, Giraldo JL,  
DeMont RG, Fu FH: University of Pittsburgh,  
Pittsburgh, PA

Numerous reflex pathways link mechanoreceptors in the anterior cruciate ligament (ACL) with muscle spindles and contractile fibers in the quadricep and hamstring muscles. Loads placed on the ACL modify the stretch reflex response and reactive muscle activity necessary for dynamic restraint. ACL injury results in some level of deafferentation to articular mechanoreceptors, which may cause aberrations in reactive muscle firing patterns. Moreover, compensatory muscle activation strategies necessary for dynamic restraint must be employed if functional stability is to be maintained. The purpose of this study was to compare the reactive muscle activity of ACL deficient (ACL-D), ACL reconstructed (ACL-R) and control females during dynamic activities. Twenty-four female subjects were stratified into groups based on their ACL status (ACL-D,  $n=6$ , ACL-R,  $n=12$ , Control,  $n=6$ ). Surface electrodes (Multi Bio Sensors Inc. El Paso, Texas) recorded the area and peak IEMG ( $\mu V \cdot sec$ ) from the vastus medialis (VMO), lateralis (VL), medial hamstring (MH) and lateral hamstring (LH) during downhill walking ( $15^\circ$ , 2.0 mph), level running (4.5 mph), hopping, and landing from a jump (20.3 cm). IEMG data was normalized with Myoresearch 97 software (Noraxon USA Inc., Scottsdale, Arizona) to the mean amplitude of 3-6 consecutive test repetitions. The mean area and peak IEMG of a 250 millisecond (ms) period after ground contact was used to represent reactive muscle activity. Side-to side differences were determined using dependent T-tests and a one-way ANOVA with Tukey post-hoc analyses was used to determine group differences. During running, the ACL-D group demonstrated significantly greater area and peak IEMG activity in the MH, and greater peak activity in the LH when compared to the ACL-R group. The ACL-D also demonstrated greater peak activity in the VMO and less area of IEMG in the LH than the control group during running. During landing, the ACL-D group demonstrated significantly less area of IEMG activity in the VL when compared to the control group. No side-to side differences were revealed. The results of this study suggest that adaptations occur in the reactive muscle firing patterns of ACL-D females during dynamic activities. Strategies to minimize anterior tibial translation in response to joint loads include increased hamstring activity and quadricep inhibition. The reactive muscle firing patterns exhibited in ACL-D subjects are presumably, attempts to regain functional stability through dynamic mechanisms. The absence of side to side differences suggests that these adaptations may occur bilaterally after ACL injury.



## Timed Bent Knee Sit-Ups Predict Single Leg Broad Jump Distance Of Average Weight Adolescent Males

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**PURPOSE:** The demands that a standing single leg broad jump (SSBJ) places on lower extremity muscular stabilizers has lead to its increased use as a method of determining readiness for return to competition following knee or ankle injury. Trunk and hip muscle strength are also considered to be vital to jumping performance. Stabilizers such as the rectus femoris, rectus abdominus, and the hamstrings may also enhance sit-up performance because of their pelvic attachments, and the ankle dorsiflexors may assist when the feet are held slightly plantar flexed. This study tested the hypothesis that bent knee sit-ups/min were predictive of SSLBJ distance. **METHODS:** Eighty male high school athletes (mean  $\pm$  SD) (age  $16 \pm 2.6$  years, height  $68.7 \pm 3.6$  in, weight  $165 \pm 41$  lbs) were tested for sit-ups/min and SSLBJ distance (3 trials/leg) during pre-season examinations. Pearson product moment correlations assessed sit-ups/min ( $41 \pm 8.6$  reps) and select SSLBJ distance variable relationships,  $p < .05$ . ANOVA with Tukey post-hoc tests ( $p < .05$ ) assessed differences by population quartile weight categories (1.  $\leq 135$  lbs; 2.  $> 135$  to  $\leq 158.5$  lbs; 3.  $> 158.5$  to  $\leq 189$  lbs; and 4.  $> 189$  lbs). **RESULTS:** Category 3 males had significant low + correlations between sit-ups and SSLBJ distance for right leg mean ( $r = .60$ ,  $p = .006$ ) and best jump ( $r = .60$ ,  $p = .005$ ), and left leg mean ( $r = .45$ ,  $p = .04$ ) and best jump ( $r = .51$ ,  $p = .02$ ) which differed from categories 1 and 4 ( $p < .05$ ), but not from category 2. **CONCLUSIONS:** Bent knee sit-ups/min among athletic adolescent males of average weight are related to SSLBJ capability and its associated core trunk and dynamic lower extremity stabilizer strength. Bent knee sit-ups/min may provide a means of improving dynamic lower extremity stabilizer strength and core trunk strength, supplementing conventional conditioning and rehabilitation programs.

## Long Term Resistance Training And Its Effects On Neuromuscular Characteristics In Females

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Numerous investigations regarding resistance training exercise predominantly focus on adaptations in extrafusal muscle fibers. Exercise induced joint loads accompanying resistance training exercise also stimulate articular and tenomuscular receptors. Repeated high intensity stimulation of these mechanoreceptors may enhance proprioceptive and kinesthetic acuity, via frequent facilitation of afferent (sensory) pathways. Increases in these afferent pathways may accentuate sensory information possibly enhancing the efferent (motor) response. Although acute adaptations have been demonstrated, debate remains surrounding chronic activation of these mechanoreceptors to resistance training exercise. The purpose of this investigation was to examine characteristics present in females participating in long term resistance training on: knee joint proprioception for threshold to detection of passive motion (TTDPM), and reproduction of passive positioning (RPP), IEMG activity during hopping, landing, walking, and jogging, for 5 muscles, and balance at two difficulty levels of 8 and 4 for both groups. Subjects included 10 control inactive females (age =  $24 \pm 3.4$  yrs.) and 11 female bodybuilders (age =  $25 \pm 4.5$  yrs.). Multiple independent t-tests were conducted to detect significant group differences for proprioception, IEMG activity ( $\mu V$ (sec), and balance ( $p < .05$ ). The Pearson product moment correlation was performed to determine relationships between proprioception, IEMG and balance. The results demonstrated significant group differences for: TTDPM at  $15^\circ$  and RPP at  $45^\circ$  of flexion and extension ( $p < .05$ ), and IEMG activity for: the medial hamstrings, lateral hamstrings and vastus lateralis during swing phases of running and preparatory phases of landing ( $p < .05$ ) and balance scores at levels 8 and 4 ( $p < .05$ ). Strong relationships were found for proprioception and balance, IEMG during landing and jogging ( $p < .05$ ). The results of this investigation indicate that neuromuscular adaptations facilitated by resistance training exercise enhances sensory motor activity. These adaptations to both the afferent and efferent pathways in the absence of static restraints can modify the mechanism for dynamic restraint resulting in a functionally stable joint thus providing prophylactic support during functional activities.

## Effects Of The Strength® Shoe And Plyometric Drills On Power, Strength, Speed, And Agility Of College-Aged Female Volleyball Players

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We investigated the effects of the Strength® Shoe and plyometric drills on vertical jump, 40-yd dash, agility, and eccentric and concentric peak torque data of bilateral triceps surae muscles of college-aged female volleyball players. Twenty-eight volunteers (mean age = 19.2  $\pm$  11.2 yr, wt = 145.6  $\pm$  12.7 lb, ht = 68.6  $\pm$  2.7 in) from Temple University, Drexel University, and the University of Pennsylvania 1996 women's volleyball teams participated in this study. Subjects were randomly assigned to either a Strength® Shoe Group (SSG) who wore the Strength® Shoe or a No-Shoe Group (NSG) who wore conventional sneakers. Subjects performed five plyometric drills (bounding, power skipping, power slides, depth jumps, and series box jumps), three times per week in addition to regular off-season exercise regimens during a 6-week training period. Vertical jump, 40-yd dash, agility run, and bilateral eccentric and concentric triceps surae peak torque data at 120 /s were assessed before and after the 6-week training period. Three 2 x 2 analyses of variance (ANOVA) with repeated measures ( $p < .05$ ) were used to analyze pretest and posttest vertical jump, 40-yd dash, and agility run data. Two 2 x 2 x 2 ANOVA with repeated measures ( $p < .05$ ) were used to analyze pretest and posttest bilateral triceps surae eccentric and concentric peak torque data. Results indicated no significant ( $p < .05$ ) differences between the groups (SSG and NSG) with regard to all of the dependent variables. Significant ( $p < .05$ ) differences were revealed from the pretest to the posttest for both groups for all variables tested except eccentric peak torque of the triceps surae. The following represent the group mean differences for the dependent variables from the pretest to the posttest: vertical jump, SSG = 1.88 in., NSG = 1.0 in.; 40-yard dash, SSG = .26 s, NSG = .27 s; agility run, SSG = .30 s, NSG = .43 s; concentric peak torque of the right leg, SSG = 7.04 ft-lbs/s, NSG = 6.46 ft-lbs/s, concentric peak torque of the left leg, SSG = 4.3 ft-lbs/s, NSG = 7.52 ft-lbs/s. Since no significant differences were found between the groups, these improvements must be attributed to the additional plyometric drills and the regular off-season exercises performed by both groups. Additionally, eccentric and concentric peak torque of the triceps surae was greater in subjects' right leg (eccentric, right leg = 27.57 ft-lbs/s vs. left leg = 25.74 ft-lbs/s) than in their left leg (concentric right leg = 31.47 ft-lbs/s vs. left leg = 27.83 ft-lbs/s). The results of the present study indicate a positive effect with regard to plyometric training. Although not significant, the mean differences between pretests and posttests of the SSG when compared to the NSG were greater for four of the five dependent variables tested. To date, training results with the Strength® Shoe have not proved to be statistically greater than plyometric training without the Strength® Shoe. The question remains whether the larger increases noted in the SSG are clinically or functionally advantageous.

## Muscle Pre-Activity Among ACL-D, ACL-R, And Control Female Subjects During Various Lower Extremity Activities

DeMont RG, Lephart SM, Giraldo JL, Swanik CB, Fu FH: University of Pittsburgh, Pittsburgh, PA

Underlying the hamstring's ability to decrease tibial anterior shear is its time of firing in comparison to the quadriceps. This timing may be aided by neural programming during a planned or expected activity. It is theorized that individuals who have a better programming ability will suffer less initial ACL injury due to protection of the joint through muscular stabilization. A component of dynamic restraint is the development of muscular tension prior to loading of the knee. The purpose of this study was to compare the muscular activity prior to footstrike in ACL deficient, reconstructed and control individuals during functional activities. Twenty-four female subjects were divided in to groups based on their ACL status (D=deficient, n=6; R=reconstructed, n=12; C=control/healthy n=6). IEMG ( $\mu V \cdot sec$ ) activity from the thigh (VMO, VL, MHam, LHam) and leg (MG, LG) as well as footswitch signals were recorded during downhill walking (15° at 2 mph), running (4.5 mph), hopping, and landing from a step (20.3 cm). IEMG activity was normalized to the mean amplitude of the sample and analyzed for area and mean amplitude for 50 ms prior to heelstrike. Side to side differences were determined by T-tests, and a one-way ANOVA with Tukey post-hoc analysis was used to detect differences for each muscle of each activity among the three groups. All statistical testing was completed at the  $p = .05$  level. For area IEMG, the T-test revealed side to side differences between the LG ( $I = 36.4 \pm 19.7$ ,  $U = 60.1 \pm 23.6$ ) of the ACL-D group during the landing activity. The ACL-D group also exhibited differences in the VMO ( $I = 11.4 \pm 3.8$ ,  $U = 7.2 \pm 3.1$ ) and VL ( $I = 13.3 \pm 2.7$ ,  $U = 8.9 \pm 1.9$ ) during running and the VMO ( $I = 9.2 \pm 4.2$ ,  $U = 19.5 \pm 7.3$ ) during downhill walking. For mean amplitude of the IEMG the ACL-D was different in the LG ( $I = 79.7 \pm 30.3$ ,  $U = 122.3 \pm 34.9$ ) during downhill walking. The ACL-R group exhibited side to side differences when compared for mean amplitude of the IEMG on VMO ( $I = 78.6 \pm 23.2$ ,  $U = 45.8 \pm 18.9$ ) during the run and LG ( $I = 74.7 \pm 40.0$ ,  $U = 52.8 \pm 14.3$ ) during the hop. The ANOVA revealed group differences on the involved VL during the hop and VMO when walking downhill. The ACL-D had significantly higher IEMG means than the Control group in VL ( $D = 12.9 \pm 5.8$ ,  $C = 7.1 \pm 3.9$ ), but lower in VMO ( $D = 9.2 \pm 4.2$ ,  $C = 15.7 \pm 3.6$ ). The side to side differences of the ACL-D and ACL-R groups, as well as the group differences between ACL-D and Control may suggest different strategies are utilized when performing different functional activities. These different strategies may be explained by quad (VMO) avoidance or VMO/VL ratio changes resulting from protective patterns or accommodation, or possibly residual weakness.



### Isotonic Power Changes Following Repeated Shoulder Internal And External Rotation In An Uninjured Population

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The purpose of this study was to determine how power levels in shoulder internal and external rotation are effected by repetition using an isotonic device, in an uninjured population. Ten male lacrosse players (age  $x=20.1$  years old, height  $x=178.7$  cm, weight  $x=82.44$  kg) and ten nonathletes (age  $x=21.6$  years old, height  $x=176.5$  cm, weight  $x=77.1$  kg) with no history of shoulder injury for the past six months volunteered to participate in this study. The dominant shoulder power levels were evaluated in the supine position and in the scapular plane by the Dynatrac Isotonic Dynamometer. Subjects were tested in internal and external rotation at 1/3 and 1/4 of their maximum voluntary isometric contraction. Prefatigue and fatigue peak power values were calculated for each resistance and direction. Four separate 2x2 repeated-measures ANOVA's indicated no significant differences between lacrosse players and nonathletes or prefatigue and fatigue peak power in the 1/3 and 1/4 internal rotation condition and the 1/4 external rotation condition. There was a significant interaction between groups at 1/3 external rotation prefatigue and fatigue peak power ( $F(1,18)=6.31$ ,  $p=.022$ ). Tukey post-hoc analysis showed a significant difference between lacrosse and nonathlete's fatigue values. Significant fatigue was only present at 1/3 external rotation fatigue peak power. However, further research is needed in the area of isotonic evaluation of fatigue and peak power levels.

### An Electromyographic Analysis Of Dynamic Stabilizing Exercises For The Shoulder

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**Purpose:** The purpose of this study was to assess the level of co-activation of the two force couples (deltoid/infraspinatus and subscapularis/infraspinatus) about the glenohumeral joint during six selected rehabilitation exercises.

**Methods:** Intramuscular fine wire electrodes were utilized in 10 healthy subjects for the assessment of muscle activity in the anterior deltoid, middle deltoid, subscapularis, and infraspinatus. Muscle activity was sampled during six dynamic rehabilitation exercises for the shoulder including a push-up, rhythmic stabilization, tracing a circle on the slide board with the dominant and non-dominant arms, horizontal motion on the slide board, and forward flexion on the slide board. Integrated EMG activity was normalized to a maximal voluntary contraction (MVC) for each muscle. A minimum of 25% of the MVC was established for the exercises to qualify as a force couple co-activation activity.

**Results:** Four exercises met the criteria for force couple co-activation and included the push-up, horizontal motion on the slide board, tracing a circle with the dominant arm on the slide board, and tracing a circle with the non-dominant arm on the slide board. Ratios of the muscle activity of the muscles comprising the force couples were also established. The ratios were established for the superior/inferior force couples: the anterior deltoid and the infraspinatus, and the middle deltoid and the infraspinatus, as well as the anterior/posterior force couple; the subscapularis and the infraspinatus. These ratios appear to indicate that the muscle activity of the muscles comprising the force couples is relatively similar between the opposing muscles. **Conclusions:** The four qualifying glenohumeral force couple co-activation exercises provide a basis for prescribing rehabilitation activities that result in the dynamic stability necessary for functional activities in the unstable shoulder.

### Enhancing EMG Activity Of The Quadriceps During Closed Kinetic Chain Exercise With Quadriceps Setting

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Closed kinetic chain (CKC) exercises are gaining popularity in quadriceps strengthening programs. These exercises are more functional, elicit greater cocontraction, increase joint compression and proprioception, and most notably, lessen the anterior shear at the knee. However, the multi-joint nature of these CKC exercises allows the redistribution of the workload away from the quadriceps and toward other muscles contributing to the exercise. This study examined whether a quadriceps set (QS) held during a CKC exercise could increase quadriceps EMG and thus lessen the compensation. Sixteen healthy female subjects (age  $=19.75 \pm 1.06$  years, Ht  $=166.45 \pm 5.61$  cm, Wt  $=62.28 \pm 6.90$  kg) participated in this study. Each subject performed two sets of three repetitions of a lateral step-up off a 20 cm box. In the first set, the subject attempted to superimpose the QS over the step-up and the second set, without the QS. The order of the sets was counterbalanced. A maximum voluntary isometric contraction (MVIC) of knee extension was also performed three times in 60 degrees of flexion. Quadriceps EMG activity was recorded by Noraxon Myosystem 2000 EMG device (Noraxon Corp., Scottsdale, AZ), then filtered and rectified by Datapac III software (Run Technologies, Laguna Hills, CA). The lateral step-up trials were averaged and normalized to the averaged MVIC, where peak and integrated EMG values were compared. A repeated measures ANOVA with the alpha level  $= .05$  was applied. There were two within-subject variables (muscle and exercise) and one between-subject variable (test order). The results showed a statistically significant increase ( $p < .05$ ) in quadriceps EMG for the lateral step-up with a QS over the no QS condition at both peak and integrated values. There was no significant muscle by exercise interaction or test order effect. These results suggest that in healthy subjects, a CKC lateral step-up exercise with a quadriceps set produces greater electromyographic activity than a step-up exercise performed without a quadriceps set.

## An EMG Comparison Of Four Closed Chain Exercises With Limited Knee Range Of Motion

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**Objective:** Closed chain exercises are used in the clinical setting to safely strengthen the muscles about the knee. This study compared EMG activity of 3 muscles during 4 closed chain exercises with limited knee range of motion to determine which exercise produced the most muscle activity. **Design and Setting:** Surface electrodes were placed on the vastus lateralis, vastus medialis, and biceps femoris. Subjects performed 3 repetitions of 4 exercises in synch with a metronome between 5° and 30° of knee flexion. **Subjects:** Subjects were 38 healthy, active female college students; age  $21.97 \pm 2.76$  years, height  $65.7 \pm 2.49$  inches, and weight  $136.2 \pm 18.6$  pounds. Each subject was free from any lower extremity pathology and lower extremity surgery. **Measurements:** EMG measurements were taken from the middle third of the flexion and extension phase of each repetition. A 3-way ANOVA with repeated measures on exercise, movement, and muscles was used to determine if differences existed, along with one-way ANOVAs and Neuman-Keuls tests for post hoc comparisons. **Results:** The FlexCord front pull and back pull produced higher levels of biceps femoris activity than the quarter squat and step-up. The FlexCord front pull also produced a higher level of vastus medialis activity during knee extension than the quarter squat. **Conclusions:** The high levels of biceps femoris activity during the FlexCord exercises could mean a greater co-contraction exists, but it could also mean there is a greater anterior shear force at the knee resulting in increased hamstring activity, or a greater torque at the hip resulting in biceps femoris activity from the proximal end. The high levels of vastus medialis activity during the FlexCord front pull could possibly make it a beneficial exercise for patellofemoral rehabilitation.

## The Effects Of Plyometrics And Weight Training On The EMG Of The Hamstrings

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**Problem:** One of the main functions of muscle is to decelerate movement of a body during an eccentric action. Eccentric contractions can produce damaging forces to the untrained muscle. In deceleration the thigh during activity, the hamstrings work eccentrically and have a high potential for injury. The purpose of this study was to compare the effect of weight training and plyometrics on the I-EMG of the hamstring muscles during eccentric activity. **Design:** This study used a 3 x 2 factorial design. The independent variables were exercise conditions (traditional weight training, plyometrics, and control) and testing (pre-and post). The dependent variables were the I-EMG of the hamstring muscles during the half-squat and a MVIC. Subjects consisted of 16 male and female volunteers who had no previous involvement in a specified conditioning program and no previous injury to their dominant leg. **Methods:** Subjects were randomly placed into one of the three exercise groups. EMG values were recorded prior to and at the end of the four week training period. During these testing sessions, subjects performed at 60% MVIC in flexion on the Kin-Com and a half-squat with hand held weights. For the four week training period, the weight training group performed leg press and hamstring curl exercises using the DAPRE technique. The plyometric group performed 25 repeated vertical jumps and a series of 10 depth jumps from a height of .61 meters. The control group maintained their activities of daily living. **Results:** There were no differences between the three groups. Training did not produce an increase in the motor unit recruitment of the biceps femoris or the semitendinosus/semimembranosus. **Conclusion:** After a four week training period, plyometrics and weight training are no different from the control group in motor unit recruitment of the hamstring muscles.

## Knee Joint Laxity And Neuromuscular Characteristics Of Male And Female Soccer And Basketball Players

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**Introduction:** Anterior cruciate ligament (ACL) injuries are occurring at disproportionate rates in female athletes compared to their male counterparts. We hypothesized that female athletes may inherently possess excessive knee joint laxity, proprioceptive deficits, and neuromuscular aberrations, resulting in inefficient or ineffective motor control, and possibly predisposing these athletes to ACL injury. This study's purpose was to compare knee joint laxity, joint kinesthesia, lower extremity balance, peak torque production time, and EMG assessed muscle activity of male and female athletes. **Materials and Methods:** Thirty four (17 male, 17 female) healthy collegiate level soccer or basketball players ( $x$  age =  $19.6 \pm 1.5$  yrs,  $x$  height =  $175.0 \pm 9.0$  cm,  $x$  weight =  $72.9 \pm 11.9$  kg) with no history of ACL injury to either lower extremity participated in this study. The dominant lower extremity of all subjects was assessed on the following five dependent variables: knee joint laxity was quantified using a knee arthrometer, knee joint kinesthesia as determined by measuring the threshold to detection of passive motion (TTDPM) into the direction of knee flexion and extension, single leg balance ability which was quantified utilizing a commercially available balance device, the time to generate peak torque of the knee joint flexor and extensor musculature as quantified using an isokinetic dynamometer, and reactive muscle activity in response to a landing task as determined with the use of surface EMG. **Results:** Independent t- tests were used to determine significant gender differences using a preset alpha level of .05 to indicate significance. Results revealed the following: (1) significantly greater knee joint laxity in females ( $p < .05$ ), (2) females revealed a significant deficit in knee joint kinesthesia moving into extension ( $p < .05$ ), (3) significantly superior balance ability in the females ( $p < .05$ ) and, (4) females recorded significantly greater EMG peak amplitude ( $p < .05$ ) and EMG area ( $p < .05$ ) of the lateral hamstring muscle. In addition, results revealed no significant gender differences in: kinesthesia moving into flexion, time to generate peak torque for either the flexor or extensor musculature, and EMG assessed muscle activity for the other sampled muscles.

**Conclusions:** The results of this study suggest that excessive joint laxity of female athletes may contribute to diminished joint proprioception, rendering the knee less sensitive to potentially damaging forces and possibly at risk for injury. In addition, healthy female athletes unable to rely on ligamentous structures, appear to have adopted compensatory mechanisms of increased hamstring muscle activity to achieve functional joint stabilization.



## The Effects Of Leg Flexion Angle On MMG And EMG Versus Isometric Torque Relationships

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Mechanomyography (MMG) records and quantifies the lateral oscillations of contracting skeletal muscle fibers and is considered to reflect the mechanical counterpart of the motor unit electrical activity as measured by electromyography (EMG). Thus, MMG may provide an alternative method for non-invasively evaluating skeletal muscle function. The purpose of this study was to examine the MMG and EMG responses of the superficial quadriceps femoris muscles (rectus femoris, vastus lateralis, and vastus medialis) during incremental isometric muscle actions at leg flexion angles of 25, 50, and 75°. Nine 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 bipolar (7.62cm center to center) surface electrode arrangement, with a piezoelectric MMG recording device positioned between the proximal and distal EMG electrodes, was placed on the rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) muscles of the dominant leg. The isometric torque data were analyzed using a two-way repeated measures ANOVA (%MVC by leg flexion angle) and Tukey post-hoc comparisons. Separate three-way repeated measures ANOVAs (%MVC by leg flexion angle by muscle) and Tukey post-hoc comparisons were used to analyze the EMG ( $\mu$ V) and MMG (mV) amplitude data. The results of the investigation indicated that for each %MVC (25, 50, 75, and 100 %MVC), the isometric torque production increased as leg flexion angle increased (75° > 50° > 25°). For each muscle (RF, VL, and VM), the EMG amplitude increased as %MVC increased (100 > 75 > 50 > 25 %MVC) at each leg flexion angle (25°, 50°, and 75°). The MMG amplitude for each muscle (RF, VL, and VM), however, increased up to 100 %MVC at 25 and 50° of leg flexion, but plateaued from 75 to 100 %MVC at 75° of leg flexion. The EMG amplitude results demonstrated that the motor unit activation strategies of the superficial quadriceps femoris muscles elicited an increase in muscle activation up to 100 %MVC at each leg flexion angle. We hypothesize that the varied patterns for the MMG amplitude-isometric torque relationships were due to leg flexion angle differences in: 1) muscle stiffness, or 2) motor unit firing frequency.

## Effect Of Concentric And Eccentric Hamstring Strength Training On 1-RM Values In Healthy Adult Females

Motl RW, Johnson SC, Walker JA, Subudhi AW, Deffner KT, Rosenberg TD: The Orthopedic Specialty Hospital and University of Utah, Salt Lake City, UT

Previous research has demonstrated that eccentric hamstring strength training resulted in greater improvements in 1-RM values than concentric training for healthy adult males. The present study examined the effects of concentric and eccentric hamstring strength training on standard 1-RM values for healthy adult females. Participants (N = 22) included healthy adult females (age = 27.50  $\pm$  1.19 yrs; wt = 136.50  $\pm$  19.29 lbs; ht = 64.43  $\pm$  2.74 in) who were randomly assigned to either concentric or eccentric training groups. During a 12-week training protocol, participants performed hamstring training sessions three-days per week. Hamstring training was performed using the NEGATORTM (Myonics Corporation, Metairie, LA) isotonic weight training device which is capable of producing independent concentric and eccentric muscle loading within a single repetition. All participants performed 3 sets of 8 repetitions at 70% 1-RM concentrically. Those in the eccentric group performed an additional 10 to 60% 1-RM eccentrically; the eccentric component progressively increased throughout the study. To monitor changes in hamstring strength, participants completed a standard 1-RM test protocol at 0-weeks, 6-weeks, 9-weeks, and 12-weeks of training. Results of a Group (Eccentric, Concentric) H Time (0-weeks, 6-weeks, 9-weeks, and 12-weeks) repeated measures ANOVA indicated a significant time main effect ( $p < .0001$ ,  $\eta^2 = .83$ ). The ANOVA provided no evidence of a two-way interaction ( $p > .34$ ,  $\eta^2 = .05$ ) or a group main effect ( $p > .45$ ,  $\eta^2 = .03$ ). Inspection of mean 1-RM values indicated that hamstring strength improved throughout the 12-weeks of training for both treatment groups. Tukey HSD post-hoc comparisons indicated that mean 1-RM values were significantly higher at 12-weeks (M = 88.1, SD = 16.5) than 0-weeks (M = 70.2, SD = 14.1) and 6-weeks (M = 74.2, SD = 15.0) of hamstring training. These results demonstrate that isotonic training is effective for developing hamstring muscle strength in healthy adult females. Interestingly, eccentric hamstring training did not produce greater improvements in 1-RM values than concentric training for the female participants. Perhaps the effects of eccentric training on hamstring muscle strength may not be measured accurately by a concentric 1-RM test. Future research should employ measures that can assess changes in both concentric and eccentric muscle strength.

## Comparison Of Concentric And Eccentric Angle Specific Hamstrings To Quadriceps Ratios In Semi-Professional Football Players

Subudhi AW, Motl RW, Johnson SC, Walker JA, Deffner KT, Rosenberg TD: The Orthopedic Specialty Hospital and University of Utah, Salt Lake City, UT

Although athletic trainers have measured "muscle balance" via a ratio of peak hamstring (H) to peak quadriceps (Q) torque (H/Q ratio), the peak H and Q torque values do not occur at the same knee joint angle. To generate a more functional model of knee flexor/extensor interaction, we previously described the H/Q ratio as a function of knee joint angle in adult females. The resulting H/Q ratios highlighted a relatively greater H deficit at knee flexion angles greater than 40°. We then demonstrated that eccentric H/Q ratios were greater than concentric H/Q ratios at 20° and 30° of knee flexion in adult females. The purpose of this study was to compare concentric and eccentric angle specific H/Q ratios in semi-professional football players. Participants (N = 30) included male football players (age = 26.37  $\pm$  3.58 yrs; wt. = 231.71  $\pm$  47.61 lbs; ht. = 72.61  $\pm$  1.91 in) who were competing in a semi-professional arena league. Employing a Cybex (6000) isokinetic dynamometer at 60°/sec, we compared H and Q torque during both concentric and eccentric knee flexion/extension (hip angle = 90°). Results of a two-way repeated measures ANOVA on H/Q ratio values indicated a significant Muscle Action  $\times$  Knee Angle interaction ( $p < .0001$ ,  $ES = .89$ , Power = 1.00). Possible differences between concentric and eccentric angle specific H/Q ratios were examined using the Bonferroni ( $\alpha = .005$ ) method of post hoc comparisons. Results indicated that eccentric H/Q ratios were significantly greater than concentric ratios at 20° and 30° of knee flexion. These results demonstrate that eccentric angle specific H/Q ratios differ from concentric ratios as the knee nears full extension in semi-professional football players. Such findings are consistent with the previously reported eccentric and concentric H/Q ratios of adult females and highlight the eccentric role of the hamstring muscle in decelerating the tibia during normal gait.

# The Effect Of Eccentric Exercise On Peak Power Production Of The Knee Extensors And The Resulting EMG Signal

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The purpose of this investigation was to determine changes in peak quadriceps power and EMG signals following fatiguing eccentric exercise. We tested 9 subjects with no current musculoskeletal injuries (3 females and 6 males) (age = 29.1 (5.5 yr, ht = 174.3 (9.4 cm, wt = 71.1 (14.6 kg). Subjects were measured for unilateral, peak knee extension power on the Dynatrac isotonic dynamometer before 20 min. of light eccentric exercise ( $t = \text{pre}$ ), immediately following exercise ( $t = :00$ ), and at subsequent 15 min. intervals ( $t = :15, :30, :45, \& :60$ ). Each time point consisted of three repetitions. The repetition at each time point with the greatest knee extensor power output was included for analyses. Light eccentric exercise consisted of 20 minutes of stepping on a 46 cm step at .25 Hz. To index fatigue at each time interval, EMG signals were collected from the vastus lateralis muscle during each contraction performed on the Dynatrac. The root mean square voltage (RMS) and median power frequency (MPF) of the EMG signal were normalized to the pre exercise peak isotonic contraction. Peak power for each isotonic contraction was calculated from force and velocity data collected by the Dynatrac and was subsequently normalized to body mass. Additionally, time to generation of peak power for each contraction was calculated and normalized to the pre exercise peak isotonic contraction (TTPP). A repeated measures design was utilized for statistical analyses of each of the dependent variables. There were significant decreases in peak power at  $t = :15 \& :45$  and significant increases in TTPP at  $t = :30 \& :60$  when compared to pre ( $p < .05$ ). There were no significant changes in the RMS or MPF of the EMG signal. Light eccentric exercise appears to reduce in vivo peak power generation and increase the time to attain peak power of the knee extensors (although not at each time point measured). These findings may theoretically correlate to an increased risk of injury. If the muscle group cannot respond as quickly and efficiently as possible, the individual may not be able to optimally avoid a physical situation that could put the body at an increased risk of injury. The lack of differences in the EMG data suggest that these changes were not neuromuscular. However, due to large standard deviations in the EMG data, it is difficult to determine this with certainty.



# NATA Research & Education Foundation CALL FOR ABSTRACTS

1999 National Athletic Trainers' Association — Annual Meeting & Clinical Symposia  
Kansas City, Missouri • June 16-19, 1999

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- 5) Clinical course
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The NATA Research & Education Foundation sponsors the Free Communication Sessions at the NATA Annual Meeting & Clinical Symposia. These events offer NATA members the opportunity to present and learn about the latest developments in athletic training.

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# Subject Index

## A

- Accelerated Rehabilitation, ACL Reconstruction, S-32
- Accuracy of MRI in Diagnosing Meniscus Tears, S-42
- Achilles Tendon
  - Rupture, S-51
  - Stretching, S-23
- ACL
  - ACL-D, S-71, S-73
  - ACL-R, S-71, S-73
  - Injury, Incidence of. *See Anterior Cruciate Ligament*
- Active Range of Motion, S-67
- Active Versus Passive Warm-Up, S-67
- Acupressure Therapy
  - Effects on DOMS, S-16
- Acute
  - Blunt Trauma, S-11
  - Knee Pain, S-56
  - Midfoot Pain, S-58
  - Onset of Neck Pain, S-30
  - Onset of Shoulder Pain, S-47
  - Proprioceptive Measurements, Ankle Exercises, S-26
  - Upper Arm Pain, S-47
- Acute Upper Arm Pain. *See Pulsed Short-Wave Diathermy*
- Adipose Tissue, S-70
- Adolescent
  - Males and Single Leg Broad Jump, S-72
  - Perceptions, Drug Use and Drug Testing, S-9
- Aerobically Trained Males
  - Nasal Patency. *See Breathe Right Nasal Strip*
  - Use of BRNS, S-35
- Agility Task, Assessment of, S-35. *See also Cybex Reactor*
- Anaerobic Threshold Evaluation in Fit Population, S-37
- Angle Specific Hamstrings to Quadriceps Ratios, S-76
- Ankle
  - Acute Lateral Ankle Sprains, S-39
  - Anterior-Posterior Laxity, S-17
  - Bracing, S-38
  - Effects of Ice Immersion on Muscle Performance, S-44
  - Eversion, S-18

- Normal Anterior-Posterior Laxity of, S-17
- Open Ankle Injury, S-31
- Resistive Exercises, S-26
- Sprain, S-38
- Stable Versus Unstable, S-23
- Support Systems, S-39
- Volumetric Measurement Of, S-36
- Anterior Cruciate Ligament
  - Deficiency, S-71
  - Injuries, S-60
  - Post Operative Evaluation, S-7
  - Reconstructed, S-32
- Anterior Hip Pain, S-29
- Anterior Knee Joint Laxity, S-25
- Anterior-Posterior Laxity of Normal Ankle, S-17
- Anthropometric Variables, S-11
- Assessment of Leg Dominance, S-23
- Attitudes about Football Helmet Removal Procedures, S-61

## B

- Balance
  - Effects of Long Term Bracing on, S-39
  - Effects of Short Term Ankle Bracing On, S-39
- Basketball
  - Balance Comparison, Male and Female Players, S-10
  - Knee Effusion in ACL Reconstructed Player, S-32
  - Knee Joint Laxity in, S-75
  - Medial Patellar Taping, Female Players, S-17
  - Player, Single Limb Balance, S-10
  - Programs, Medical Coverage and Injury, S-9
- Biodex
  - Stability System, S-41
  - Strength Measures, S-9
- Brachial Plexus Injury
  - Incidence and Risk Factors, S-8
- Breathe Right Nasal Strip
  - Assessments of Nasal Patency, S-37
  - Effect on Performance, S-35

## C

- Cadence And Step Sequence, S-16
- Caffeine, Effect on Female Endurance Runners, S-36
- Cardiac Arrhythmia, S-52
- Clinical Postural Stability Tests, S-18
- Closed Chain Exercise
  - Closed Chain Isometric Knee Extension, S-12
  - Effects of Knee Joint ROM and Load During, S-7

- EMG Comparison, S-75
- Closed Kinetic Chain
  - Enhancing EMG Activity of Quadriceps, S-74
  - Prophylactic Knee Bracing in, S-24
- Cognition
  - Effect of Mild Head Injury on, S-8
- Cold
  - Cold Application and Muscle Trauma, S-45. *See also Cryotherapy*
  - Whirlpool, Effect on Symptoms of DOMS, S-43
- College
  - Basketball Player, S-51
  - Female Volleyball Players, S-73
  - Pitcher, S-48, S-49
- Collegiate
  - Coaches' Knowledge of Eating Disorders, S-61
  - Football Player, Acute Midfoot Pain in, S-58
  - Football Player, Acute Upper Arm Pain in, S-47
  - Football Player, Foot Pain in, S-52
  - Football Player, Muscle Aches and Fatigue in, S-56
  - Football Player, Scapular Fracture in, S-30
  - Football Players, Mild Head Injury in, S-22
  - Lacrosse Player, Acute Knee Pain in, S-56
  - Soccer Player, Cardiac Arrhythmia in, S-52
  - Soccer Player, Pulmonary Emergency in, S-32
  - Soccer Player, Traumatic Eye Injury in, S-31
  - Track and Field Athlete, S-50
  - Woman Gymnast, Open Ankle Injury in, S-31
  - Wrestler, Syncope in, S-57
- Compartment Syndrome, S-50
- Computer-Assisted Learning Program, S-63
- Concentric and Eccentric
  - Angle Specific Hamstring to Quadriceps Ratios, S-76
  - Hamstring Strength Training, S-76
  - Hamstrings to Quadriceps Ratio, S-13
  - Isokinetic Muscle Performance in Ankle, S-44
  - Isokinetic Peak Torque Values, S-18
- Conditioning Variables, Effect on Patellar Tendon, S-11
- Condom Use, S-61
- Conservative Treatment of Osteitis Pubis, S-66

## Continuing Education

- Factors Affecting Self-Perceived Needs, S-15
- Contrast Bath, Effect on Symptoms of DOMS, S-43
- Crossover Cutting and Dynamic Knee Control Deficit, S-23
- Cryotherapy, S-44, S-45
- Cybex Reactor, S-35

## D

- Deceptive Athletic Injuries, S-10
- Decreased Function, Symptomatic Tendinitis, S-68
- Delayed Onset Muscle Soreness
  - Effect of Contrast Bath on Symptoms, S-43
  - Following Eccentric Exercise, S-16
  - Pulsed Ultrasound in Treatment of, S-69
  - Whirlpool Therapy in Treatment of, S-44
- Dexamethasone Iontophoresis
  - A Double Blind Clinical Efficacy Study, S-68
  - In Treatment of Symptomatic Tendinitis, S-67
- DOMS. *See Delayed Onset Muscle Soreness*
- Drug Use and Testing, Adolescent Perceptions of, S-9
- Dynamic
  - Activities, Reactive Muscle Firing, ACL, During, S-71
  - Knee Control Deficits, S-23
  - Stabilizing Exercises, S-74

## E

- Eating Disorders, S-61
- Eccentric Exercise, S-77
  - DOMS and Muscle Function Following, S-16
- Eccentric Hamstrings to Quadriceps Torque Ratios, S-13
- Electromyographic Analysis, S-74
- Electronic Goniometry, S-42
- EMG
  - An EMG Comparison of Exercises, S-75
  - Analysis of Knee Extension Exercise, S-12
  - Biofeedback Training and VMO:VL Ratio, S-71
  - Effect of Physical Activity and Leg Shape on, S-15
  - Effects of Leg Flexion Angle on EMG, S-76
  - Enhancing EMG Activity, S-75

## Signal Following Eccentric Exercise, S-77

- Epidemiological Investigation of Mild Head Injuries, S-59
- Estrogen, Effects of, on Knee Joint Laxity, S-42
- Evertor Strength, S-71
- Excel Glider Exercise Device, S-43
- Exercise
  - Closed Kinetic Chain, S-74
  - Exercise-Trained Rat Skeletal Muscle, S-45
  - Isometric Knee Extension, S-12
  - Musculoskeletal Injury after, S-67
  - Neuromuscular Control Exercises, S-15

## F

- Face Protection
  - Face Shields in Hockey, S-21
  - Football Helmet Face Mask, S-43
- Facial Trauma, S-21
- Fatigue, in Collegiate Football Player, S-56
- Female
  - Basketball Players, S-17
  - Collegiate Athletes, S-61
  - Endurance Runners, S-36
  - Hamstring Stretch Training in Healthy Females, S-76
  - Knee Joint Laxity, S-42
  - Long Term Resistance Training in, S-72
  - Soccer Player, Acute Knee Pain in, S-55
  - Soccer Players, Incidence of ACL Injury in, S-10
  - Volleyball, Power in College Players, S-73
- Field Hockey Player
  - Quadriceps Fasciculation In, S-54
  - Viral Infection in, S-57
- Foot Pain
  - In Collegiate Football Player, S-52
- Football
  - Brachial Plexus Injury, S-8
  - Collegiate and High School Participants, S-59
  - Helmet Removal Procedures, S-61
  - Hip Angles in Player, S-13
  - Injury Incidence And Relative Risk, High School, S-22
  - Players
    - Return to Play Decisions, S-22
    - Semi-Professional, S-76
  - Removing A Face Mask, S-43
- Forearm Pain, S-29
- Forefoot Varus, S-12
- Forward and Backward Walking, S-65

## Functional Performance

- Effect of Ice Application on, S-46
- Outcomes, S-17
- Functional Training vs. Weight Training, S-71

## G

- Gastrocnemius Muscle, S-66
- Gender
  - Differences in Injuries to Javelin Throwers, S-60
  - Effects on Ability to Remove Face Mask, S-43
  - Equity in Medical Coverage and Injury Prevention, S-9
  - Perceptions on Drug Use and Testing, S-9
- Grip Strength, S-43

## H

- Hamstring
  - EMG Of, S-75
  - Fatigue, S-23
  - Musculature, S-66
  - Strains, S-9
- Hand Size, Effect on Face Mask Removal, S-43
- Head Injury
  - Effect on Cognition and Postural Stability, S-8
  - Evaluation, S-18
  - Mild, in Football, S-59
  - Return to Play Decisions Following, S-22
- Heat Illness, S-36
- Heel Forces
  - Mean Peak, S-65
- High School Football, S-59
  - And Seasonal Risk of Injury, S-22
  - Knee Dislocation in Player, S-55
  - Relationship Between Life Events and Incidence of, S-8
- High School Lacrosse Player, Stress Fracture, S-53
- High School Soccer
  - Epidemiological survey of Injuries, S-59
  - Knee Injury in Player, S-53
- High School Wrestler, Acute Onset of Shoulder Pain, S-47
- Hip, Effect of Position on VMO:VL Ratio, S-71
- HIV/AIDS Knowledge and Attitudes, S-62
- Hockey Players, S-21
- Human Fat, S-70
- Hyperbaric Oxygen, S-11



## I

### Ice

- Effect of Application on Knee Function, S-46
- Effects of Ice Immersion on Muscle Performance in, S-44
- Use in Reducing Intra-Muscular Temperature, S-45
- Immediate Extensibility Effects, S-66
- Incidence of Injury in High School Football, S-8
- Incremental Cycle Ergometry, S-37

### Injury

- Incidence in Seasonal HS Football, S-22
- Mechanisms in Mexican Soccer, S-21
- Prevention, NCAA Div. I, S-9
- To Anterior Cruciate Ligament, S-60
- Instrumented Measurement, S-17
- Intercollegiate Athletes, S-65
- Internet Resources, S-62
- Intertester Reliability, S-18
- Intra-Muscular Temperature, S-45
- Intratester Reliability, S-41
- Intravenous Versus Oral Rehydration, S-36
- Inversion Loading, S-38
- Isometric
  - Force Production, S-67
  - Force Variability, S-45
  - Torque, S-76

### Isotonic

- Exercise, Effect on Peak Muscle Force, S-68
- Exercise, Healthy Shoulder, S-26
- Power Changes, S-74

## J

- Javelin Throwers, S-60

### Joint

- Hypermobility Syndrome, S-25
- Position Sense, S-24
- Reaction Force Characteristics, S-7
- Reposition Sense, S-26

## K

- KIN COM, S-18

### Knee, S-46

- Angles, Effects on Torque Ratios, S-13
- Brace Migration, S-15
- Effusion, S-32
- Extensors, S-77
- Joint Laxity, S-75
- Joint Proprioception, S-25
- Joint ROM and Load, S-7
- Low-Velocity Dislocation, S-55
- Prophylactic Bracing, S-24
- Range of Motion, S-75

## L

- Lateral Ankle Sprains, S-39

- Learning Styles in CAAHEP Accredited Athletic Trai, S-62

### Leg

- Dominance, S-23
- Flexion Angle, S-76
- Life Events, S-8
- Long Term
  - Ankle Bracing, S-39
  - Resistance Training, S-72
- Low Impact Stepping Exercises, S-16
- Lower Extremity
  - Activities, S-73
  - Loading Forces, S-43
  - Muscle EMG Activity, S-38

## M

- Magnetic Resonance Imaging, S-9, S-42
- Manual Goniometry, S-42
- Maximal Isokinetic Knee Strength, S-19
- Medical Coverage, S-9
- Meniscus Tears, S-42
- Menstrual Cycle, S-36
- Metabolic Stimulant, S-57
- Mexican Soccer Team, S-21
- MMG, S-76
- Mood Disturbances Following Injury, S-65
- Motor Function, S-23
- Muscle
  - Fatigue, S-24
  - Injury, S-25
  - Pre-activity in ACL-D and ACL-R Female Subjects, S-73
  - Temperature Rise, S-11
  - Trauma, S-45
- Musculoskeletal Injury, S-67

## N

- Naloxone, S-37
- Naprosin, S-11
- Nasal Patency, S-37
- NATABOC Certification Examination, S-62
- National Injury Patterns, S-59
- Neck Pain, S-30
- Neuromuscular
  - Characteristics, S-72, S-75
  - Control Exercises, S-15
  - Electrical Stimulation, S-26
- Novice Wrestler, S-30
- Nursing Students, S-62

## O

- One-Legged Postural Sway, S-71
- Open and Closed Kinetic Chain, S-24
- Open Ankle Injury, S-31

## Orthotics

- Effects on Postural Sway, S-35
- Plantar Pressure Measures, S-12
- Osteitis Pubis, S-66
- Oxygen Free Radicals, S-45

## P

- Paramedic Education, S-61
- Patellar Tendon Thickness, S-11
- Patellofemoral Joint Reaction Forces, S-16
- Peak
  - Muscular Force, S-68
  - Plantar Pressure Location and Timing, S-17
  - Power Production, S-77
- Perceived Pain, S-67, S-68
- Performance
  - In Aerobically Trained Males, S-35
- Physical Performance, Effects of Viral Illness on, S-12
- Plantar Pressure Measures, S-12
- Plyometric
  - Drills, S-73
  - Training, Effects on EMG of Hamstrings, S-75
- PNF, S-66, S-67
- Positive Polarity Galvanic Stimulation, S-45
- Postural Stability, S-41
  - Effect of Mild Head Injury on, S-8
- Postural Sway
  - Effects of Training on, S-71
  - Subtalar Pronation and Orthotics, S-35
- Posture Measurements, S-65
- Productivity Environmental Preferences Survey, S-63
- Professional Preparation, S-63
- Progesterone, S-42
- Prolonged Muscle Aches, S-56
- Proprioception
  - Assessment of Leg Dominance by, S-23
  - Rehabilitation of Baseball Pitcher, S-49
- Proprioceptive Acuity, S-26
- ProStretch™, S-66
- Protein Levels, S-45
- Pulmonary Emergency, S-32
- Pulsed
  - Low Intensity Ultrasound, S-69
  - Short-Wave Diathermy, S-70

## Q

- Quadriceps, S-74
  - Fasciculation, S-54
  - Pain, S-55
  - Setting, S-74

## R

### Range of Motion

And Muscle Injury, S-25

Static Foot/Ankle, S-65

### Rat Skeletal Muscle, S-11

### Reactive Muscle Firing in Normal

Females, S-71

### Reconditioning, S-62

### Reconstruction, Anterior Cruciate

Ligament, S-17

### Recreational Athlete, S-29

### Rehabilitation, S-49, S-51, S-62

### Relationship Between Life Events and

Injury, S-8

### Relationship of Muscle Injury to Pain,

S-25

### Reliability

of Cybex Reactor, S-35

of Productivity Environmental Prefer-

ences Survey, S-63

### Removal of Football Helmet Face Mask,

S-43

### Repeated Shoulder Rotation, S-74

### Resistive Ankle Exercises, S-26

### Return to Play Decisions, S-22

### Rupture

Of Achilles Tendon, S-51

Post-Operative Anterior Cruciate

Ligament, S-7

### Russian Stimulation, S-68

## S

### Scapular Fracture, S-30

### Secondary Injury, S-44

### Selected Psychological Correlates, S-10

### Semi-Professional Football Players, S-76

### Semi-Rigid Prophylactic Ankle Stabilizer,

S-38

### Sensation, S-45

### Sensorimotor Evaluation

ACL Rupture, Post-Operative, S-7

### Sexual Activity and Condom Use, S-61

### Short Term Ankle Bracing, S-39

### Shoulder

Internal and External Rotation, S-74

Joint Reposition Sense, Healthy

Shoulder, S-26

Neuromuscular Control Exercises, S-15

Pain, S-48

Proprioception, S-24

### Single

Leg Broad Jump Distance, S-72

Limb Balance, S-10

### Skeletal Muscle, S-44

### Soccer

Injury in Female Players, S-10

Knee injury, HS Soccer Player, S-53

Knee Joint Laxity, S-75

Seasonal Injuries, S-21

### Speed, Effects of Shoes and Drills on,

S-73

### Spine Boarding Techniques, S-41

### Stable Versus Unstable Ankles, S-23

### Static Stretching

Effects on Hip Extension, S-67

Vs. PNF, S-66

### Strength

Assessment of Leg Dominance by,

S-23

Effects of Muscle Injury on, S-25

### Strength® Shoe, S-73

### Stress Fracture, S-53

### Stretching Programs, S-66

### Students, Paramedic, S-61

### Submaximal Measurements

And Knee Strength, S-19

### Subtalar

Joint Range of Motion, S-42

Pronation, S-35

### Symptomatic Tendinitis

Double Blind Study of DmNaP, S-68

Effects of Dexamethasone

Iontophoresis, S-67

### Syncope, S-57

## T

### Temperature

Change of, in Human Fat, S-70

Elevation, in Adipose Tissue, S-70

### Thermal Modalities, S-67

### Tibial Stress Fracture Healing, S-69

### Traumatic Eye Injury, S-31

## U

### Ultrasound

Rate of Temperature Change During

3 Mhz Ultrasound, S-70

Treatments, S-11

### Undergraduate Athletic Training

Students, S-63

### Unstable Shoulder, S-15

### Unusual Forearm Pain in HS Baseball

Player, S-29

## V

### Viral

Infection in Varsity Field Hockey

Player, S-57

Upper Respiratory Illness, Effects on

Performance, S-12

### VMO:VL Ratio, S-71

### Volleyball, Strength in Female Players,

S-73

### Volumetric Measurement of the Ankles,

S-36

## W

### Weight Training

Effects on EMG of the Hamstrings,

S-75

Effects on Posture and Strength, S-71

### Whirlpool Therapy, S-44



# Author Index

## A

Abergel PA, S-70  
 Acuqa ME, S-21  
 Albensi RJ, S-65  
 Anderson K, S-41  
 Andres FA, S-44  
 Andrews AJ, S-75  
 Andrzejewski DN, S-38  
 Arciero R, S-30  
 Armstrong CW, S-38, S-43  
 Armstrong LE, S-36  
 Arnold BL, S-23, S-26, S-60, S-74, S-77  
 Austin M, S-15  
 Austin MC, S-30  
 Axen K, S-37

## B

Ball TE, S-36  
 Baracos VE, S-11  
 Barber KD, S-59  
 Bateman W, S-50  
 Batts J, S-22  
 Bealle D, S-47  
 Beck CL, S-42  
 Beckett JA, S-9  
 Behnke RS, S-43  
 Bernard A, S-66  
 Bernhardt DT, S-9, S-29  
 Bernier JN, S-25  
 Best TM, S-9, S-10  
 Bittner MB, S-24  
 Blanc RO, S-44  
 Bleggi SD, S-68, S-75  
 Boersma D, S-72  
 Bohling CM, S-10  
 Brand J, S-69  
 Brechue WF, S-16  
 Brindle TJ, S-12, S-47, S-69  
 Brown DJ, S-67  
 Buckley T, S-68  
 Buckley WE, S-17, S-35, S-45  
 Butcher M, S-60

## C

Caborn DNM, S-17, S-23, S-69, S-72  
 Calabrese GJ, S-48  
 Cameron KL, S-30  
 Canlas RL, S-31  
 Carey PJ, S-17  
 Casa DJ, S-36  
 Casey, KC, S-57

Castel JC, S-70  
 Castle RR, S-63  
 Catlaw K, S-15  
 Charles-Liscombe RS, S-16  
 Chudleigh D, S-11  
 Cisar CJ, S-45  
 Cokeley KLT, S-36  
 Confessore R, S-15  
 Connaughton D, S-24  
 Conte A, S-55  
 Coppola A, S-12  
 Corbin DR, S-51  
 Cordova ML, S-38  
 Couper KL, S-26  
 Croce R, S-15  
 Curl LA, S-52, S-56  
 Curtis N, S-31, S-52

## D

Dailey SW, S-47  
 Davlin C, S-71  
 Decoster LC, S-25, S-53  
 Deffner KT, S-13, S-76  
 DeMont RG, S-67, S-71, S-73  
 Denegar CR, S-17, S-35, S-45  
 DeSmet A, S-9  
 Draper DO, S-11, S-69, S-70  
 Druse TL, S-66  
 Duncan JB, S-29  
 Duncanson R, S-55  
 Dupont LA, S-12  
 Durrant E, S-69

## E

Eastepp C, S-43  
 Ebersole KT, S-76  
 Echegoyen S, S-21  
 Edwards JE, S-43  
 Eisenman PA, S-42  
 Elbe WM, S-35  
 Elder C, S-62  
 Elliott TA, S-36  
 Ernst GP, S-74  
 Ernst M, S-22  
 Evetovich TK, S-76

## F

Fain R, S-37  
 Fernandez JC, S-55  
 Ferullo K, S-47  
 Fields K, S-72  
 Fisher BD, S-11, S-45  
 Fletcher R, S-11  
 Freeman ML, S-58  
 Frounfelter GG, S-21  
 Fu FH, S-15, S-71, S-72, S-73, S-74, S-75

## G

Gallaspy JB, S-63

Gangstead S, S-63  
 Gansneder BM, S-23, S-26, S-35, S-60, S-74  
 Garza C, S-32  
 Gass PL, S-42  
 Gear WS, S-26, S-75  
 Gehlsen G, S-7, S-12  
 Giannantonio FP, S-15, S-25, S-44, S-72  
 Gieck JH, S-60  
 Giraldo JL, S-71, S-73, S-74  
 Graham V, S-7  
 Graybash LA, S-73  
 Greene JJ, S-10, S-29  
 Gribble PA, S-49  
 Grossman JM, S-66  
 Grutzner SJ, S-45  
 Guadagnoli MA, S-23, S-71  
 Gunnoe AG, S-8  
 Gurchiek LR, S-17  
 Guskiewicz KM, S-8, S-18, S-22, S-39, S-49, S-57, S-59

## H

Haas F, S-37  
 Hacker FT, S-36  
 Hafner TL, S-59  
 Hals T, S-38  
 Hanley KF, S-53  
 Harrelson GL, S-62, S-63  
 Harris TB, S-21  
 Hart CH, S-9  
 Hatzel BM, S-44  
 Hawke RL, S-26  
 Hayes E, S-43  
 Heath K, S-47  
 Heitman RJ, S-17  
 Heitz NA, S-42  
 Henneman C, S-52  
 Henry TJ, S-15, S-74  
 Herrera-Soto JA, S-36  
 Hertel JN, S-35  
 Hester P, S-65  
 Higbie EJ, S-12  
 Hinman CL, S-44  
 Hoewischer PE, S-42  
 Hoffman MA, S-7  
 Hoffman R, S-37  
 Holcomb WR, S-23, S-36, S-39, S-42, S-43, S-71  
 Hollis JM, S-17  
 Hopkins JT, S-75  
 Horodyski MB, S-8, S-18, S-22, S-24, S-44  
 Horsman G, S-52, S-56  
 Housh TJ, S-76  
 Hunt H, S-61

## I

Ingersoll CD, S-41, S-43, S-58, S-67, S-68, S-71, S-75

## J

Jacobs D, S-69  
Jenkinson DM, S-67  
Jensen KA, S-9  
Jimenez C, S-31, S-52  
Johnson DL, S-23  
Johnson GO, S-76  
Johnson PD, S-35  
Johnson SC, S-13, S-16, S-76

## K

Kaiser DK, S-10  
Kaminski TW, S-8, S-18, S-22, S-24, S-44  
Kavouras SA, S-36  
Keith NR, S-36  
Kendrick ZV, S-67, S-68, S-73  
Kersey RD, S-32  
Keskula DR, S-29  
Kimura IF, S-41, S-67, S-68, S-73  
Klein BM, S-23  
Kleiner DM, S-23, S-36, S-39, S-42, S-43  
Klingensmith MT, S-8  
Klootwyk TE, S-58  
Knaul J, S-55  
Knight C, S-63  
Knight KL, S-45  
Koceja DM, S-7  
Kovaleski JE, S-17  
Kronisch RL, S-45  
Kuligowski LA, S-44

## L

Laise K, S-47  
Lansing K, S-41  
Laws TEV, S-22  
Leaver-Dunn D, S-62, S-63  
Leavy C, S-46  
Lee BW, S-66  
Lephart SM, S-15, S-24, S-25, S-26, S-44,  
S-67, S-71, S-72, S-73, S-74, S-75  
Lichty DM, S-12  
Lima H, S-21  
Loriz LM, S-62  
Lott J, S-29  
Ludwikowski ME, S-42

## M

Maitra R, S-11, S-32  
Maresh CM, S-36  
Martin L, S-41  
Martin M, S-61  
Mattacola CG, S-38, S-41, S-67, S-68,  
S-73  
Matthews J, S-45  
Max J, S-32  
McCue FC, S-60  
McFarland EG, S-52, S-56  
McGuine TA, S-10  
McLendon M, S-56

McLeod IA, S-54  
McNally K, S-49  
McNew S, S-32  
Meister K, S-22  
Merrick MA, S-44  
Miguel A, S-21, S-66  
Miller CA, S-53  
Miller J, S-15  
Miller MG, S-23, S-39, S-62  
Miller WN, S-65  
Mochizuki M, S-43  
Moore JH, S-23  
Moran MJ, S-25  
Morgan RO, S-35, S-37  
Motl RW, S-13, S-76  
Mumaw C, S-32  
Murphey M, S-8  
Myers JB, S-22, S-57, S-59  
Myrer JW, S-11

## N

Namisanak SM, S-66  
Nelson TL, S-51  
Newell, KM, S-45  
Newman V, S-62  
Nicholaides NK, S-25  
Norris WC, S-53  
Nyland J, S-9, S-11, S-12, S-17, S-23,  
S-32, S-65, S-69, S-72

## O

O'Connor CE, S-8  
Onate JA, S-39  
Ostdiek DPG, S-66  
Ozmun JC, S-68, S-71

## P

Padua DP, S-22, S-57, S-59  
Passerallo AJ, S-48  
Payne VG, S-45  
Pearsall AW, S-17  
Pekow PS, S-8  
Perez-Guerra E, S-9  
Perrin DH, S-8, S-26, S-35, S-60, S-74  
Perry AC, S-35, S-37  
Perry SR, S-76  
Pfeifer KE, S-26  
Pfeiffer R, S-59  
Pincivero DM, S-24  
Poust DL, S-36  
Powell JW, S-59  
Prentice WE, S-61

## R

Rabadan A, S-21  
Ragatz AE, S-42  
Rankin JM, S-38, S-44  
Ransone JW, S-19, S-45  
Redden WW, S-43

Reynolds C, S-67  
Ricard MD, S-69  
Richardson TB, S-11  
Riemann BL, S-15, S-18, S-39, S-57, S-72  
Robertson R, S-67  
Rodriguez C, S-21, S-66  
Rodriguez-Nava R, S-21  
Romani WA, S-74  
Rosenberg TD, S-13, S-76  
Rozzi SL, S-44, S-75  
Rubley MD, S-45

## S

Saliba EN, S-60  
Sandrey MA, S-41, S-67, S-71, S-75  
Schmitz RJ, S-77  
Schrader JW, S-7  
Schulthies SS, S-11, S-69  
Schurr T, S-12  
Schwartz E, S-37  
Selder D, S-10  
Sewell J, S-71  
Sgherza A, S-37  
Shapiro R, S-23  
Shoemake SA, S-51  
Shorty MB, S-68  
Siemann A, S-46  
Signorile JL, S-35, S-37  
Sinclair AJ, S-19  
Sitler MR, S-38, S-41  
Smedley B, S-32  
Smith AN, S-30  
Smith DB, S-76  
Smith KJ, S-31  
Stabler CL, S-17  
Stave ES, S-31  
Stay JC, S-69  
Steele B, S-12  
Stemer RL, S-24  
Steves RG, S-74  
Stone D, S-74  
Stopka CB, S-24  
Streator SS, S-17, S-42  
Subudhi AW, S-13, S-76  
Sumida K, S-9  
Surgent F, S-46  
Swanik CB, S-24, S-71, S-72, S-73  
Swartz EE, S-43

## T

Tennant LK, S-8  
Thompson W, S-63  
Threlkeld AJ, S-66  
Tis LL, S-12  
Turk JC, S-61  
Tuttle GH, S-57

## U

Uhl TL, S-26  
Ullery R, S-17



# V

Vailas JC, S-15, S-53  
 Van Lunen BL, S-26, S-35, S-60  
 VanBemden AL, S-35, S-37  
 Vieson M, S-61

# W

Walker JA, S-13, S-42, S-76  
 Waruch R, S-74  
 Watson A, S-61  
 Webster K, S-67  
 Weidner T, S-7, S-12  
 Weisman BP, S-31  
 Welsh WE, S-9  
 West SA, S-35, S-37  
 Wiksten DL, S-10  
 Wilson B, S-66  
 Wimer JW, S-61  
 Winslow KA, S-41  
 Wood-LaForte M, S-54  
 Wright K, S-62  
 Wright V, S-62

# Y

Yap J, S-52, S-56  
 Yartym C, S-67  
 Yates JA, S-12  
 Yeasting RA, S-38  
 Young AL, S-67  
 Young M, S-11

# Z

Zlatniski PA, S-18

NOTES:

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NOTES:

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Journal of Athletic Training S-87-8



# NOTES:

NOTES:

Valley K, 5-73, 5-74  
 Valley L, 5-73, 5-74, 5-75  
 Valley M, 5-73, 5-74  
 Valley N, 5-73

W

Wade A, 5-73, 5-74, 5-75  
 Wade B, 5-73  
 Wade C, 5-73  
 Wade D, 5-73  
 Wade E, 5-73, 5-74  
 Wade F, 5-73  
 Wade G, 5-73, 5-74  
 Wade H, 5-73  
 Wade I, 5-73, 5-74  
 Wade J, 5-73  
 Wade K, 5-73  
 Wade L, 5-73  
 Wade M, 5-73  
 Wade N, 5-73  
 Wade O, 5-73  
 Wade P, 5-73  
 Wade Q, 5-73  
 Wade R, 5-73  
 Wade S, 5-73  
 Wade T, 5-73  
 Wade U, 5-73  
 Wade V, 5-73  
 Wade W, 5-73  
 Wade X, 5-73  
 Wade Y, 5-73  
 Wade Z, 5-73

Y

Yale A, 5-73, 5-74  
 Yale B, 5-73  
 Yale C, 5-73  
 Yale D, 5-73  
 Yale E, 5-73  
 Yale F, 5-73  
 Yale G, 5-73  
 Yale H, 5-73  
 Yale I, 5-73  
 Yale J, 5-73  
 Yale K, 5-73  
 Yale L, 5-73  
 Yale M, 5-73  
 Yale N, 5-73  
 Yale O, 5-73  
 Yale P, 5-73  
 Yale Q, 5-73  
 Yale R, 5-73  
 Yale S, 5-73  
 Yale T, 5-73  
 Yale U, 5-73  
 Yale V, 5-73  
 Yale W, 5-73  
 Yale X, 5-73  
 Yale Y, 5-73  
 Yale Z, 5-73

Z

Zion A, 5-73

AI  
 W  
 Pl

27  
 lrv  
 75

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High Performance ATF™ with  
Comfort Wedge™ designed to  
anatomically fit women's ankles

Sizes XXS - XL

COMFORT  
WEDGE™



## WOMEN'S

200 Left	200W Left	White
205 Right	205W Right	White
201 Left	201W Left	Black
206 Right	206W Right	Black

SIZING: According to shoe size. Indicate left or right.

	XXS	XS	SM	MD	LG	XL	XXL
MEN	—	6-7	8-9	9-11	11-13	13-14	15-17
WOMEN	5-6	7-8	9-10	10-12	12-14	14-15	—

**Mueller**®

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