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THE JOURNAL OF THE NATIONAL ATHLETIC TRAINERS ASSOCIATION, INC. • VOLUME 25 • NUMBER 2 • SUMMER 1990



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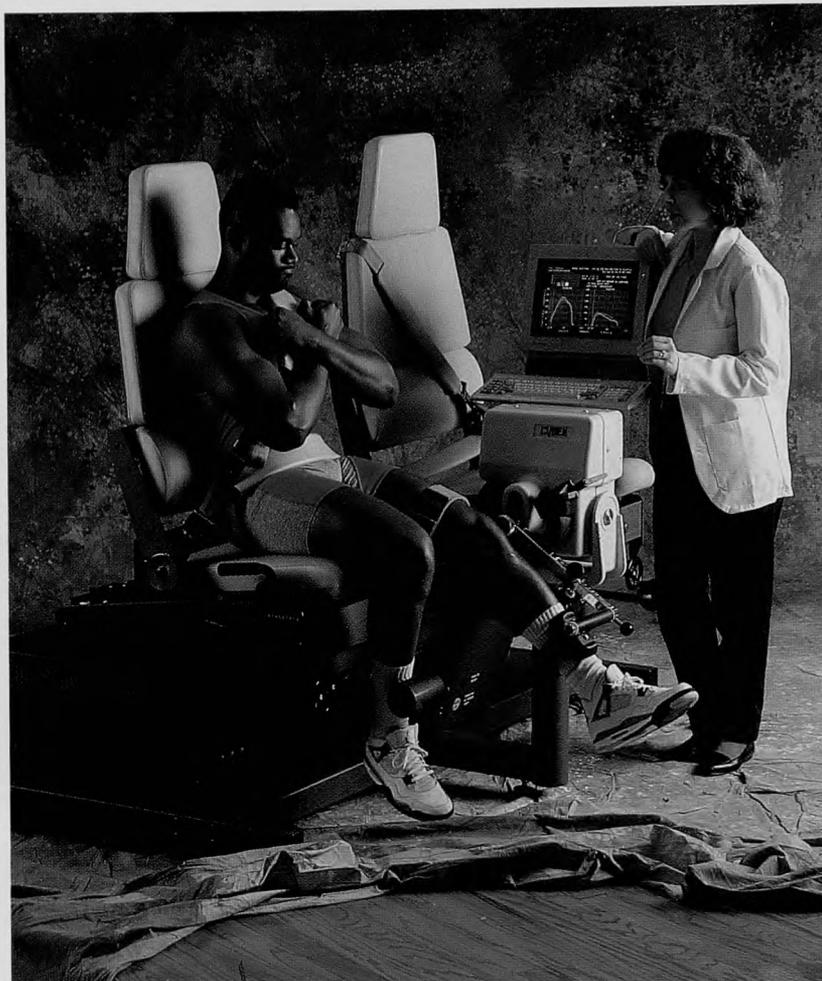
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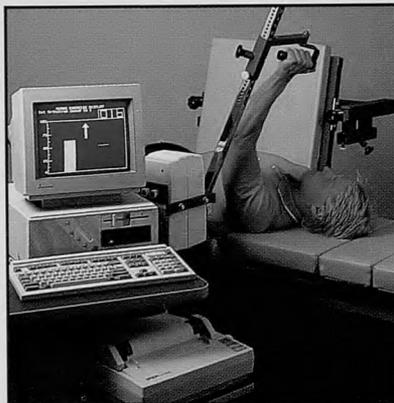
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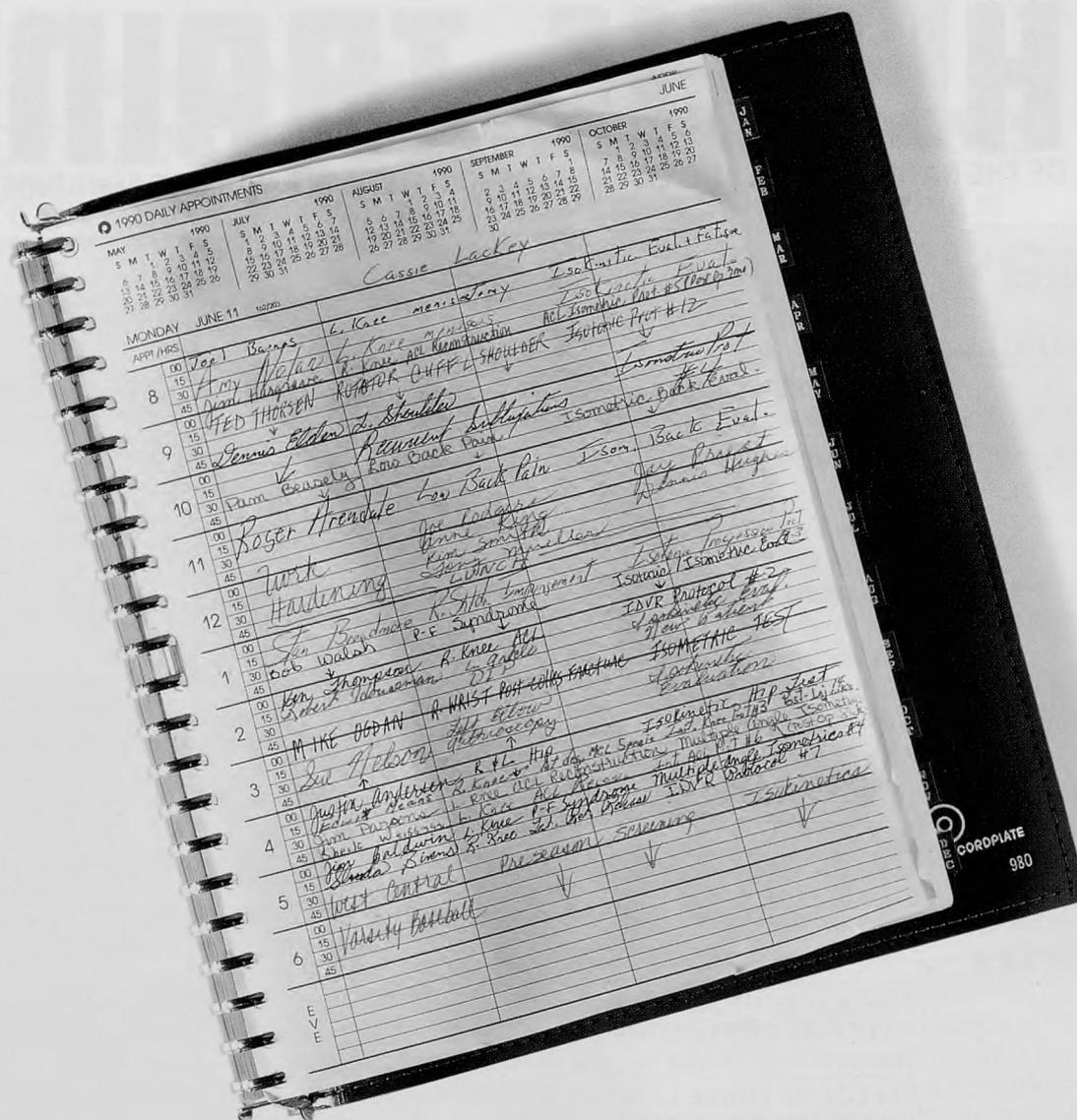
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Editor-in-Chief Comments



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Welcome to the 41st Symposium of the National Athletic Trainers' Association.

This meeting will provide an excellent forum on relevant issues confronting our organization. It will also provide an opportunity for the membership to convey professional problems, complaints and salutations to their fellow athletic trainers and officers.

Since this is the 1990s, we must now address the current as well as the future issues facing the NATA.

Our Cover

The Soldiers and Sailors Monument serves as Indianapolis's centerpiece. It is currently undergoing a \$14 million restoration. Monument Circle, located in the heart of downtown, is known as a site for lunchtime and evening gatherings, as well as for numerous outdoor festivals which take place throughout the year. Indianapolis has been called the "Circle City" because of Monument Circle.

Don't Miss This Exhibit

Gotcha! It has been reported by several of our exhibitors that conventioners should **not** pick up items from the exhibit booths that are not intended to be sample items.

Help us protect our image as professionals by not allowing this to occur.

Index

If you need the complete (1956-1989) Cumulative Author/Subject Index, it is available on diskette which may be purchased for \$10.00. Make check payable to ATHLETIC TRAINING, JNATA and send request to Dr. Ken Knight (address at left). Please specify 3½ inch or 5¼ inch format.

Closing

Thank you for your continued support of the Journal. If you have suggestions or ideas regarding our publication, please feel free to contact me. The Journal welcomes your input.

Have a pleasant summer and some needed time off.

SY(SSSA)

President's Message

Dear Members,

The convention in Indianapolis is fast approaching and it should be an exciting one. The national and local committees have done an outstanding job to make your stay educational and enjoyable. A special thanks for the support of our corporate sponsors, Gatorade and McNeil.

At our midyear Board of Directors meeting in Dallas, Texas last February several important decisions were made to lead us into the 1990s. Several task forces and committees were appointed from the Board of Directors to evaluate business matters pertaining to NATA and make us more consistent and effective in the next decade. The Board of Directors also endorsed the concept of research and grant funding as proposed by John Powell and the Research and Injury Committee. Look for the NATA to invest in research during this decade with the support of Johnson & Johnson.

The most important objective accomplished at this meeting was the hiring of our first full time Executive Director. This has been a long and carefully planned process, assisted by Lawrence Leiter and Co. from Kansas City, Missouri. It began with an assessment of the NATA, Inc., a long range plan, and an extensive search and careful analysis of candidates. There were over 200 applicants for this position. Finalists were interviewed at the midyear meeting. We will be pleased to introduce to the membership **Mr. Alan A. Smith, Jr.** at the June convention. He brings to the NATA several years of association experience and we feel he will contribute to the growth of our Association and profession in a most positive way. For those of you who attend the convention, I encourage you to extend Alan a warm welcome to the NATA family.

I'll look forward to seeing you all in Indianapolis.

Sincerely,



Mark J. Smaha, ATC

CEU Credit Quiz

Patellofemoral Pain Syndrome and Its Treatment in Runners

Pauli Rintala, Ph Lic

ABSTRACT: The purpose of this paper is to address anatomical and biomechanical factors related to long distance running, symptoms of the patellofemoral problems, causes of overuse syndromes, and different treatment modalities to overcome these problems. The symptoms of the patellofemoral problems can be divided as follows: retro-patellar pain, retro-patellar crepitus, swelling of the knee joint, subjective feeling of instability, and pain on ascending or descending stairs or hills. Most common causes of problems are training errors, anatomical factors, running shoes, or training surface. Several treatment modalities have been used more or less successfully to help runners. If the runner is aware of these different causes, she/he will likely notice the early physical signs and symptoms of conditions which, if left untreated, will develop into more significant injuries and interfere with the runner's regular workout schedule.

“**R**unner's knee” is a nonspecific term for pain around the anterior aspect of a knee in athletes whose primary activity is running (3,24,35). The most common cause of anterior knee pain is the patellofemoral stress syndrome (9,18). However, the term “chondromalacia patellae” is often used in reference to patellofemoral problems in runners. Chondromalacia means a softening of the cartilage of the patella (25) and should not be used indiscriminately to describe a syndrome of pain behind the patella. The term “chondromalacia patellae” should be used only to describe the physical changes of articular cartilage of the patella and the term “patellofemoral pain syndrome” should be used to describe the symptom complex that is usually found in runners (9,18). The terms patellofemoral arthralgia (12), patellalgia (30), and patellar chondropathy (39) are also used to describe patellofemoral pain.

The onset of patellofemoral pain in runners is usually insidious and may be related to an increase in mileage, a change in terrain, or a change in running shoes (9). Overuse injuries in athletes are generally due to overload or

repetitive microtrauma of the musculoskeletal system (33). Because injuries to runners are usually overuse injuries they must be treated differently from direct trauma (27). This article will review the anatomical and biomechanical components, symptoms, etiological factors, and different treatment modalities related to patellofemoral problems in running.

ANATOMY AND BIOMECHANICS OF THE PATELLA

The patella considerably decreases the friction of the quadriceps mechanism passing over the distal femoral condyles (21). It acts as a guide for the quadriceps mechanism and centralizes the divergent input of the four muscles of the quadriceps (5,18). The forces are then transmitted to the patellar tendon. The presence of the patella in the extensor apparatus protects the tendon from excessive friction and permits the extensor apparatus to tolerate high compressive loads (5,28).

In biomechanical studies of patellofemoral forces, the forces transmitted to the femur through the patella increased as knee flexion angle increased (31,36). Morrison (29) reported average patellofemoral compression force values of 0.5 times body weight during level walking. In contrast, when an individual is ascending and descending stairs or running up and down hills, the patellofemoral joint reaction force may reach 3.3 times body weight (32). These activities may place pathologic loads on the patellofemoral joint.

SYMPTOMS

The symptoms associated with patellofemoral joint problems can be organized into five categories (9):

1. **Retro-patellar pain.** This is described as a dull aching pain that is well-localized to the anterior aspect of the knee behind the patella. It is related directly to running and usually occurs during the run. Pain may be persistent or may vary in intensity throughout the period of the run and can be aggravated by going up and down hills.
2. **Retro-patellar crepitus.** The individual describes a noise or “grating” in the knee. Crepitation is not necessarily indicative of pathology in the knee joint, and by no means a diagnostic sign of chondromalacia patellae, as it is frequently found in normal knees (1).
3. **Swelling of the knee joint.** Intra- or extracapsular

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effusion in the knee joint is usually associated with a generalized synovitis. This swelling may be from general irritation of the synovium caused by prolonged running and activity. Effusion in this region is more likely to be indicative of pathology in the tibiofemoral joint and is uncommon in patellofemoral syndrome.

4. **Subjective feeling of instability.** Patellofemoral pain caused by pressure during prolonged running may result in occasional muscular "release" of the quadriceps mechanism. The individual will perceive this as a feeling of giving away or instability. However, this "giving away" should not be confused with ACL or meniscus related giving away.

5. **Pain on ascending or descending stairs or hills.** The patellofemoral pressure is markedly increased in an individual going up or especially going down ramps or hills, and also sitting for prolonged periods - in class, at the movies or buses, etc., and it is thought that this increase in pressure causes the increase in pain.

ETIOLOGY OF OVERUSE SYNDROMES

Numerous authors (8,10,11,18,19,42,45) have outlined the causes of patellofemoral joint pain in endurance athletes. The causes can be divided into four general categories:

1. **Training errors.** Training errors include persistent high-intensity training without alternate easy days; sudden increases in training mileage and/or intensity without allowing the supporting structures of the lower extremities sufficient time to adapt to the increased work load; a single severe training or competitive session, such as a 10-km race or a marathon; and repetitive hill running or jump training (16,19,24).

2. **Anatomical factors.** Anatomical factors include, e.g., functional leg-length discrepancy; quadriceps and hamstring insufficiency, poor flexibility, tight iliotibial band and lateral retinaculum, and/or muscle dysfunction compared with the asymptomatic leg; and excessive Q-angle (greater than 15 degrees) (7).

3. **Running shoes.** Factors implicated in running shoes are, e.g., inadequate heel wedging; soft, loose-fitting heel counters; and removal or breakdown of orthotics. However, a major problem is not the design of running shoes but that many runners do not maintain their shoes. Too often runners allow their shoes to wear down, which creates an abnormal foot strike and excessive pronation (2,19,22,40).

4. **Training surface.** Running on hard road surfaces, road camber (transverse grade), and uneven terrain are examples of causes of pain related to training surface. Running on a transverse grade causes increased pronation of the uphill foot. The increased pronation creates tibial rotation which stresses the knee, among other structures. Running downhill produces increased stress on knees and may create problems with the patellofemoral joint (2,37).

TREATMENT MODALITIES

Many injured runners are not willing to totally discontinue physical activity. Activities such as swimming, running in swimming pool, cycling, cross-country skiing, or walking can satisfy some of the aerobic conditioning needs of the runner (27). Specific, goal-oriented return to running must be explained to the injured athlete. This can be achieved by gentle progression to full running after a period of complete cessation of running. On the basis of the runner's commit-

ment, and the usual time to recovery, a goal-oriented program may be developed. In any case, the rehabilitation program should begin as early as the diagnosis is made and sometimes even before a final diagnosis is achieved (4). The following modalities have been employed in patellofemoral pain syndrome treatment with varying degrees of success.

Medication

Nonsteroidal anti-inflammatory drugs (NSAIDs) such as aspirin or ibuprofen have been useful, but compliance is difficult to obtain (16,27). Anti-inflammatory drugs inhibit cartilage degeneration, and act as a catalyst in the enzyme reaction this is involved in the regeneration of cartilage cells (35).

One method of using aspirin and other anti-inflammatory medications is to have the runner take the medication one hour before running. This will guarantee that there is a good serum level during the run. The individual can repeat the medication later in the day if necessary. The medication is working to relieve both pain and inflammation as well as providing analgesia. In patellofemoral syndrome, aspirin is the least expensive and most readily available medication (9).

Patellar Stabilizing Devices

Several varieties of elastic sleeves, pads, and braces have been used for patellofemoral syndromes, most of which are intended to maintain the patella within its normal range of excursion in the femoral groove (9). The results of two studies evaluating the infrapatellar stabilizing brace are controversial: Levine and Splain (26) found the brace to be effective in 77% of 53 patients, although they did not state over what period of time they had reviewed their subjects. Villar (43) showed good results in only 22% of 37 subjects, with satisfactory improvement in a further 24%. The study was based upon subjective assessments only. All patients stated that the appliance was uncomfortable to wear in whatever position it was applied.

Total immobilization of the knee joint is contraindicated. A cast provides only temporary relief and always results in quadriceps atrophy. The pain syndrome may be worsened when the mobilization is resumed (9).

Orthotics

Pronation increases the patellofemoral Q-angle, causing pressure and symptoms in the patellofemoral joint (9,41). Rigid functional orthotics are used to balance the heel at contact, support the arch in midstance, and allow resupination at the subtalar joint before lift-off (14). Soft orthotics or padding within the existing shoe are also appropriate to use (41), although soft orthoses are often temporary (33). Before inserting of any sort of orthotic correction, specific shoe wear patterns should be identified.

Although several articles have been published emphasizing the values of orthotic devices, these articles have not presented the detailed method of study and analysis needed to scientific scrutiny. The study of Rodgers and Leveau (34) attempted to use improved methods in examining the foot orthotic devices; however, the results do not conclusively prove or disprove the effectiveness of the orthotics. More investigation is needed to significantly support or refute the use of orthotics for runners.

Ice and Other Infrared Modalities

Ice massage to the injured area immediately after a workout will decrease the immediate inflammation and pain. Ten to 15 minutes with a plastic bag and ice chips or cold pack will suffice (27). However, in chronic cases ice can be applied for 30 to 50 minutes regularly, especially after a workout, but can also be used at other times (33).

Heat (whirlpool, moist heat packs, infrared lamps, or heating pads) is useful prior to exercise to increase circulation to the patellofemoral joint (9). Studies investigating the effects of contrast therapy (alternate cold and heat treatment) (33), cryotherapy (the use of cold in the treatment) (20,23), and cryokinetics (combined cold and exercise) (23) on patellofemoral pain syndrome appear warranted.

Change In Running Terrain

As mentioned earlier, patellofemoral pressure is increased when ascending and descending hills. The individual should be encouraged to run on level ground until the symptoms subside (9).

Quadriceps Exercises

Central tracking of the patellofemoral joint is dependent on a balanced quadriceps mechanism and lower-extremity alignment (18). A problem may arise if there is muscle imbalance between vastus medialis obliquus (VMO) and vastus lateralis (VL). The VL is the largest of the quadriceps muscles (46) and typically causes lateral tracking of the patella. Thus, quadriceps exercises are important. Isometric straight leg raising exercises (4,11,18,47) should be performed in a supine or partially sitting position, with the knee slightly flexed, using distal ankle weights: the weights are increased to 10 lbs. and the repetitions to several hundred, depending on the person (18).

Isokinetic strengthening of the quadriceps in short arc fashion (25,47) has successfully been used as a treatment. Short arcs, which limit knee motion from 0-45 degrees, allow the quadriceps to be strengthened while maintaining a reduction of the patellofemoral joint compression force (4,25).

Iliotibial band tightness may be the primary or secondary cause of many lower extremity complaints, including knee problems. This has been the case specifically with young adult long distance runners (15). It is important to stretch the iliotibial band at the same time that strengthening exercises are being performed on the vastus medialis (9).

Electrical Muscle Stimulation and IEMG

Steadman (41) has suggested that electrical stimulation in the area of the vastus medialis obliquus complex can maintain patellofemoral alignment during knee extension. This notion has not been examined extensively, although there is some evidence that it might be true (38).

Clinical integrated electromyography (IEMG) testing can be utilized for monitoring the rehabilitation process and documenting isometric muscle function in situations where dynamic strength testing is contraindicated, e.g., acute patellofemoral pain syndrome (6,13).

Surgery

Wittenbecker and DiNitto (47) observed that even the most successful surgery will not solve the patellofemoral joint pain problem unless muscular performance and

functional status are returned to normal. According to Wallace (44), five common postsurgical problems—pain, effusion, reduced strength, limited range of motion, and imbalance—must be resolved and basic principles of lower quadrant mechanics applied to patients with patellofemoral problems. However, surgery is indicated in patients with chronic patellofemoral pain only after all attempts at conservative treatment have failed (9).

CONCLUSION

Distance running has increased enormously in popularity in the last twenty years. An estimated 40 million North Americans run to achieve good cardiovascular and mental health (42). In runners training at longer distances, the chance of overuse injuries are more common, and a number of etiological factors have been recognized. Common etiologies for patellofemoral pain syndrome in runners include anatomical factors, running shoes, training surface, and training errors. Of these, training errors are responsible for more than a half of the cases (17,19).

Running injuries, specifically the patellofemoral pain syndrome, do not usually occur suddenly or with life-threatening consequences. These problems are more associated with microtrauma, the daily repetitive loading of the involved musculoskeletal components, e.g., bone, articular cartilage, tendon, which results in inflammation, pain and dysfunction. The runner should notice the mildest signs before more serious symptoms appear and the adaptive capacity of the body has been overcome.

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PATELLOFEMORAL PAIN SYNDROME AND ITS TREATMENT IN RUNNERS

Paul Rintala, Ph Lic

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Questions	a	b	c	d	e
1. "Runner's knee" is also known as 1. chondromalacia patellae. 2. patellofemoral arthralgia. 3. patellalgia. 4. patellar chondropathy.	a. 1,2,3 b. 2,3,4 c. 1,4 d. 2 e. 1,2,3,4				
2. The onset of patellofemoral pain is usually a. rapid. b. related to structural changes in the knee. c. insidious. d. related to changes in training schedule. e. all of the above					
3. Biomechanical analysis of patellofemoral forces demonstrates that the forces transmitted to the femur through the patella _____ as knee flexion increases. a. decrease b. increase c. remain unchanged d. vary independently e. none of the above					
4. Which of the following is probably the most common etiology for patellofemoral pain syndrome in runners? a. anatomical factors b. running shoes c. training surface d. training errors e. all of the above are equally common					
5. Surgery alone is as likely to resolve the patellofemoral pain syndrome as any other treatment modality. a. True b. False					

Questions

	a	b	c	d	e
6. The vastus lateralis muscle typically causes tracking of the patella. a. inferior b. lateral c. medial d. oblique e. superior					
7. Isometric straight leg raising exercises should be performed in which position to achieve optimal effect? 1. partially sitting 2. prone 3. standing 4. supine a. 1 b. 4 c. 1,2,3,4 d. 1,4 e. 3					
8. Crepitation is always indicative of knee pathology. a. True b. False					
9. Sitting for prolonged periods - like ascending steps - causes the following change in patellofemoral pressure. a. decrease b. increase c. no significant change d. no change at all					
10. Stabilization of the patella by means of total immobilization is a particularly appropriate treatment modality. a. True b. False					

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ORAL PRESENTATIONS

A COMPARATIVE STUDY OF SELECTED ANKLE RESTRICTION MODALITIES

Wilson DJ, Brown EW, Kerry AG, Monroe JS,
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48824

The purposes of this study were to: (a) measure and compare the degree to which various ankle restriction modalities (ankle taping and reusable braces, two manufacturers each) limit ankle plantar flexion, inversion, and eversion before activity and (b) maintain their limitations on ankle movement after the intervention of an athletic contest; (c) determine and compare the relative comfort of wearing various ankle restriction modalities during competition; (d) determine the extent to which athletes feel inhibited or aided in their sport by wearing various ankle restriction modalities during competition; and (e) determine and compare the extent to which reusable ankle braces maintain their restrictive properties over the course of four sport contests. The subjects for this study were male college students who participated in intramural basketball or indoor soccer, club volleyball, or intercollegiate indoor soccer training. They were assigned to either a reusable ankle brace group or to an athletic adhesive tape group. A modified Inman ankle machine was used to measure the range of ankle movement. Unrestricted range of motion for both pre and post activity was measured in both ankles of all subjects in order to use the subjects as their own control group. In addition, pre and post activity measures, for as many as four contests, were taken. The following is an overview of the results: (a) On a Likert scale for comfort ("very comfortable" to "very uncomfortable") the model category for each restrictive device was "comfortable". There was an increase in negative ratings from pre to post activity in the soccer players. (b) Most subjects felt that their restriction modality neither aided nor hindered their performance. (c) Both reusable ankle braces restricted the pre-activity range of ankle plantar flexion more than either type of tape. All experimental conditions restricted pre-activity inversion and eversion. (d) From pre to post activity, reusable ankle braces maintained their restrictive characteristics better than tape. For inversion and eversion, pre to post activity differences were noted by restrictive modality and by load condition. (e) For both reusable ankle braces, over contests one through four, there was a breakdown with usage in their properties to restrict ankle movements tested.

THE EFFECT OF A NEUTRAL ORTHOTIC ON STANDING PROPRIOCEPTION, FUNCTIONAL ABILITY, AND PAIN POST INVERSION ANKLE SPRAIN

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The purpose of this study was to test the clinically observed effectiveness of neutral orthotics post inversion ankle sprain in relation to joint proprioception, functional ability and pain. This study consisted of three parts: assessment with the digital balance evaluator (DBE) of an experimental and control group, assessment of jogging gait of an experimental group, and subjective assessment of pain with jogging on an experimental group. During each part of this experiment, the subjects were tested with a neutral orthotic, a placebo orthotic, and no insert in shoe. The order of these treatments was alternated with each consecutive subject. The results indicated that: 1) the ankle sprain group was significantly deficient in DBE skills when compared to the control group; 2) neutral orthotics did not have a significant effect on DBE skills in the control group; 3) neutral orthotics significantly improved DBE skills in the ankle sprain group, however, these improvements may be secondary to a placebo effect; 4) neutral orthotics had no significant effect on jogging gait post ankle sprain; and 5) neutral orthotics significantly decreased ankle pain during jogging post ankle sprain. These findings suggest that neutral orthotics may play a role in the treatment of inversion ankle sprains.

REHABILITATION FOLLOWING ACL RECONSTRUCTION

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AC: Methodist Sports Medicine Center, Indianapolis,
IN 46202

Within the last decade, there has been a great deal of discussion concerning rehabilitation following ACL reconstruction. The original approach to ACL rehabilitation at this facility was based on the early work of Paulos and Noyes and has progressed to an accelerated program which emphasizes early terminal extension, early weight bearing, and closed kinetic quadriceps strengthening. The purpose of this study was to compare the clinical results of traditional rehabilitation to the accelerated program that is utilized

today. From June 1982 to January 1988, 1208 patients underwent intra-articular ACL reconstruction. Those patients who underwent surgery during the June 1982 through December 1986 time frame were assigned to the traditional group and those having surgery in January 1987 or later were assigned to the accelerated group. The clinical factors under consideration included range of motion, ligamentous stability, and isokinetic strength. Unpaired t-tests were used to compare the above clinical factors between the traditional and accelerated groups. The accelerated group was able to regain extension significantly earlier ($p=0.0000$). Ligamentous stability as measured on the KT 1000 was not compromised with the accelerated rehab program. Stability was found to be better ($p=0.024$) in the accelerated group than in the traditional group. Isokinetic strength comparisons between the two groups were not significant. The accelerated rehabilitation program allows the patient to return to their desired activity level with a fully functional and stable knee within approximately six months following reconstruction.

TIBIAL DISPLACEMENT AS A CONSEQUENCE OF QUADRICEPS AND HAMSTRING ISOMETRIC CONTRACTION

Perrin DH, Wilson L, McCue FC: Univ. of Virginia, Charlottesville, VA 22901

Early rehabilitation from acute injury to the anterior cruciate ligament (ACL) or following reconstruction of the ACL deficient knee frequently includes multiple angle isometric exercise of the quadricep and/or hamstring muscle group. The purpose of this study was to assess the tibial displacement occurring as a result of isometric contraction of the quadricep and hamstring muscle groups at three positions (10,30, and 90 deg) of knee flexion. Eight ACL insufficient subjects having a minimum of 10mm of passive anterior tibial displacement performed isometric contractions of the quadricep and hamstring muscle groups against distally placed resistance on a Cybex. A KT 1000 knee arthrometer was positioned on the leg and measured anterior or posterior displacement of the proximal tibia. Results indicated that during quadricep contractions, the greatest anterior displacement occurred at 30 deg ($\bar{x}=12.44$ mm \pm 3.17) and the least at 90 deg ($\bar{x}=2.99$ mm \pm 2.04). Analysis of variance indicated different displacement for the three joint positions (10 vs 30 deg, Δ 5.6 mm; 10 vs 90 deg, Δ 3.6 mm; 30 vs 90 deg, Δ 9.2 mm; $p < .05$). Hamstring contraction produced anterior displacement at 10 deg ($\bar{x}=6.7$ mm \pm 2.54) and posterior displacement at 30 deg. ($\bar{x}=7.5$ mm \pm 2.45) and 90 deg ($\bar{x}=1.94$ mm \pm 2.19). Only the difference between 10 and 90 deg was significant ($p < .05$). These findings suggest that early rehabilitation programs using multiple angle quadricep isometric exercises will produce the greatest anterior knee joint stresses at the mid-range of available joint motion and that hamstring isometric exercises will produce anterior displacement near terminal extension.

COMPARISON OF THREE STRETCHING TECHNIQUES DESIGNED TO INCREASE HIP RANGE OF MOTION

Johnson, KL, Harter, RA: Dept. of Human Performance, San Jose State Univ., San Jose, CA 95192-0054

Research findings have yet to conclusively indicate the superiority of one specific mode of stretching over another for increasing joint range of motion. The purpose of this study was to determine which of three hamstrings stretching techniques, specifically, [1] static stretch (SS), [2] PNF hold-relax technique (HR), or [3] modified hold-relax (MHR) resulted in the greatest improvement in hip flexion range of motion (ROM) following a program of stretching both limbs five days per week for four weeks. Thirty-one female high school students (mean age, 14.1 yrs) who were involved in a required physical education class participated in the study. Subjects were randomly assigned to treatment groups, and given specific, individualized instruction regarding the proper application of their assigned stretching technique. Pretest and posttest hip flexion range of motion (ROM) values were measured (in degrees) with a Leighton flexometer by the same examiner. Tests for homogeneity of variance at the pretest scores revealed no significant differences between the experimental groups at the beginning of the study. The one-way ANOVA performed on the absolute change in degrees of hip flexion ROM (+ or -) from pretest to posttest revealed a significant main effect for the stretching techniques ($p < .03$). The MHR technique resulted in an average increase of 3.9 degrees of hip flexion ROM, the SS technique produced an average increase 7.8 degrees, while the HR technique increased hip flexion ROM by an average of 16.4 degrees. Post-hoc analysis utilizing the Tukey HSD test revealed a significant difference between the MHR and the HR techniques ($p < .05$). The HR technique employed in this study involved application of two PNF diagonal patterns during the stretch, while the MHR technique did not. The results of this study indicate that the PNF stretching technique (HR) was more effective in increasing hip flexion ROM than were the sagittal plane stretching techniques (MHR and SS). These findings support the growing amount of evidence which suggests that PNF stretching methods produce the greatest gains in flexibility.

ISOKINETIC STRENGTH OF THE TRUNK AND HIP IN FEMALE RUNNERS

Tis LL, Perrin DH, Snead DB, Weltman AW: Univ. of Virginia, Charlottesville, VA 22901

A plethora of research has examined bilateral and reciprocal concentric strength relationships of the thigh musculature in a variety of athletic populations. However, little research has reported strength values of the trunk and hip musculature. Thus, the purpose of this investigation was to examine concentric (CON) and eccentric (ECC) strength of the trunk and hip flexor (FLEX) and extensor (EXT) muscle groups in female runners. Twenty-one habitual female runners (age = 29.9 ± 6.3 yrs; ht = 163.9 ± 5.3 cm; wt = 57.62 ± 1.32 kg) were assessed for trunk and hip strength via isokinetic dynamometry (KinCom, Chattex Corp.). Strength was reported in Newtons (N) and calculated as the average force over the range of motion in which the joint was tested. ECC strength at the



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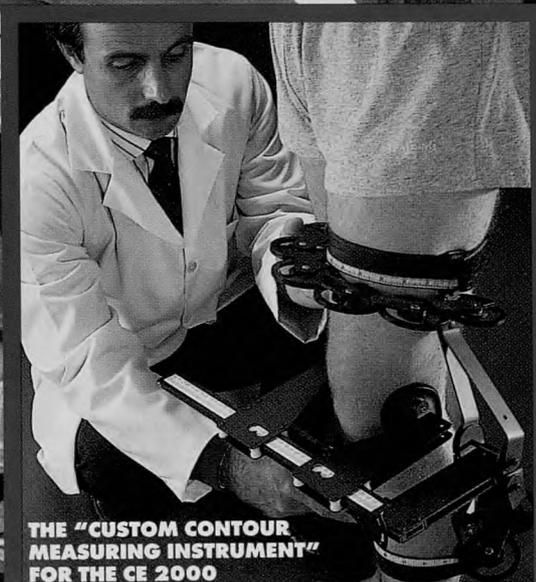
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trunk was greater than CON strength (ECC EXT = 553.0 ± 107.7N vs. CON EXT = 391.4 ± 84.4N; $p < 0.01$; ECC FLEX = 212.2 ± 49.4N vs. CON FLEX = 196.7 ± 39.1N; $p < 0.01$). Similar results were found at the hip (ECC EXT = 337.7 ± 97.4N vs. CON EXT = 297.8 ± 94.0N; $p < 0.01$; ECC FLEX = 325.7 ± 44.3N vs. CON FLEX = 273.0 ± 35.7N; $p < 0.01$). Reciprocal muscle group ratios revealed that CON trunk FLEX was 52% of EXT. ECC trunk FLEX was 39% of EXT. The trunk ratios were found to be significantly different ($p < 0.01$). CON hip FLEX was 98% of EXT. ECC hip FLEX was 103% of EXT. The ratios were not significantly different. However, 8 of the 21 subjects demonstrated greater hip FLEX strength in comparison to the hip EXT. These findings establish previously unreported isokinetic strength values for the trunk and hip in female runners.

EFFECTS OF DEHYDRATION ON CONCENTRIC AND ECCENTRIC STRENGTH OF THE ELBOW FLEXOR AND KNEE EXTENSOR MUSCLE GROUPS

Konin, JG, Perrin DH, Denegar CR: Univ. of Virginia, Charlottesville, VA 22901

The purpose of this investigation was to determine the effects of non-exercise induced 3% dehydration on muscle strength. Subjects included 8 males (M, \bar{x} age = 24.5 yrs, \bar{x} ht = 70.3 in, \bar{x} wt = 180.6 lbs) and 6 females (F, \bar{x} age = 21.8 yrs, \bar{x} ht = 67.2 in, \bar{x} wt = 140.5 lbs) with no previous history of heat illness. Subjects were randomly assigned to a control group (N = 5,3M,2F), a dehydrated group (N = 4,3M,1F), and a rehydrated group (N = 5,2M,3F). It was hypothesized that a 3% deficit in body weight would cause a decrease in muscular strength. Subjects gave informed consent and had their knee extension (right leg, concentric, eccentric) and elbow flexion (left arm, concentric, eccentric) average torque recorded at 60%/sec on a Kin-Com isokinetic dynamometer. Dehydrated group subjects were exposed to a Metos sauna (\bar{x} time = 94.25 min) at 170°F until 3% of body weight was lost. Rehydrated subjects were exposed to the same sauna (\bar{x} time = 107.2 min) and were simultaneously replenished with cold water (\bar{x} temp = 45°F). Control group subjects were post-tested 90 min following pre-test, while rehydrated and dehydrated group subjects were re-tested when their heart rate and rectal and core temperature returned to pre-sauna levels. Analysis of variance failed to identify a significant group by time interaction. However, several trends in the average torque data were observed. Post-test results of the dehydrated group revealed decreased knee extension (Δ - 13.1% concentric; Δ - 11.6% eccentric) and elbow flexion (Δ 7.6% concentric; Δ - 8.5% eccentric) average torque. The rehydrated group also had decreased knee extension (Δ - 4.8% concentric; Δ - 11.2% eccentric) and elbow flexion (Δ - 11.5% concentric; Δ - 9.6% eccentric) values. The control group had smaller changes in knee extension (Δ - 5.7% concentric; Δ + 1.0% eccentric) and elbow flexion (Δ - 1.1% concentric; Δ + 5.0% eccentric). These results suggest that there is a relationship between sauna exposure and a decrease in muscular strength. It is not clear if these results were due to the effect of dehydration since sufficient fluid absorption may not have occurred. Further study is needed to determine the effects of dehydration and heat exposure on strength loss.

THE EFFECTS OF COMBINING COLD AND TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION TREATMENTS ON DELAYED ONSET MUSCLE SORENESS

Denegar CR, Perrin DH: School of Physical Therapy, Slippery Rock Univ., Slipper Rock, PA 16057

Cold and transcutaneous electrical nerve stimulation (TENS) are commonly used in the treatment of musculoskeletal pain and spasm. The analgesic response to cold has been proposed to be due to a decrease of afferent nerve fiber transmission while TENS is thought to relieve pain by increasing large diameter afferent input. Despite opposing physiological mechanism, cold and TENS are often employed together. To examine the effects of combined treatments, 40 female subjects were randomly assigned to treatment with cold (C), TENS, a combined treatment (CT), sham TENS (ST) or no treatment (NT). Each subject had elbow extension range of motion (EEROM) measured in her non-dominant arm and received orientation to a graphic pain rating scale. Delayed onset muscle soreness (DOMS) was induced in the elbow flexor muscle group of the non-dominant arm with repeated eccentric exercises. Forty-eight hr. after exercise subjects reported pain in the exercised muscle group and were found to have significantly decreased ($p < .05$) EEROM. At this time subjects received their assigned treatment lasting 20 min. Following treatment, significant ($p < .05$) decreases in perceived pain were reported by the C, TENS and CT groups with a trend toward a greater analgesic response when subjects received TENS or CT. Significant ($p < .05$) increases in EEROM were found in the C and CT groups. These results support the practice of combining cold and TENS and suggest that, of the treatments studied, it is most effective in the treatment of musculoskeletal pain and spasm.

INCIDENCE OF LATERAL MENISCUS INJURY IN PROFESSIONAL BASKETBALL

Abdenour TE, Krinsky MB, Starkey C, Albo RA, Sulieman JS, Chu DA: Golden State Warriors, Oakland, CA 94621

National Basketball Trainers Association data over a six year period was reviewed to determine the incidence of lateral meniscus injury among professional basketball players. Results of this study indicate 58% lateral meniscus injury while 42% medial, and this differs significantly from what existing literature has reported for basketball. The lateral meniscus may be vulnerable to chronic injury and subject to microtrauma from repetitive sub-maximal stresses associated with cutting or changing direction while running, or from pivoting. A professional player is at more risk of injury during a game than practice, thus is exposed to injury more than a collegian because the professional season has three to four times as many games. Also, the MRI may accurately diagnose some tears that otherwise would have been undetected or have been diagnosed through arthroscopy. Injury to the lateral meniscus could produce secondary symptoms such as instability, chondromalacia, or patellofemoral crepitation.



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ACUTE VS. GRADUAL ONSET INJURY AMONG FEMALE GYMNASTS AND LONG-TERM EFFECTS OF THESE INJURIES

Wadley GM, Albright JP: SportsMedicine Grant, Columbus, OH 43221

Although participation among girls and women in the sport of gymnastics has continued to grow since 1972, few controlled epidemiological studies have documented injury among these athletes. The purpose of this prospective study was to identify factors related to acute and gradual onset injuries to members of a Division I women's gymnastics team over four seasons, and to assess the long-term effects of these injuries. Injury data were recorded by the team athletic trainer (ATC) who was on site daily throughout the study period. Injury was defined as any sport-related incident which limited participation in any or all of the four gymnastics events. Time loss due to injury was recorded as days until return to participation, days until full participation and days until full healing. Three years after the end of the study period participants completed a follow-up questionnaire detailing residual effects of injuries sustained during gymnastics participation. Twenty-seven different athletes, comprising 53 gymnast-seasons, sustained 123 injuries. Of these injuries, 43% were of gradual onset and could not be related to any one event. The breakdown by body part was as follows: 76% of the back injuries, 45% of upper extremity injuries and 38% of lower extremity injuries were of gradual onset. These findings were higher than those reported in the literature, which may be related to the sensitivity of the injury definition and daily injury reporting. While 76% of the athletes missed fewer than 7 days, only 24% of all injured gymnasts were at full participation at the time of their return to activity. Upon full healing of the injury, 18% had residual signs on exam and 9% had limited function of the injured body part. Injuries still affecting or limiting the athletes at the three-year follow-up were those to the lower back, knee, wrist, ankle and foot.

FINANCIAL AND APPOINTMENT TRENDS OF THE ATHLETIC TRAINER CLINICIAN/EDUCATOR

Lephart SM, Metz KF: Univ. of Pittsburgh, Pittsburgh PA 15261

Athletic training education programs are finding it increasingly difficult to retain and attract experienced and competent clinicians as educators. The purpose of this study was to survey Division I intercollegiate athletic trainers to identify the financial and appointment trends of athletic trainers, both those involved exclusively as clinicians and those who are involved in both the clinical and educational components of athletic training programs. 90 surveys were mailed to Division I athletic directors with 70 returned (78%). Surveys were returned by 34 universities that offer both an athletic training academic and service program. There were no significant differences in base salaries between those athletic trainers who were exclusively clinicians and those with combined responsibilities. Additionally there were no salary differences between those who had athletic appointments and those who had academic appointments. The mean salaries based on the 70 surveys returned for the selected staff athletic trainers were the following: Head athletic trainer/head football trainer, \$38,630; Head

basketball trainer, \$25,391; Academic coordinator, \$35,605; Staff assistant trainers, \$24,440. Additionally, it is significant to note that there were no differences in annual base salary relative to the length of appointments, 9 vs. 12 months. Additional benefits which were identified in those programs offering an academic curriculum included 50% of the staffs receive teaching stipends, 54% of the staffs receive complete travel expenses to national conferences, and 57% of the staffs had at least one courtesy car available for the athletic trainers. The role of the athletic trainer/clinician is often misunderstood by administrators, coaches, and colleagues. Clinical expectations of the athletic trainer are not contingent upon whether the athletic trainer must assume teaching responsibilities. This survey indicates that salaries are also not contingent upon additional responsibilities in the classroom. In an attempt to encourage experienced clinicians to continue to be involved in the preparation of young professionals several programs are rewarding the athletic trainer with supplementary stipends for their teaching efforts. Additionally, some programs are providing valuable perks which foster professional satisfaction. It seems inevitable that programs will have difficulty retaining quality athletic trainer clinician/educators if they continue to ignore the additional responsibilities which are assumed. The future development of the profession is contingent upon the preparation of young athletic trainers and it is becoming readily apparent that an effort must be made to encourage our experienced colleagues to retain their involvement in the educational component of our athletic training programs.

A COMPARISON OF THE CLINICAL EFFECTIVENESS OF TWO REHABILITATION PROTOCOLS FOLLOWING ACL RECONSTRUCTION

Ploski MR, Helfst RH, Shelbourne KD: Univ. of Indianapolis, IN 46227

The purpose of this study was to examine the results of two rehabilitation protocols following anterior cruciate ligament (ACL) reconstruction. The results of 85 patients who underwent ACL reconstruction in 1985 (Group 1) were compared to 116 patients in 1987 (Group 2). Group 1 was rehabilitated with a conservative protocol; Group 2 was rehabilitated more aggressively. The dependent variables were: range of motion, involved to uninjured peak torque ratios, tibial displacement, return to activity, and post-operative stiffness. Data were collected through medical record review. Average knee flexion at nine weeks was 2-117° for Group 1, and 0-120° for Group 2 ($p < .001$). Average quadriceps peak torque ratios at six months ranged across a velocity spectrum from 57-69% for Group 1 and 74-80% for Group 2 ($p < .001$). Tibial displacement differences at six months were less than 2 mm for both groups ($p > .05$). Equal proportions of patients returned to the same or higher level of activity after surgery ($p > .05$). In Group 1, 11.8% of patients experienced postoperative stiffness, versus 6% in Group 2 ($p < .001$). Conclusions were that the rehabilitation protocol employed following ACL reconstruction is clinically significant in the eventual outcome of the reconstructed knee. By careful adaptation of a postoperative rehabilitation program, it is possible to maximize range of motion and strength gains while minimizing the complication of postoperative stiffness without sacrificing knee stability.

THE ROLE OF JOINT LOAD IN LIMITING ANTERIOR TIBIAL TRANSLATION IN ACL DEFICIENT KNEES

Washco LA, Yack HJ, Whieldon T: SportsCare, Rochester, NY 14610

Strengthening and re-educating the muscles about the knee without stressing the remaining restraining mechanisms in anterior cruciate ligament (ACL) deficient knees remains as one of the challenges in knee rehabilitation. While recent research has shown the potential advantage of closed (weight bearing) versus open (non-weight bearing) kinetic chain activities in limiting anterior tibial translation (ATT), the specific mechanisms which limit ATT have not been determined. The purpose of this study was to determine the role of knee joint loading in limiting the amount of ATT in ACL deficient knees under various conditions of quadriceps and hamstrings activity. Nine subjects, all diagnosed as ACL deficient by orthopedists and assessed clinically by the principle investigator as being ACL deficient, participated in the study. An electrogoniometric system (Knee Signature System, Acufex Microsurgical, Inc.) was used to measure ATT of the ACL deficient knee. Muscle activation levels of the quadriceps and hamstrings were monitored by EMG during all testing conditions. The subjects were seated with the involved knee in full extension. The amount of ATT was measured during the following situations: an anterior tibial translation test; rest; a 30% maximum voluntary isometric quadriceps contraction; a 30% maximum voluntary isometric hamstrings contraction and a co-contraction under conditions of no compression and compression. In the compression condition, an external force equal to 50% of the subject's body weight was applied through the calcaneus to simulate weight bearing. Data for each subject were averaged across three trials. A two-way ANOVA revealed significantly less ($p=0.03$) ATT across all trials in the compression condition as compared to all trials in the no compression condition. The results of this study suggest that exercises which employ joint loading and compressive forces lessen the amount of ATT and stress on secondary restraints in ACL deficient knees. This would further support the use of closed kinetic chain exercises in ACL rehabilitation protocols.

THE EFFECTS OF CRYOTHERAPY UPON ANKLE PROPRIOCEPTION

Gerig BK, Methodist Sports Medicine Center, Indianapolis, IN 46202

The purpose of this investigation was to study the effects of cryotherapy on ankle proprioception. Thirty volunteer subjects participated in this study. The stabilometer was used to test the subjects' ability to balance. Each subject was trained on the stabilometer and required to meet a set criterion of 'time in balance' on the instrument before proceeding with the investigation. Immediately after meeting this criterion, the subject's lower leg was submerged in a cold whirlpool (50° Fahrenheit) for 15 minutes. A post-test was then performed on the stabilometer. Pre and post-test scores as measured on the stabilometer were compared to determine if the ice immersion affected balance ability. It was found that ice immersion did have a significant effect on balance ability. There was a significant decrease in overall 'time in balance' scores after ice

immersion in each of the 30 subjects. Considering these findings further investigation is warranted to determine such things as the length of time ice immersion affects balance stability. One implication of this work would be the use of ice immediately before athletic activity.

PROFICIENCY AND USE OF THE OPHTHALMOSCOPE AND OTOSCOPE IN RECOGNITION AND EVALUATION OF EYE AND EAR INJURIES AND ILLNESSES IN SPORT

Jones SS, Harter RA, Dept. of Human Performance, San Jose State Univ., San Jose, CA 95192-0054

Twelve specific athletic injuries/illnesses related to the eye and ear appear in the NATA Competencies List (NATA, 1983), as certified athletic trainers (ATCs) are often called upon to provide immediate care and evaluation of sport-related ophthalmic and otic nerve injuries. The purpose of this study was to assess the collective attitudes of NATA-approved educational program directors regarding the use of the ophthalmoscope (OPH) and otoscope (OTO) in assessment of these injuries/illnesses, and to have these individuals rate both their own proficiency with these devices and present skill level in recognition of 15 specific eye/ear conditions. Seventy-one of the 80 program directors surveyed (89%) completed the Likert scale questionnaire. Respondents averaged 14.5 yrs experience as an ATC, 13.3 yrs of university/college teaching experience, and 8.1 yrs as an NATA-approved program director. Only 19.7% of the program directors judged themselves to be proficient with the OPH, while 32.4% believed they could properly evaluate the ear with an OTO. In contrast, 42.3% and 47.9% agreed that ATCs should be proficient with an OPH and OTO, respectively. Nearly two-thirds of the respondents (63.4%) agreed that graduate study was the appropriate level for formal instruction in the use of these instruments, while 19.7% indicated that these skills were beyond the scope of practice of ATCs. Of the 12 eye and ear injuries/illnesses listed in the NATA Competencies List, the program directors surveyed rated themselves most proficient at recognizing styes, conjunctivitis and corneal abrasions, and least proficient in recognition of pericoritis, impacted cerumen and detached retina. On a 5-point scale (5 = excellent, 1 = poor), the respondents' self-evaluations of their proficiency in evaluation of these 12 injuries/illnesses averaged $3.63 \pm .48$ ("above average"). While the majority of the program directors surveyed were not proficient in the use of the OPH or OTO, their responses indicated strong support for the development and subsequent implementation of a formal instructional program for student athletic trainers regarding the proper use of the OPH and OTO in recognition and evaluation of eye and ear injuries and illnesses.

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A COMPARISON OF HEMOGLOBIN AND HEMATOCRIT IN PRIMARILY ANAEROBIC AND AEROBIC ACTIVITY OF THREE FEMALE INTERCOLLEGIATE ATHLETIC TEAMS DURING THEIR RESPECTIVE SEASONS

Perkins S, Knight CS, Narve M, Buckenmeyer P, Blackman C, Hootman JH, Zager K, Perkins R: Southern Illinois University-Carbondale, IL 62901

Twenty-eight Division I intercollegiate female athletes (aged 18-23 years) were studied to determine the extent and timing of changes in hemoglobin (Hgb) and hematocrit (Hct) and the correlation between the changes. Hgb and Hct levels were calculated from 5 ml blood draws of 10 field hockey (FH), 9 cross country (XC) and 9 volleyball (VB) players at preseason (PRE), mid-season (MID) and pre-conference (PREC). The slightly anaerobic (55%) FH group had a positive increase in the mean change of Hgb at $.30 \pm .987$ as well as a positive increase in the mean change of Hct at 1.99 ± 2.686 from PRE to MID. Both values continued to rise through PREC with Hgb showing a mean change of $.10 \pm 1.101$ and Hct at $.630 \pm 2.024$. XC, highly aerobic (72%), had a negative mean change in Hgb of $.067 \pm 1.017$ from PRE to MID followed by a further decline in mean change of $.122 \pm .494$ through PREC. XC Hct changes rose 1.21 ± 2.707 from PRE to MID followed by a decline in mean change of $.255 \pm 1.506$ through PREC. VB, highly anaerobic (67%), had a positive mean change in Hgb and Hct, $.36 \pm 1.095$ and 3.30 ± 2.791 respectively from PRE to MID. Both levels declined through PREC with the mean change in Hgb at $.15 \pm .871$ and Hct at $.72 \pm 1.814$. An ANOVA was computed to determine if there was a relationship between the changes of Hgb and Hct according to the primary type of activity, aerobic or anaerobic. PRE Hgb found $F = .10$, $p = .9045$ followed by a MID score of $F = .35$, $p = .7120$ and a PREC score of $F = .44$, $p = .6554$. Hct scores for PRE, MID and PREC respectively are as follows: $F = .52$, $p = .6055$; $F = 1.12$, $p = .3432$ and $F = .27$, $p = .7701$. A correlational analysis was calculated to test the relationship of Hgb and Hct changes throughout the seasons of each team. FH found an overall score of $r = .8469$, $p = .0012$ while XC found $r = .9859$, $p = .0001$ and VB found $r = .9659$, $p = .0001$. This data suggest there is not a significant difference in the extent or timing of changes that occurred in Hgb and Hct levels during anaerobic or aerobic activity but there is a significant correlation between the changes during the season.

ASSESSMENT OF CALF BLOOD FLOW IN THE FEMALE IN RESPONSE TO THE APPLICATION OF COLD AS MEASURED BY IMPEDANCE PLETHYSMOGRAPHY

Wagner JM, Bell GW: Univ. of Illinois, Urbana-Champaign, IL 61801

The therapeutic use of cold, cryotherapy, is the modality of choice during acute injury management and selected phases of rehabilitation. Cryotherapy produces several physiologic adaptations (i.e., parathesia, changes in blood flow) which are beneficial during the management of injury. Controversy exists about the changes in peripheral circulation in response to cryotherapy, more specifically, is there an increase or decrease in blood flow? The purpose of this study was to determine the effect of the application of cold on calf blood flow in adult female subjects. Calf blood flow of eight (8)

adult female subjects (\bar{x} age: 25.5) was assessed following a 20 minute application of crushed ice bags and a 10 minute ice massage. Pulse rate, pulse volume, and cardiac output were measured using impedance plethysmography. Blood flow was calculated by dividing cardiac output by calf tissue volume. Calf blood flow was measured for 50 minutes without application of a cryotherapy modality for control values. Calf blood flow was found to decrease during the first 12 minutes of ice bag application. A gradual increase in calf blood flow was noted during the remaining 8 minutes of application. Post-treatment blood flow measurements for both ice bag and ice massage were recorded for 50 minutes. A two factor ANOVA revealed significant time and treatment effects. Analysis of the effect of time on blood flow revealed: the first 25 minutes of post-treatment data collection were significantly ($p = .01$) lower than the last 25 minutes of measurement; blood flow measurement recorded during minutes 21-25 were significantly higher than minutes 1-20 and significantly lower than data collected during minutes 26-50. These results indicate a general increase in blood flow throughout the 50 minutes of post-application measurement. Analysis of the effect of treatment on blood flow revealed: average blood flow values recorded following ice bag application did not significantly differ from control measurements, and average blood flow values recorded following ice massage were significantly higher than ice bag and control measurements. These results suggest that the application of ice massage increased blood flow for 50 minutes following the removal of the cooling device. In conclusion, calf blood flow in adult female subjects was found to increase following both ice bag and ice massage application, with ice massage producing a significantly longer duration of increased blood flow.

MULTIPLE REGRESSION MODELING OF THE CONTRIBUTION OF UPPER EXTREMITY MUSCULATURE TO FASTBALL SPEED IN COLLEGE BASEBALL PITCHERS

Thornton JL, Boelter JG: Univ. of the Pacific, Stockton, CA 95211

The purpose of this study was to determine the relative contribution of shoulder internal rotator strength to ball speed in the fastball pitch as performed by college pitchers. Previous research suggests that variables other than upper extremity strength account for approximately 50% of ball speed in an overhand throw. Recent research using O-order correlation techniques has shown that the shoulder internal rotators play a major role in the generation of ball speed. It was hypothesized in this study that shoulder internal rotators are the largest contributor to ball speed when other variables are held constant. The objective of this study was to model at least 40% of the variance in ball speed with multiple regression techniques. Eighteen college pitchers were tested for dominant upper extremity peak torque production on a Cybex II isokinetic dynamometer at speeds of 90 and 240 degrees/second. All subjects were tested in the ranges of motion of shoulder flexion and extension, shoulder internal and external rotation, and elbow flexion and extension. Fastball speed was measured by means of a radar gun; the datum used as dependent variable for subsequent analysis was highest speed recorded among ten trial pitches. Results of multiple regression analysis indicated a strong correlation between internal

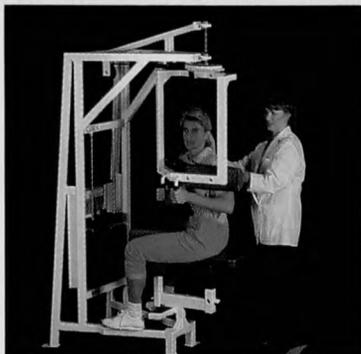
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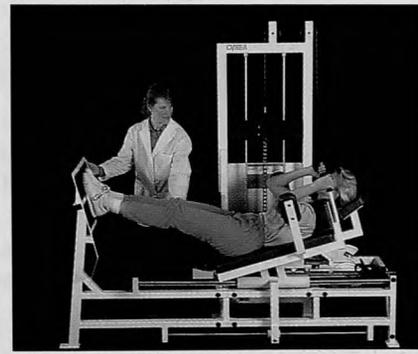
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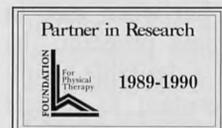


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rotator strength and ball speed. A regression equation developed using hierarchical strategy to maximize R^2 accounted for 40% of the variance in ball speed using independent variables of shoulder internal rotation at $90^\circ/\text{sec}$. (X_1) and elbow flexion at $240^\circ/\text{sec}$ (X_2); $\text{Speed} = 62.861 + .245X_1 + .390X_2$. The standardized beta weights for this equation indicated that the larger proportional contributor to ball speed was strength of internal rotators at $90^\circ/\text{sec}$. R^2 reached .596 when elbow extension at $90^\circ/\text{sec}$. (X_3) was added to the equation; $\text{Speed} = 68.605 + .268X_1 + .807X_2 - .403X_3$. This equation indicated these three variables accounted for approximately 60% of the variance in ball speed. It was concluded that fastball speed can be modeled as a function of proportional contributions of upper extremity muscle group strength. Implications for differential training/conditioning programs are apparent from the results of this and related studies.

POSTER PRESENTATIONS

PERIPHERAL AND CENTRAL RESPONSES TO COLD APPLICATIONS TO THE HAND AND FOOT

Baker RJ: Univ. of Illinois - Urbana, IL 61801

Blood flow, heart rate and arterial pressure were measured in response to immersion of the hand and foot in ice water. The subjects were healthy, young (24 ± 3 years of age), male volunteers. Two different methods of measuring blood flow, impedance and strain gauge plethysmography, were compared. Subjects immersed their foot in ice water for two minutes while heart rate, blood pressure, and blood flow in the upper extremity were measured. Then they immersed their hand in ice water while blood flow was measured in the lower extremity. Heart rate and arterial pressure increased during both immersions. Analysis by MANOVA shows a significant increase in both between rest and immersion. While heart responded quickly, blood pressure increase and decreased more slowly. Both upper and lower extremities responded with a linear decrease in blood flow. It was concluded that heart rate and blood pressure are under separate control, and these blood flow responses may be measured by impedance plethysmography.

"RAPID REHABILITATION" FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

Blair DF, Wills RP: Wenatchee Valley Clinic Sports Medicine Center, Wenatchee, WA 98801

An aggressive "rapid rehabilitation" program can return athletes quickly and safely to their previous level of activity following an Anterior Cruciate Ligament Reconstruction (ACLR). This clinical study consists of 62 ACLR patients (median age = 28) five high school athletes, six college athletes, 26 recreational athletes, and 25 non-athletes. An intra-articular bone-patellar tendon bone-procedure provides a solid fixation and, when isometrically placed, allows an early aggressive rehabilitation program. The early results of the study are very encouraging. Athletes have returned to competitive athletics at 4-6 months post-operatively depend-

ing upon strength, functional ability, and sport activity. Early motion and early weight bearing are the keys to the program. It has been documented in a study by one of the authors that there was no significant difference in A-P laxity between early motion/weight bearing patients versus braced or casted/delayed weight bearing patients in a follow-up of 137 ACLR cases. Continuous passive motion (CPM) begins immediately following surgery while the patient remains under the effect of a long-lasting regional anesthetic. The formal rehabilitation begins at 5-7 days post-operatively. Passive extension/flexion, stationary bicycle, co-contractions of the quadriceps and hamstrings with electrical muscle stimulation, and a series of rubber tubing exercises are started at this time. Patients progress from partial weight bearing to full weight bearing within two weeks post-operatively. Emphasis is placed on closed kinetic chain activities (leg press, quarter squat, etc.) and proprioceptive exercises as the rehabilitation progresses. Light agility and jogging may be started when the involved extremity reaches 70% of the uninvolved extremity on high speed isokinetic testing at six weeks. Sport specific drills and a more intensive strengthening program follow in a progressive manner. Although our preliminary observations are very positive, a larger patient base and longer period of follow-up is needed to determine the long-term success of the "rapid rehabilitation" protocol.

PREVENTION OF PRE-SEASON MUSCLE SORENESS: PLYOMETRIC EXERCISE

Borkowski, JL: Beloit College, Department of Biology, Beloit, WI 53511

The purpose of this study was to determine whether plyometric exercise prevents pre-season muscle soreness. Eleven college volleyball players ranging from 18 to 21 years of age served as subjects. In mid-May, subjects were sent summer conditioning calendars which outlined plyometric exercise days. It has been suggested that subjects are less susceptible to new soreness for up to six weeks after performing a single bout of eccentric exercise. The program involved three 1-hour sessions of all-out eccentric exercise performed at 6, 4 and 2 weeks before the start of pre-season practice. The specific plyometric exercises were explained to each subject in advance and subjects were informed that they would be sore after each session of plyometric exercise. At the onset of the regular season, players were asked to rate their pre-season soreness for the previous year (when plyometrics were not a part of summer conditioning) and for the present year (when plyometrics were a part of summer conditioning). The scale ranged from 1 to 5, with 1 indicating no soreness and 5 indicating extreme soreness. Last year's pre-season received a median score of 4 on the soreness scale (uncomfortable, entire body) while this year's pre-season received a median score of 2 on the soreness scale (minimal, restricted to specific areas). Critics have suggested that the benefits of plyometrics are primarily psychological and that the landing techniques used in plyometric exercise can cause injury, but when used in conjunction with a summer conditioning program, the plyometric exercise program produced a desirable result: athletes came to pre-season camp resistant to muscle soreness.

A PREFERRED SEQUENCE OF COMPETENCIES FOR ATHLETIC TRAINING EDUCATION PROGRAMS

Cramer CR: Kansas State Univ., Manhattan, KS 66502

The purpose of this study was to determine the preferred sequence of the NATA Competencies of Athletic Training. A survey instrument was developed using the list of competencies divided into cognitive, psychomotor, and affective domains. A total of 64 undergraduate program directors of NATA approved curricula received the instrument of which 30 were returned usable. Of the returned surveys 15 included the requested program description information. Participants ranked from basic to advanced each competency for each domain of each of the seven major task areas. Respondents' information was collected, coded, tabulated, and compared. A Wilcoxon Signed-Ranks non-parametric analysis revealed that no significant differences existed between the preferred sequence and the random ordered list of the competencies. In conclusion, program directors do not collectively agree on an instructional sequence of the competencies that is significantly different from chance. Recommendations include that additional research should be conducted to determine reasons for the lack of a statistically significant instructional sequence of the competencies. Performance criteria for each competency statement should be developed. Future competency research and development should include all interested researchers in athletic training education. Competencies need to be re-evaluated, according to the findings in the new role delineation study soon to be completed, for their relevance to academic experiences in athletic training education programs.

RTV-11 PLAYING CASTS: A SURVEY OF ITS USE WITH ATHLETIC HAND AND WRIST INJURIES

Darmelio JP, DeCarlo MS, Rettig AC: Methodist Sports Medicine Center, Indianapolis, IN 46202

Over the last three years, we have used silicone rubber playing cast to treat 144 cases of athletic wrist and hand injuries. The purpose of this study was to evaluate the results of this treatment regimen. From August to December 1988, all 49 patients who received RTV-11 playing casts at this clinic were surveyed for loss of time from sport, eligibility to play with the cast, suitability of the cast for their position, fit of the cast, and overall satisfaction rating. The majority of the patients were high school football players (group age range 12-21 years). Over 60% of the cases involved metacarpal fractures, phalanx fractures, or ulnar collateral ligament injuries, with the remainder involving wrist fractures and sprains, triangular fibrocartilage tears, and finger dislocations. There have been no reinjuries reported in the cases in this study. All fractures were healed clinically and radiographically. Among the 49 surveyed (36 respondents), an average of 1.4 days were missed from practice while an average of 3.9 days were lost from competition. Fifteen were questioned by officials, but none were removed from practice or competition as a result of wearing the cast. Most of the athletes (26 or 72%) responded that their cast worked well for their position, and nearly all (32 or 94%) reported continued good fit of the cast. On a

scale of 1 to 4, with 1 denoting excellent satisfaction, the average overall rating of the cast was 1.4. It can be concluded from this study that RTV-11 silicone provided an effective means of protection for this group of athletes with wrist and hand injuries when returning to competition. The cast was adapted for various positions with minimal time lost to sport and was found to fit well as long as needed following injury.

LYSHOLM SCORING SCALE AND BIODEX TESTING SYSTEM USED TO ASSESS KNEE FUNCTION AFTER ACL RECONSTRUCTION

Duby MJ, Ray JM: The Univ. of Kentucky Sports Medicine Center, Lexington, KY 40536

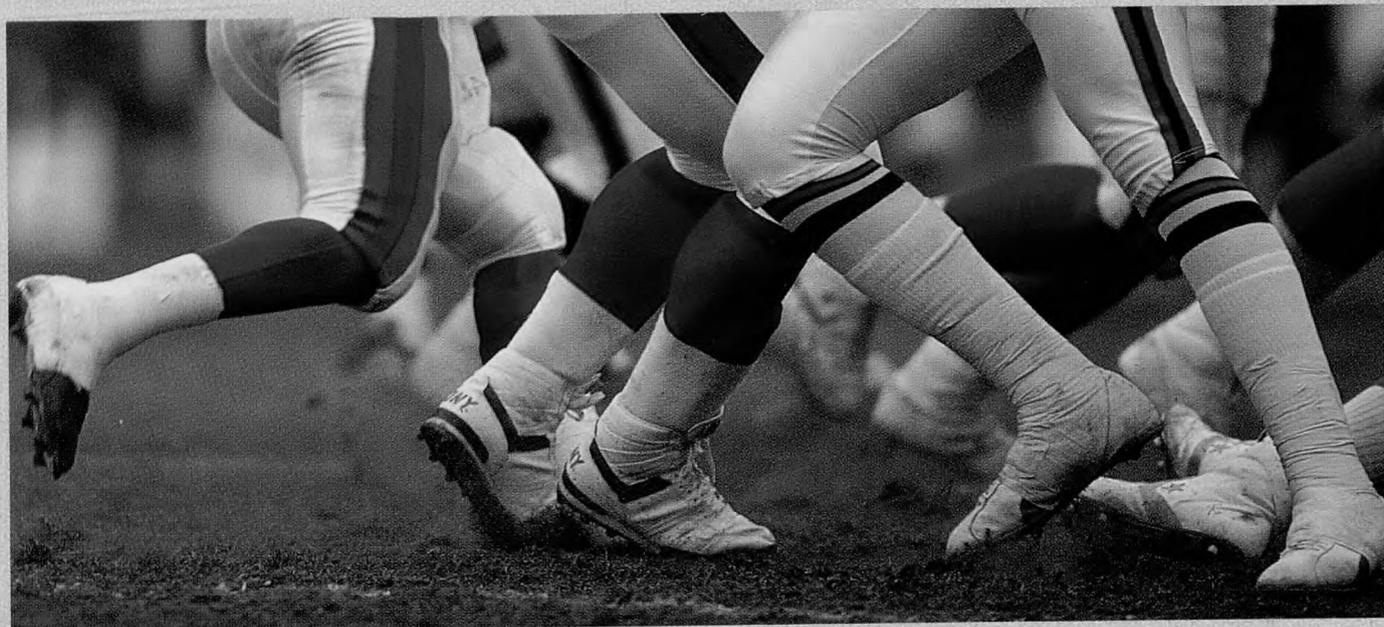
The purpose of this study is to determine if there is a relationship between the data obtained from a modified Lysholm-Gillquist scoring scale and the Biodex knee system. This relationship is indicative of the patient's functional capacity and strength gains. Determining this relationship will assist in the improvement and modification of current rehabilitation techniques as well as remove bias from post-operative knee evaluation. The scale is designed to establish the patient's knee function on the basis of everyday activities. Seventy post-operative anterior cruciate ligament (ACL) reconstruction patients were given the scoring scale to rate their progress and recovery status. Eight months post-operative time period was chosen to ensure adequate healing time and consistency in the rehabilitative process. The scoring scale evaluated eight categories which included: limp, support, stair climbing, squatting, walking-running-jumping, pain, and swelling. In each category a different descriptive term with a numerical score was assigned to each term. The total score was obtained by adding each score from the eight categories. The Biodex was used to obtain strength ratio and endurance ratio at settings of 90 and 180 degrees per second. Obtaining a subjective evaluation from the patient in conjunction with clinical analysis will present information which will remove the bias from past clinical knee evaluations.

THE INJURY EXPERIENCE OF THE COMPETITIVE SKIER WITH A DISABILITY

Ferrara MS, Buckley WE: Department of Health Education, The Pennsylvania State Univ., University Park, PA 16802

The purpose of the investigation was to describe the injury experience of the competitive skier with a disability. A retrospective survey was administered to 68 athletes who participated in the National Handicapped Sport and Recreation Association and the United States Association for Blind Athletes Winter National Games held in March 1989. The time frame criteria for recording information was six months prior to the national games (October 1988 to March 1989). The definition of an injury was any trauma to the participant that occurred during any practice, training, or competitive session that resulted in the cessation, limitation, or modification of the athlete's participation for at least 24 hours. Categorical definitions for acute and chronic types of injuries were also developed. The athlete was asked to record the general body part category and the month of onset of the occurrence. Specific variables related

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to the initial evaluation and management of the injuries were included. The upper extremity was injured 1.4 times more than the lower extremity. The number of chronic injuries was greater than the number of acute injuries for both the upper and lower extremity. In the neck and spine there were more acute injuries than chronic injuries reported. The thigh and knee was involved in 30% of the acute injuries followed by the shoulder (25%), and neck and spine (15%). For chronic injuries, the shoulder, thigh/knee complex, and arm/elbow accounted for 73.3% of the total injuries reported. The skier with a disability incurred approximately the same rate of injury as the skier without a disability. Conditioning programs should be developed to emphasize both the aerobic and anaerobic energy systems to reduce the number of injuries.

ISOKINETIC TORQUE CHARACTERISTICS OF THE QUADRICEPS AND HAMSTRING MUSCLES DURING CONCENTRIC AND ECCENTRIC LOADING

Ghena DR, Kurth AL, Thomas MA, Mayhew JL:
Methodist Sports Medicine Center, Indianapolis, IN 46202

This study investigated the effects of speed and dominant limb on torque values and ratios of the quadriceps and hamstrings during both eccentric and concentric exercise. The purpose of this study was to determine the dominant leg's peak isokinetic torque production of male college athletes. One hundred subjects, 18-25, were tested on a Biodex B-2000 isokinetic dynamometer concentrically at 60, 120, 300, and 450°/sec, and eccentrically at 60 and 120°/sec. Concentric torque production of the quadriceps and hamstring muscles significantly decreased ($p < 0.0001$) as the angular velocity increased. Concentric and eccentric torque production of the quadriceps muscles were significantly greater ($p < 0.0001$) than the hamstring muscles at all speeds tested. Eccentric torque production of the quadriceps and hamstring muscles were significantly greater ($p < 0.0001$) than concentric torque production of the quadriceps and hamstring muscles at 60 and 120 degrees per second. Concentric hamstring/quadriceps ratios significantly increased ($p < 0.01$) as the angular velocity increased. Eccentric hamstring/quadriceps ratios were significantly greater ($p < 0.0001$) than concentric hamstring/quadriceps ratios at 60 and 120 degrees per second. These findings are important when establishing testing and rehabilitation conditioning techniques for athletes who participate in high-speed concentric movements and eccentric loading conditions.

BIOMECHANICAL TESTING OF FOUR ANKLE PROTECTIVE DEVICES DURING PLANTAR AND DORSIFLEXION MOTION

Graham V, Bahamonde RE, Gehlsen G, Pearson D:
Ball State Univ., Muncie, IN 47306

Ankle sprains are one of the most common injuries in sports. In order to prevent the occurrence and/or reoccurrence of ankle sprains it is normal procedure to utilize a protective device to support the ankle joint. The primary function of the ankle support devices is to restrict ankle inversion, but very often they also restrict plantar and dorsiflexion. It was

the purpose of this investigation to compare ankle joint isokinetic torque, total work, and range of motion (ROM) among two commercially available ankle braces: Aircast (AC), Swede-O (SW), one prototype ankle brace Active Ankle System (Active Innovation Inc.) (AA), protective tape wrapping (TP), and a control treatment group (NOS). Ten male subjects were tested using a Cybex 340 System Isokinetic Dynamometer testing protocol. The order in which the subjects wore the experimental supportive device was systematically rotated using a counterbalance treatment design. A certified athletic trainer applied a conventional closed basketweave with heel locks and under wrap tape. In addition, passive ROM was measured with a Zimmer goniometer. Statistical analysis, ANOVA with a repeated measure design showed significant differences ($p < 0.05$) between and among treatments for the plantarflexion peak torque, total work and ROM. Of the ankle support devices tested only the AA brace did not differ from the NOS condition in ankle isokinetic torque and total work. In the ROM testing the AA and the AC braces demonstrated the least amount of restriction during ankle plantar and dorsiflexion.

ANALYSIS OF NATA HIGH SCHOOL INJURY REGISTRY DATA ON WRESTLING

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Data on high school wrestling reported to the NHSIR during the 87-88 and 88-89 Wrestling Season were compiled. Forty-seven schools participated in the study the 1st season and 45 the 2nd. Over this 2 year period 159,470 total athlete-exposures (participants X sessions) were accumulated. There were 36,262 athlete-exposures (A-E) owing to individual matches, and 5,750 practices with an average squad size of 22. The rate of injury for all reported cases was 7.6/1000 A-E. When severity is considered the case rate/1000 A-E for Minor (time-loss from participation for 7 days or less) is 5.1/1000 A-E; for Moderate (time-loss from participation for 8-21 days) is 1.3/1000 A-E; and for Major (time-loss from participation for longer than 22 days) is 1.2/1000 A-E. The average A-E per school is 1,733 which produced 13 injuries per school. Shoulder/arm was the most frequently injured class accounting for 1.2 injuries/1000 A-E; forearm/wrist/hand 1.2/1000 A-E; trunk 1.2/1000 A-E; and the knee 1.1/1000 A-E. Four positional categories were established by weight (based on NFSHSAA). Lower weight wrestlers (98-107) comprise 26.6% of injuries; middle (128-132) 33.1%; upper (149-200) 32.7%; and the heavyweight (201-***) 4.8%. The majority of injuries occurred during the takedown 44.1%; near fall 12.0%; and sparring 10.5%. The rates per 1000 were spread evenly across 4 body categories, the knee being the lowest. According to Wroble, 1986, and Frey, 1978, college studies, the knee was the most frequently injured anatomical region, differing from the high school data. The variables severity, position, and occasion (game vs practice) were considered in a loglinear model there was a three-way interaction found. Time will be spent determining the extent to which the above three-way interaction exists, and determining similar relationships among other variables.

A COMPARISON OF OVERUSE AND ACUTE INJURIES IN PRIMARILY AEROBIC AND ANAEROBIC ACTIVITY OF FOUR WOMEN'S INTERCOLLEGIATE TEAMS DURING THE NCAA SEASON

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Fifty-three Division I intercollegiate female athletes (aged 18-23 years) were studied to determine if overuse and acute injuries were related to aerobic and anaerobic activity. The subjects included 12 cross country (XC), 14 basketball (BB), 14 field hockey (FH) and 13 volleyball (VB) to total 53 athletes. Aerobic, anaerobic and non-specific activity was recorded and injuries logged during each team's preseason (PS) and competitive season (CS). XC, an almost exclusively aerobic sport (PS = 61%, CS = 72%), experienced primarily overuse injuries (PS = 91.7%, CS = 100%). BB was 60% aerobic PS and 46% aerobic during the CS, while injuries were 64.5% overuse PS and acute injuries accounted for 77.4% of total injuries during the CS. Field hockey PS was 30% aerobic and 48% anaerobic activity with the majority of injuries classified as overuse (68%). The CS for FH was 55% anaerobic with acute injuries being the majority (65.2%). VB was a highly anaerobic sport during both PS and CS (64% and 67% respectively). PS had a high incidence of overuse injuries (62.5%) which decreased during the CS to 46.4%. A correlational analysis revealed a significant relationship between aerobic activity and overuse injuries ($r = .6208$, $p = .0494$), but failed to prove a significant relationship between anaerobic activity and acute injuries ($r = .0790$, $p = .4230$). An additional Chi Square analysis revealed a significant difference in the number of overuse and acute injuries of each team during their respective CS [$X^2(3) = 33.7701$, $p = .0001$] but not during the PS [$X^2(3) = 3.5073$, $p = 0.3198$].

COLD-INDUCED PAIN: HABITUATION TO COLD IMMERSIONS

Ingersoll CD, Mangus BC, Wolf S: University of Nevada, Las Vegas, NV 89154

Numerous authors have described a habituation phenomenon to therapeutic ice bath immersions. Athletic trainers in general have explained to athletes that their perceptions of the pain induced by the therapeutic ice bath would decrease each day as they proceeded through therapy. Essentially, it is assumed that there is a habituation effect taking place shortly after initiation of the treatment regimen. This study incorporated the McGill Pain Questionnaire (MPQ) as an objective measure of pain during therapeutic ice bath immersions. The subjects were 22 male and female college students with limited experience of cold immersion. The subjects' right feet were immersed on 5 consecutive days using a 21 minute ice bath immersion followed by a 21 minute recovery period. During the testing session, each subject completed the MPQ 30 seconds following immersion and then every 3 minutes until completion of the test. Overall, the results indicate that there is very little difference in the subjects' objective measure of the cold-induced pain. However, there was a significant difference in the subjects' perception of pain when comparing the first and fifth days with a similarly significant difference in the second and fifth

days. Neither of these differences clearly document a habituation effect. It has been demonstrated that cold-induced pain does not drastically change over a three or four day period. The subjects' perception of cold-induced pain does change over a five day period, but to document a habituation effect would require a period longer than five days.

COMPARISON OF DURA*KOLD COMPRESSION ICE WRAPS TO CRUSHED ICE AND REFREEZABLE FLEXIBLE GEL PACKS

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Most commercial ice packs are made with a chemical gel enclosed in a vinyl cover. Dura Kold has introduced a new technology to the field with an ice pack made with sheets of "reusable ice cubes" (rows of 3x4 cm water and glycol bubbles in sheets of vinyl). Since there were no public data concerning the temperature responses of the human body to Dura Kold ice packs, we compared them to crushed ice packs and Chattanooga frozen gel packs. Each of 12 volunteers gave informed consent and completed each of 12 experimental conditions which represented combinations of the three types of cold packs, two application lengths (30 and 60 min), and application immediately or 20 min after removing the pack from refrigeration. The order of treatment application was determined by Balanced Latin Squares and randomly assigned to the subjects. Skin-modality interface temperatures were measured each min at four sites on the thigh with an Isothermex (Columbus Instruments, factory calibrated for use with CI#31 J-type thermocouples) interfaced with a Zenith 248 microcomputer. Crushed ice application resulted in a greater decrease in thigh skin temperature ($48.1 + 2.9$ degF) than either Dura*Kold ($35.7 + 4.2$ degF) or Chattanooga packs ($36.9 + 3.5$ degF, $F(2,33) = 2.6$, $p < .05$). There was no difference in thigh skin temperature response to the Dura*Kold and Chattanooga packs when the packs were applied immediately after removal from their chilling devices. Delaying application for 20 min after removing the pack from its chilling device affected the Chattanooga pack ($8.2 + 2.8$ degF less chilling) but not the Dura*Kold or ice packs. There was no difference in thigh skin temperature at 10, 30, and 60 min following application of the three packs (i.e., during rewarming).

THE EFFECTIVENESS OF SEMI-RIGID ORTHOTICS AND ATHLETIC TAPING SUPPORT USED TO MODIFY PRONATION IN RUNNERS

Moss CL, Gorton B, Deters S: Bowling Green State Univ., Bowling Green, OH 43403

Foot orthotic devices are commonly used to correct biomechanical abnormalities in runners. The purpose of this study was to examine the effect of a prescribed semi-rigid orthotic device (FOD), two athletic taping techniques (Low-dye (L-D) and reverse 8-stirrup (R8S)), and no additional support in the running shoe (SH) on the control of amount and rate of foot pronation while running. Six intercollegiate cross-country runners (3 males, 3 females), using FOD orthotics, were filmed (200 frames/sec) from

the rear while running on a treadmill (4.5 m/min pace for males, 3.8 m/min pace for females). The film was digitized and used to determine the eversion (component of pronation) or inversion of the heel relative to the lower leg throughout foot contact. Degree of maximum pronation (MP°), total range of motion ($TROM^\circ$), and peak pronation velocity (PPV°/sec) were measured from heel contact to heel lift. A repeated measures ANOVA was used. The data (mean \pm SE) are summarized below:

	MP°	$TROM^\circ$	PPV°/sec
SH	-19.04 ± 4.45	17.78 ± 5.15	599.52 ± 292.87
FOD	-15.88 ± 3.96	18.57 ± 4.48	$343.31 \pm 74.95^*$
R8S	$-13.73 \pm 3.33^*$	14.83 ± 3.53	411.28 ± 126.71
L-D	-18.91 ± 4.96	18.65 ± 5.97	415.24 ± 127.34

* $p < 0.05$

R8S displayed significantly less MP° than SH and L-D. $TROM^\circ$ showed no differences and FOD showed significantly lower PPV°/sec than SH. All other comparisons were not significant. It was concluded that R8S would be a possible short-term treatment for excessive pronation in runners. Possible gender differences were not examined.

THE EFFECTS OF A LACE-UP CANVAS ANKLE BRACE ON VERTICAL JUMP IN TRAINED AND UNTRAINED MALES

Rankin JM, Ingersoll CD: Univ. of Toledo, OH 43606

Ankle injuries are very common injuries in individuals involved in jumping activities. External support has been added in various ways to inhibit inversion and plantar flexion. Recently lace-up canvas ankle braces have become popular. This study was conducted to assess the effects of lace-up canvas ankle braces on vertical jump in varsity Division I basketball players (V), non-varsity athlete gifted jumpers (NV), and untrained males (UT). $N=10$ in each group. Subjects were randomly tested with and without a lace-up canvas ankle brace (McDavid type) for vertical jump. Increase or decrease between the unbraced condition and the braced condition was calculated (VJumpDif). A one-way ANOVA was done with group as the independent variable and VJumpDif as the dependent variable. There was a significant difference between groups ($P < .05$). The greatest decrease in vertical jump occurred in V ($1.90 \pm .91$ in) and NV ($1.90 \pm .91$ in). The smallest decrease was in UT (0.3 ± 1.4 in). The results suggest that lace-up canvas ankle braces have their greatest effect where vertical jump is high (> 25 in) and plantar flexion and inversion were at their greatest extent. Where vertical jump was lower and less force was used in plantar flexion and inversion, the differences between braced and unbraced conditions were less apparent.

KNEE INJURIES IN COLLEGE FOOTBALL: AN 18 YEAR REPORT

Scriber K, Matheny M: Ithaca College, Ithaca, NY 14850

The purpose of this paper is to present knee injury data that were collected during an 18 year period between the 1972 and 1989 seasons for a Division III college football team. For this investigation a reportable knee injury was defined

as an injury that resulted in a player: 1) missing at least a full week of practice; 2) missing at least one game; or 3) having surgery regardless of time loss. A total of 115 reportable knee injuries occurred with 45 of these resulting in surgical management. The medial collateral ligament was the structure most frequently injured, followed by meniscal injuries, and injuries to the anterior cruciate ligament. Direct medial or lateral blows resulted in 49 (43%) injuries and non-contact, torsion mechanisms resulted in 44 (38%) injuries. Linebackers suffered the most knee injuries followed by linemen, quarterbacks, and running backs. When adjustments were made based upon the number of players at each position, quarterbacks had the highest injury rate followed by linebackers. The total injury rate for the 18 seasons study was 1.38/1000 athlete exposures (AE). Game knee injury rates were 8.87 times greater than knee injury rates occurring during practices (5.72/1000 AE vs. 0.645/1000 AE). For the last six years of the investigation data were kept relative to the use of lateral prophylactic knee braces. Players wearing braces had an injury rate of 1.48/1000 AE, whereas non-braced players had an injury rate of 1.09/1000 AE. This investigation provides baseline data from a longitudinal study of knee injuries and does not support the use of prophylactic knee braces for injury prevention.

EFFECTIVENESS OF RUBBER TUBING FOR STRENGTHENING THE ROTATOR CUFF

Taylor JO, Glass BA: Austin Peay State Univ. Clarksville, TN 37044

Injuries to the throwing arm can be a debilitating injury to the baseball player. A pitcher may lose 15 to 20 percent of shoulder strength during the season. This paper examines the effects of elasticized rubber tubing compared to free weights on strength increases for specific rotator cuff exercises. Twenty intercollegiate baseball players were tested for shoulder internal and external rotation strength at 60 and 240 degrees per second on the Cybex II Isokinetic Dynamometer. The subjects were divided into two groups. The free weight group (FW), ($n = 10$) performed the exercises with free weights. The rubber tubing group (RT), ($n = 10$) performed the same exercises with elasticized rubber tubing. Following eight weeks of rehabilitative training, the subjects were re-tested. Significant difference was shown in the strength gains at 240 degrees per second with both internal ($p = .0124$) and external rotation ($p = .0015$), indicating the tubing to be as effective as the free weights. The effectiveness, adaptability, cost, and convenience of elasticized rubber tubing offers a practical alternative to free weights for injury prevention and rehabilitation.

THE EFFECTS OF SELECTED ANKLE PROPHYLAXIS ON COMBINED RANGE OF MOTION

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It was the purpose of this study to investigate the supportive capabilities of prophylactically-applied tape and selected ankle braces upon combined inversion and plantar flexion

(CROM). The subjects for this study were 13 recreational basketball players ranging in age from 21 to 43 years. The volunteer subjects were randomly assigned to one of six restrictive conditions per day for six testing sessions. The restrictive conditions consisted of a control, closed basket-weave ankle taping and four commercially manufactured ankle braces. Specifically, the ankle braces utilized were the Cramer Ankle Stabilizer, two ankle braces manufactured by Mueller Sports Medicine (M1 & M2) and the 3-D Orthopedic 3-Way Functional Ankle brace. The control condition measurements were obtained from each subject prior to participating in three recreational basketball games per session. CROM measurements were obtained and recorded with each subject wearing athletic shoes. This exact sequence was repeated at mid-exercise and post-exercise. A 6(RC) * 3(Time) * 2(Foot) ANOVA with repeats on all factors was conducted to determine if any differences existed between treatments. In the event that the omnibus test for interaction was found to be significant at the .05 level, simple main effects were then investigated. If the simple main effects were found to be significant, the Student Newman Keuls procedure was utilized to determine where the differences existed. A significant interaction effect was found to exist for RC*Time. The results of the simple main effects for Time at RC indicated significant differences existed for the Control, Tape and both Mueller restrictive conditions. CROM restriction for tape was found to be greatest pre-exercise. The results of the simple main effects for RC at Time indicated that the Tape M1 and M2 restrictive conditions were not significantly different from each other pre-exercise. The best CROM restriction pre-exercise was provided by the Mueller ankle brace M2. The results of this study indicate that ankle braces can effectively reduce CROM as well as ankle taping.

COMPARATIVE BIOMECHANICAL EFFECTS OF THE STANDARD METHOD OF ANKLE TAPING AND A TAPING METHOD DESIGNED TO ENHANCE SUBTALAR STABILITY.

Wilkerson GB: Centre College, Danville, KY 40422

The purpose of the study was to compare the restrictive effects of the widely recognized standard method of ankle taping with those of a modified ankle taping method that incorporates an additional component, referred to as the subtalar sling. The subtalar string consists of two strips of semi-elastic tape that are anchored on the plantar aspect of the forefoot and wrapped around the leg in such a way that their orientation on the lateral aspect of the ankle is approximately 45 degrees relative to the long axis of the foot. Both ankles of 30 college football players were measured for maximal passive motion before tape applica-

tion, immediately after tape application, and after a 2 to 3 hour football practice session. Downward and inward motions of the foot within the sagittal and frontal planes were induced separately and in combination with each other to permit quantification of four ankle motions. The data were analyzed by a 2 x 4 x 2 multivariate analysis of variance, a separate 2 x 3 analysis of variance for each of the four motions, and the Newman-Kuels method of multiple comparisons of cell means. The results of the study suggest that the incorporation of the subtalar sling greatly enhances the intended protective function of ankle taping, but at the expense of slightly greater restriction of sagittal plane motion.

COMPARISON OF ISOKINETIC STRENGTH AND FLEXIBILITY MEASURES BETWEEN HAMSTRING INJURED AND NON-INJURED ATHLETES

**Worrell TW, Perrin DH, Gansnader B, Gieck J:
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The purpose of this study was to compare isokinetic strength and flexibility measures between hamstring injured and non-injured athletes. Sixteen university athletes with history of hamstring injury were matched by sport and position to sixteen university athletes without history of hamstring injury. Each subject was tested for concentric and eccentric quadriceps and hamstring peak torque on a Kinetic Communicator[®] dynamometer at 60°/s and 180°/s. Reciprocal muscle group ratios were determined from both the concentric and eccentric strength measures. Each subject's hamstring flexibility was also determined by passively extending the knee while the hip was maintained at 90° of flexion. Analysis of variance indicated no significant strength differences existed between injured and non-injured extremities in the hamstring injured group ($p > .05$). Also, no significant strength differences existed between the hamstring injured and non-injured group on any isokinetic measure. Analysis of variance indicated the hamstring injured group was less flexible ($p < .01$) than the non-injured group. A group of extremity interaction indicated that the injured extremity was significantly less flexible ($p < .01$) than the non-injured extremity in the hamstring injured group. Also, no significant flexibility differences existed between extremities in the hamstring non-injured group ($p > .05$). The results of this study revealed that no long-term hamstring weakness existed following hamstring muscle injury. However, the hamstring injured group was less flexible than the non-injured group and the injured extremity was less flexible than the non-injured extremity. Further research concerning hamstring muscle injury is recommended.

Editor's Note: The application for presentations in New Orleans (June 1991) will be published in the Fall issue. ⊕

Concussions and Intracranial Injuries in Athletics

J. Michael McWhorter, MD

ABSTRACT: Football, one of the most popular sports in our country today, is associated with a substantial number of injuries occurring as a result of participation in that sport. It has been estimated that approximately 600,000 injuries related to football occur annually. From the years 1931 to 1976 there were 822 fatalities occurring in football players. Of these, 80% were due to trauma to the head and cervical spine. In another series covering the years 1950 to 1955, 386 of 8,586 injuries sustained by high school football players involved the head. It is very difficult to separate head and neck injuries that occur in contact sports. I must emphasize that any sport that is popular in the United States today has the potential of becoming a contact or a collision sport. The latest participation figures show that there are some 1.3 million players participating in junior and senior high school football, and 75,000 players participating on the university level. According to Mueller and Blyth in the second annual report covering the years 1983 and 1984 of the National Center for Catastrophic Sports Injury Research, there were a total of 24 high school fatalities, and 6 fatalities at the college level. Ten of the high school fatalities were due to head injuries. There were also 21 non-fatal catastrophic injuries in football which resulted in permanent paralysis, all being the direct result of fractured cervical vertebra. Surprisingly, fewer injuries are sustained by sand lot players than by high school or college level players.

How well does the football helmet protect the head? Much better than in years past, but obviously not well enough. The earliest report of head protection is found at the Temple of Amon at Karnak, illustrating the conquest of Thotomoses, III, receiving a golden helmet and iron suit of armor. In First Samuel, 17:38, we find that David put on his helmet of brass.

In 1889, the Princeton University Football Players grew long hair, ostensibly for protection of the head, and this became the standard for approximately six years, until 1895 when Yale University dominated football and their players appeared in close-cropped hair. In 1893, Joseph Mason

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Reeves, later to become Admiral Reeves, made and wore a leather head gear in the Army-Navy game. This was fashioned by a harness maker and apparently was the result of numerous concussions which Admiral Reeves obtained during his football career.

FOOTBALL HELMET

At Rutgers University in 1896, the "football helmet" was invented. It too was made by a harness maker and consisted of a leather cap and ear flaps which were added later to the leather cap. All of these offered little protection for head injury. Leather helmets then became the standard, and in 1939 head gear was required by the NCAA for all sanctioned games. That same year, the plastic football helmet was invented and patented by Gerry Morgan of Ridell Corporation in Chicago. In 1940, the first plastic helmet was worn in a college All-Star Game. It is interesting to note that it was not until 1943 that the professional football teams were required to wear head gear (2).

About the same time players began to wear plastic head gear, they also went behind bars. The older professional football players reckoned their worth by the number of teeth they had lost or nose fractures they had sustained. After World War II, professional players considering these unappealing badges of courage chose not to sacrifice their good looks to the violence of the game, and in 1954 the National Football League issued a ruling making face masks compulsory. While these early face masks were good for the teeth and nose, they made a terrific handle for bringing a player to the turf, which was obviously bad for the cervical spine. Because of this, in 1962 rule changes occurred making it illegal to use the face mask as a means of tackling.

From 1940 to the early 1970s, the tests for safety, strength, and durability of today's one part domed helmet remained essentially unmodified. Then in 1975, in Dade County, Florida, a nineteen year old football player was rendered permanently quadriplegic on the field. He sued the manufacturer of the helmet he had worn and was awarded 5.3 million dollars in damages. He later settled out of court for 3 million dollars. At that time there were fourteen helmet manufacturers in this country. Today, there are only five. The decline in the number of helmet manufacturers is mirrored in the number of law suits brought against these companies in the last ten years. In 1981, 1982, juries

rendered judgements of 22 million dollars against the remaining helmet manufacturers. During that period the total gross income of the companies was 20 million dollars.

In 1974 the annual cost of liability insurance for a helmet manufacturer was \$40,000. This added about 50 cents to the cost of each helmet. In 1979 that figure had jumped to one million, three hundred thousand dollars, or \$16.50 per helmet. In 1982, the helmet problem became a problem of school districts. Not only were the helmet manufacturers being sued, but local coaches and school systems are now named in the legal proceedings.

In 1972, the AMA Committee on Medical Aspects of Sports recommended that football helmets be padded with a soft outer covering - a decidedly unpopular recommendation. Football coaches argued that such padding would increase torque so that more injuries would result. The players complained that their logos and decals would not stick on the soft material, and, most distressing psychologically, that the soft helmets did not make a noise on impact. One major university used externally padded football helmets for over twenty years and the opposing players had fewer bruises, rib fractures, and head and spine injuries, but the resounding whack was not there and that university no longer uses padded helmets.

RULE CHANGES

Perhaps the most significant improvement in head and neck injuries occurred in 1976 when rule changes were implemented in an effort to keep the head out of football. The elimination of such maneuvers as spear blocking, rake blocking, face to numbers tackling, is slowly decreasing the incidence of head and cervical spine injuries.

In spite of all of these attempts at decreasing the catastrophic injuries related to this sport, one of eight players in intercollegiate football competition will sustain a concussion this year, and 54,000 concussions will be sustained by high school football players. We still must learn to correctly assess head and neck injuries on the playing field.

EVALUATION - HEAD AND CERVICAL SPINE

In evaluating a player on the field with a suspected head injury or cervical spine injury, differentiation between the two is often difficult, as each can cause unconsciousness. The first step is the mini neurological examination. One should check the player's level of consciousness, the strength of his extremities, his pupillary and eye movements, and his reflexes. The head should not be moved and one does not remove the head gear as a first maneuver. If a cervical injury has occurred, the helmet can be used as a traction device while the player is being removed from the playing field onto a stretcher. It is a very good idea to have a bolt cutter handy so that a face guard can be removed to have access to the patient's airway.

CRANIAL INJURY

Skull injuries are relatively uncommon in football and are probably more common in other sports that are not usually classified as contact sports but in which the possibility always exists. The athlete may sustain a simple linear fracture of the skull which may be associated with a laceration of the scalp, thus be a compound or open fracture. These are usually of little consequence.

More serious is the depressed skull fracture in which bone

fragments are driven inward and can cause injury to the intracranial contents. This type of injury is usually a surgical problem. Perhaps the most common type of skull fracture seen in football is the basilar skull fracture where a blow to the vertex of the head is transmitted downward and a fracture occurs through the base of the skull. This is not usually seen on a routine skull x-ray, and is usually a clinical diagnosis. This is manifested by a Battle's sign, which is contusion about the mastoid area behind the ear, or possibly a facial paralysis because of contusion of the facial nerve or actual transection of the nerve as it courses through the fracture site.

CONCUSSION

Cerebral concussion is probably the most common brain injury that occurs in contact sports, and is defined as an immediate post-traumatic brain dysfunction characterized by unconsciousness, blindness, or inability to focus the eyes, followed by a complete recovery. Cerebral concussions are further classified as mild, which is transient neural impairment characterized by headache, tinnitus, and confusion. There may not be a loss of consciousness and recovery is rapid. The moderate cerebral concussion syndrome is a definite loss of consciousness, complete recovery in less than five minutes, some retrograde amnesia, and frequent headaches, nausea or dizziness. Close observation for these patients for at least twenty four hours is recommended.

The severe cerebral concussion syndrome is characterized by a period of unconsciousness for more than five minutes with severe retrograde amnesia, and these athletes should be hospitalized for further evaluation. Whether a central nervous system problem will develop cannot always be predicted during the initial evaluation. A good rule of thumb is to use the ten second count. If a player is unconscious for ten seconds or longer, do not allow him to go on with the game.

INTRACRANIAL INJURY

The most feared, most serious, and responsible for most of the fatalities in the head-injured athlete is intracranial bleeding. Subdural hematoma is the most common cause of increased intracranial pressure due to football injuries. As a general rule it occurs from venous bleeding because of shearing of veins entering the sagittal sinus. Computerized tomography is useful in diagnosis of subdural hematoma and should always be done on a patient with a significant head injury.

The epidural hematoma is also a common cause of increased intracranial pressure and is usually associated with a fracture of the skull. The middle meningeal artery lies in a groove in the inner table of the skull and a fracture through the temporo-parietal region may shear the middle meningeal artery and the result is arterial bleeding inside the cranial vault. Probably an epidural hematoma is more frequently associated with baseball than with football. The epidural hematoma is a true neurosurgical emergency.

Intracerebral hemorrhages and contusions of the brain are relatively rare in football. However, they do occur and are readily apparent with Computerized Cranial Tomography or Magnetic Resonance Imaging.

As a general rule of thumb, suspect brain injury in all players who have a period of unconsciousness or a neurological deficit. These players should probably have a

CT scan of the brain before they are allowed to continue participation in contact sports.

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Maxillofacial Trauma from Athletic Endeavors

Brian Matthews, MD

ABSTRACT: *The use of proper head gear and mouth protectors during contact sports has reduced the incidence of maxillofacial injuries and should be encouraged. When such injuries do occur, they should be evaluated promptly and treated appropriately. Contusions will resolve spontaneously; abrasions should be cleaned; and lacerations should be sutured. Any tooth injury should be seen by a dentist. Often, hematomas of the ear or nose must be evacuated. Decreasing hearing, changes in vision, or dizziness following trauma should always be investigated. Laryngeal injury should be suspected with any anterior neck trauma. Malocclusion, double vision, obvious deformity, or persistent pain and tenderness should alert the athletic trainer to the possibility of jaw or other facial fractures, which, in general, will require either open or closed reduction. The prompt recognition and treatment of maxillofacial injury will usually result in full restoration of form and function.*

The use of proper head protection and mouthpieces in contact sports undoubtedly has reduced the incidence of maxillofacial injury, but such injury is still a frequent occurrence in athletic competition. Fortunately, most maxillofacial injuries so sustained are minor and only rarely result in permanent disability.

The maxillofacial area is easily accessible for examination and most significant injuries are easily recognized. In this article I review the types of maxillofacial injuries seen most frequently, discuss their recognition, and suggest their initial management.

CONTUSIONS, ABRASIONS, AND LACERATIONS

Contusions

Contusions on the face, such as "black eyes," should be handled just as they are on other parts of the body, with the application of ice or cool compresses during the first few hours to minimize the swelling. Contusions will resolve spontaneously in a few days.

Abrasions

Abrasions on the face should be cleansed thoroughly with

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soap and water to be sure that no particles of dirt, tar, asphalt, etc., are left in the wound. If these dark materials are not removed, a permanent "tattoo," or darkly pigmented area, will remain after the abrasion heals.

Tar and asphalt are particularly difficult to remove. If the foreign material cannot be removed with water irrigation or a washcloth, it is necessary to anesthetize the involved area so that it can be scrubbed thoroughly with a stiff brush or, when the particles are deeply embedded, so that it can be dermabraded (a process similar to sanding). After the abrasion has been thoroughly cleansed, a nonadherent dressing, such as Xeroform or Adaptic should be applied daily until a dry crust has formed over the wound. So treated, abrasions should heal with no residual scarring.

Lacerations

Facial lacerations often bleed profusely due to the exceptional vascularity of the face. Bleeding should be controlled with application of direct pressure over the wound. Any laceration on the face large enough to cause a visible gap should be referred to a physician for suturing, which will result in better cosmesis than allowing the laceration to heal by itself. Careful suturing is particularly important when the laceration involves a facial landmark such as the vermilion border of the lip, the nasal ala, the eyelid, or the eyebrow, because malalignment of any of these structures results in a very noticeable cosmetic defect.

Although it is preferable to close lacerations as soon as possible after injury, lacerations on the face should be closed even if delayed for 24 hours or longer. If a significant delay is anticipated, irrigate the laceration with sterile saline solution and cover it with a sterile dressing. Antibiotic treatment is rarely necessary with facial lacerations unless the wound is particularly dirty or the result of a human bite.

Judgment must be used in determining how soon an athlete with facial lacerations may resume competition. If the laceration is relatively small and bleeding has been controlled, then the athlete may return immediately to competition. Skin tapes will temporarily approximate the wound in this situation. In general, athletes can return to competition without delay after the lacerations have been sutured. Skin tapes over the sutures may be used to reinforce the closure. With severe lacerations or if further trauma is anticipated, then a healing period of two to three weeks without competition may be advised.

DENTAL INJURIES

A variety of dental injuries, including luxations, intru-

sions, extrusions, and fractures, occur during athletic endeavors. Loose and partially displaced teeth should be guided gently back into the normal position as soon as possible. Exceptions to this rule are intruded teeth, i.e., teeth that have been driven into the gums. These teeth should not be manipulated. A permanent tooth that has been completely knocked out of the jaw should be rinsed with saline solution and immediately replaced in the socket; however, if the victim is unconscious, this should be avoided due to the risk of aspiration. Sometimes these teeth can be salvaged, although the prognosis is generally poor.

A dentist should be consulted for evaluation and treatment of all dental injuries. Loose teeth will usually require stabilization by a small peridontal splint until they solidify. Fractured teeth are treated by several methods, depending upon the type and severity of the fracture. Periodic dental followup is wise, since any tooth that has been traumatized may become nonvital, days, months, or years after the injury. The pulp may become necrotic, leading to a periapical abscess. Many of these devitalized teeth can be salvaged by root canal therapy. After any significant dental injury, the dentist should be the one to determine how soon the player can resume athletic activity. A properly fitted mouth protector should be worn during all contact sports to minimize the chance of dental injury.

EAR TRAUMA

Before the use of protective headgear in wrestling and boxing, hematomas of the pinna were common. Although less common now they do still occur, and any significant swelling that follows a blow to the ear should alert the athletic trainer to the possibility of an auricular hematoma. If undetected and untreated, the hematoma will resolve spontaneously, but it will be followed by fibrosis and partial dissolution of the cartilage, leading to the gross malformation known as a "cauliflower" ear. Refer any patient with a hematoma of the pinna to a physician, who will drain the hematoma through a small incision and apply a tight-fitting dressing to prevent its reaccumulation.

A blow to the side of the head or to the ear may injure the eardrum, the middle ear, or the inner ear. Any injury that produces dizziness, bleeding, or a noticeable decrease in hearing should be evaluated promptly by a physician. Similar injuries may occur when the ear forcefully strikes the water, as in diving or waterskiing accidents.

The sudden pressure changes in barometric pressure that can occur with scuba diving may rupture the round window membrane or the small blood vessels in the middle ear with resultant bleeding behind the eardrum (hemotympanum). Although the hemotympanum will resolve spontaneously without sequelae, rupture of the round window may lead to a permanent hearing loss and to dizziness requiring surgery.

LARYNGEAL INJURY

Any forceful blow to the anterior neck has the potential for producing a laryngeal injury. Difficulty in breathing following laryngeal trauma should be treated as an emergency, with immediate transport of the victim to a medical facility. Ecchymosis of the anterior neck, crepitus due to free air in the tissues of the neck, voice changes, or pain in swallowing should indicate the possibility of laryngeal injury. Athletic competition should be suspended and medical evaluation obtained promptly if a laryngeal injury is suspected. Laryngeal fractures with significant

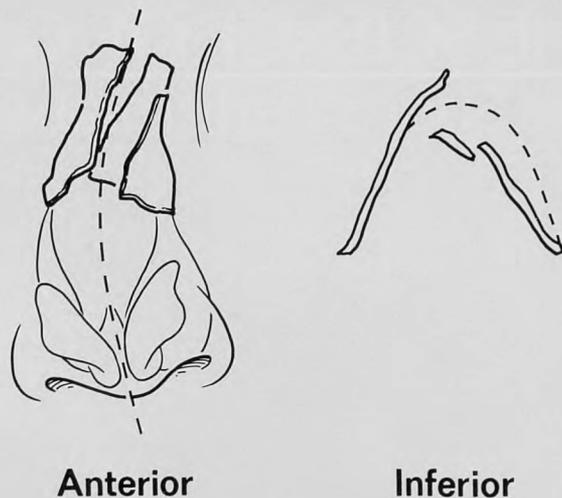


Figure 1. Typical nasal fracture demonstrating depression of the left nasal bone with deviation of the dorsum to the right.



Figure 2. Mandibular fractures often occur at two points as demonstrated by this illustration of a left parasymphyseal and a right angle fracture.

displacement will require open reduction for proper treatment.

NASAL INJURY

Because of its prominence, the nose is frequently injured during athletic competition. Nasal fractures are common and are usually accompanied by nosebleed, which usually resolves spontaneously. Inspection of the nose immediately after the injury (Figure 1) usually reveals a depression of the nasal dorsum to one side if a fracture has occurred. If a fracture is suspected, apply ice immediately to reduce the swelling. Within an hour of the injury, significant swelling and tenderness is usually seen, making evaluation and treatment difficult.

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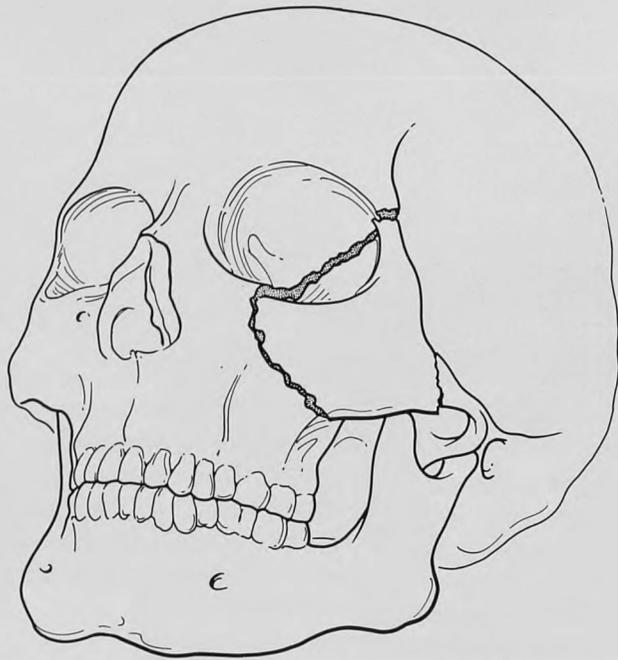


Figure 3. Fractures of the zygoma usually result in posterior displacement of the fractured segment and, if not repaired, in a flat cheek.

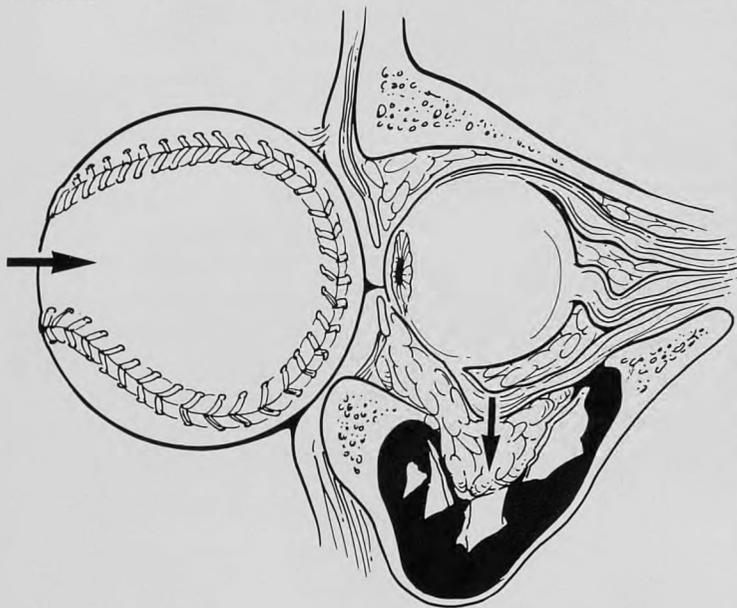


Figure 4. Blow out fractures occur from blows to the eye. These fractures may cause sagging of the orbital contents into the maxillary sinus, with resultant double vision and enophthalmos.

In two to three days, after the swelling has subsided, the nose should be reexamined carefully for signs of fracture. Nondisplaced fractures require no treatment. Displaced fractures should be reduced within seven days of injury. Usually, this can be accomplished using local anesthesia with a protective splint being applied over the reduced fracture. Old nasal fractures that have healed with resulting nasal deformity can be corrected by refracturing and repositioning the bones at any time. Following repair of a nasal fracture, competitive activities may be resumed in seven to ten days if further trauma is not anticipated. Otherwise, a protective noseguard should be worn for approximately three weeks.

Fracture of the nasal septal cartilage may also occur with nasal trauma, occasionally accompanied by a septal

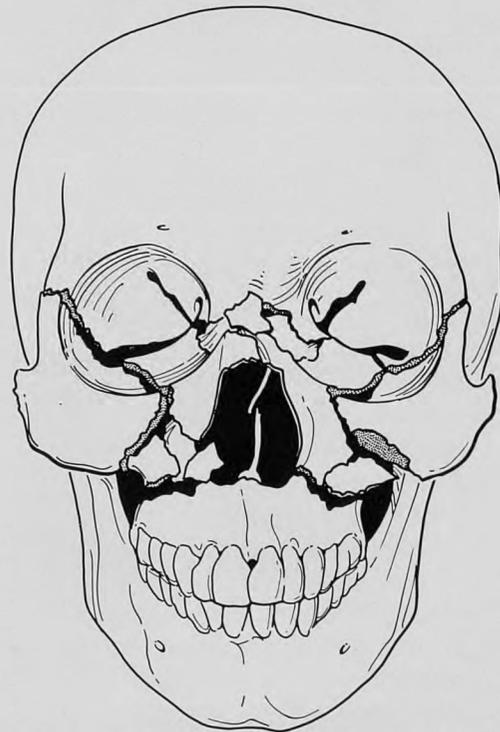


Figure 5. Midface fractures usually result from high impact forces. These fractures are variable and may involve the palate, nose and zygoma.

hematoma. Septal hematoma can be recognized as a large, reddish swelling within the nose, which usually obstructs the nasal passages. If a septal hematoma is suspected, refer the patient to a physician for evaluation and immediate drainage. Failure to drain a septal hematoma almost always results in infection and destruction of the septal cartilage, producing a characteristic "saddle nose" deformity.

Septal fractures without hematoma may or may not require repair. If the septum is deviated enough to cause problems with nasal airflow, repair may be immediate or delayed, depending on the patient's and the surgeon's preferences.

FACIAL FRACTURES

Mandible Fractures

Although major facial fractures are unusual in athletic competition, mandibular fractures are the most common (Figure 2). A mandibular fracture should be suspected whenever dental occlusion has been altered. If there is significant displacement at the fracture site, the malocclusion will be obvious only to the patient. Any athlete who complains of a change in the way his or her teeth fit together should be evaluated for a mandibular fracture or dental injury. Usually pain and tenderness at the fracture site are significant.

Radiographs of the mandible are used to confirm a fracture and to determine the treatment. Treatment may require wiring the mouth closed to immobilize the jaw or, if the fracture is severe, open reduction and rigid internal fixation with a metal plate will be required.

Zygoma Fracture

Blows to the cheek can fracture the zygoma, or cheek bone (Figure 3). Suspect such a fracture whenever significant tenderness, ecchymosis, or swelling over the cheek or around the eye follows a facial blow. Sub-

conjunctival hemorrhage is often associated with a zygoma fracture. Sometimes you can palpate a "step off" along the inferior orbital rim, which represents a displaced fracture. Most patients with zygoma fractures will complain of marked tenderness to palpation along the infraorbital rim, lateral eyebrow, and zygomatic arch. Fractures of the zygoma should be treated with open reduction and internal fixation to prevent flattening of the cheek. Occasionally, there may have been significant disruption of the floor of the orbit, which, if not repaired, may lead to permanent ocular problems, including double vision and enophthalmos.

Firm blows to the eye itself, such as when the eye is struck with a tennis or paddle ball, can generate enough force within the eye socket to fracture the floor of the orbit and cause a so-called "blow out" fracture (Figure 4). This may allow the orbital contents to sag into the axillary sinus. Usually blow out fractures do not require surgical intervention, but if the disruption of the orbital floor is severe, surgical repair may be necessary to prevent permanent double vision, enophthalmos, or both. Of course any athlete

who complains of double vision following facial trauma should have a thorough evaluation.

Midfacial Fractures

Fortunately, fractures to the midface (LeFort fractures) are rare in sports, because they usually occur only from very high impact forces. With midfacial fractures, the entire midportion of the face, including the palate, is fractured and therefore mobile (Figure 5). Mobility of the palate may be assessed by grasping the front teeth and gently rocking the palate back and forth. These fractures may also include the nose or cheek bones, and usually produce multiple comminuted fragments.

The exact type and extent of a midfacial fracture should be evaluated with computed tomography and repaired surgically.

With fractures of the mandible, zygoma, or midface, a physician's advice regarding return to athletic competition is mandatory. In general, these types of injuries will require approximately three months for sufficient healing. ⊕

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Cervical Spine Stenosis with Cord Neurapraxia and Transient Quadriplegia

Joseph S. Torg, MD

ABSTRACT: *The purpose of this paper is to define as a distinct clinical entity the syndrome of cervical spinal cord neurapraxia with transient quadriplegia. Sensory changes include burning pain, numbness, tingling, or loss of sensation, while motor changes consist of weakness or complete paralysis. The episodes are transient, with complete recovery usually occurring in 10 to 15 minutes, although in some cases gradual resolution occurred over 36 to 48 hours. Except for burning paresthesia, neck pain is not present at the time of injury and there is complete return of motor function and full, pain-free cervical motion. Routine radiographs of the cervical spine were, in all instances, negative for fractures or dislocations. However, finding did include developmental spinal stenosis, congenital fusions, cervical instability, and intervertebral disc disease. Spinal stenosis was determined by two different radiographic methods. The first was the standard method, and the second was a ratio method devised by the authors. Both measurements were obtained at the level of the third through sixth vertebral bodies, on routine lateral views of the cervical spine available in 24 of the 32 patients, and on a control group of 49 males of similar age without neurologic complaints. Using the ratio method, a measurement of less than 0.80 indicated significant spinal stenosis, as compared to a ratio determination of approximately 1.00 in the control groups of the 24 patients with available radiographs. Statistically significant spinal stenosis ($p < 0.0001$) occurred in all of the patients as compared to the controls by both methods of determining spinal stenosis. A survey of 503 schools participating in National Collegiate Athletic Association (NCAA) football in the 1984 season found an incidence rate of 1.0 per 10,000 athletes with a history suggestive of cervical spine neurapraxia. The phenomenon of cervical spinal cord neurapraxia occurs in individuals with 1) developmental cervical spinal stenosis, 2) congenital fusions, 3) cervical instability, or 4) intervertebral disc protrusions when associated with a decrease in the*

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anteroposterior diameter of the spinal canal. We postulate that athletes with diminution of the anteroposterior spinal canal diameter can on forced hyperextension or hyperflexion compress the spinal cord, causing transitory motor and sensory manifestations. There is no evidence that the occurrence of cervical spinal cord neurapraxia predisposes an individual to permanent neurologic injury. Patients with this syndrome, and who have associated cervical spine instability or acute or chronic degenerative changes, should be precluded from further participation in contact sports.

The purpose of this paper is to define as a distinct clinical entity the phenomenon of cervical spinal cord neurapraxia with transient quadriplegia.

Characteristically, the clinical picture involves an athlete who sustains an acute, transient, neurologic episode of cervical cord origin, having sensory changes associated with motor paresis of either both arms, both legs, or all four extremities, following forced hyperextension, hyperflexion, or axial loading of the cervical spine. Sensory changes include burning pain, numbness, tingling, or loss of sensation, while motor changes consist of weakness or complete paralysis. The episodes are transient, with full recovery usually occurring in 10 to 15 minutes; although in some cases complete resolution does not occur for 36 to 38 hours. Except for burning paresthesia, neck pain is not present at the time of the injury. Routine radiographs of the cervical spine show no evidence to fracture or dislocation.

This retrospective of 32 patients will attempt to answer four questions:

1. What factor or factors can explain the described neurologic picture of the face of both benign radiographs and subsequent clinical course?
2. What was the incidence of cervical spinal cord neurapraxia during a collegiate football season?
3. Is the individual who experiences an episode of cervical spinal cord neurapraxia predisposed to permanent neurologic injury?
4. Are activity restrictions indicated for those who experience cervical spinal cord neurapraxia?

MATERIAL AND METHODS

The study group consisted of 32 athletes, nine of whom were either patients of, or had been in consultation by, the author. The remaining 23 cases were obtained from the

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records of the National Football Head and Neck Injury Registry*(6).

The patients were all males, aged 15 to 32 (mean age 20). Twenty-nine (29) were injured while playing football, one while playing ice hockey, one while boxing professionally. Of the 29 patients who played football, four were professional, 16 were college, and nine were high schools players. All had experienced one or more episodes of cervical spinal cord neurapraxia. Clinical records and radiographic reports were reviewed in all cases. Clinical material was reviewed for information pertaining to previous history of cervical spine injury, determination of mechanism of injury, extent of either motor or sensory involvement or both, duration of neurologic signs and symptoms, presence and character of pain, radiographic evaluation of range of cervical spine motion, treatment, recovery pattern, subsequent activity restriction, and history of recurrence of cervical spinal cord neurapraxia.

Lateral cervical spine radiographs were available for personal review in 24 patients. These radiographs were reviewed for congenital anomalies, instability, disc disease, and spinal stenosis. Measurements for the determination of spinal stenosis were made at the level of the third through the sixth cervical vertebrae on the lateral view of the cervical spine. The presence of spinal stenosis was determined by two methods. The first was the standard method in which the sagittal spinal canal diameter is determined from the midpoint of the posterior aspect of the vertebral body to the nearest point of the corresponding spinolaminar line (1,2,3,4,6,8). The second was devised by the authors and is called the ratio method. The ratio method compares the sagittal spinal canal diameter measured as described to the anteroposterior width of the vertebral body measurement through the midpoint (Figures 1, 2a and 2b). Lateral cervical spine radiographs of 49 males of similar age but without neurologic complaints were used as a control group and measurements for spinal stenosis were performed at the third through the sixth cervical vertebral level by both the standard and ratio methods.

In an attempt to establish whether or not individuals experiencing transient cervical spinal cord neurapraxia were predisposed to permanent neurologic injury, a mail and telephone survey was conducted of all known patients with permanent quadriplegia listed with the National Football Head and Neck Injury (6) to ascertain whether or not they had experienced prodromal neurologic symptoms. Also, the Registry listings were cross-checked with all of the subjects in the study group to determine whether any of them had subsequently sustained any permanent neurologic injury.

In order to ascertain the nature and incidence of cervical spinal cord neuropraxia during the 1984 football season, a mail survey of 503 schools participating in NCAA football (Divisions I-III) was conducted.

*The National Football Head and Neck Injury Registry was established to document the incidence and nature of severe intracranial and cervical spine injuries resulting from tackle football. Maintained by the University of Pennsylvania Sports Medicine Center, Philadelphia, data has been collected retrospectively from 1971 to 1975 and prospectively from 1976 to 1985. Criteria for inclusion in the Registry are injuries that: 1) require hospitalization for a minimum of 72 hours; 2) involved a fracture, subluxation or dislocation; 3) involved intracranial hemorrhage; 4) had associated quadriplegia; and 5) resulted in death. To date 1,412 cervical spine injuries have been reported for the fourteen year period 1971-1984.

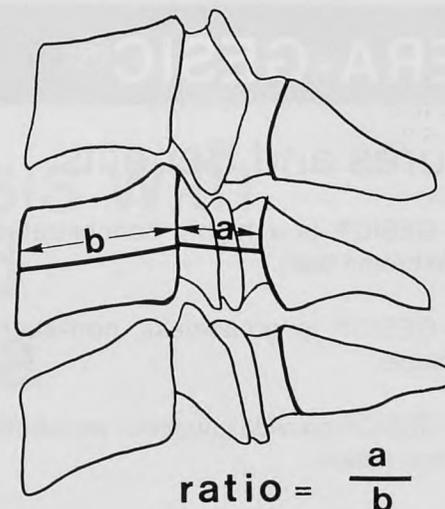


Figure 1. The spinal canal: vertebral body ratio is the distance from the midpoint of the posterior aspect of the vertebral body to the nearest point on the corresponding spinolaminar line (a) divided by the AP width of the vertebral body (b). Pavlov's ratio = a/b.



Figure 2a



Figure 2b

Figure 2a & b. A comparison between the ratio of the spinal canal to the vertebral body of a "normal" control subject to that of a stenotic patient demonstrated on lateral roentgenograms of the cervical spine. Pavlov's ratio is 1:1 (1.00) in the control subject (Fig. 2a) as compared to 1:2 (0.50) in the stenotic patient (Fig. 2b).

RESULTS

Evaluation of the medical records including radiographic reports on 32 patients and lateral cervical spine on 24 patients revealed that all of the 32 individuals in this group who sustained cervical spinal cord neurapraxia could be subdivided into the following four sub-groups (none of these patients had "normal" cervical spines):

1. Developmental Stenosis

Seventeen (17) of the subjects had radiographic evidence of developmental stenosis of the spinal canal (Figures 3a,b and c). In this group the mechanism of injury was hyperflexion in five cases, hyperextension in eight cases, and axial loading in four cases. All 17 had experienced sensory manifestation: eleven had paralysis, three had weakness in four extremities, one had

continued on page 143



Figure 3a

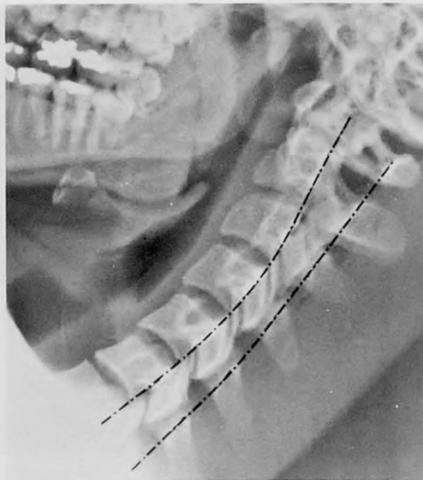


Figure 3b



Figure 3c

Figure 3a, b, & c. A 17 year old high school football player sustained a hyperflexion injury while making a tackle which resulted in paralysis and paresthesias in all four extremities lasting ten minutes. Examination showed him to be neurologically negative with a full range of cervical motion. Roentgenograms were interpreted as normal, and treatment consisted of rest. A month following the initial episode, he returned to football and experienced a recurrence of transient quadriplegia associated with another cervical hyperflexion injury. When seen in our clinic, Pavlov's ratios were 0.62 at C3, 0.55 at C4, 0.67 at C5, and 0.68 at C6. These are consistent with a diagnosis of developmental cervical spinal stenosis. The anterior and posterior aspects of the spinal canal were demarcated and there was marked narrowing of the sagittal diameter at the third and fourth vertebral level on (A) neutral; (B) flexion; and (C) extension views. He was advised to discontinue participation in football and other contact sports and has had no recurrence at eight-year follow-up.



Figure 4a

Figure 4a & b. A twenty-year old university football player sustained an injury to his cervical spine when he "lowered his head and hit an opposing carrier head on." He suffered a period of unconsciousness and 10 to 15 minutes of inability to move his arms and legs. Initial x-rays, which did not include flexion and extension views, were interpreted as normal. He was discharged from the hospital after two days of observation; however, he complained of "excruciating pain" in his neck for two weeks. He was treated in a cervical collar for six weeks. Subsequently, he experienced intermittent neck pain and six months following the injury had repeat roentgenograms, including flexion and extension views which demonstrated C1-C2 instability. In neutral position, the ADI (atlantodens interval) measured within the normal limits of 2.5mm between the posterior aspect of the anterior arch of C1 and the anterior aspect of the odontoid (4a). In flexion, the ADI increased beyond the normal limits, indicating an atlantoaxial subluxation (4b). Pavlov's ratios were 0.74 at C3, 0.72 at C4, 0.74 at C5, and 0.84 at C6, consistent with the diagnosis of developmental stenosis. Because of instability, he underwent a C1-C3 cervical wiring fusion. He has not had recurrence of motor and sensory symptoms.



Figure 4b



Figure 5



Figure 6



Figure 7

Figure 5. A 15-year-old high school football player had two episodes of paresthesias throughout his body after having been struck on the top of the head while tackling. There was no history of paralysis. Cervical spine roentgenograms taken following the first injury were interpreted as normal. Subsequently, the youngster participated in high school wrestling and had several episodes of total body numbness associated with hyperflexion of the cervical spine. When seen in our clinic, he had full range of cervical motion and was neurologically negative. However, lateral roentgenograms of the cervical spine made in flexion demonstrated laxity and instability of the posterior ligamentous complex at the fifth and sixth cervical levels. Laxity is identified by a "fanning" increase in the intraspinous distance, loss of parallelism between the facet joints on the lateral view (the inferior aspects of the apophyseal joints diverge as opposed to being parallel), widening of the posterior aspect of the intervertebral disc space, and narrowing of the anterior intervertebral disc space at this level. There was no evidence of anterior subluxation. Pavlov's ratios were: 0.75 at C3, 0.74 at C4, 0.75 at C5, and .55 at C6. These were compatible with the diagnosis of the developmental spinal stenosis associated with the described laxity. The patient was advised to discontinue both football and wrestling and has not had a recurrence of symptoms at three year follow-up.

Figure 6. A 19-year-old university football player injured his neck in spring practice while "engaged in spearing." Apparently, he was involved in a blocking exercise and struck the dummy with the top of his head. He was unconscious for a few seconds and when he awoke, had total quadriplegia without breathing difficulty which lasted for five minutes. The paralysis gradually subsided; however, weakness and paresthesias in a shawl-like distribution persisted for several days. He was admitted to the hospital, placed in traction for three weeks, and had a cervical myelogram which demonstrated an anterior extradural defect at the C3-C4 intervertebral disc space consistent with a herniated nucleus pulposus. Pavlov's ratios were: .711 at C3, .643 at C4, .667 at C5, and .667 at C6, indicating significant spinal stenosis. Because of persistent limitation of cervical spinal motion and pair, the patient underwent an anterior C3-C4 discectomy and interbody fusion one month following the injury. His postoperative course was uncomplicated, and he had no recurrence of symptoms at 14-year follow-up.

Figure 7. A 21-year-old intercollegiate player sustained a hyperextension injury to his cervical spine and experienced four

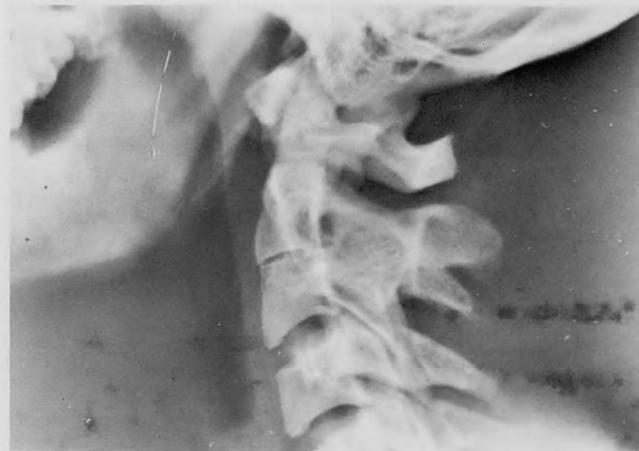


Figure 8

extremity motor and sensory loss for five minutes. There are small hypertrophic spurs and sclerosis in the posterior corner between the fourth and sixth cervical vertebrae. The intervertebral disc spaces are narrowed at these locations and the spurs extend beyond the posterior border of the vertebral bodies, decreasing the sagittal diameter of the spinal canal. Pavlov's ratio = 0.84 at C3, 0.79 at C4, 0.75 at C5, and 0.78 at C6.

Figure 8. A 21-year-old university football player sustained a hyperextension injury to his cervical spine. He had upper extremity weakness for 10 seconds and paresthesias that lasted for 48 hours. At the time of injury, he was hospitalized. A lateral view roentgenogram of the upper cervical spine demonstrated a congenital fusion between the apophyseal joints at C2 and C3 and a partial interbody fusion between C2 and C3, especially posteriorly. The intervertebral disc space was markedly reduced and obliterated in the posterior aspect. Pavlov's ratios were: 1.75 at C3, .070 at C4, and 0.68 at C5. He was treated conservatively with head-halter traction for two days. With full return of motor and sensory function, he was released from the hospital. At six year follow-up, he has remained asymptomatic but has not returned to contact sports.



Figure 9a



Figure 9b



Figure 9c

Figure 9a. A 29-year old recreational basketball player was rebounding and experienced a forced hyperflexion injury when elbowed. He had a sudden onset of transient numbness and later weakness in all four extremities. He resumed play and at the end of the game, experienced paresthesias in both upper extremities. Evaluation at the emergency room, including roentgenograms of the cervical spine, was considered normal. His paresthesias improved after several days. Two weeks after the initial injury, while spotting a weight lifter, the paresthesias returned. His family physician prescribed Indocin (indomethacin) and rest. At one month postinjury, he was evaluated at our clinic. He had full range of motion, normal muscle tone, and normal reflexes. Roentgenograms obtained at the time of injury were reviewed. Pavlov's ratios were: 0.85 at C3, 0.79 at C4, 0.75 at C5, and 0.78 at C6, indicating developmental spinal stenosis. Magnetic resonance imaging (MRI) of the midsagittal cervical spine showed a herniated disc at the C4-C5 level (Left). Further flexion of the cervical spine demonstrated cord compression due to limited anteroposterior diameter at the C4-C5 level (Right). After a course of conservative treatment, consisting of anti-inflammatories and a collar, the paresthesias still persisted. The patient subsequently underwent a C4-C5 anterior discectomy and fusion.

Figure 9b. A magnetic resonance image of the same patient with mild flexion of the cervical spine demonstrates the herniation of the disc with displacement of the posterior longitudinal ligament and compression of the cord with a decrease in its anteroposterior diameter at the fourth and fifth cervical vertebrae.

Figure 9c. A magnetic resonance image made with a greater flexion of the cervical spine demonstrates an additional decrease in the anteroposterior diameter of the cord or tenting over the herniated nucleus pulposus.

weakness in both lower extremities, and two had no motor involvement.

2. Ligamentous Instability

Four patients had radiographic evidence of ligamentous instability: one between the first and second cervical vertebrae (Figure 4a and b), one between the second and third, and two between the fifth and sixth (Figure 5). In three cases the initial insult was reported as a result of axial loading to the spine. One case followed a hyperextension injury; in one younger patient with instability between the fifth and sixth cervical vertebrae, the symptoms followed a hyper-

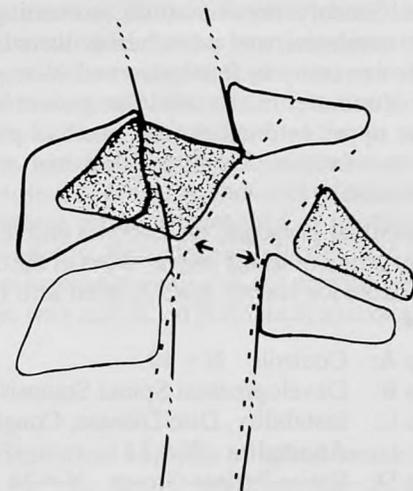


Figure 10. The "pincers" mechanism, as described by Penning (7), occurs when the spinal cord is pinched between the posterior inferior aspect of the vertebral body and the anterior superior aspect of the spino-laminar line of the subjacent vertebra.

flexion injury. Two of the patients in this group had paralysis of all four extremities, while two had no motor impairment. All four had sensory manifestations, one having upper extremity paresthesias and the remainder having involvement in all four extremities.

3. Intravertebral Disc Disease

Intervertebral disc disease was demonstrated in six patients, one having a myelogram (Figure 6) and another a magnetic resonance imaging scan compatible with an acute disc herniation (Figure 9a,b and c) while the remaining four had chronic changes manifested by intervertebral disc space narrowing and posterior

osteophyte formation (Figure 7). Both subjects with acute disc herniation had a stenotic canal at the involved level. Axial loading of the spine was the mechanism identified in two patients, hyperflexion in one and hyperextension in the remaining three. Five of the six subjects had motor paralysis and one had weakness in four extremities. Five had sensory manifestations in all four extremities, while one had bilateral upper extremity sensory manifestations only.

4. Congenital Cervical Anomalies

Five patients had congenital anomalies. Two patients had failure of segmentation involving the second and third cervical vertebrae (Figure 8), one of the third and fourth, and one between the second and third and fourth cervical vertebrae. The fifth patient had marked proliferative changes of the anterior aspects of the third, fourth, and fifth vertebral bodies characteristic of diffuse idiopathic skeletal hyperostosis (5). Hyperextension was the precipitating mechanism in all five cases. Sensory manifestations, consisting of burning pain, numbness, and paresthesias, were limited to the upper extremity in four cases and were present in all four extremities in one case. One patient had weakness in the upper extremities, and one had paralysis of all four extremities. Three patients had no motor involvement.

For statistical purposes, the controls and the 24 cases in the patient group in which lateral views of the cervical spine were available for review were divided into the following subgroups:

- Group A: Controls N = 49
- Group B: Developmental Spinal Stenosis N = 12
- Group C: Instability, Disc Disease, Congenital Anomalies N = 12
- Group D: Entire Patient Group N = 24

The sagittal spinal canal diameter (Table I) and the spinal canal/vertebral ratio (Table II) was statistically analyzed at the third through sixth vertebral level. The Mann-Whitney test was used to compare each subgroup with the controls and the entire patient group with the controls. There was statistically significant spinal stenosis in both subgroups B and C and in the entire patient group D as compared with the control Group A by both the standard and the ratio methods at all levels.

A telephone survey of 223 known patients with quadriplegia, listed with the National Football Head and Neck Injury Registry, resulted in 117 interviews. None of these patients recalled any episodes of transient motor paresis prior to the permanent injury. When asked about any sensory episodes, 115 said they had none, one described unilateral numbness lasting for one minute, and one described numbness and tingling involving all four extremities and lasting for one minute.

COLLEGE FOOTBALL INJURIES

In an attempt to determine the nature and incidence of cervical spinal cord neurapraxia during the 1984 collegiate football season, a mail survey of 503 NCAA institutions participating in football was conducted. Three hundred forty-four (344) institutions (68 percent) responded, representing 39,377 football players.

Of these athletes, we received reports of 29 who showed symptoms of cervical spine injuries. From this information

we were able to categorize them into two distinct groups. Group I (N = 5) had experienced transient quadriplegia with paresthesia, while Group II (N = 24) had experienced transient paresthesia in either the upper or lower extremities, or both.

Group I which had experienced both transitory paresis and paresthesia, described classic examples of cervical spinal cord neurapraxia. Numbness was reported lasting from one minute to 12 hours. Tingling in all four extremities persisted anywhere from 30 minutes to several weeks. Paralysis in this group ranged from one minute to 24 hours, with five subjects reporting quadriplegia. The incidence rate for Group I was 5/39,377, or 1.3 per 10,000 participants.

Group II reported only sensory involvement. Numbness and tingling was reported lasting from 30 seconds to 48 hours. The sensory symptoms were confined to the upper extremities in the majority of cases and only seven subjects reported paresthesia in all four extremities. The incidence rate for Group II was 24/39,377, or 6.0 per 10,000 participants.

RECURRENT EPISODES

An attempt was made to establish recurring patterns in the 32 patients we studied. Of the 17 individuals with developmental cervical stenosis, nine did not attempt to return to their activity after the one episode. Three did return to football, had a second episode, and withdrew from the activity. One patient returned to football and despite a second episode, continued to play without further problems at three years follow-up. Three individuals returned to football without any problems at two years follow-up. A professional boxer who had a cervical laminectomy following two episodes of transient quadriplegia, continues to box and has no further problems at five years follow-up.

Of the five patients with congenital fusion of the upper cervical spine, four withdrew from football after one episode. One has continued to play collegiate ice hockey without a problem at three years follow-up.

Of the four individuals with cervical instability, two withdrew from football. One of the younger patients with ligamentous instability between the fifth and sixth cervical vertebrae had three episodes of whole body numbness precipitated by cervical spine hyperflexion while wrestling. He stopped wrestling and is asymptomatic at two years follow-up. One younger patient with instability between the second and third cervical vertebrae was allowed to return to football using a neck roll, and keeping his head up while tackling. He has had no further problem at one year follow-up.

Three of the six patients with degenerative disc disease withdrew from football following the initial episode. A professional football player discontinued his activity after one recurrence and was lost to follow-up. Two patients with acute intervertebral disc herniation (one basketball player and one football player) underwent anterior disectomy and interbody fusion. Both are without recurrence; however, neither returned to his sport.

DISCUSSION

On the basis of our observations we conclude that the factor identified which explains the described neurologic picture of cervical spinal cord neurapraxia is diminution of the anteroposterior diameter of the spinal canal, either as an isolated observation or associated with intervertebral disc

herniation, degenerative changes, post-traumatic instability, or congenital anomalies. In instances of developmental cervical stenosis, forced hyperflexion or hyperextension of the cervical spine causes a further decrease in the caliber of an already stenotic canal, as explained by the "pincer mechanism" of Penning (7) (Figure 9). In those patients with stenosis associated with osteophytes or herniated disc, direct pressure can occur, again with the spine forced in the extremes of flexion or extension. This phenomenon of mechanical compression of the cervical cord with flexion is vividly demonstrated by a magnetic resonance imaging scan of one of our patients with an acute herniated palposus at C3-C5 (Figure 10a, b, and c). We further postulate that with an abrupt but brief decrease in the anteroposterior diameter of the spinal canal, the cervical spinal cord is mechanically compressed, causing transient interruption of either its motor or sensory function, or both distal to the lesion. The neurologic aberration which results is transient and completely reversible.

A review of the literature has revealed few reported cases of transient quadriplegia occurring in the athlete. Attempts to establish the occurrence rates indicate that the problem is more prevalent than expected. Specifically, in the population of 39,377 exposed participants, the reported incidence rate for transient paresthesia in all four extremities was 6 per 10,000 while the incidence rate reported for paresthesia associated with transient quadriplegia was 1.3 per 10,000 in the one football season surveyed. From this data we conclude that the prevalence of this problem is relatively high and an awareness of the etiology, manifestations, and appropriate management principles are warranted.

Characteristically, following an episode of cervical spinal

cord neurapraxia with or without transient quadriplegia, the first question raised concerns the advisability for activity restrictions. In an attempt to address this problem, we interviewed 117 young athletes who sustained cervical spine injuries associated with complete, permanent quadriplegia while playing football between the years 1971 and 1984. None of these patients recalled a prodromal experience of transient motor paresis. Conversely, none of the patients in this series who had experienced transient neurologic episodes subsequently sustained an injury which resulted in permanent neurologic injury. On the basis of this data, we conclude that the young patient who has had an episode of cervical spinal cord neurapraxia, with or without transient quadriplegia, is not predisposed to permanent neurologic injury.

With regard to activity restrictions, no definite re-occurrence patterns have been identified to establish firm principles. However, we believe that athletes who have this syndrome associated with demonstrable cervical spine instability or acute or chronic intervertebral disc disease should not be allowed further participation in contact sports. Those athletes with developmental spinal stenosis, with or without congenital abnormalities, should be treated on an individual basis. As indicated, of the six youngsters with obvious cervical spinal stenosis who returned to football, three had a second episode and withdrew from the activity and three returned without any problems at two years follow-up. Our data clearly indicates that those with developmental spinal stenosis are not predisposed to more severe injuries with associated permanent neurologic sequelae.

TABLE 1. Statistical analysis of sagittal spinal canal diameter

GROUP	MEAN (mm)	S.D.	RANGE (mm)	N
C3 LEVEL				
A: Controls	19.24	.188	13.7-23.5	49
B: Stenosis	14.38**	.221	9.5-17.0	12
C: Inst., HNP, Cong. Fus.	17.45+	.285	13.5-23.5	12
D: Combined	15.92**	.297	9.50-23.50	24
C4 LEVEL				
A: Controls	18.56	.195	14.3-23.5	49
B: Stenosis	14.17**	.221	9.0-17.0	12
C: Inst., HNP, Cong. Fus.	16.67++	.183	13.5-19.5	12
D: Combined	15.42**	.241	9.00-19.50	24
C5 LEVEL				
A: Controls	18.71	.183	14.7-23.5	49
B: Stenosis	13.50**	.218	8.5-17.0	12
C: Inst., HNP, Cong. Fus.	16.25*	.187	13.0-19.0	12
D: Combined	14.87**	.247	8.50-19.50	24
C6 LEVEL				
A: Controls	19.03	.193	15.0-23.5	48
B: Stenosis	14.13**	.206	10.0-17.0	12
C: Inst., HNP, Cong. Fus.	15.59**	.219	12.0-18.5	11
D: Combined	14.83**	.221	10.00-18.50	23

**p < .0001 *p < .001 ++p < .01 +p < .05

TABLE 2. Statistical analysis of spinal canal: vertebral body ratio

GROUP	MEAN (mm)	S.D.	RANGE (mm)	N
C3 LEVEL				
A: Controls	1.008	.118	.69-1.27	49
B: Stenosis	.652**	.143	.33-.81	12
C: Inst., HNP, Cong. Fus.	.807**	.156	.591-.18	12
D: Combined	.730**	.166	.330-1.180	24
C4 LEVEL				
A: Controls	.973	.110	.76-1.19	49
B: Stenosis	.648**	.134	.32-.81	12
C: Inst., HNP, Cong. Fus.	.764**	.061	.64-.86	12
D: Combined	.707**	.118	.320-.860	24
C5 LEVEL				
A: Controls	.975	.091	.80-1.17	49
B: Stenosis	.637**	.116	.31-.770	12
C: Inst., HNP, Cong. Fus.	.734**	.087	.57-.90	12
D: Combined	.685**	.112	.310-.900	24
C6 LEVEL				
A: Controls	.978	.104	.80-1.23	48
B: Stenosis	.648**	.098	.36-.75	12
C: Inst., HNP, Cong. Fus.	.686**	.090	.55-.85	11
D: Combined	.665**	.094	.360-.850	23

**p < .0001 *p < .001 ++p < .01 +p < .05

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The Epidemiologic, Biomechanical, and Cinematographic Analysis of Football Induced Cervical Spine Trauma

Joseph S. Torg, MD

ABSTRACT: *Epidemiologic, biomechanic, and cinematographic data on head and neck injuries occurring in tackle football has been compiled since 1971 by The National Football Head and Neck Injury Registry. Preliminary analysis performed in 1975 indicated that the majority of serious cervical spine injuries to football players were due to axial loading. Based on this observation, the NCAA and NFHSAA implemented rule changes banning "spearing" and the use of the top of the helmet as the initial point of contact in striking an opponent during a tackle or block. Between 1976 and 1987, as a result of these rule changes, the Registry has documented a dramatic decrease in both the total number of cervical spine injuries and those resulting in quadriplegia at both the high school and college levels. It is suggested that development and implementation of similar preventive measures would decrease injuries in diving, rugby, ice hockey, trampolining, wrestling, and other high risk sports.*

Athletic injuries to the cervical spine resulting in damage to the spinal cord are infrequent but catastrophic events. Accurate descriptions of the mechanisms responsible for a particular injury transcend simple academic interest. Before preventive measures can be developed and implemented, identification of the mechanisms involved in the production of the injury is necessary. Due to the inability of the nervous system to recover significant function following severe trauma, prevention assumes a most important role when considering these injuries.

This study, through the use of epidemiologic data, biomechanical evidence, and cinematographic analysis, will 1) describe the effect of axial load forces in cervical spine injuries occurring in football and 2) demonstrate the success of appropriate rule changes in the prevention of these injuries.

During the 1975 season, twelve football players in Pennsylvania and New Jersey sustained severe cervical spine injuries. Eight of these injuries resulted in permanent cervical quadriplegia. Analysis of the injuries determined that all twelve occurred during a head first tackle or block (24). In order to ascertain whether the local increase in catastrophic football neurotrauma reflected a national

trend, the National Football Head and Neck Injury Registry was established (21,22,23). Consideration of the head and neck injuries by the Registry included four parameters: 1) intracranial hemorrhages; 2) intracranial injuries resulting in death; 3) cervical spine fractures, subluxations, and dislocations; and 4) cervical spine traumas resulting in permanent quadriplegia. The total number of head and neck injuries was calculated retrospectively from 1971-1975 and compared to the values compiled by Schneider in a similar study during the years 1959-1963 (20) (Table 1).

Comparison of head injury data from the period 1959-1963 to that obtained by the Registry for the years 1971-1975 demonstrated that both intracranial hemorrhages and intracranial deaths had decreased (Table 1). Schneider found 139 lesions (3.39/100,000) in which intracranial hemorrhages were a component and 65 deaths (0.92/100,000) from craniocerebral injuries. The Registry documented 72 intracranial lesions (1.15/100,000) and 58 craniocerebral injuries (0.92/100,000) occurring between 1971 and 1975. These rates represent a 66% decrease in hemorrhages and a 42% decrease in craniocerebral deaths.

With regard to cervical spine injuries, Schneider reported 56 injuries (1.36/100,000) that involved a fracture and/or dislocation and 30 with associated permanent cervical quadriplegia (0.73/100,000) (20). The Registry documented 259 injuries (4.14/100,000) involving a fracture and/or dislocation of the cervical spine and 99 cases (1.58/100,000) of cervical quadriplegia. These rates represented a 204% increase for cervical spine fractures/subluxations/dislocations and a 116% increase for cases of cervical quadriplegia. While the rates of head injuries had decreased, the rates of cervical spine injuries with or without quadriplegia had increased dramatically from the data reported by Schneider (Table 1).

Three conclusions were made based on these findings: 1) the improved protective capabilities of modern helmets accounted for the decrease in head injuries between the two studies; 2) the improved protection of the head led to the development of playing techniques that used the top or crown of the helmet as the initial point of contact; and 3) these head first techniques placed the cervical spine at risk for serious injury. It was postulated that head first techniques (tackling/blocking) increased the risk of neck

injury by exposing the athlete's spine to excessive axial loads, a force to which it appears to be particularly susceptible.

These preliminary observations were reported at the annual meeting of the National Collegiate Athletic Association Football Rules Committee (NCAA) in February 1976. As a result, the following rules were instituted: 1) no player shall intentionally strike a runner with the crown or top of the helmet; 2) spearing is the deliberate use of the helmet in an attempt to punish an opponent; and 3) no player shall deliberately use his helmet to butt or ram an opponent (NCAA Football Rule Changes and/or Modifications, Jan. 23, 1976, rule 2, section 1, article 2-L, 2-N).

TABLE 1. In comparing the occurrence and rate of head and neck injuries in American football during two five year periods, 1959-1963 (Schneider) and 1971-1975 (N.F.H.N.I.R.), a 66% decrease in intracranial hemorrhages and a 42% decrease in craniocerebral deaths between the two periods is noted. More significantly, of cervical spine fractures, subluxations and dislocations increased 204% and cervical spine injuries associated with permanent quadriplegia increased 166%.

Source, Yr.	Intracranial Hemorrhages	Cranio-cerebral Deaths	Cervical Spine	
			Fractures/ Subluxations/ Dislocations	Permanent Cervical Quadriplegia
Schneider, 1959-1963	139 (3.39)	65 (1.58)	56 (1.36)	30 (0.73)
Football Head and Neck Injury Registry, 1971-1975	72 (1.15)	58 (0.92)	259 (4.14)	99 (1.58)

Similar rules were also adopted by the National Federation of High School Athletic Associations (NFHSAA) during the same year. The goal of these rule changes was to bring about changes in coaching and playing in order to eliminate the use of the head as the initial point of contact in blocking and tackling.

Axial loading has been implicated as the primary mechanism producing severe cervical spine injuries in tackle football through review of epidemiologic, biomechanic and cinematographic data compiled by the National Football Head and Neck Injury Registry. In the course of a contact activity, such as tackle football, the cervical spine is repeatedly exposed to potentially injurious energy inputs. Fortunately, however, most forces are effectively dissipated by the energy-absorbing capabilities of the cervical paravertebral musculature and the intervertebral discs through controlled spinal motion. However, the vertebra, intervertebral discs, and supporting ligamentous structures can be injured when contact occurs on the top or crown of the helmet with the head, neck, and trunk positioned in such a way that forces are transmitted along the vertical axis of the cervical spine. When the cervical spine assumes the physical characteristics of a segmented column, motion is precluded in response to axial directed impacts, and the forces are directly transmitted to the spinal structures.

When viewed from the lateral perspective, with the neck in the neutral position, the normal alignment of the spine is one of extension because of the normal lordotic curve (Figure 1).

It is with 30 degrees of neck flexion that the cervical spine is straightened (Figure 2). With impact exerted along the longitudinal axis of a straight spine, loading of a segmented column occurs (Figure 3a and b). At first, energy inputs are absorbed by the intervertebral discs and compressive deformation occurs. When maximum deformation is

TABLE 2. Twelve-year data for severe and catastrophic head and neck injuries occurring in American football at the high school, college, and professional/recreational levels. Rates in parentheses are per 100,000 participants based on participation numbers from the National Collegiate Athletic Association and the National Federation of State High School Athletic Associations for 11-man football.

Injury	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
INTRACRANIAL HEMORRHAGE												
High School	10(0.89)	6 (0.55)	10(0.93)	8 (0.85)	8 (0.85)	11(1.15)	17(1.88)	12(1.30)	16(1.62)	9 (0.96)	15(1.57)	17(1.78)
College	1 (1.33)	1 (1.33)	1 (1.33)	1 (1.33)	0	3 (4.00)	1 (1.33)	1 (1.33)	4 (5.33)	2 (2.66)	1 (1.33)	0
Other	1	0	0	2	4	3	1	0	1	0	1	0
Total	12	7	11	11	12	17	19	13	21	11	17	17
CRANIOCEREBRAL DEATHS												
High School	11(0.98)	5 (0.46)	5 (0.46)	1 (0.10)	7 (0.74)	6 (0.63)	8 (0.88)	6 (0.65)	6 (0.60)	3 (0.32)	5 (0.52)	1 (0.10)
College	0	0	0	1 (1.33)	1 (1.33)	2 (2.66)	1 (1.33)	1 (1.33)	1 (1.33)	1 (1.33)	1 (1.33)	0
Other	1	0	0	2	3	1	1	0	2	2	1	0
Total	12	5	5	4	11	9	10	7	9	6	7	1
CERVICAL SPINE FX/DISL/SUBL												
High School	86(7.72)	76(7.06)	40(3.72)	42(4.47)	52(5.54)	49(5.16)	46(5.10)	60(6.50)	36(3.65)	32(3.43)	36(3.78)	22(2.31)
College	23(30.66)	15(20.00)	8 (10.66)	7 (9.33)	9 (12.00)	8 (10.66)	6 (8.00)	7 (9.33)	5 (6.66)	6 (8.00)	11(14.66)	8 (10.66)
Other	1	5	3	2	1	0	5	2	1	5	3	2
Total	110	96	51	51	62	57	57	69	42	43	50	32
PERMANENT QUADRIPLÉGIA												
High School	25(2.24)	14(1.30)	14(1.30)	8 (0.95)	13(1.38)	7 (0.73)	7 (0.77)	9 (0.97)	4 (0.40)	7 (0.75)	6 (0.63)	7 (0.73)
College	8 (10.66)	2 (2.66)	0	4 (5.33)	2 (2.66)	2 (2.66)	1 (1.33)	1 (1.33)	0	2 (2.66)	0	0
Other	1	2	2	1	1	2	2	1	1	1	0	1
Total	34	18	16	13	16	11	10	11	5	10	6	8

reached, continued energy input results in angular deformation and buckling with failure of the intervertebral discs and/or bony elements. This results in subluxation, facet dislocation at one spinal level (3) (Figure 3c, d, and e).

Axial loading of the cervical spine occurs when the neck is slightly flexed, normal cervical lordosis is straightened, and the spine is converted into a segmented column. Assuming the head, neck, and trunk components of a composite injury model to be in motion, rapid deceleration of the head occurs when it strikes another object, such as an opposing player, and results in the fragile cervical spine being compressed by the force of the oncoming trunk. Essentially, the head is stopped, the trunk is still moving, and the spine is crushed between the two. As mentioned, if the compression force is not dissipated by controlled motion in the spinal segments, fracture and/or dislocation results.

MATERIAL AND METHODS

In order to obtain data on football related injuries with associated neurologic sequelae, the National Football Head and Neck Injury Registry was established. Initiated in 1975 as an ongoing registry, information was first collected retrospectively to 1971. Criteria for inclusion in the Registry were those head or cervical spine injuries that: 1) required hospitalization for more than seventy-two hours; 2) required surgical intervention; 3) involved a fracture, subluxation, or dislocation; or 4) resulted in permanent paralysis or death.

TABLE 3. Presentation of the estimated force of impact values for eleven axial loading injuries resulting in quadriplegia calculated in stop frame analysis. M represents the injured players mass in kilograms. V_i represents injured player's velocity measured in meters per second prior to impact. V_f represents injured player's velocity measured in meters per second after collision. O_i represents the incident angle for those collisions which were oblique, and EST. FORCE represents the estimated force calculated in the stop frame analysis. See Figure 8 for a sample calculation of the estimated force of impact values.

Case	Age	M. (kg.)	V_i (m/sec)	V_f (m/sec)	O_i (deg.)	EST. FORCE (kg. f.)
Type one collisions						
-1-	19	84	4.90	0	/	700.00
-2-	19	77	6.63	0	/	368.21
-3-	17	75	5.08	0	/	667.96
-4-	15	68	5.83	0	/	674.22
Type two collisions						
-5-	17	80	6.10	0	/	829.89
-6-	17	75	3.59	0	/	457.91
-7-	16	75	3.39	0	/	432.40
Type three collisions						
-8-	15	75	4.70	0	10	550.03
-9-	15	64	3.81	0	90	439.85
-10-	17	73	6.10	0	30	751.11
-11-	17	73	5.08	0	90	501.71

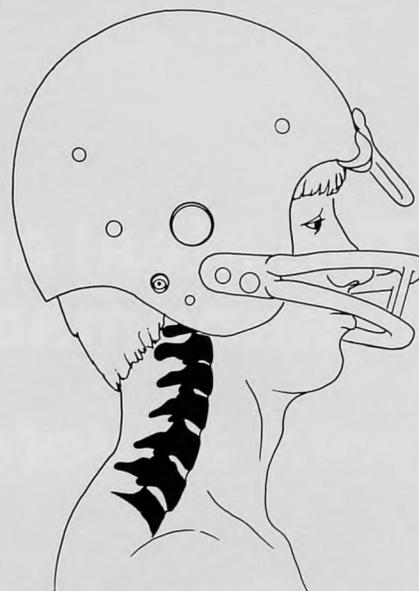


Figure 1. When the neck is in a normal, upright, anatomic position, the cervical spine is slightly extended due to natural cervical lordosis.



Figure 2. When the neck is slightly flexed to approximately thirty degrees, the cervical spine is straightened and converted into a segmented chain.

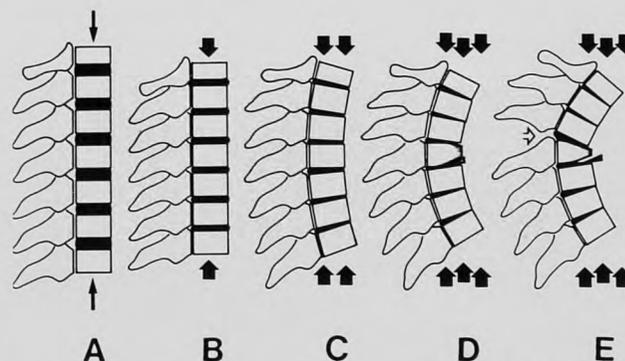


Figure 3. Biomechanically the straightened cervical spine responds to axial loading forces like a segmented column. Axial loading of the cervical spine first results in compressive deformation of the intervertebral discs (A&B). As the energy input continues and maximum compressive deformation is reached, angular deformation and buckling occur. The spine fails in a flexion mode (C) with resulting fracture, subluxation, or dislocation (D&E). Compressive deformation or failure with a resultant fracture, dislocation, or subluxation occurs in as little as 8.4 msec (12).

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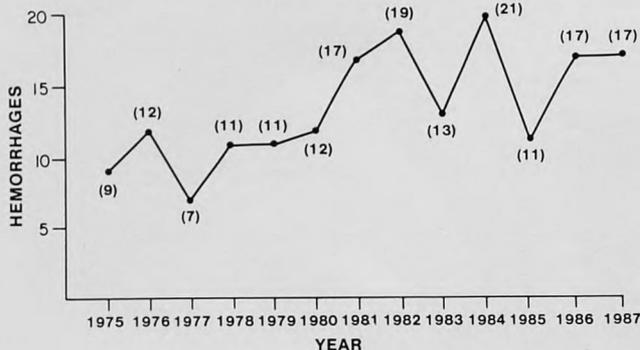


Figure 4. Incidence of intracranial hemorrhages for all levels of participation (1975-1987) demonstrated a gradual increase between 1976 and 1982. Levels remained fairly constant from 1983-1987.

CRANIOCEREBRAL DEATHS (1975-1987)

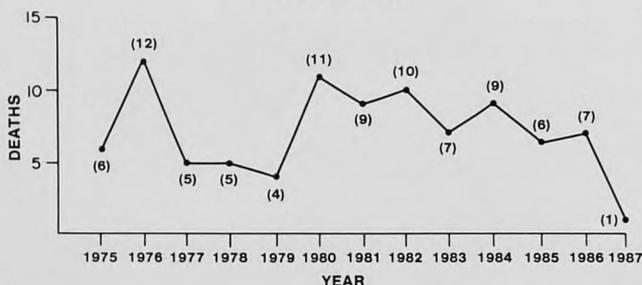


Figure 5. Incidence of craniocerebral deaths for all levels of participation (1975-1987) remained constant for the duration of the study.

CERVICAL SPINE FRACTURES/DISLOCATIONS/ SUBLUXATIONS (1975-1987)

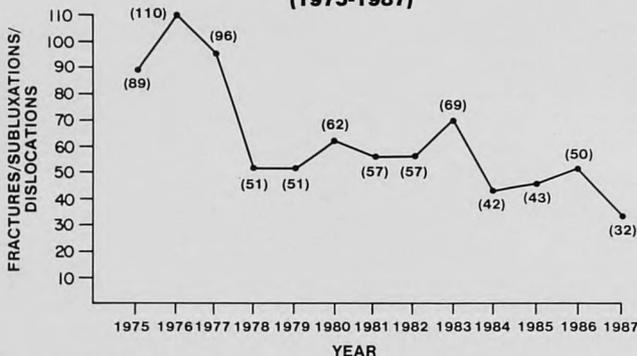


Figure 6. The yearly incidence of cervical spine fractures/dislocations/subluxations for all levels of participation (1975-1987) decreased markedly in 1978 and continued to decline during the remaining nine years as a direct result of the rule changes instituted in 1976 banning head-first blocking, tackling, and spearing.

Information was obtained by several methods. Project descriptions and injury report forms were mailed at the conclusion of each football season to the 40,000 members of the National Association of Secondary School Principals and the 5,000 members of the National Athletic Trainers Association. In addition, a newspaper/media-clipping service was contracted each year to identify those head and

PERMANENT CERVICAL QUADRIPLEGIA (1975-1987)

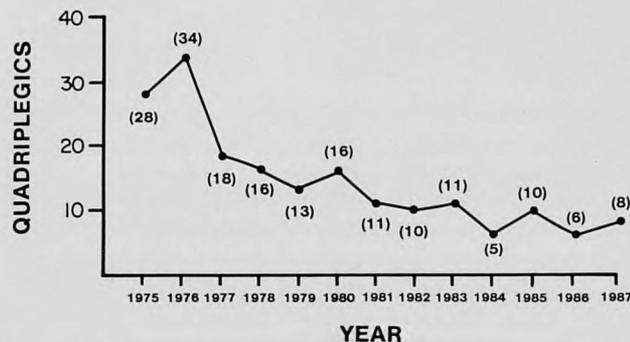


Figure 7. The yearly incidence of permanent cervical quadriplegia for all levels of participation (1975-1987) decreased dramatically in 1977 following the initiation of the rule changes prohibiting the use of head-first tackling and blocking techniques. The number of injuries continued to decline until 1984 when the dramatically lowered levels were constant throughout the remainder of the study.

Figure 8. Sample calculation using the law of conservation of momentum in order to estimate the force of impact values by stop-frame analysis.

Sample Calculation Case 1-Type one collision

$$\begin{aligned} W_t &= 84 \text{ kg.} \\ V_i &= 4.9 \text{ m/sec.} \\ V_f &= 0 \text{ m/sec.} \\ t &= 0.06 \text{ m/sec.} \end{aligned}$$

According to Newton's 2nd law and the concept of conservation of momentum,

$$\begin{aligned} F_1 &= m_1 a_1 = F_2 = m_2 a_2 \\ &= \frac{(m_1 v_{i1}) - (m_1 a f_1)}{t} = \frac{(m_2 v_{i2}) - (m_2 v_{f2})}{t} \end{aligned}$$

$$v_{f1} = 0 = v_{f2}$$

$$F_1 = \frac{m_1 v_{i1}}{t} = F_2 = \frac{m_2 v_{i2}}{t}$$

$$\text{Therefore, } F = \frac{(84 \text{ kg}) (4.9 \text{ m/sec})}{0.06 \text{ sec}}$$

$$\begin{aligned} &= 6860 \text{ kg, m/sec}^2 \\ &= 6860 \text{ Newtons} \end{aligned}$$

Since 1 kg f = 9.8 Newtons,

$$\begin{aligned} F &= 6860 \text{ N} = 700.00 \text{ kg f} \\ &= 9.8 \text{ N/kg f} \end{aligned}$$

700.00 kg f is the estimated axial force acting upon the victim's cervical spine during the injury producing impact. The same type of calculation is used to estimate the force of impact in type two collisions. In type three collisions, however, the additional variable O_i (angle of incidence) must be added into the calculation of momentum.

neck injuries reported in the press, radio, or television. When an injury was reported, more detailed information was obtained from the athlete, parent and school officials. Pertinent medical and radiographic data from the physicians and hospitals responsible for the care of the athlete was also required. All the information collected on each athlete was reviewed for: 1) the mechanism of injury; 2) the pathologic

state of spinal and neural elements; 3) the type of treatment received; and 4) the extent and duration of neurologic deficit resulting from the injury. Injury rates for intracranial hemorrhages, intracranial deaths, cervical spine fractures/dislocations/subluxations, and permanent quadriplegia were calculated for both high school and collegiate participants each year of the study.

When available, game films or videotapes of the injury were studied in order to determine the mechanism of injury and to calculate the force of impact. Cinematographic records were reviewed for sixty athletes with injuries resulting in neurologic deficits. Stop frame analysis, a method which allows estimation of the magnitude of injury producing forces, was performed on eleven films of athletes sustaining injuries which resulted in quadriplegia. The force acting on the athlete's head, cervical spine, and trunk segment was calculated using the law of conservation of linear momentum. The orientation of the head, cervical spine, and trunk segment of each athlete was analyzed to determine the mechanism of injury.

A review of the biomechanical literature was undertaken to correlate the clinical observations documented from the Registry data with the experimental information on cervical spine injury mechanisms.

RESULTS

Analysis of the Registry data revealed definite trends in the incidence of head and cervical spine injuries occurring in both high school and collegiate football. Intracranial hemorrhages showed an apparent increase between the years 1976 and 1982 and then maintained a fairly constant rate for the duration of the study (Figure 4). The brief increasing trend was due to the improved diagnostic capabilities in identifying these lesions provided by the advent of Computerized Axial Tomography. Intracranial hemorrhages resulting in death remained relatively constant throughout the study (Figure 5).

Fractures, subluxations, and dislocations of the cervical spine demonstrated a progressive decrease between the years of 1976 and 1987 (Figure 6). The 1976 injury rates of 7.72/100,000 and 30.66/100,000 for high school and college athletes respectively decreased to 2.31/100,000 and 10.66/100,000 during the subsequent twelve years (Table 2). These rates represented a 70% reduction in high school injuries and a 65% reduction in college injuries. The largest single year drop occurred between 1977 and 1978, two years following the 1976 rule changes. During this year, high school injury rates fell from 7.06/100,000 to 3.72/100,000, a 47% decrease, and college injury rates declined from 20.00/100,000 to 10.66/100,000, also a 47% decrease.

Cervical spine injuries resulting in quadriplegia consistently declined from a total of 34 cases in 1976 to 5 cases in 1984 (Figure 7). In 1976 the injury rate was 2.24/100,000 at the high school level and 10.66/100,000 at the college level (Table 2). In 1977, just one year following the rule changes, the rates dropped to 1.30/100,000, a 42% decrease, and 2.66/100,000, a 75% decrease, for high school and college athletes respectively. The rates continued to decline at both the high school and college level until 1984. In 1984, the injury rates had fallen to 0.40/100,000 for high schools, an 82% decrease, and to 0/100,000 for colleges, a 100% decrease. In 1985, the injury rates at both the high school and college levels increased slightly from the low noted in

1984 and remained constant from 1985-1987 (Table 2).

From 1971 to 1975, 39% of nonquadriplegic cervical spine injuries and 52% of the quadriplegias were attributed to axial compression. During the years between 1976 and 1987, 52.5% of the quadriplegias and 49% of the nonquadriplegic cervical spine injuries were caused by the same mechanism.

Documentation of axial loading as the responsible mechanism of injury in the production of catastrophic football cervical spine injuries was obtained from the review of game films of actual injuries. Sixty films of injuries resulting in neurologic deficits were available for study. In the fifty-one (85%) films in which it was possible to observe the mechanism of injury, axial loading was responsible in every instance. Stop frame analysis performed on eleven of these films determined that three distinct types of collisions existed. The first type was a direct collision in which two bodies travelled along the same straight line and in opposite directions prior to impact. The second type of collision was also direct but one in which a moving body hit another which was stationary. The third type was an oblique collision in which two moving bodies met at an angle. All eleven of the injuries were the result of head-first contact and all resulted in permanent cervical quadriplegia. Four of the injuries were type one collisions, three were type two, and four were type three. All eleven athletes were injured while tackling an opposing player.

The forces involved in the eleven injuries were calculated based on the law of conservation of linear momentum. By determining the rate of change of the momentum of a body upon collision, the force of that collision can be determined. The impulse of a force ($F \times \Delta t$) is equal to the change of momentum that it produces ($mv^2 - mv^2$). In a collision, the respective changes in momentum of the two bodies must be equal and opposite such that the total momentum of the system is unaltered by the impact. A sample calculation (Figure 8) and the results for the eleven cases (Table 3) are presented. According to the data, the range of axial force which acted on the cervical spine during a direct collision resulting in cervical quadriplegia was approximately 400 to 800 kg f, and the oblique resultant force range was approximately 400 to 700 kg f. This estimated force was similar to the forces calculated by Hodgson (7). He calculated the estimated force of impact in axial loading cervical spine injuries from the work = kinetic energy point of view. The average force involved in each collision Hodgson studied was determined from the following formula:

$$\text{work} = F \times \Delta x = \frac{1}{2} mv^2$$

where the variables are: x = stopping distance
 m = body mass
 v = player's velocity

Hodgson concluded the average force acting on the neck was between 700 and 1600 lb f (318.18 kg f to 727.27 kg f), a range nearly identical to that derived from stop frame analysis (Table 3).

DISCUSSION

Refutation of the "freak accident" concept with the more logical principle of the cause and effect has been the most rewarding in dealing with the problem of football induced cervical spine trauma and quadriplegia. Understanding axial loading, in which a football player, usually a defensive back, makes a tackle by striking his opponent with the tip of

his helmet has been key in this process. Implementation of rule changes and coaching techniques eliminating the use of the head as a battering ram have resulted in a dramatic reduction in the incidence of cervical spine injuries with or without quadriplegia between 1976 and 1987.

Although this data leads to the conclusion that axial loading is the predominant force involved in the production of athletic cervical spine injuries, classically these injuries have been attributed to either hyperflexion or hyperextension. Schneider (19,20), the first researcher to catalog head and neck injuries occurring in athletic competition, supported this traditional view. In his discussion of cervical spine injuries occurring in tackle football, he concluded that the most severe injuries to the cervical spine occur as a result of hyperflexion. Schneider also mentioned that hyperextension may cause cervical lesions resulting in neurologic damage. He did not list axial loading or vertex impact among the forces associated with cervical spine neuro-trauma.

Other authors have also used these mechanisms to account for a variety of catastrophic athletic cervical spine injuries. Gehweiler et al. (5) (diving), Leidholt (9) (football), McNab (10) (diving), McCoy et al. (13) (rugby), Paley and Gillespie (15) (general sports), all proposed hyperflexion as the most frequent cause of serious cervical injuries in the activities they reviewed.

Others, who like Schneider, have emphasized both hyperextension and hyperflexion as the two dominant forces producing most types of cervical spine lesions with cord damage include Dolan (2) (football) and Funk (4) (football). Although some authors, such as Kazarian (8) (general sports), Maroon et al. (12) (football), and Rogers (17) (diving), recognized that axial loading is associated with severe cervical spine injuries, they continued to emphasize the dominant role of hyperflexion and/or hyperextension forces in the production of these lesions.

A review of the literature pertaining to the biomechanics of cervical spine injuries yielded experimental support to the axial loading theory. Mertz et al. (14), Hodgson and Thomas (7), and Sances et al. (18) measured stresses and strains within the cervical spine when axial impulses were applied to helmeted cadaver head-spine-trunk specimens. They were able to produce fractures of the lower cervical spine when the impulse was applied to the crown of the helmet. Hodgson and Thomas determined that direct vertex impact imparted a larger force to the cervical vertebra than forces applied further forward on the skull. Gosch et al. (6) investigated three different injury modes - hyperflexion, hyperextension, and axial compression - in their experiment involving anesthetized monkeys and concluded that axial compression produced cervical spine fractures and dislocations. Maiman et al. (11), Roaf (16), and White and Punjabi (25) demonstrated vertebral body fractures in the lower cervical spine due to the axial loading of isolated spinal units. Roaf subjected spinal units to forces differing in direction and magnitude, i.e., compression, flexion, extension, lateral flexion, rotation, and horizontal shear. He stated unequivocally that he had never succeeded in producing pure hyperflexion injuries in a normal, intact spinal unit, and concluded that hyperflexion of the cervical spine was an anatomical impossibility. Roaf was able to produce almost every variety of spinal injury with a combination of compression and rotation.

Bauze and Ardran (1) postulated that axial loads were

responsible for cervical spine dislocations as well as fractures. They demonstrated that failure of the facet joints and posterior ligaments occurred when axial loads were applied to cadaveric spines. When the lower portion of the spine was flexed and fixed, and the upper part extended and free to move forward, vertical compression produced bilateral dislocation of the facet joints without fracture. If lateral tilt or axial rotation occurred as well, a unilateral dislocation was produced. The forces observed were all less than those required for bony failure and allowed facet dislocation without associated bony pathology.

CONCLUSION

This study has delineated the importance of axial loading in the production of football related cervical spine injuries. Injury occurs as the fragile cervical spine is compressed between the rapidly decelerated head and the continued momentum of the body.

Appropriate rule changes recognizing this mechanism have resulted in a marked reduction of cervical injuries with and without quadriplegia. The success of the preventive measures advocated by the National Football Head and Neck Injury Registry leads to the suggestion that similar studies, directed toward the prevention of injuries, rather than their treatment, would most likely decrease rates for many types of injuries in a wide variety of athletic activities.

Continued research; development of clear and concise definitions of the responsible injury mechanisms based on sound biomechanical, epidemiologic, and clinical evidence; education of coaches and players; and enforcement of rules is essential in order that the preventative measures may succeed.

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Management of Cervical Spine Sports Injuries

Julian E. Bailes, MD

ABSTRACT: *Spinal cord injuries in athletics present inherent difficulties in decisions regarding on-the-field management, diagnosis, and subsequent return to full participation. Different spinal cord injury syndromes may be seen depending on the spinal level and the type of injury. Initial management of the patient with suspected spinal cord and/or vertebral column injury follows the rules of cardiopulmonary resuscitation, with careful attention to airway establishment and maintenance. The player must be transported with cervical spine immobilized. Careful neurological and radiographic evaluation should be conducted as necessary. Guidelines are discussed on the decision to return to competitive and contact sports.*

Athletic injuries to the cervical spine constitute rare but potentially serious problems. With improvements in equipment design, greater emphasis on safety, and changes in rules, some sports injuries have been significantly reduced (1,13,14); however, catastrophic accidents may still occur and must be analyzed from both the prevention and treatment viewpoints.

These injuries are of two types: those which occur during unsupervised recreational activities and those which take place during organized sports. Skiing, diving, swimming, and trampolining accidents are of the first type. Diving accidents cause the greatest proportion of these injuries—about ten percent of all spinal injuries (6). The second group are injuries which occur in organized, supervised sports with high levels of competition and bodily contact. These include pursuit and team sports, such as football, wrestling, and gymnastics (3,17). They constitute two to four percent of spinal cord injuries (3).

SPINAL CORD INJURY SYNDROME

Trauma to the spinal column may cause a variety of clinical syndromes depending on the type and severity of the impact and bony displacement. In addition, secondary damage may result from hemorrhage, edema, and ischemia of the cord. Complete spinal cord injury results in a transverse myelopathy with total loss of spinal function below the level of the lesion. This insult is caused by either anatomic disruption of the spinal cord or hemorrhagic or ischemic injury. Such injury is rarely reversible, although

improvement of one spinal level of function may be seen as a result of resolution of initial segmental traumatic spinal cord swelling.

There are several patterns of incomplete spinal cord injury, usually produced on a vascular basis. The central cord syndrome results in an incomplete loss of motor function with a disproportionate weakness in the upper extremities as compared with the legs. This is the result of injury to the corticospinal tracts because of their somatotopic arrangement. Nerve tracts that participate in cervical nerves and innervate the upper extremities are arranged more medially than those supplying function to the lower extremities. As the blood supply is compromised more in the interior portion of the spinal cord, the inner or medial fibers to the upper extremities are selectively involved.

The central cord syndrome probably best indicates only the site of spinal cord injury. A wide range of clinical expression and overlap exists with other incomplete spinal cord injury syndromes, especially the Brown-Sequard Syndrome. The central cord syndrome is, therefore, an injury pattern based on an insult with a good prognosis for some extent of recovery (10).

The anterior spinal cord syndrome is caused by injury to the anterior two thirds of the spinal cord in the territory supplied by the anterior spinal artery. Patients exhibiting this syndrome have a complete loss of all motor function below the level of injury, in addition to loss of pain and temperature sensation. In contrast to the disproportionate motor deficit seen in central cord syndrome, an equal deficit usually occurs in the arms and legs. Although there is relative preservation of the posterior sensory portion of the spinal cord, this has little effect on function and outcome because permanent paralysis usually occurs.

The Brown-Sequard syndrome is described as hemisection of the spinal cord with loss of ipsilateral motor function and contralateral pain and temperature sensation. This occurs because of the crossing of sensory pathways one or two spinal levels above their entry site into the cord, where the motor pathways have already crossed higher in the brainstem and have a straight course to lower spinal levels. The Brown-Sequard syndrome usually occurs not in isolation but together with other types of incomplete injury. Often there is a combination of central cord and Brown-Sequard syndromes in which the patient will have some degree of unilateral weakness and contralateral sensory deficit, with a relatively greater weakness in the arms. The posterior spinal cord syndrome is a rare clinical entity

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characterized by loss of position sense but preservation of movement and the other sensory functions. This is believed to be due to ischemia in the distribution of the posterior spinal artery, which supplies blood to the posterior one-third of the spinal cord.

Other patients may have an incomplete injury not classifiable into any certain pattern. Usually, these injuries have loss of all or nearly all useful motor function below the level of injury with a sensory loss that does not fit any specific pattern. This sensory preservation does, however,

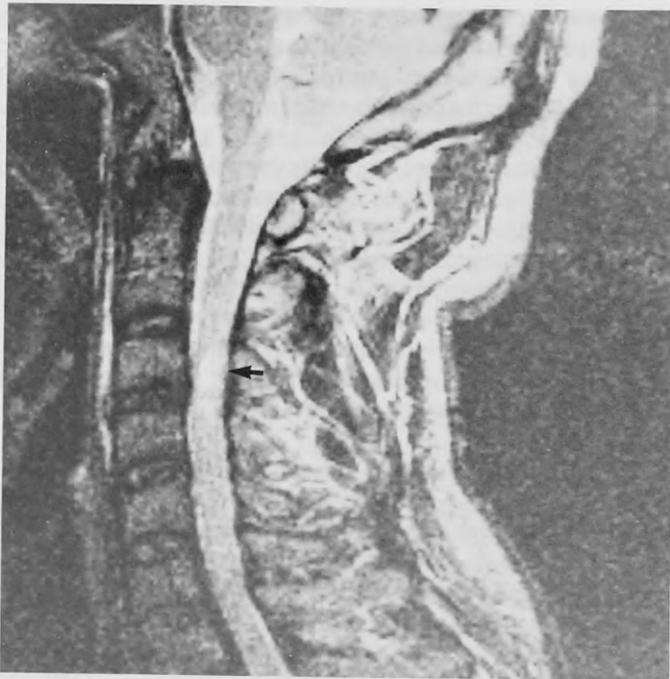


Figure 1. Sagittal T2-weighted MRI scan showing an area of spinal cord contusion at C₃ (arrow). Although this patient recovered completely from his central cord syndrome, he in fact did have a spinal cord injury. Thus, return to contact sports would not be advised.



Figure 2. Lateral cervical spine radiograph shows cervical stenosis. This person would be at a higher than normal risk of spinal cord compromise if he participated in contact sports.

portend a potential for better recovery than does complete functional loss.

The burning hands syndrome, causing burning dysesthesiae and paresthesiae in both hands, is commonly seen in athletes who participate in contact sports (8), especially football and wrestling. It has been proposed that the burning hands syndrome is caused by selective injury to the central fibers of the spinothalamic tract that relay pain and temperature from the upper limbs. Because this injury does not result in permanent loss of function, it is believed to represent edema or vascular insufficiency as the pathogenic mechanism. The burning hands syndrome has been known to occur both with fractures and dislocations of the cervical spine and in patients without radiographic abnormalities (16).

The carotid arteries are rarely injured in athletic competition, but whenever signs of symptoms suggest cerebral hemispheric dysfunction (hemiparesis, hemiplegia, hemianesthesia, dysphasia, homonymous visual field defects), this must be considered. A delay in the appearance of the neurologic defect, even up to several days, is characteristic. Transient ischemia attacks (TIAs) in the distribution of the cerebral arteries may occur secondary to distal embolization of thrombotic material forming at a tear in the lining of the vessel. The carotid and vertebral arteries are at risk from direct compression, stretching, or as a result of traumatic fracture-subluxation; however, radiographs of a patient with a vascular injury may show only chronic degenerative changes or have a normal appearing spine.



Figure 3. Lateral cervical spine radiograph demonstrating a chip fracture of the anterior-inferior C₂ vertebral body. Since this athlete was neurologically intact, stable on flexion-extension radiographs and this was a relatively minor fracture. He was allowed to return to active competition.

ON-FIELD EVALUATION AND MANAGEMENT

Suspected injury to an athlete's spine must follow set guidelines. The initial step is to follow the basics of cardiopulmonary resuscitation: airway, breathing, and circulation. The practical issue is the establishment and maintenance of the airway, as the heart and circulatory system are not often involved.

It is imperative that every unconscious athlete and every injured athlete who complains of numbness, weakness, paralysis, or neck pain be handled as if he or she had a cervical fracture and thus an unstable spine. Moving a player should take place with sufficient personnel (usually four) so that the athlete's spinal column will remain stabilized. In particular, flexion and extension movements should be avoided, since they are most likely to compromise the size of the cervical spinal canal. One person should be responsible for stabilizing the cervical spine and transferring the patient by cradling the shoulders and neck in the forearms while applying a slight force in the axial direction. This person should not actually lift the body. Sufficient personnel should be available to easily transport the athlete without distracting the person at the head from the sole responsibility of maintaining proper cervical alignment. If it becomes necessary to remove an athlete's helmet, this can be safely done by cutting the chin strap and pulling outward on the ear pads. This allows the helmet to be removed without moving the neck. This is best done after the athlete has been taken from the playing field.

The evaluation of conscious patients is initiated by questioning about extremity numbness, painful dysesthesiae, weakness, and neck pain. A limited examination can determine any major neurological deficit. If the patient cannot move all or any limbs; has obvious weakness,

numbness, or significant neck pain; or is unconscious, he should be carefully transported on a spine board with the head and cervical spine in a neutral and immobilized position. This may be accomplished by placing the patient in a rigid cervical collar in conjunction with a commercially manufactured cervical/head immobilization device. In injured athletes with an altered level of consciousness, brain trauma should also be considered (2).

Once the patient is removed from the playing field, depending on the degree of suspected injury, time is made for a more detailed examination of nervous system function. The presence of persisting numbness, burning dysesthesiae or paresthesiae should alert one to examine more closely for evidence of spinal cord injury. The presence of weakness should alert one for possible spinal injury. Since athletes are usually much stronger than the general population, subtle degrees of weakness may be easily missed. If there is sensory disturbance, neck pain, or an obvious deficit in movement, the patient should be kept immobilized and appropriate diagnostic testing obtained.

Whenever neurologic involvement is suggested, the patient should have a complete radiologic evaluation beginning with a cervical spine radiographic series. Further workup may be indicated such as flexion-extension radiographs (for assessment of stability) and computerized tomography (CT).

Magnetic resonance imaging (MRI) is being increasingly used in the evaluation of spinal-injured patients, being particularly helpful when all other radiologic examinations do not reveal a fracture, dislocation, or spinal instability. By directly imaging the spinal cord, the MRI can visualize areas of spinal cord contusion (Figure 1).

The ultimate treatment of spinal injuries in athletes



Figure 4. Lateral cervical radiograph showing compression fracture of the C₆ vertebral body before (left) and after reduction (right) in a halo vest.

depends on several factors. It is helpful to first determine if the injury is neurological or skeletal. If it is the former and permanent, these athletes do not participate again in contact sports; although transient neurological injuries do not necessarily restrict future activities. One must endeavor to distinguish spinal cord from brachial plexus symptoms, the latter being burning in nature, usually in the C5-C6 distribution, and in one arm only (4,12). Symptoms involving more than one extremity suggest spinal cord origin.

Injuries to the skeletal column, if unstable on flexion-extension radiographs or if involving a significant structural component of the spine, usually are not compatible with future contact sport participation. Abnormalities such as spinal ligamentous instability, cervical canal stenosis (Figure 2), or spinal cord contusion usually preclude further contact sport participation. (5,7,15). Persons with herniated discs, congenial vertebral fusion, and degenerative changes must be considered on an individual basis. The need for external stabilization (bracing) or internal fixation (surgical) is determined by criteria for suspected healing rates (11).

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Effect of Three Lateral Knee Braces On Speed and Agility in Experienced and Non-Experienced Wearers

Lance M. Fujiwara, MEd, ATC
David H. Perrin, PhD, ATC
Barton P. Buxton, MEd, ATC,

ABSTRACT: The purpose of this study was to examine the effect of three lateral knee braces on speed and agility in subjects experienced as brace wearers and subjects with no prior experience as brace wearers. Nine subjects having prior experience and 10 subjects having no prior experience as brace wearers were tested for speed and agility under four treatment conditions including: 1) no brace, 2) McDavid Knee Guard, 3) Donjoy Defender, and 4) Anderson Knee Stabler. Subjects performed a 40 yard forward sprint and a 10 yard shuttle run during one test session, and a 20 yard backward sprint and a 40 yard square cone drill during a second test session. Analysis of Variance indicated that for experienced wearers, no differences were found between any of the treatment conditions during the 20 yard backward sprint, square cone drill, or shuttle run. During the 40 yard dash, the no brace times were faster than each of the braced times. For non-experienced wearers, significant differences were found between the no brace and braced times during the 40 yard dash, shuttle run, 20 yard backward sprint, and square cone drills. These findings suggested that for experienced wearers the effect of knee bracing is greatest on reducing only forward speed, while for non-experienced wearers both forward and backward running speed and agility is reduced. In general, little difference was found between the three braces during any of the performance tests.

Research has previously examined the role of prophylactic lateral knee bracing on joint biomechanics (1,5) and incidence of injury in football (3,4). Also of concern has been the effect of lateral knee bracing on performance. Knee braces have been shown to decrease forward running speed but not backward running and agility (6) and to have no effect on muscular strength, power, and endurance (2).

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Barton Buxton is Head Athletic Trainer at Fork Union Military Academy in Fork Union, Virginia, and a sports medicine doctoral student at the University of Virginia in Charlottesville, Virginia.

No research has examined the role of familiarization with bracing on athletic performance. Furthermore, no scientific evidence exists to substantiate the clinical impression that familiarization with bracing would presumably minimize any deleterious effects on performance. Thus, the purpose of this investigation was to examine the effect of three lateral knee braces on speed and agility in subjects experienced as brace wearers and subjects with no prior experience as brace wearers.

METHODOLOGY

Nineteen post-graduate military academy football players served as subjects (age = 19.3 yr, wt = 207 lb, ht = 73 in). Nine subjects had prior experience and were accustomed to wearing lateral braces and 10 subjects had no prior experience wearing a brace. All subjects were tested for speed and agility under four treatment conditions including no brace (NB), McDavid Knee Guard (MKG), Donjoy Defender (DJ) and Anderson Knee Stabler (OMNI). The braces were applied bilaterally with neoprene/velcro straps by a certified athletic trainer according to manufacturer guidelines.

Subjects were tested under four treatment conditions during two test sessions. Session I consisted of a 40 yard forward sprint and a 10 yard shuttle run. The shuttle run was designed to test lateral agility. Session II consisted of a 20 yard backward sprint and a 40 yard square cone drill. The square cone drill included a 10 yd forward sprint, 10 yd lateral shuffle, 10 yd backward sprint, and 10 yd carioca. Following a stretching period, subjects were given two practice trials per drill. Data collection consisted of one trial for each drill recorded as the mean of two hand held timings. The order of brace condition and performance test was randomized for each subject.

A one-way analysis of variance with repeated measures was computed for subjects experienced as brace wearers and for subjects having no prior experience as wearers for each of the speed and agility tests. Fisher LSD post hoc analysis was computed to determine how the two groups differed.

RESULTS

The mean times for the two speed and two agility tests for each treatment condition for all subjects are presented in

Table 1. For experienced wearers, no differences were found between any of the treatment conditions during the 20 yard backward sprint, square cone drill, or shuttle run. A significant difference was found during the 40 yard dash. ($F(3,24) = 5.23, p < .01$). The NB times were faster than each of the three braced times ($p < .05$).

For non-experienced wearers, a significant difference was found during the 40 yard dash ($F(3,27) = 3.98, p < .05$), shuttle run ($F(3,27) = 2.86, p < .05$), 20 yard backward sprint ($F(3,27) = 5.49, p < .01$), and square cone drill ($F(3,27) = 5.08, p < .01$). During the 40 yard dash, NB times were faster than both the MKG and DJ times ($p < .05$). During the shuttle run, NB times were faster than MKG ($p < .05$). The 20 yard backward sprint and square cone times were faster for NB than for each of the three brace conditions ($p < .05$).

Table 1. Average time (seconds) for performance tests (Mean \pm SE)

Condition	Performance Test							
	40 yd Dash		10 yd Shuttle Run		20 yd Backward Sprint		40 yd Square Run	
	Ex	NEx	Ex	NEx	Ex	NEx	Ex	NEx
NB	5.36 (.13)	5.11 (.07)	3.46 (.06)	3.29 (.09)	4.15 (.14)	3.75 (.11)	9.34 (.26)	8.76 (.21)
MKG	5.53 (.12)	5.27 (.07)	3.47 (.09)	3.48 (.08)	4.28 (.13)	3.93 (.10)	9.69 (.17)	9.12 (.24)
DJ	5.51 (.14)	5.22 (.07)	3.54 (.07)	3.37 (.09)	4.14 (.09)	3.86 (.10)	9.34 (.26)	9.11 (.30)
OMNI	5.51 (.13)	5.17 (.08)	3.52 (.07)	3.42 (.11)	4.23 (.15)	3.85 (.09)	9.59 (.21)	9.35 (.19)

NB (No Brace), MKG (McDavid Knee Guard), DJ (DonJoy Defender), OMNI (Anderson Knee Stabler), Ex (Experienced Wearer), NEx (Non-Experienced Wearer)

DISCUSSION

The prevalence of prophylactic knee bracing in football has previously been documented (3,4,6). The purpose of this investigation was not to criticize the efficacy of such bracing, but rather to determine if any difference existed between those accustomed to wearing a brace and those without previous familiarity with bracing.

For both experienced and non-experienced wearers, 40 yd dash times were faster for the no brace (NB) condition than for all but one brace condition, which is consistent with data reported by Prentice and Toriscelli (6). All three brace conditions were slower for non-experienced wearers during the backward running test. Moreover, we found that backward running had no effect on experienced wearers, as

also shown by Prentice and Toriscelli (6). The implication of these findings demonstrate that familiarization with brace wearing for players involved in backward running, for example linebackers and defensive backs, would seem beneficial. In addition, the non-experienced wearers displayed faster times for the NB condition than for all three brace conditions on the square cone drill. The square cone drill would also seem to replicate activities more commonly associated with defensive specialty players, and thus the need for familiarization.

This investigation demonstrated that essentially no differences exist between the three brace conditions for either the agility or speed tests for experienced wearers. This finding suggests the rationale for brace selection should be based on player or clinician preference rather than on the brace's potential effect on performance.

The implication of these findings with regard to clinical practice suggests that players given the opportunity to become familiar with lateral knee braces may experience a decrement in only forward sprinting performance. In contrast, first time wearers are likely to experience some reduction in both forward and backward running speed and agility. The magnitude of this effect on actual on-field performance remains unclear. However, these findings would seem to justify the use of brace wearing in practice and conditioning situations to enhance familiarization and reduce potential detrimental effects on performance.

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Tip From the Field

Bubble Packing: An Alternative Technique For Padding Severe Thigh Contusions

Dan Sims, PT
Jeanne M. Markey, MA, ATC

A contusion of the quadriceps muscle is produced by an external force significant enough to damage the muscle, yet not completely eliminate its function as a prime mover of the tibia about the femur. This injury is most common in young males ranging from age 15 to 20 years of age and a high percentage of these injuries are related to contact sports (1,2). Even though the underlying tissue may still be in the final stages of healing, the athlete may safely participate if heavily padded and protected against further injury.

If the athlete returns to competition too soon and the quadriceps muscle continues to be traumatized, the contusion may become severe enough to yield heterotrophic bone formation in the underlying muscle mass (1,3). This formation of lamellar bone tissue is a response to muscle fibers, underlying connective tissues, blood vessels and periosteum being continuously traumatized. The resulting condition is myositis ossificans traumatica.

In most training rooms, hard plastics, heavy felt and manufacturers' pads are used to protect quadriceps muscle contusions. The purpose of this tip is to demonstrate how 2-inch bubble packing can be applied as an alternative form of quadriceps contusion protection, preventing further injury during competitive play.

The athletic trainer has expertise in padding and strapping techniques; therefore, it may be helpful to utilize the following cost effective, light weight material for contusion protection.

PROCEDURE FOR APPLYING BUBBLE PACK

Materials

Tape adherent
pre-wrap
2 ft x 1 ft sheet 2 inch bubble pack
6 inch elastic wrap
1½ inch elastic tape

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Jeanne M. Markey is the athletic trainer at W.C. Hinkley High School in Aurora, Colorado and is employed at the Colorado Athletic Conditioning Clinic, Aurora, Colorado as a clinical athletic trainer.



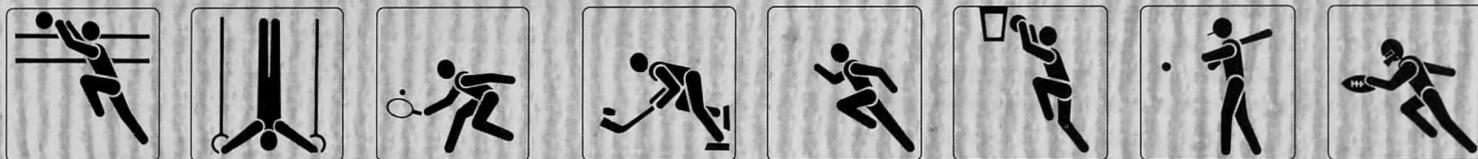
Figure 1. Athlete with residual echymosis following contusion injury.



Figure 2. Application of pre-wrap above and below contusion site.



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Figure 3. Placement of bubble pack over region of insult.



Figure 4. Securing bubble pack in place with elastic wrap.



Figure 5. Athlete wearing thigh pad over bubble pack padding.

Position for Application

The athlete stands with the injured thigh facing forward and the knee in a 15 degree flexed position with the quadriceps muscle contracted. (Contracting the quadriceps muscle will decrease the chances of a tourniquet effect from a wrap secured too tight.) To assist the athlete in this flexed position, place a 2-inch lift under the heel until the wrap is completed.

Application

After the athlete is positioned and the contused area is located (Figure 1), tape adherent and pre-wrap are applied two inches above and below the contusion site (Figure 2). Two-inch bubble pack material is then applied to cover the same area and may be doubled if greater protection is needed (Figure 3). A 6-inch elastic wrap is applied to secure the bubble pack in place (Figure 4). Elastic tape may be used instead of the elastic wrap or it may be utilized to secure the elastic wrap from slipping. The athlete then wears a large thigh pad in his game pants which also helps hold the bubble pack in place about the thigh, as seen in Figure 5.

The bubble pack padding is not as cumbersome as other bulky padding techniques, thus allowing the athlete to compete without loss of motion. This form of padding is not limited to a contused thigh, but may be utilized in other areas, such as the ribs, iliac crest, and the brachii soft tissue.

ACKNOWLEDGMENT

Special thanks to my friend and colleague Steve Stepp, ATC, for allowing me to experience the real meaning of sports medicine.

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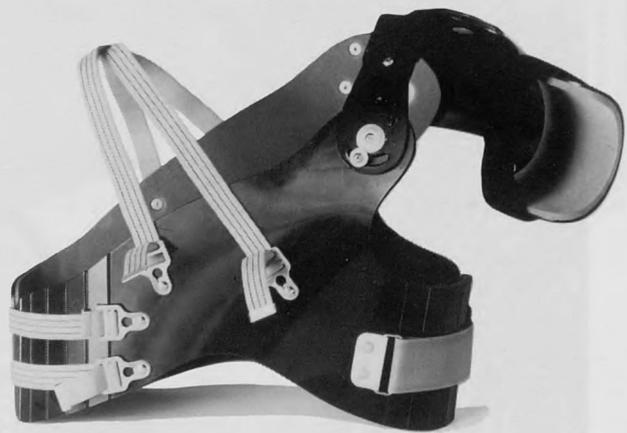
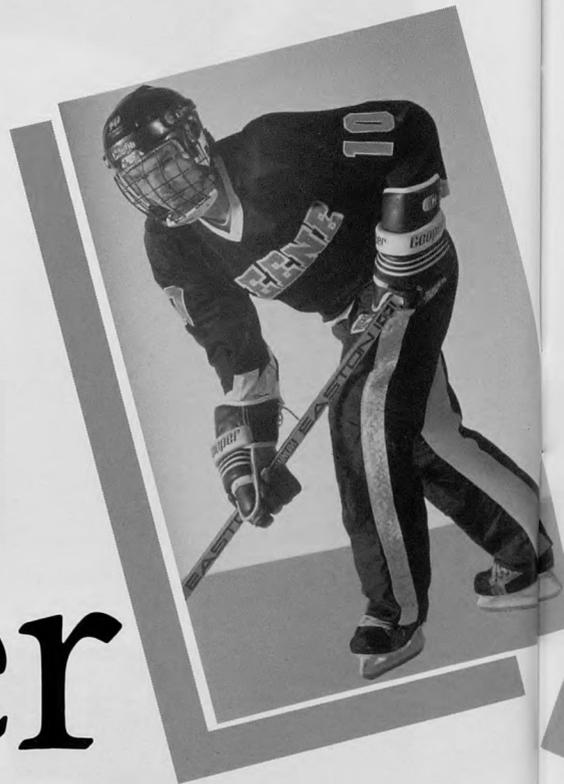
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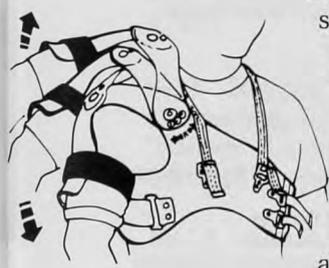
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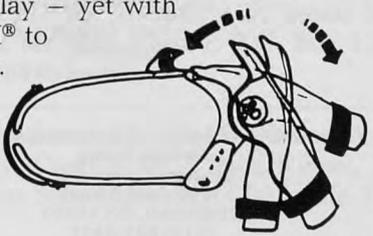


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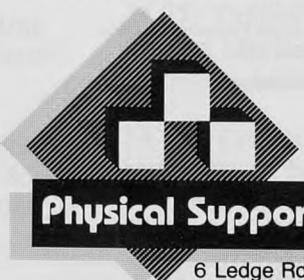
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National Athletic Trainers Association, Inc.

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June 9-13, 1990

Saturday, June 9

NACDA Seminar - Drug and Alcohol Seminar
Evening - Gatorade Welcome Party

8:00 a.m. — 8:30 a.m.

—Keynote Address - Coach Bobby Knight
"A Perspective of Athletics in the 1990s"

8:30 a.m. — 12:00 p.m.

—Closed Kinetic Chain/Biomechanics
—Clinical Biomechanics

Sunday, June 10

A.M.

Session I: AOSSM Seminar - Knee Injuries

Session II:

8:30 a.m. — 12:00 p.m.

Shoulder

—Global Instability of the Shoulder
—Labrum Tears and Instability of the Shoulder
—Shoulder Impingement Syndrome
—Rotator Cuff Dysfunction
—Rehabilitating Shoulder Problems

Session II: PFATS Workshop - Performance Enhancement

Session III:

8:30 a.m. — 12:00 p.m.

—High School Athletic Trainers Workshop

P.M.

SCHERING SYMPOSIUM: EATING DISORDERS

EVENING

Session I: PBATS - Elbow Injuries

Session IV:

8:30 a.m. — 10:30 a.m.

—Dental Injuries in Athletics

Session II: Women's Conference

11:00 a.m. — 12:00 p.m.

—Free Communications

Monday, June 11

A.M. - 3 Concurrent Sessions

Session I:

7:00 a.m. — 8:00 a.m.

—10 Mini Sessions - See Registration

8:30 a.m. — 9:00 a.m.

—Welcome and Opening Remarks

9:00 a.m. — 9:30 a.m.

—Keynote Address - Milton Thompson, J.D.
"The Amateur Sports Movement"

9:30 a.m. — 10:00 a.m.

—"Psychology of the Athletic Trainer - Learning More About Ourselves"

10:00 a.m. — 10:30 a.m.

—"Counseling the Athlete"

11:00 a.m. — 1:00 p.m.

—National Business Meeting

Session II:

9:30 a.m. — 11:00 a.m.

—Poster Presentations

Session III:

9:00 a.m. — 10:00 a.m.

—Licensure Committee "Town Meeting"

10:00 a.m. — 10:30 a.m.

—Orthotics in the Training Room

P.M. - 5 Concurrent Sessions - 2:00 P.M. - 4:30 P.M.

Session I:

Conditioning/Performance Training

—Training of the High School Multi Sport Athlete

—Running Development of the College Athlete

—Strength Development of the Professional Athlete

—Developing Speed and Quickness

Session II:

Manual Therapy - An Overview

—Concepts of Joint Mobilization

—PNF - Theory and Clinical Application

—Deep Friction Massage

—Soft Tissue and Myofascial Techniques

Session III:

2:00 p.m. — 3:00 p.m.

—Student Trainer Workshop

Session IV:

2:00 p.m. — 3:00 p.m.

—Gatorade Seminar

3:30 p.m. — 4:00 a.m.

—NCAA Report - Randy Dick

4:00 p.m. — 4:30 p.m.

—Follow-Up Study on Paper Presented by Dr. Donald Cooper 20 Years Ago

Session V:

Seminar on Research Techniques

4:30 p.m. — 6:00 p.m.

—District Meetings

P.M. - 4 Concurrent Sessions - 2:00 P.M. - 5:00 P.M.

Session I:

Isokinetics

—Isokinetic Equipment & Its Application to Rehabilitation

—Clinical Application of Isokinetics

—Isokinetic Research

—Issues and Answers in Isokinetics

Session II:

Overuse Syndromes

—Biomechanics of the Foot and Ankle

—Lower Leg Compartment Syndrome

—Ankle/Foot Overuse Problems

—Herniated Lumbar Disc - Surgical Management

—Back Pain - The Organic Approach

—Muscular Imbalances

Session III:

Clinical/Industrial Athletic Trainers Seminar

Session IV:

Free Communications

Evening - Annual Awards Banquet

Wednesday, June 13

Session I:

8:15 a.m. — 9:15 a.m.

—Sports Vision: A Guideline for Screening and Training

9:15 a.m. — 10:00 a.m.

—Sexually Transmitted Diseases

10:00 a.m. — 10:30 a.m.

—Erythropoietin - Use and Misuse

10:30 a.m. — 11:00 a.m.

—Endocrinological Concerns of the Competitive Athlete

Session II:

8:15 a.m. — 9:00 a.m.

—ACLs - Researching Repairs and Rehabilitation

—Meniscal Repairs and Transplants

—ACLs and the Female Athlete

—Knee Injuries - A Road to Total Joint Replacement

—New Orleans - "1991" - Dean Kleinschmidt

Tuesday, June 12

A.M. - 5 Concurrent Sessions

Session I:

7:00 a.m. — 7:45 a.m.

—10 Mini Sessions as Per Monday
See Registration

For Information on Product Exhibits Contact:

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Calendar of Events

Jeff Fair, EdD, ATC, CCT

ATHLETIC TRAINING will list events of interest to persons involved in sports medicine, providing items are received well in advance of publication. Please include the name and address of the person to contact for further information. Send items for the CALENDAR to Jeff Fair, Ed.D., ATC, Head Athletic Trainer, Athletic Department, Oklahoma State University, Stillwater, OK 74078.

Refer to the following dates to ensure your event will appear in the desired issue.

ISSUE	COPY DUE DATE
Spring	December 15
Summer	March 1
Fall	June 15
Winter	September 15

MAY

22-25 37th American College of Sports Medicine Annual Meeting, Salt Lake City, UT. Contact American College of Sports Medicine National Center, P.O. Box 1440, Indianapolis, IN 46206-1440.

27-31 Sixteenth Annual Convention of the Association for Behavior Analysis, Nashville, TN. Contact ABA, Western Michigan University, 258 Wood Hall, Kalamazoo, MI 49008-5052.

JUNE

3-6 Cramer Student Workshop, Eastern Kentucky University. Contact Dr. Bobby Barton, Eastern Kentucky, Athletic Department, Richmond, KY 40475.

11-15 Cramer Coaches Clinic, University of Oregon. Contact Rick Troxel, Department of Physical Education, 153 Gerlinger Annex, University of Oregon, Eugene, OR 97403.

9-13 National Athletic Trainers' Association National Convention, Indianapolis, IN. Contact National Athletic Trainers' Association, 2952 Stemmons, Suite 200, Dallas, TX 75247.

16-17 Advanced Isokinetics and Eccentric Exercise Course, La Crosse, WI. Contact GJD Advanced Educational Conferences, S&S Publishers, 1707 Jennifer Court, Onalaska, WI 54650.

17-20 Cramer Student Workshop, Arkansas State University. Contact Mr. Ron Carroll, P.O. Box 1225, State University, AR 72467.

17-20 Cramer Advanced Student Workshop, Austin Peay State University. Contact Mr. Chuck Kinnel, P.O. Box 4515, Austin Peay State University, Clarksville, TN 37044.

17-20 Cramer Advanced Student Workshop, Ball State University. Contact Mr. Rex Sharp, 2000 University Avenue, Ball State University, Muncie, IN 47306.

17-20 Cramer Student Workshop, Emporia State University. Contact Mr. John Baxter, 1200 Commercial, Emporia State University, Emporia, KS 66801.

17-20 Cramer Student Workshop, University of Wisconsin - Platteville. Contact Ms. Mary LaRue, 1 University Plaza, University of Wisconsin - Platteville, Platteville, WI 53818.

17-21 14th Annual Basic and Advanced Athletic Training Workshop for High School Students, Pittsburgh, PA. Contact Kerry Waple, Athletic Training Education Program, Suite 140 Trees Hall, University of Pittsburgh, Pittsburgh, PA 15261, (412) 648-8264.

17-21 Cramer Coaches Clinic, Washburn University. Contact Mr. Steve Ice, Washburn University, 17 & College, Topeka, KS 66621.

17-22 Student Trainer Workshop, Columbus, OH. Contact Linda W. Daniel, The Ohio State University, 410 Woody Hayes Drive, Columbus, OH 43210.

18-20 Universal Fitness Institute, Cedar Rapids, IA. Contact Universal Gym Equipment, Inc., P.O. Box 1270, Cedar Rapids, IA 52406.

20-23 The Art and Science of Sports Medicine, Charlottesville, VA. Contact Joe Gieck, University of Virginia, P.O. Box 3785, Charlottesville, VA 22903.

24-27 Cramer Student Workshop, University of Charleston. Contact Mr. Joe Beckett, Department of Sports Medicine, 2400 MacCorkle Avenue, Charleston, WV 25304.

24-27 Cramer Student Workshop, Indiana University. Contact Mr. Dean Plafcan, Department of Intercollegiate Athletes, Assembly Hall, Indiana University, Bloomington, IN 47405.

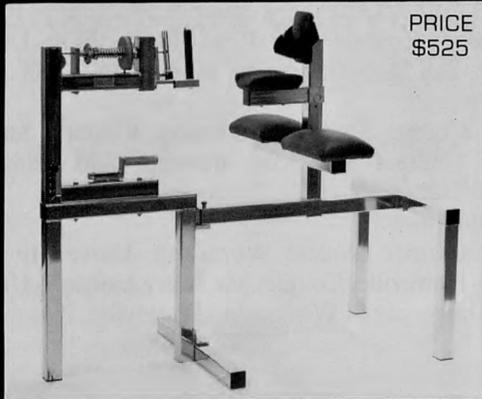
24-27 Cramer Basic and Advanced Student Workshop, Kent State University. Contact Mr. John Faulstick, Dix Stadium, Kent State University, Kent, OH 44240.

24-27 Cramer Student Workshop, Millersville University. Contact Mr. Hank Fijalkowski, Pucillo Gym, Millersville University, Millersville, PA 17551.

24-27 Cramer Basic and Advanced Student Workshop, University of North Texas. Contact Mr. George Young, P.O. Box 13917, University of North Texas, Denton, TX 76203.

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24-27 Cramer Student Workshop, Salisbury State. Contact Mr. Pat Lamboni, Athletic Training Room, Salisbury State University, Salisbury, MD 21801.

24-28 Cramer Coaches Clinic, Montclair State University. Contact Mr. John Davis, Athletic Department, Montclair State College, Upper Montclair, NJ 07043.

24-28 Cramer Coaches Clinic, University of Florida. Contact Mr. Ron Siders, Department of Exercise & Sport Science, 302 Florida Gymnasium, Gainesville, FL 32611.

25-27 Sports Medicine Symposium, Huron, OH. Contact The Cleveland Clinic Educational Foundation, Department of Continuing Education, 9500 Euclid Avenue, Room TT-31, Cleveland, OH 44195-5241.

JULY

5-8 Orthopaedic Sports Medicine Seminar, Hilton Head Island, SC. Contact George M. Converse, M.D., Director of Medical Education, Lloyd Noland Hospital, 701 Lloyd Noland Pkwy., Fairfield, AL 35064.

8-11 Cramer Student Workshop, University of Colorado. Contact Mr. Dave Burton, University of Colorado, Box 368, Boulder, CO 80309.

8-11 Cramer Student Workshop, Northern Illinois. Con-

tact Mr. Bob Cochrane, Huskie Stadium, Northern Illinois University, DeKalb, IL 60115.

13-17 Cramer Coaches Clinic, Texas Tech. Contact Mr. Ken Murray, P.O. Box 4199, Athletic Department, Texas Tech University, Lubbock, TX 79409.

15-18 Cramer Student Workshop, Arizona State University. Contact Mr. Dave Grossman, Arizona State University, IAC-2nd Floor, Tempe, AZ 85287-2505.

15-18 Cramer Student Workshop, McNeese State University. Contact Mr. Ricky Mestayer, McNeese State University, P.O. Box 92735, Lake Charles, LA 70609.

15-18 Cramer Student Workshop, The College of William and Mary. Contact Steve Cole, College of William and Mary, P.O. Box 399, Williamsburg, VA 23185.

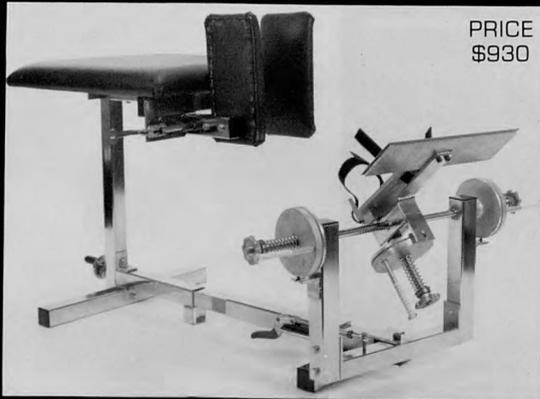
16-20 8th Annual Student Trainer Workshop, Dayton, OH. Contact Jerry Whetstone, ATC, 513/229-6692.

22-25 Cramer Student Workshop, Seattle Pacific College. Contact Bob Grams, School of P.E. and Athletics, Seattle Pacific University, Seattle, WA 98119.

22-25 Cramer Advanced Student Workshop, Western Illinois University. Contact Mr. Don Zylks, 220 Brophy Hall, Western Illinois University, Macomb, IL 61455.

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22-25 Cramer Advanced Student Workshop, The College of William and Mary. Contact Steve Cole, College of William and Mary, P.O. Box 1399, Williamsburg, VA 23185.

26-29 The Family Physician in Sports Medicine, Minneapolis, MN. Contact Pamela Williams, Manager, CME Production and Development, The American Academy of Family Physicians, 8880 Ward Pkwy., Kansas City, MO 64114-2797.

29-August 1 Cramer Student Workshop, Furman University. Contact Mr. Bruce Getz, Athletic Department, Furman University, Greenville, SC 29613.

29-August 1 Cramer Student Workshop, Grand Valley State University. Contact Ms. Deborah Springer, College Landing, Allendale, MI 49401.

29-August 1 Cramer Advanced Student Workshop, University of Northern Colorado. Contact Mr. John Libera, University of Northern Colorado, Greeley, CO 80639.

AUGUST

5-8 Cramer Student Workshop, Northeastern University. Contact Mr. Chad Starkey, Northeastern University, 215 Cabot, Boston, MA 02115.

5-8 Cramer Student Workshop, University of South Florida. Contact Mr. Barry Clements, Department of Athletics, Tampa, FL 33620.

6-8 Universal Fitness Institute, Cedar Rapids, IA. Contact Universal Gym Equipment, Inc., P.O. Box 1270, Cedar Rapids, IA 52406.

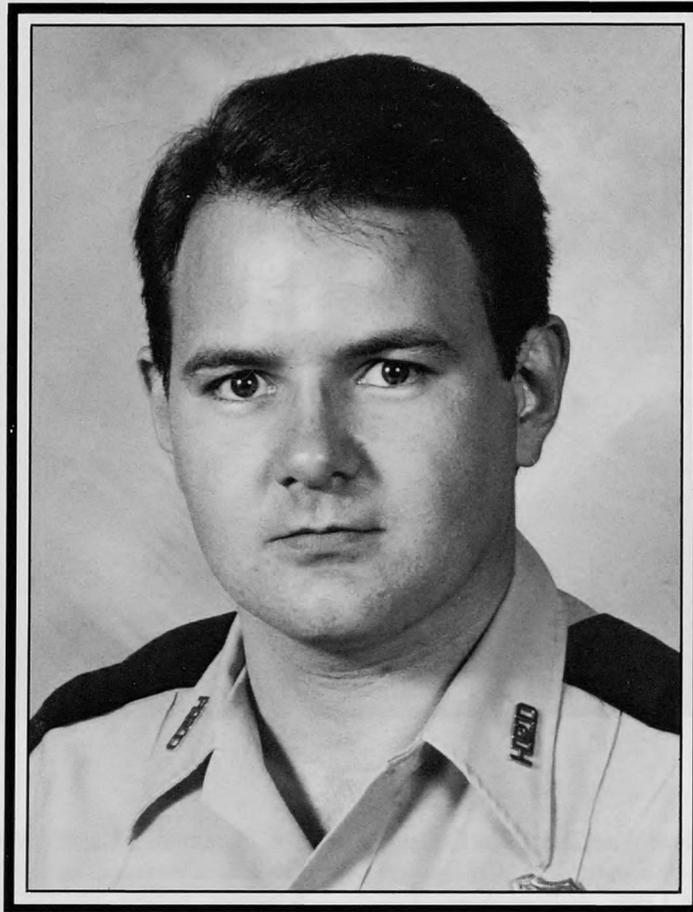
12-15 Cramer Student Workshop, University of California-Riverside. Contact Mr. Jim Clover, The S.P.O.R.T. Clinic, 4444 Magnolia Avenue, Riverside, CA 92501.

22-26 9th Annual Convention of the National Association of Orthopaedic Technologists, Richmond, VA. Contact Pamela M. Buckman, NAOT, P.O. Box 1829, Martinez, CA 94553. ☉

MOVING?

Please notify the National Headquarters of your new address as well as your old address (at least 30 days in advance of publication).

In Memoriam



James Charles Boswell

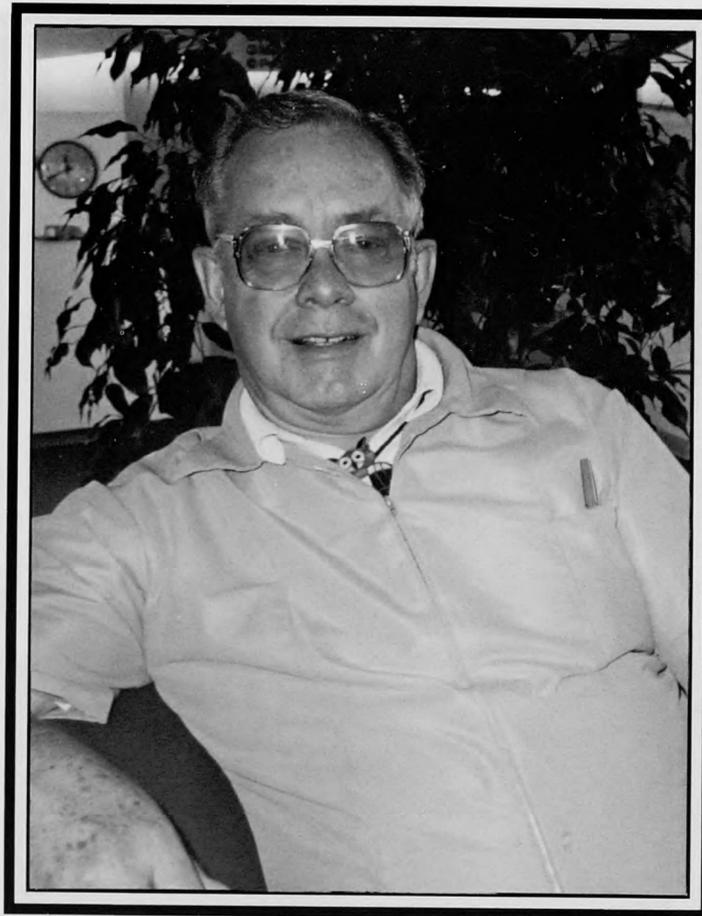
November 29, 1960 — December 9, 1989

James C. Boswell, a certified athletic trainer and a patrol officer with the Houston, Texas Police Department, was killed while on duty December 9, 1989. James was 29 years old.

Mr. Boswell graduated from Lamar University with a degree in athletic training. He worked for a short time as a teacher and trainer at Liberty High School, Liberty, Texas. After leaving Liberty High School, he joined the Houston, Texas Police Department.

He is survived by his parents, Cecil and Martha Boswell, three brothers and one sister.

In Memoriam



C. Richard Hix

November 14, 1922 - December 26, 1989

C. Richard Hix, a certified athletic trainer and a physical therapist, passed away on December 26, 1989. He was 67 years old.

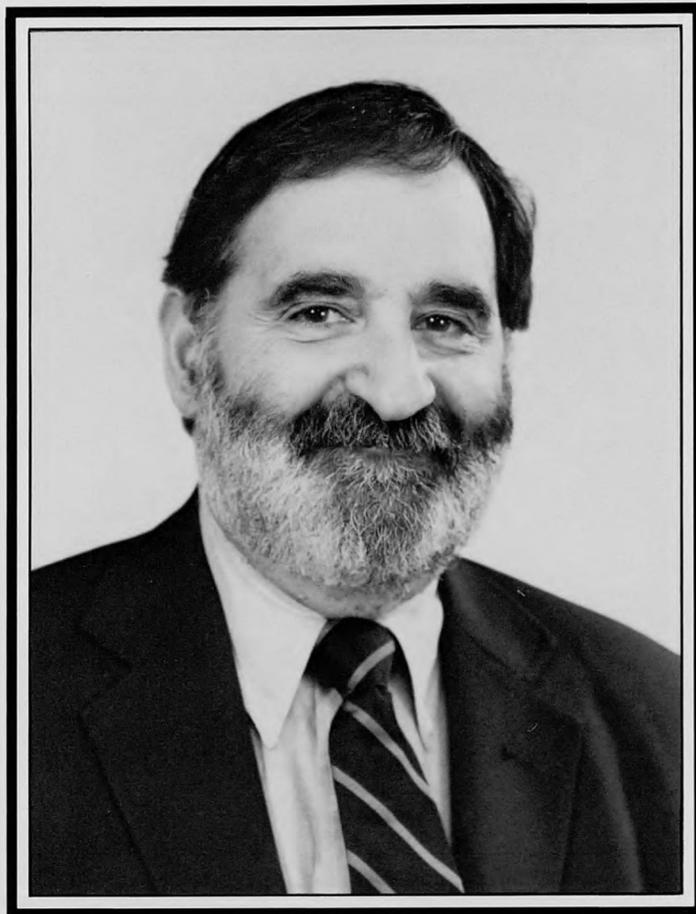
Richard attended Washington State University where he received a teaching credential in physical education. He then received his physical therapy degree from Stanford University. He served in the Army during World War II and received the Silver Star and the Purple Heart.

He served in clinics as a physical therapist and certified athletic trainer in Spokane, Washington; Yerington, Nevada; and Roseburg, Oregon.

He was associated with the Western Hockey League from 1949 to 1974. He was instrumental in establishing a supervised athletic training program in the Spokane area high schools and the high schools in Yerington, Nevada.

He is survived by his wife, Jody, and three children, Connie, Charles R., and Tom.

In Memoriam



Kerkor "Koko" Kassabian

December 12, 1929 — November 18, 1989

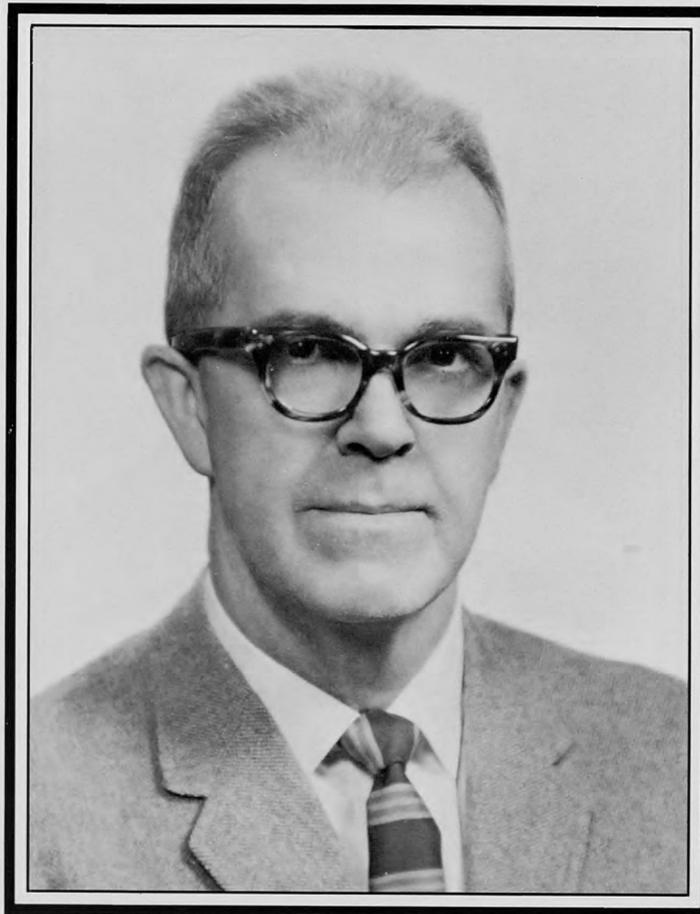
Kerkor Kassabian, known as "Koko", was an Associate Professor of Health Sciences and Athletic Training Program Director at Northeastern University in Boston, Massachusetts for fourteen years. He was the founder of Northeastern's Sportsmedicine Program. For twelve years (1953-1965) he served as the Head Athletic Trainer at Northeastern University. He was also the Head Athletic Trainer for a professional football team, the Boston Olympics hockey team, the Newton Pop Warner League and Newton North High School.

As much as "Koko" was a teacher, he always was a student. He was quoted many times to say, "You're never too old to learn. I always listen to my students." "Koko" felt life is people helping people and working together to make a better life for everyone—not just a few. He was happy, genial, helpful, available and cared deeply about his work and friends.

Mr. Kassabian held several leadership positions in Athletic Training at the state, district, regional and national levels. In 1986, he was inducted into the National Athletic Trainers' Association Hall of Fame. He was also a member of Northeastern's Hall of Fame. He served his country in the Armed Forces during the Korean War.

He is survived by his wife Elizabeth and two sons, Greg and Paul.

In Memoriam



Lenwood Paddock

May 21, 1915 — February 5, 1990

Lenwood "Lennie" Paddock, an assistant athletic trainer at the University of Michigan for 33 years passed away on February 5, 1990. He was 75 years old.

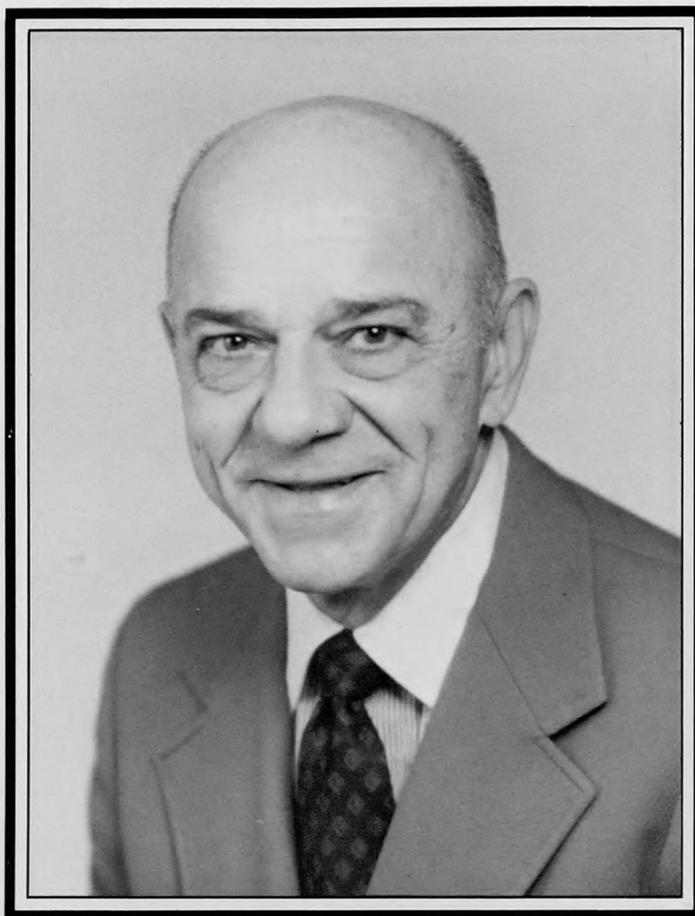
After serving his country in the Air Force, Lennie returned to the University of Michigan and completed a Master's degree in 1947. That year he joined the athletic training staff at the University of Michigan. He served the athletes, coaches, administrators and his fellow colleagues until his retirement in 1980.

His love for the individual athlete was his greatest joy. He had the ability to make all the athletes feel they were All-Americans in his eyes. He was loved by all whose lives he touched.

Lennie received numerous awards and honors. He was given honorary membership in two Michigan honorary societies. The Michigauma bestowed on Lennie their honorary "M" club membership. He was also voted an honorary Druid at Michigan. The Lenwood "Lennie" Paddock Memorial scholarship has been established in his honor. This scholarship will benefit student athletic trainers.

He was preceded in death by his wife, Betty. They had no children.

In Memoriam



Paul J. Schneider

December 17, 1915 — January 5, 1990

Paul J. Schneider, affectionately known as "Schnitz," passed away after a long illness on January 5, 1990. He was 75 years old.

Paul served as the Head Trainer at the University of Nebraska for 25 years before retiring in 1976 as the Head Trainer to become an Administrative Assistant to Jim Ross—Bob Devany Sports Center Director. He retired from the University of Nebraska in 1982.

Paul received many honors during his career. They include induction into the NATA Hall of Fame in 1985, election to the Nebraska Basketball Hall of Fame, reception of the Nebraska Football Hall of Fame special Merit Award and a 25 Year Award from the NATA.

He served his country as a captain in the U.S. Army Air Corps.

Paul, who was known as one of the most colorful characters in Nebraska Intercollegiate Athletics, will be missed by all whose lives he touched.

He is survived by his wife Georgia, and four children, Connie, Pam, Cyndi, Jeff and ten grandchildren.

In Memoriam



George Allen Utterback

September 16, 1919—September 24, 1989

George A. Utterback, the first full-time athletic trainer in the Corpus Christi Independent School District, passed away September 24, 1989 at the age of 70.

Before becoming a Texas school district athletic trainer, he was at one time the winningest high school basketball coach in the Corpus Christi Independent School District. From 1964-1970 he devoted his entire effort to the school district as a full-time athletic trainer. He retired from athletic training in 1970.

He served in the Army during World War II and received numerous medals, including the Bronze Star.

George touched many lives as a coach and trainer. He will be missed by all those whose privilege it was to have known him.

He is survived by his wife of 34 years Irma and and three children, Laura, David, George Jr. and four grandchildren.

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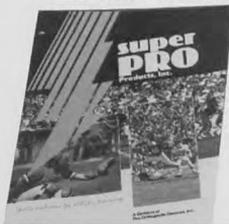
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Book Review

Phil Callicutt, EdD, ATC

Coaches Guide To Sports Injuries

J. David Bergeron and Holly Wilson Greene

Human Kinetics Publishers, Inc.

P.O. Box 5076

Champaign, IL 61825-5076

1989

211 pages: Illustrated

Price: \$16.00

Because of my strong interest in athletic trainer education at all levels, especially at the secondary level, I am always searching for quality texts, and again I have discovered one which I would like to share with our readership. As I have stated on more than one occasion, the market is saturated with all types of textbooks dealing with sports medicine and injury management. As sports medicine educators we have to select diamonds from the rock pile, **Coaches Guide To Sports Injuries** is one such diamond.

The authors have written this text with the high school coach in mind, but I found it to be an excellent source of information for all individuals who are charged with the care of injured athletes. It is more than just a band-aid approach to injury care. This comprehensive text teaches the reader how to prevent, care for, and rehabilitate common sports injuries and conditions. It is skillfully divided into three parts: Understanding Sports Injuries, Emergency Care of Sports Injuries, and Follow-Up Care. These three parts are then subdivided into twenty well written and concise chapters dealing with The Coach's Role, Assessing the Athlete for Injuries and Medical Emergencies, Basic Life Support, Soft Tissue Injuries, Environmental Factors, Moving the Injured Athlete, Heat and Cold Therapy, Therapeutic Taping, and closes with a chapter on Taping Patterns.

Coaches Guide to Sports Injuries is a joint effort of J. David Bergeron, an instructional technologist, and Holly Wilson Greene, an athletic trainer with twenty years of expertise in the field. The authors have made this text a guide for high school coaches and student trainers. It is written in plain language, and is easy to understand. This text is an excellent beginning for coaches and student trainers who desire a basic knowledge of the science of sports medicine. ⊕

ATTENTION NATA MEMBERS

Contact the National Headquarters in Dallas, Texas (telephone: 214/637-6282) for Association matters OTHER THAN those relating to the Certification Office, which will continue operations in Greenville, North Carolina (telephone: 919/355-6300) until further notice.

The Journal production office may be reached at telephone 919/355-5144.

Video Review

Tom Gocke, MS, ATC

Nutrition and Eating Disorders in College Athletics

Part I: Afraid to Eat: Eating Disorders and the Student Athlete

Part II: Out of Balance: Weight and Nutrition

Part III: Eating Disorders: What can we do?

National Collegiate Athletic Association

6201 College Boulevard

Overland Park, KS 60211-2422

45 minutes (3 tapes, 15 minutes/tape)

½" VHS Color, Supplemental Information

Price: \$14.95/tape, \$39.95/set of 3 tapes*

Nutrition and Eating Disorders in College Athletics is the educational program developed by the NCAA committee on Women's Athletics and the Committee on Safeguards and Medical aspects of Sports. This video tape specifically addresses Eating and Nutritional disorders. The purpose of **Nutrition and Eating Disorders** is to educate the student athlete, coaches, athletic trainers and athletic department staff about the effects eating and nutritional problems have on the student athlete. The primary focus is not limited to the changes in competitiveness but also delves into the physiological, psychological and emotional changes that accompany this phenomenon. Particular attention is devoted to Anorexia Nervosa and Bulimia. These are the two most often reported eating disorders.

While most people concern themselves only with the eating disorder aspects of nutritional problems, **Nutrition and Eating Disorders in College Athletics** also focuses on the necessity of maintaining a well balanced intake of nutrients. The area of emphasis centers around the proper factors for weight loss and the importance a well balanced diet plays in sustaining athletic performance. An important point is made regarding "standard height-weight charts".

Originally it was thought that if you were a certain height then your body weight should correspond to that listed on the height-weight chart. However, this is a poor standard, at best, for measuring the athlete's ideal body weight. The height-weight charts were developed by insurance companies for determining supposed premium rates and the health of the proposed insured. What it did not take into account is that no two people, athletes and non-athletes, are alike. The NCAA's Eating Disorders Project suggests that the athlete's competitive body weight be determined by body composition measurements and not by some arbitrary, out-dated chart.

The measurement of body composition means that the athlete's height, lean body weight and fat composition are all taken into account when calculating body weight. More importantly, this process is individualized for each athlete. Thus, an acceptable, safe approach can be achieved to monitoring the athlete's body weight.

The final part addresses intervention strategies dealing with the athlete who has an eating disorder. The NCAA highlights the importance of detecting the warning signs that may indicate the athlete has a nutrition problem. The importance of pre-planning and the establishment of an eating disorders team are also discussed.

I found the NCAA's project on eating disorders and
continued on page 194

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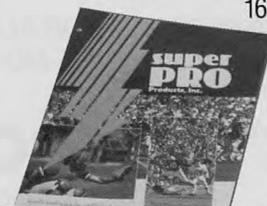
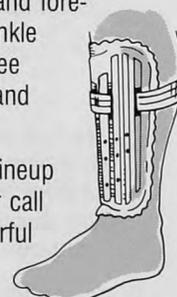
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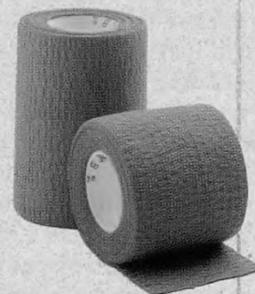
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Madison, WI 53705

Membership

Don Lowe
Syracuse University
Syracuse, NY 13210

Memorial Resolutions

Earlene Durrant
Brigham Young University
Provo, UT 84602

Minority Athletic Trainers

Phil Horton
Florida A & M University
Tallahassee, FL 32307

National Convention

Fred Hoover
Clemson University
Clemson, SC 29633

Placement

Ronald Medlin
Cleveland Browns
Burea, OH 44017

Professional Education

Bob Behnke
Indiana State University
Terre Haute, IN 47809

Public Relations

Bobby Barton
Eastern Kentucky University
Richmond, KY 40475

Research & Injury

John Powell
University of Iowa
Iowa City, IA 52242

Student Trainers

Ken Locker
Dallas Cowboys
Irving, TX 75063

Certification

Certification Examination Schedule for 1990

All regional sites are subject to a **minimum** of six candidates per site and limited to a **maximum** of forty candidates. Completed applications must be received by the Certification Office within the prescribed deadline for the examination date chosen.

January 14, 1990 — Deadline for the receipt of application is December 8, 1989.

Albuquerque, NM	Kansas City, MO
Boston, MA	Montclair, NJ
Chicago, IL	Mt. Pleasant, MI
Columbia, SC	Omaha, NE
Costa Mesa, CA	Orlando, FL
Eugene, OR	Pittsburgh, PA
Fort Worth, TX	Santa Clara, CA
Granville, OH	

May 20, 1990 — Deadline for the receipt of application is April 6, 1990.

Anderson, IN	Kansas City, MO
Boston, MA	Lexington, KY
Caldwell, NJ	Minneapolis, MN
Chicago, IL	New Britain, CT
*Columbia, SC	Phoenix, AZ
Costa Mesa, CA	Santa Clara, CA
Denver, CO	Seattle, WA
Hershey, PA	
Houston, TX	

*changed to May 12

July 8, 1990 — Deadline for the receipt of application is June 1, 1990.

Ann Arbor, MI	Kansas City, MO
Boston, MA	Madison, WI
Cheney, WA	Minneapolis, MN
Claymont, DE	Omaha, NE
Costa Mesa, CA	Raleigh, NC
Dayton, OH	Salem, OR
Denver, CO	Santa Clara, CA
Edinboro, PA	Scranton, PA
Ft. Worth, TX	St. Louis, MO
Indianapolis, IN	

November 18, 1990 — Deadline for the receipt of application is October 5, 1990.

Albuquerque, NM	Mechanicsburg, PA
Anderson, IN	New Britain, CT
Birmingham, AL	Providence, RI
Bowling Green, OH	Seattle, WA
Madison, WI	

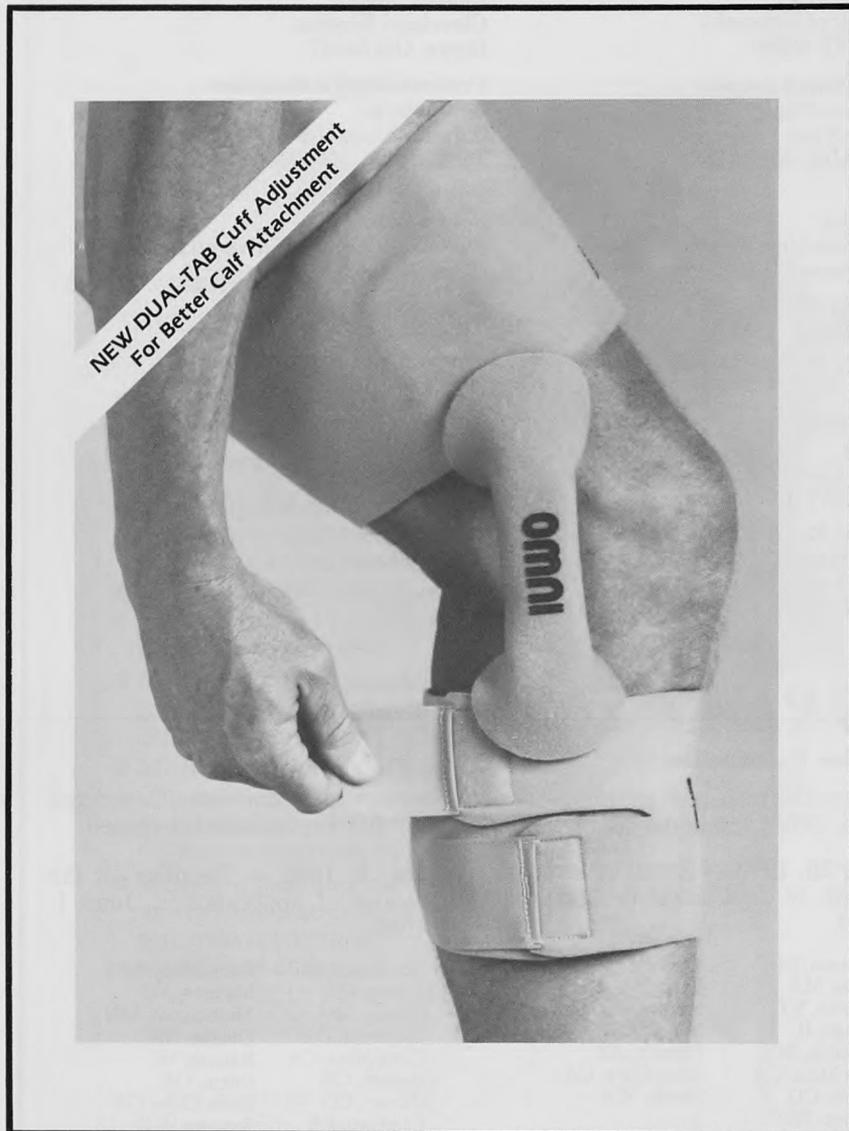
July 9, 1990 — Deadline for the receipt of application is June 1, 1990.

Columbus, GA

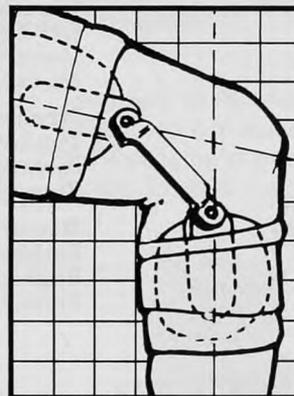
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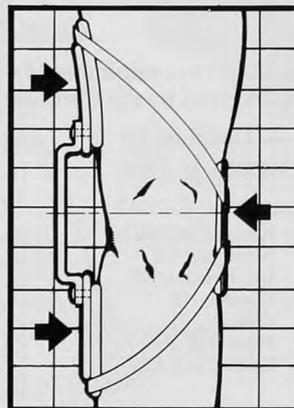


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Placement

To: Members

From: Ron Medlin, Committee Chair

The Placement Committee would like to present the following guidelines for the NATA Convention. We hope that these guidelines will help eliminate previous problems that you have had in prior meetings. If you have any questions, feel free to contact your district representative or myself.

Placement Procedures

1. Do not post announcements except through the placement desk.
2. All job announcements will be typed onto standardized forms. These forms will be color-coded according to specific job area (e.g., high school: blue; college: green, etc.).
3. If possible, send job announcement by May 25th to Greg Williamson, Anderson University, Anderson, IN 46012.
4. To sign up for job interview, see placement desk.
5. See bottom of job listing to check whether or not position is conducting interviews at convention.
6. Anyone who may wish to interview at the convention should bring resumes to leave at placement desk.
7. Placement hours Monday-Wednesday 8 a.m.-5 p.m.

Again, if there is a problem, check with the placement desk, and we will assist you as quickly as possible. ☺



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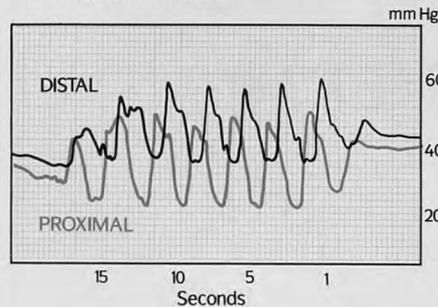
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References: Please call 1-800-526-8785 for reprints and further information.

1. Bergfeld JA, Cox JS, Drez D, Raemy H, Weiker CG: Symposium: Management of acute ankle sprains. *Contemp Orthoped* 1986; 13.
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6. Hamilton WC: Sprained ankles in ballet dancers. *Foot and Ankle* 1982; 3:99-102.
7. Stover CN, York JM: AIRCAST/Air-Stirrup system for graduated management of lower extremity injuries. Scientific exhibit paper, AAOS, San Francisco, 1979.

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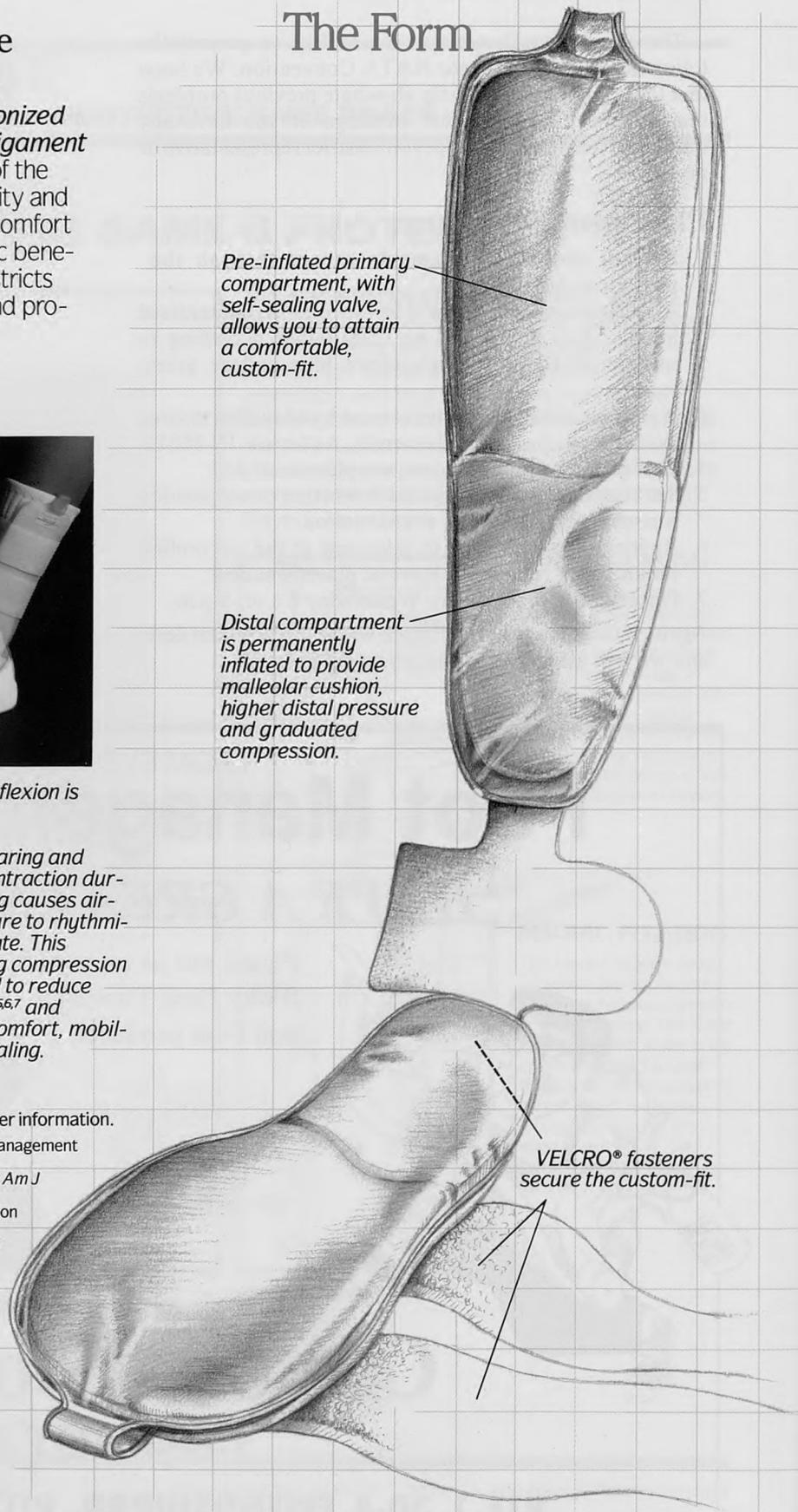
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Potpourri

Dennis Aten, ATC, RPT, MS

Win-At-Any Cost Attitude Disturbs A P.E. Veteran

Southern Illinois University News Release

CARBONDALE, ILL.—Too many coaches today tell players it IS whether they win or lose, and many don't give a second thought to how the game is played, says Edward J. Shea, a retired professor of physical education at Southern Illinois University-Carbondale.

Sideline talk like that contributes to America's crumbling ethical standards and destroys one of the oldest premises of organized sports: its ability to build character, says Shea, who has devoted a lifetime to the cause of physical education.

"I feel that this is a subject that is right at the top of our national moral agenda today," he said. "Character really means ethics, the ability to choose right over wrong."

From corporate board rooms to hospital operating rooms, the lack of ethical standards is at the root of front-page scandals, Shea believes. "It attacks our quality of life," he says quietly. "It is a real threat." The key to building character in the sports arena is the coach, Shea says.

Whether coach-sanctioned cheating comes in the form of NCAA recruiting violations or a Little League player who raises his glove high indicating he caught the fly ball even

though he knows it grazed the ground, it chips away at accepted standards.

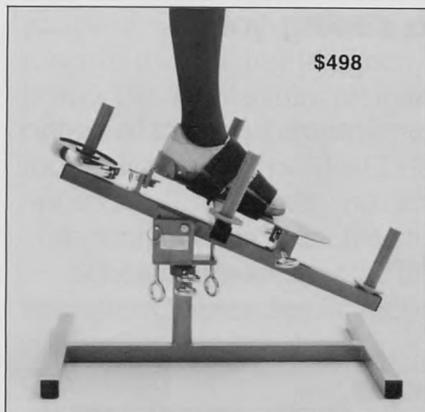
"Winning should never be the ONLY thing," Shea says. "When winning is the only thing, a person simply becomes a means to an end. The individual doesn't count. Our society is governed by a belief in the principles of individual rights and equality. When coaches go beyond winning, individuals can concentrate on how they play the game."

Shea says he sees a cynicism in modern America — a belief that youngsters shouldn't be expected to strive for honesty, loyalty, perseverance and fair play. It disturbs him. He worries that parents and coaches don't realize that lessons learned on a playing field do carry over to later life.

Competitive sports are a testing ground of sorts, he says. "Emotion and conflict bubble to the surface and split-second decisions must be made." A classroom equivalent is hard to find.

Ironically, coaches receive little formal training in how to mold youngsters. Many are volunteers who act instinctively. Few physical education teachers take anything resembling Ethics 101. "We just take for granted that coaches know the right thing," Shea says.

Parents who want to make sure their child is involved in an enlightened sports program should follow some simple guidelines, Shea says.



ANKLECISER

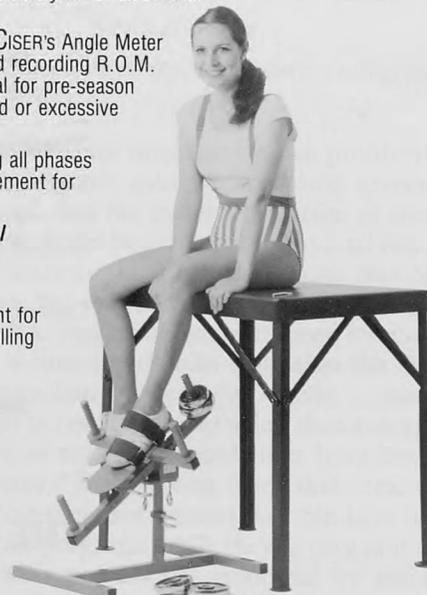
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District 8:	June 24, 1990 9:15-10:15 a.m.
District 9:	July 9, 1990 2:30-3:30 p.m.
District 6:	July 27, 1990 2:30-3:30 p.m.

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"Winning is important. We wouldn't want to give the impression that is isn't," Shea adds. "It motivates people to strive for perfection, but it destroys when it's the only goal."

Pain Could Be In Your Brain

Good Health Digest

If you have a mother who is constantly complaining about her nagging backache, and a father who suffers from a never-ending migraine, then you could be plagued with such aches and pains for the rest of your life. Prevention magazine cites a recent study which suggests a person's susceptibility to pain may be based on their family's past. Psychologist Patrick Edwards, Ph.D., of North Dakota State University, says pain could be all in your brain, a conditioned response taught to you by your family. After recording the aches and pains suffered by 288 college students, Dr. Edwards also documented the types of pains the students' families complained about on a regular basis. His findings revealed that children who grow up in pain-plagued households are more likely to experience pain themselves as adults. He also discovered that women are more influenced by how family members handle pain, and also report more pain than men.

Exercise, Pregnancy & Risk

News Release

Raul Artal, A.D., associate professor of obstetrics and gynecology, USC School of Medicine

As exercise classes for pregnant women proliferate, Dr. Artal is counseling his patients, including several professional athletes, that the maternal benefits of strenuous exercise may sometimes be accompanied by fetal risk. Artal, co-author of "Exercise in Pregnancy," says that complications are rare, but evidence is mounting that strenuous exercise — such as jogging at maximal speed for more than 15 minutes at a time or aerobics that raises the maternal heartbeat to more than 140 beats per minute — can induce premature labor or result in babies of less than average birth weight. "Some of my recommendations have been criticized," Artal says, "But I'm concerned that some experts seem to be telling pregnant women they can have it all—a vigorous exercise programs while they're pregnant *and* no side-effects. That's not always supported by the facts." According to Artal, this doesn't mean that *moderate* exercise increases fetal risks. In fact, he is now working on a study to see if pregnant diabetics can use exercise to replace insulin. Artal is a consultant for the American College for Obstetricians and Gynecologists pregnancy exercise and women's exercise programs and for Dr. Art Ulene's "Exercise in Pregnancy" tape.

AAOS Strategic Plan Includes Relationships With Allied Health Professions

AAOS Bulletin

The Academy's Board of Directors has adopted a strategic plan to identify and address the critical issues facing the orthopaedic specialty. As a result of the strategic planning process, the Academy has revised its mission statement and developed goals and objectives for future Academy action on these critical issues. The new mission statement and a portion of the guidelines for AAOS action follow.

AAOS Mission Statement

The mission of the American Academy of Orthopaedic Surgeons is to foster and assure the highest quality musculoskeletal health care through: education or orthopaedists, other providers of health care and the public; promotion of research; communication with other professionals and the public; and leadership in the development of health care policy.

Allied Health Education and Liaison

Allied health professions are an integral part of the delivery of timely, effective, quality musculoskeletal health care. The Academy desires constructive relationships with organizations representing these disciplines to meet their needs and those of the patients they serve. In the past, the American Academy of Orthopaedic Surgeons has provided educational services for allied health disciplines and will continue to fulfill this educational role in areas of perceived need.

Goal: Support the professional development and continuing education of orthopaedic related allied health disciplines to assure quality health care.

Objectives:

1. Produce texts, monographs, and other educational materials for orthopaedic related health professions.
2. Participate and assist in the conduct of a limited number of continuing education courses for faculty and practitioners in related health disciplines.
3. Maintain formal and informal relationships with allied organizations to determine their needs and create mutual strategies that advance their professional interests and enhance their patient care roles.

Iron Relationship To Endurance

Good Health Digest

Iron depletion may affect athletic performance even if it's not severe enough to cause anemia, says researchers at the Baystate Medical Center in Springfield, Mass. They studied 14 high-school girls who were long-distance runners. All the girls had low iron levels, but not anemia. Half were given a daily iron supplement, the rest received a placebo. The girls who received iron supplements significantly improved their endurance levels compared to those who took the placebo. ©



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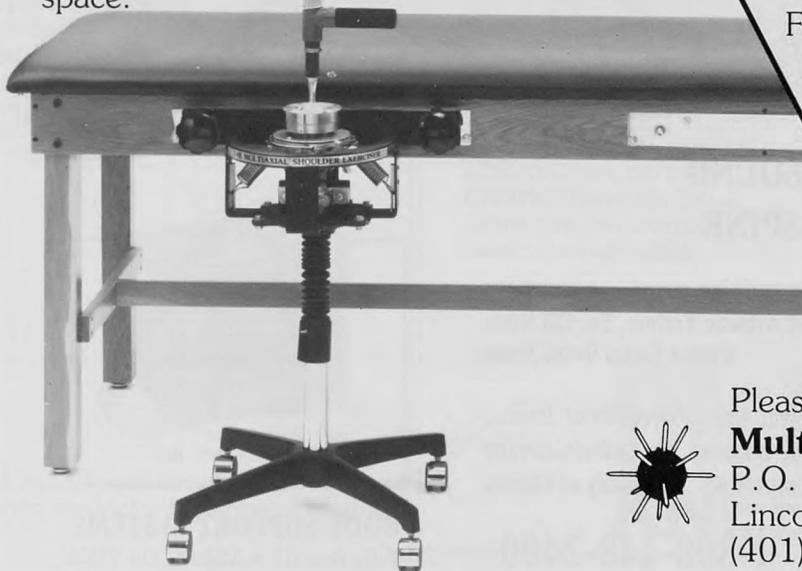
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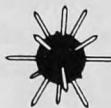
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Medical Update

Nina Partin, MEd, ATC

INTERNAL MEDICINE

Exertional Heatstroke

In non heat-acclimated humans, exercise in the heat produces an initial period of cardiovascular instability characterized by increases in body temperature, heart rate, and plasma volume and a decrease in stroke volume (1). This effect on the cardiovascular system produces a strain, resulting from increased demand for cardiac output to transfer heat and water for evaporative cooling to superficial, vasodilated vascular beds in the skin (1). During exercise, capillary beds, in skeletal muscles, vasodilate to supply the increased demands for blood flow in support of muscle metabolism. The demands for blood flow exceed the capacity of the heart as a pump, which represents a major regulatory problem.

Heatstroke is a condition caused by excessive rise in body temperature brought about by either "overloading" or "failure" of the thermoregulatory system during exposure to heat stress (2). In recent sports medicine studies, much attention has been focused on one type of heat illness: exertional heatstroke (EH). EH death ranks third, behind only head and neck injuries and heart failures, in the number of deaths occurring in high school athletics. Exertional heatstroke usually occurs in healthy, physically fit individuals who are forced to perform strenuous exercises, either through peer pressure, discipline, or athletic competition demands. Another problem with EH stems from directors of certain competitions and activities being reluctant to postpone activities that occur during periods of excessive heat and humidity.

By definition, exertional heatstroke is a state of extreme hyperthermia that occurs when heat production, generated by muscular exercise, exceeds the body's heat dissipation capacities. This illness has been reported among young active individuals, laborers, religious pilgrims, and military personnel. In contrast to "classical" heatstroke, a common disorder of the elderly during heat waves, EH occurs sporadically and its onset is sudden. EH may be the most serious heat illness due to not being expected, especially in milder climates and in the physically fit athlete. Being aware of the signs and symptoms of EH is essential for anyone who trains or competes in a hot environment (3). The usual symptoms, which are described for heatstroke, include three common signs (1): 1) body core temperature above 41°C, 2) disturbances in the central nervous system; and 3) hot, dry skin, which is reddish in color. When all three are present, heat stroke is easily detected. In some cases, relying on these three classical symptoms alone can be very misleading.

In all cases, body temperature of 39.5°C is found when measured immediately upon collapse. A delay in measuring body temperature can hinder a prompt realization of EH. It must, therefore, be indicated that if a lower body temperature is found, it does not contraindicate a heatstroke. As far as using the central nervous system to detect EH, careful account of the actions of the person possibly experiencing EH should always be provided for the emergency medical team. Also, contrary to many beliefs, in many cases of EH,

the sweat glands can remain very active at the stage of collapse and profuse sweating is sometimes present. Dry skin is usually apparent in the latter stages.

The loss of consciousness is a constant symptom of heatstroke. Symptoms such as headache, confusion, disorientation, drowsiness, and irrational behavior may all serve as constant warning signals also. Increasing the awareness of EH is very important, due to the fact the real incidence of EH being unknown to most people, many cases are not reported or diagnosed properly (1). The delay in recognition usually occurs in areas of mild climates where suspicion of heat illness possibilities normally are very low.

Some of the complications that can occur during an exertional heatstroke are (1): 1) Disturbances of the central nervous system are present due to the brain being extremely sensitive to hyperthermia. Extreme hyperirritability often appears in the form of coma, stupor, delirium, and aggressiveness. Seizures occur in approximately 60% of all the cases, especially in the physically fit. Pupillary changes are common; in over two-thirds of the cases the pupils are found to be constricted. 2) Pulse pressure is high, cardiac output is low, and diastolic blood pressure is low. 3) Hyperventilation is present in most cases. 4) Acute renal failure is common and occurs in approximately 25% of all EH patients. 5) Gastrointestinal dysfunction, including diarrhea and vomiting, occurs. 6) And last, hemorrhaging can occur in the form of bloody diarrhea or lung and myocardial bleeding.

The damage inflicted by EH is determined by the duration of hyperthermia. Treatment for EH should include removing the patient from the hot environment as quickly as possible, removing restrictive clothing, dousing with water, applying ice packs, and fanning the patient to increase heat dissipation (4). Cooling should be initiated immediately upon recognition of the symptoms. Rapid transportation to the nearest medical facility is extremely important, with the cooling techniques being continued throughout all stages of transport. As with any life threatening emergency, airways must be kept clear, blood pressure and pulse must be checked, a quick clinical examination performed, and body temperature measured.

As with any athletic emergency, prevention is the primary concern for athletic trainers, coaches, and athletes. With any technique for prevention of heat illness, exertional heatstroke is no different (1): 1) Training schedules should be avoided during the hottest part of the day in the summer months. 2) Rest at least 10 minutes per every 50 minutes of physical activity. 3) Get adequate amounts of rest during the day, with ample amounts of sleep at night. 4) Loose fitting clothing should be worn to allow for efficient evaporation. Allow athletes to remove protective headgear periodically during practice to aid in heat dissipation. 5) Provide adequate amounts of fluids before, during, and after physical activity. (6) Weigh athletes before and after practice to account for the amount of weight loss during activity. 7) Special consideration should be given to those who are heat-susceptible, such as the obese, the unfit, the dehydrated, those unacclimated to the heat, and especially those with a previous history of heat illness.

Heat illnesses can occur on any given day to anyone, even

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Fat Soluble Vitamins	Vitamin D	150 I.U.	38
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High B-complex	Vitamin C (Ascorbic Acid)	50 mg.	83
	Vitamin B ₁ (Thiamine Mononitrate)	5 mg.	333
	Vitamin B ₆ (Pyridoxine HCl)	3 mg.	150
	Vitamin B ₂ (Riboflavin)	2 mg.	118
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on cool days when performing physical activity. Education programs directed toward athletes, coaches, activity directors, event coordinators, and medical care persons, must continue in order to increase the awareness of exertional heatstroke and its life-saving treatment.

BIBLIOGRAPHY

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VIDEO REVIEW

continued from page 179

nutrition to be outstanding. They address an often overlooked or misunderstood problem that we as athletic trainers are called upon to deal with. The supplemental materials add a solid support base for the video tape program. I was particularly impressed with the information that was provided. I felt that the supplemental information contained was very concise and easy to understand. At the end of the supplemental material is a list of centers that deal with eating disorders. While this is only a partial listing of such centers, it does afford the athletic trainer a starting point when trying to locate an appropriate facility close to his/her area.

I would strongly suggest that all athletic trainers view this program. It will provide the necessary insight to prepare us to better understand the problems the athlete is confronted with when suffering from an eating disorder.

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to the effect of "the significance of the information is discussed in the article". Also, do not confuse the abstract with the introduction.

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16. The body or main part of the manuscript varies according to the type of article (examples follow). Regardless of the type of article, however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. Liberal use of headings and subheadings; charts, graphs and figures is recommended.

a. The body of an experimental report consists of a methodology section, a presentation of the results, and a discussion of the results. The methodology section should contain sufficient detail concerning the methods, procedures, and apparatus employed that others can reproduce the results. The results should be summarized using descriptive and inferential statistics and a few well planned and carefully constructed illustrations.

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c. The body of a **Case Study** should include the following components: personal data (age, sex, race, marital status, and occupation when relevant — but not name), chief complaint, history of present complaint (including symptoms), resulting or physical examination (example: "Physical findings relevant to the rehabilitation program were..."), medical history (surgery, laboratory, exam, etc.), diagnosis, treatment and clinical course (rehabilitation until and after return to competition, criteria for return to competition, and deviation from the expected (what makes this case unique)). NOTE: It is mandatory that *Athletic Training* receive, along with the submitted manuscript, a signed release form by the individual being discussed in the **Case Study**. **Case Studies** cannot be reviewed if the release is not included.

d. The body of a technique article should include both the "how" and "why" of the technique: a step-by-step explanation of how to perform the technique supplemented by photographs or illustrations and why the technique should be used. The discussion of "why" should review similar techniques, point out how the new technique differs, and the advantages and disadvantages of the technique in comparison to the other techniques.

e. A **Tip From the Field** is similar to a technique article but much shorter. The tip should be presented and its significance briefly discussed and related to other similar techniques.

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18. Citations in the text of the manuscript take the form of a number in parentheses, (7), directly after the reference or name of author being cited, indicating the number assigned to the citation. References should be used liberally. It is unethical to present others' ideas as your own, but also, readers who desire further information on the topic should be able to benefit from your scholarship.

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- Knight K: Tips for scientific/medical writers. *Athletic Training* 25(1): 47-50, 1990.
- Day RA: *How to Write and Publish a Scientific Paper*. 3rd Ed. Phoenix: Oryx Press, 1988.
- Albom M: Common injuries in women's volleyball. In Scriber K, Burke EJ (eds): *Relevant Topics in Athletic Training*. Ithaca NY: Monument Publications, 1978, pp.79-81.
- Behnke R: Licensure for athletic trainers: problems and solutions. Presented at the 29th Annual Meeting and Clinical Symposium of the National Athletic Trainers Association. Las Vegas, Nev., June 15, 1978.

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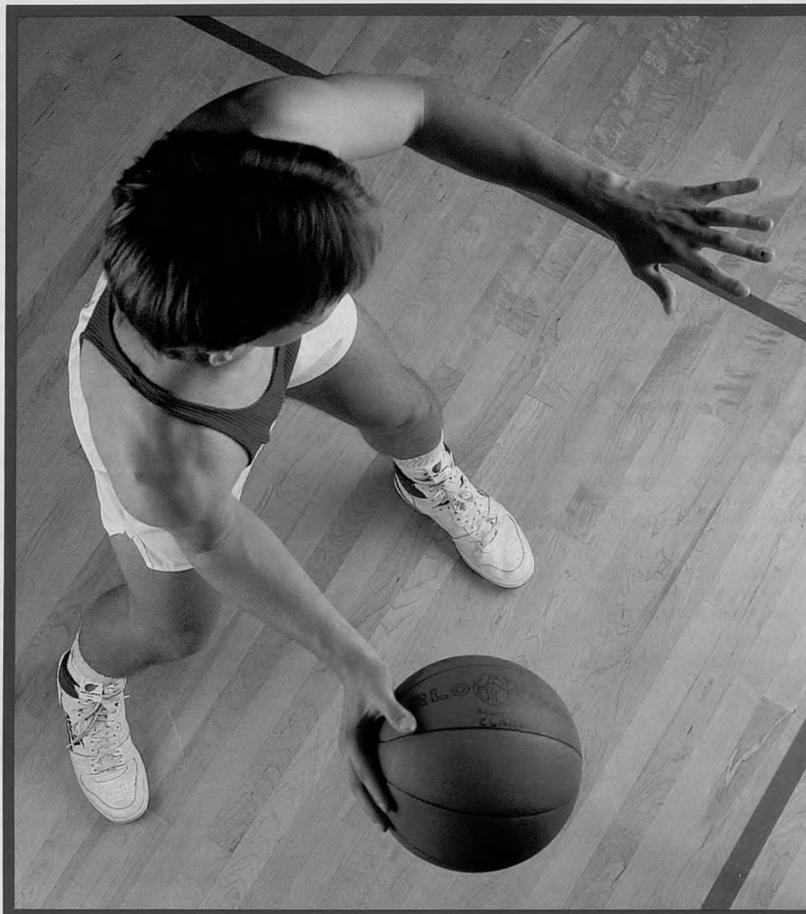


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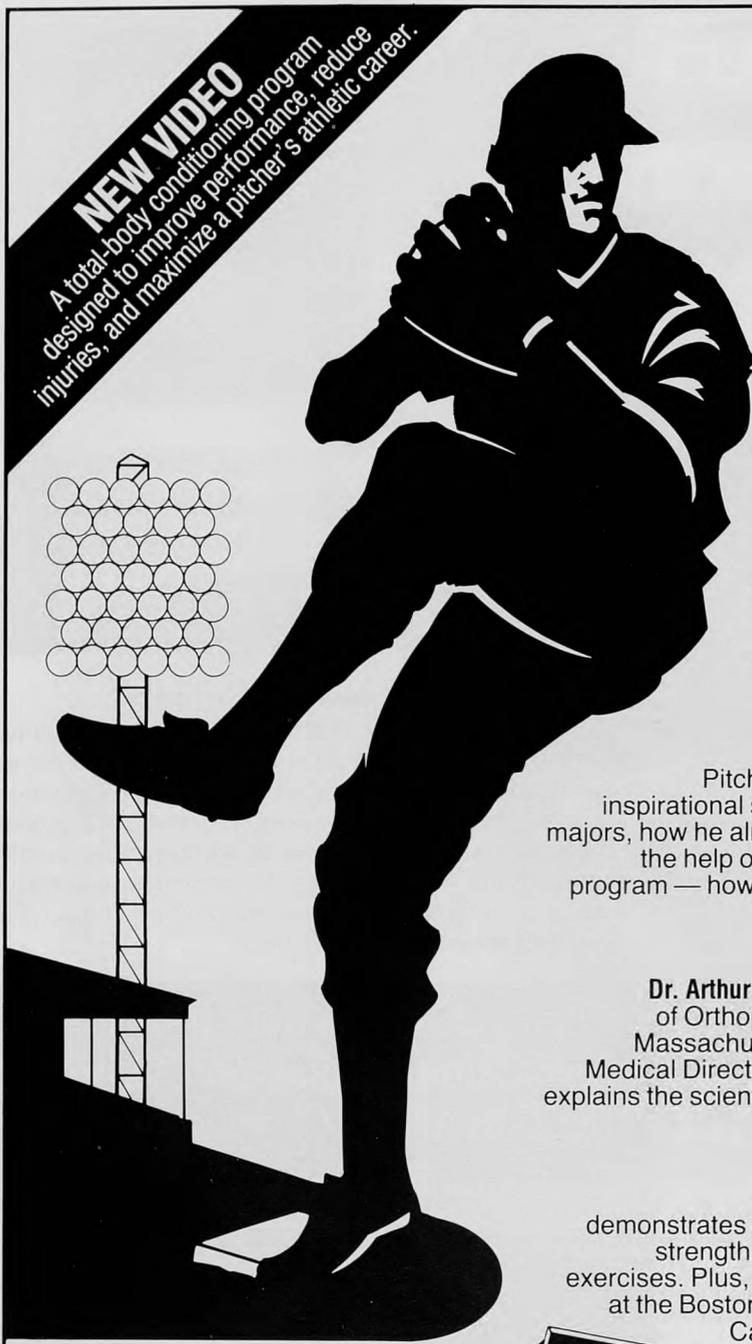
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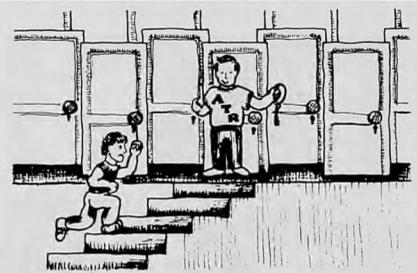


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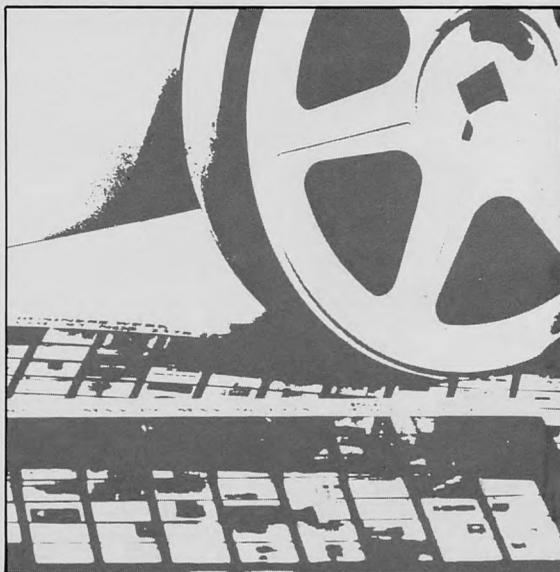
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