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Still More on Carpal Tunnel Syndrome

I read with intent Edward Kane’s comments in Letters to the Editor (JAT, 1994; 29:197), arising from the article I wrote titled, “Carpal Tunnel Syndrome” (JAT, 1994;29:22–30). His comments may serve as an example for us all regarding intelligent use of this open forum. Although I would have preferred to have been given an opportunity to defend my work at the time of Mr. Kane’s comments, my explanation is as follows.

First, there is question as to the validity of electromyography (EMG) eliciting fibrillations or F-wave abnormalities in the paravertebral muscles of those experiencing cervical radiculopathy. Although Mr. Kane cites current literature performed by individuals in the electrodiagnostic profession, practitioners have not come to agreement on this subject. Hence, electromyography may or may not elicit fibrillations in cervical radiculopathy. Clinicians surmise that if there is nerve root irritation without nerve damage, the result will be an unremarkable test. However, when nerve damage accompanies the nerve root irritation, there may be fibrillation present on the EMG. Although the value of F-wave studies in the evaluation of carpal tunnel syndrome (CTS) remains to be established, it is currently being used by a number of very respected individuals. It should not be used exclusively, but rather may be used in conjunction with EMG and nerve conduction studies in determining the diagnosis of CTS. I will agree that, traditionally, F-wave studies have not been routine in the evaluation of carpal tunnel syndrome.

Secondly, while Mr. Kane gives proper credit to the authors (Upton and McComas) for the term “double crush” syndrome, he incorrectly makes reference to my use of the term “occasionally required” regarding employment of EMG and nerve conduction studies prior to CTS surgery. I believe he has misinterpreted my point here. My use of the phrase, “occasionally required” (differential diagnosis section), refers to those tests that are available should a patient not respond to conservative treatment. Surely Mr. Kane does not promote the use of EMG and nerve conduction studies during the initial stage and mild grade of CTS? It may be argued that it is this judicious use of untimely diagnostic tests that has helped propel our society into the health insurance debate we now face.

Lastly, it is implied that I made reference to conducting CTS surgery without first determining the nature of the neural involvement through further tests. In fact, I state in the differential diagnosis section of the article that “careful physical examination and objective testing are important steps in evaluating compressive nerve lesions. Clinical examination should assess both sensory and motor involvement.” I don’t believe I can make it any clearer.

The goal of many authors is to provoke the reader into questioning common practice and accepted theory. My deepest admiration of Mr. Kane for his insightful editorial of my work.

Gregory R. Zimmerman, MSA, ATC
Saginaw Division—
General Motors Corporation
Saginaw, MI 48601-9494

EDITOR’S NOTE: Our policy is to allow authors a chance to respond to correspondence concerning their works in the same issue as the correspondence. We goofed. Our apologies to Mr. Zimmerman.
17th Annual NATA Student Writing Contest

In an effort to promote scholarship among young athletic trainers, the National Athletic Trainers' Association, Inc. sponsors an annual writing contest.

1. The contest is open to all undergraduate members of the NATA.
2. Papers must be on a topic germane to the profession of athletic training and can be case reports, literature reviews, experimental reports, analysis of training room techniques, etc.
3. Entries must not have been published, nor be under consideration for publication by any journal.
4. The winning entrant will receive a cash award and the paper will be published in the Journal of Athletic Training with recognition as the winning entry in the Annual NATA Student Writing Contest. One or more other entries may be given honorable mention status.
5. Entries must be written in journal manuscript form and adhere to all regulations set forth in the "Author's Guide" of the Journal of Athletic Training. We suggest that, before starting, you read: Knight KL. Tips for scientific/medical writers. J Athl Train. 1990;25:47-50. NOTE: A reprint of this article, along with other helpful hints, can be obtained by writing to the Writing Contest Committee Chairman at the address below.
6. Entries must be received by March 1, 1995. Announcement of the winner will be made at the Annual Meeting and Clinical Symposium in June.
7. The Writing Contest Committee reserves the right to make no awards if, in their opinion, none of the entries is of sufficient quality to merit recognition.
8. An original and two copies of the paper must be received at the following address by March 1, 1995.

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The Integrated Dynamic Exercise Advancement System Technique for Progressing Functional Closed Kinetic Chain Rehabilitation Programs

William A. Pitney, MS, ATC
Edwin E. Bunton, MS, ATC, CSCS

Abstract: Graded exercise progressions are necessary during the rehabilitation process. We developed the Integrated Dynamic Exercise Advancement System (IDEAS) to fill this void. There appears to be a lack of progression/advancement systems for closed kinetic chain exercises, even though the IDEAS technique for advancing closed chain activities is comprised of two phases: preparing a safe environment and advancing the exercise. Phase one includes a conceptual checklist to assess the safety of the environment. Phase two is a six-step process that challenges each plane of motion by adding speed, workload, external stimuli, and terrain changes. The IDEAS technique is suggested for use in other arenas such as strength and conditioning.

Many systems have been used to help clinicians systematically progress injured and noninjured individuals in rehabilitation and exercise programs. Examples include Delorme’s progressive resistive exercise protocol and a variation of this system developed for a daily rehabilitation regime called the daily adjusted progressive resistive exercise, or DAPRE program. Although a structured system of progression is important in any rehabilitation program, no such system currently exists for closed chain kinetic programs.

A systematic program for progressing an injured individual through closed chain exercises is essential for several reasons. First, many clinicians may be apprehensive of aggressively using closed chain kinetics because they are charting unfamiliar territory. Second, a functional step-by-step progression is necessary to ensure that an injured individual is not placed in an unsafe environment or progressed too quickly.

The purpose of this paper is to introduce the Integrated Dynamic Exercise Advancement System (IDEAS) that we developed to address the void of systematic progressions for functional closed kinetic chain rehabilitation programs (Fig 1). Also, an example of advancing an exercise will be illustrated and discussed.

The Importance of Functional Progression
A rehabilitation program must provide for calibrated (controlled) biomechanical stresses to the joint and

![Diagram of IDEAS](image)

Fig 1.—Elements of the IDEAS.

William A. Pitney received his undergraduate degree from Indiana State University and is currently a physical educator and athletic trainer at American Rehabilitation Network, 14799 Dix-Toledo Hwy, Southgate, MI 48195. He received his masters degree from Eastern Michigan University where he currently serves as an educational consultant for the athletic training department.

Edwin E. Bunton is a clinical athletic trainer at American Rehabilitation Network in Southgate, Michigan. He received his graduate degree from Indiana State University, Terre Haute, IN.
progress by gradually increasing the intensity of the program. Kegerreis described the need for functional acclimatization as: first, to safely restore ability, and, second, to acclimatize an athlete to the demands of sport or activity. Kegerreis continued by stating that this acclimatization should progress "in a precalculated step-by-step manner. Each successful stage builds on preceding stages." The IDEAS technique addresses these concepts by providing a structured yet flexible system for preparing and progressing/advancing a closed kinetic chain rehabilitation program.

The flexibility of the system is found in the clinician’s responsibility for determining the number of sets, repetitions, weights, type of exercise, and speeds to be used. The first and foremost responsibility of the clinician is to be familiar with body mechanics, muscle action, and goals of closed kinetic chain rehabilitation. These concepts are discussed in the literature and will not be discussed here in detail. What will be discussed in Phase one, however, is a conceptual checklist to be certain that the IDEAS technique is appropriate for the individual. Phase two consists of a six-step advancement system for progressing exercises from simple to complex.

**IDEAS Phase One: Preparing an Environment**

An environment simply refers to the area, surface, or mode that an athlete will interact with during an exercise. Examples include the floor, a step, a miritramp, or a BAPS board. As clinicians, we must include a variety of environments to help facilitate adaptive responses. The environment is responsible for facilitating a biomechanical response and can be pivotal in creating a successful rehabilitation program. Many exercises can be performed and progressed in a closed chain fashion. Without thought, planning, and proper progression, however, an undesired biomechanical response may occur which could be potentially hazardous for the injured athlete. Selecting and preparing a safe clinical environment is procedural to any clinician. Whether by asking an athlete how they are doing or constantly observing for compensations, you should always check to be sure that an exercise is safe. However, when using sagittal plane-dominated exercises or equipment, the considerations may be far less involved than when you are using a multiplanar closed chain kinetic exercise. Therefore, a conceptual checklist is essential when selecting and preparing an environment prior to performing functional closed kinetic chain exercises (Fig 2).

First and foremost, the environment must deliver the expected biomechanical response. Clinicians must ask themselves if the environment will help to achieve the established goals of the rehabilitation program in a safe and controlled manner. In addition, clinicians must be sure that the environment can be progressed or altered in a functional manner and that calibrated (controlled) gradual stresses can be provided (ie, partial weight bearing).

Another consideration when preparing the environment is objectivity. Does the created environment allow for functional objective measurement? An environment that does not allow us to measure improvement is, at times, hard to justify. Therefore, we must choose an environment that will allow us to make functional statements to assess the improvement of an individual. For example: "The athlete is able to perform 30 lateral step-ups on a 6-inch step with a 10-lb load, using proper control and posture." It is imperative for clinicians to monitor or record an individual’s progression, specifically, the type of terrain (hard, soft, slanted), step heights (if applicable), the amount of resistance used, the number of repetitions, and the type of control exhibited by the individual (abnormal/normal compensations). These objective measurements demonstrate that you have attempted to create functional situations. In addition, the athlete’s subjective reports should always be considered.

It is important for the athlete and clinician to feel comfortable with the environment. If doubts exist as to the safety of the environment, it should be reconsidered. If you are to err, err to the conservative. The process of selecting an environment can be summed up with two preparatory questions. First, is the environment

---

**IDEAS Conceptual Checklist Phase One: Preparing and Selecting the Environment**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Will the environment help to achieve established goals?</td>
<td>✔️</td>
</tr>
<tr>
<td>Is the environment biomechanically safe?</td>
<td>✔️</td>
</tr>
<tr>
<td>Can the environment be objectively measured and safely progressed?</td>
<td>✔️</td>
</tr>
<tr>
<td>Is the clinician comfortable with the environment?</td>
<td>✔️</td>
</tr>
<tr>
<td>Is the patient comfortable with the environment?</td>
<td>✔️</td>
</tr>
<tr>
<td>Can the environment be justified?</td>
<td>✔️</td>
</tr>
</tbody>
</table>

Fig 2.—Conceptual checklist for preparing an environment.
IDEAS Phase Two: Advancing the Exercise

Step one:
Select a plane of movement

Step two:
Adjust or change the speed

Step three:
Adjust the resistance

Step four:
Add a dynamic external stimuli

Step five:
Change the terrain

Step six:
Select a new plane of movement and advance the exercise from step two

Fig 3.—Six steps to the exercise advancement system.

IDEAS Phase Two: Advancing the Exercise

During Phase two of the IDEAS concept you adjust five components of the exercise: speed, resistance, external stimuli, terrain, and the selected planes of movement (Fig 3). When these components are adjusted in a precalculated and organized manner, they act together to advance an exercise.

In the first step of the IDEAS concept, you select a plane of motion in which to work. With an anterior cruciate ligament injury, for example, function in the transverse/frontal plane is typically deficient. Therefore, activities in the transverse/frontal plane need to be challenged in a graded manner to help regain joint stability and position sense. Function in a deficient plane is first challenged to address the biomechanical requirements of having three planes of motion available during functional tasks.

Step two advances an exercise in the selected plane by gradually increasing the speed of the exercise (Fig 4). The speed must be adjusted to help control limb acceleration and deceleration. The stresses may need to be calibrated in the early phases of a rehabilitation program by simply using partial weight bearing. Once the athlete is able to function in a given plane and can control acceleration and deceleration forces with varied speed and full weight bearing, move to step three.

Step three involves adding a workload to the current exercise (Fig 5). The workload can be in many forms, such as hand-held weights or a sport cord. Adding resistance increases the intensity of the exercise causing the joint to further control limb acceleration and deceleration. Furthermore, because acceleration and deceleration can only be witnessed in a dynamic sense, adding a workload allows you to observe for compensations occurring in a multiplanar environment.

Step four involves adding a dynamic external stimuli (Fig 6). The external stimuli can be at a variety of levels, from simply holding a basketball to throwing a medicine ball. The addition of an external stimuli serves two purposes. First, the athlete must manipulate the stimuli which enhances stability. Second, and perhaps more importantly, the external stimuli creates a diversion to the task at hand. In other words, the athlete

Fig 4.—After an environment has been prepared, exercising in a selected plane at various speeds can be performed.

Fig 5.—A sport cord has been added to increase the workload.

Fig 6.—The body blade has been added as an external stimuli to help make activity at the lower extremity a subconscious task.
concentrates on the stimuli instead of the movement. This is significant because the conscious task of movement on any terrain, at any speed, and in any plane should be subconscious.4 Step five involves changing the terrain (Fig 7). Many rehabilitation environments do not accommodate for the types of terrain faced by individuals in daily activity. Therefore, it is necessary to create these terrains with clinical control while being sure that the previous steps are accommodated.

When the athlete can: function in a given plane, control added speed, accommodate to a different terrain, manipulate an external stimuli, and control an increased workload, then function in a new plane can be challenged. Activity in the new plane is then advanced in the same way until the athlete can control added speed, accommodate a different terrain, manipulate an external stimuli, and control an increased workload (Fig 8, A-D). This system is repeated until function in all planes have been challenged in a dynamic sport-specific sense with maximum weight and speed.

The clinical challenge is for an individual to progress and build confidence so that subconscious control of functional movement patterns is possible. Upper and lower extremity structures function in multiplanar environments and, therefore, must be trained as such under clinical control.

Conclusion
The IDEAS concept may not be suitable for all clinicians or for every exercise. When used as directed, however, it offers the clinician a safe, graded exercise advancement system for closed kinetic chain exercises.

Acknowledgments
We would like to thank Alex W. Kane, ATC, and Nancy C. Smith, ATC, for their technical support of this manuscript. Photos were taken by Don Bolinski.

References
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Recognition and Treatment of Osteochondritis Dissecans of the Femoral Condyles

Matthew E. Sailors, MEd, PT, ATC

Abstract: Osteochondritis dissecans (OD) of the femoral condyles is a vague and often confusing diagnostic entity encountered by many clinicians. Unfortunately, there are several factors that add to this confusion. Chief among these is the proper recognition and understanding of the disease process, which is not well-documented. In addition, OD is often generically grouped together with other femoral condylar lesions that require differing diagnostic and treatment methods for proper care. OD is commonly divided into two categories, juvenile and adult forms. Each requires different methods of correction and rehabilitation. This paper describes the disease process of OD, explains the differences between the juvenile and adult forms (including common symptoms and diagnostic techniques), describes several of the pathologies that OD is mistakenly grouped with, and gives a brief review of the common arthroscopic and surgical techniques used to treat this pathology. In addition, rehabilitation guidelines and suggestions are offered to aid the athlete’s return to functional activities.

With the recent popularity of research dedicated to the knee, great strides have been made in understanding the many pathologies associated with the joint. One area, however, that is still controversial and confusing to many clinicians is osteochondritis dissecans (OD) of the femoral condyles. This disease process, first described by Paget, and named by Koenig, is often mistakenly grouped with several other distinctly different pathologies, which serves to add to the confusion surrounding it. OD can occur at many sites in the body, including the talus, mandible, elbow, shoulder, patella, and the femur.

The purposes of this paper are to describe the disease process that occurs with OD, differentiate its juvenile and adult forms, contrast OD to similar pathologies at the femoral condyles, discuss some commonly used arthroscopic and surgical interventions for OD, and to provide some suggestions for rehabilitating athletes suffering from OD.

The Disease Process

OD is a disease process of a mysterious, and usually controversial, nature. Several etiologies have been proposed including heredity and familial disposition, acute or repeated trauma, epiphyseal ossification abnormalities, avascular necrosis or impaired blood supply, and endocrine imbalances. Typically, OD is divided into two groups: juvenile, which is also commonly referred to as “early” or “under fifteen”, and adult, which is also called “late” or “over fifteen”. For purposes of simplification, these groups will be referred to as juvenile and adult throughout the body of this paper.

Juvenile OD is described as a single area of ossification developed separately from the main body of an otherwise normal epiphysis. Initial radiographic examination reveals an irregularity in the ossifying margin of the epiphysis. Later radiographs reveal a concentric flake of bone which grows at the same rate as the epiphysis yet remains separated from it by a transradiant line. The bone flake is usually several millimeters thick but has few, if any, trabeculae and has the general appearance of a non-union fracture.

Adult OD is described as a bone fragment or loose body that is usually a result of previous juvenile OD, although some insist later trauma can cause occurrence of the disease. The loose body results in a concave crater on the femoral condyle with steeply sloping edges.

Aichroth described five basic sites of OD lesions on the femoral condyles, with 85% of the lesions presenting on the medial condyle and 15% on the lateral condyle. Of these lesions, 69% occur on the “classic site,” which is the lateral aspect of the medial femoral condyle. Bradley and Dandy arthroscopically examined 5000 patients with varying lesions at multiple sites on the femoral condyles. The authors found what they described as true OD in both the juvenile and adult stages at only the classical site, despite a careful search for the condition at other areas. They suggested that the imprecise use of terminology regarding OD leads to much of the controversy surrounding it and that many of the patients generically termed as suffering from OD may actually be suffering from other nondissecting pathologies.

Symptoms and Diagnosis

As stated above, there are two distinct forms of OD, juvenile and adult, that can occur at various sites on the femoral condyles. Each of these presentations offer differing symptoms and treatment forms. In both the juvenile and adult forms, medial condylar lesions tend to be somewhat more anterior on the condyle and lead to patellofemoral joint pain and dysfunction of the extensor mechanism. Lateral condylar lesions...

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often occur more posterior and lead to tibiofemoral derangement and are more prone to fragmentation.2,13

Juvenile OD may result in symptoms of nonspecific knee pain, mild effusion, quadriceps muscle atrophy, point tenderness, tibial external rotation with gait, and may have episodes of catching or locking.2,4,9,13 Bradley and Dandy4 point out that all of their juvenile OD cases occurred in the second decade of life and that a hemorrhrosis occurred only in those patients with acute osteochondral fractures. Patients presenting with juvenile OD typically do not have a history of knee trauma.4,13 Diagnosis is usually made with a radiograph,9,13 but arthroscopy is considered an invaluable tool for assessing the progression of OD.9

Adult OD patients present with many of the same symptoms as the juvenile form but are more prone to catching or locking of the knee joint, "giving way" of the knee, and they may have a specific history of trauma.13 Bradley and Dandy4 pointed out that they did not see adult OD in any patients under the age of 18. Adult lesions tend to slough loose bodies9 creating a condylar defect which may be palpable with the knee flexed to 90°.13 Wilson's test is often positive for these patients as well.13,16 This test is performed with the patient sitting with the knees flexed over the edge of the examining table. The tibia is internally rotated and the knee actively extended. Pain increases at approximately 30° of knee flexion if there is an osteochondritis dissecan lesion at the classical site, and the patient is asked to stop the motion. The tibia is then externally rotated, and, if the pain disappears, the test is considered positive for OD.16 Radiographs, arthroscopy, three-dimensional CT scans, and MRI are used to confirm the diagnosis and to monitor its progress.4,7,9,13

**Differentiating OD From Other Pathologies**

OD can be differentiated from other sources of joint line pain during the physical examination. Meniscal and collateral ligament injuries can be assessed with testing in a routine physical examination.2,13 However, there are some specific condylar lesions that need to be defined and differentiated arthroscopically. Recently,2 many disorders that result in condylar fragment separation have been incorrectly termed OD; therefore, some clarification is warranted.

Idiopathic osteonecrosis is distinguishable as a cavity created by the disappearance of subchondral bone roofed by a plate of cortical bone.4 The cortical bone roof is unstable and reveals a cavity containing shapeless soft tissue.

Chondral separations are full separations of articular cartilage that expose subchondral bone. Typically, chondral separations have very vertical margins.4 Very similar to chondral separations are chondral flaps, where there is partial separation of the articular cartilage but the subchondral bone is not exposed.

Osteochondral fractures are recognizable by having both a flat and a convex surface.4,9 Acute injuries cause a hemorrhrosis, and the fragment is made of cancellous bone on the flat surface and a layer of articular cartilage of the convex surface. Old injuries have a loose body in the joint and a flattened region at the site of its origin.

In addition to these pathologies, steroid osteonecrosis and epiphysyal dysplasia can also cause fragmentation of the femoral condyles,4 but these conditions are usually quite distinguishable from the others.

**Treatment of OD**

Once OD is accurately recognized and diagnosed, it must be effectively treated. The standard treatment for juvenile OD is a period of rest lasting from 3 months to 1 year, and this is often enforced with immobilization or casting. Larger lesions may take on the appearance of adult OD and, as such, may require arthroscopy as the mode of treatment.9

Adult OD is usually treated arthroscopically. For a thorough coverage of the many procedures used arthroscopically, see Garrett.9

Simple drilling has been advocated as an effective mode of treatment but has recently been deemed controversial because the osteochondral fragment is usually removed within 1 to 2 years anyway.2,7,9 Retrograde drilling and bone grafting are suggested as a treatment method but are considered much more demanding and, at times, technically impossible and, as such, would not be suitable for the inexperienced surgeon.9

Extraction of the loose body is often performed and best indicated when the bone has fragmented, been altered in shape, or lacks sufficient bony backing to warrant other forms of stabilization.9,13

Replacement pinning of the loose body has long been the gold standard of treatment.9 However, this method is questionable.9 For the procedure to be fully effective, some bone grafting is required, and, in many cases, all one has left after the procedure is the equivalent of a stable, pinned, nonunion fracture that will not heal.9

Fixation has been performed with such items as smooth Kirschner wires, bone pegs, nails, biodegradable pins, and cannulated screws2,5,13 but each of these items has some failing that makes it less than ideal. One fixation device that does seem to work well is the Herbert screw, which both compresses well and may be countersunk to allow early motion of the knee joint.9 The screws are relatively stiff, though, and must be removed early to prevent bone formation along the shank of the screw.

Abrasion arthroplasty and heterotopic autogenous grafting have also been used with good results on smaller lesions, but with little success on larger lesions.

**Rehabilitation and Prognosis for OD Patients**

Since the treatment for juvenile OD involves relatively lengthy immobilization and possible casting, many steps must be taken to counter the negative effects of this process. During this period, the young athlete must be encouraged to perform cardiovascular exercises such as the Upper Body Ergometer, seated Versaclimber exercise, or other sim-
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ilar aerobic activities. Lower extremity flexibility should be maintained, and every major muscle group, with the exception of the quadriceps, can be safely stretched while maintaining immobilization of the knee joint.

Strength can be maintained through use of such exercises as “four-way” straight leg raises (hip flexion/adduction/abduction/extension) and ankle tubing exercises. Quadriceps and hamstring coactivation, or setting, can be performed while in an immobilizer or cast. The use of neuromuscular electrical stimulation to the quadriceps and hamstring for coactivation contractions can further augment the strength maintenance program.15

Following immobilization, the techniques described above should be continued, and range of motion exercises and joint mobilizations of the knee, as well as progressive quadriceps and hamstring strengthening, should be performed. Weight-bearing progression throughout rehabilitation should be to patient tolerance, and aquatic therapy is very beneficial in facilitating the return to full-weight-bearing status. Gait training techniques, such as manual facilitation and visual feedback to the patient via a full-length mirror, may be used to address any gait deviations that developed during the immobilization and decreased weight-bearing phases of rehabilitation. In addition, exercises to restore normal knee and ankle joint proprioception, such as biomechanical ankle platform systems (BAPS board) exercises or unilateral stance, are also beneficial to the athlete planning to return to competition.

The prognosis for juvenile OD is very good as most conditions result in excellent healing and a complete restoration of normal joint mechanics.4,9

The rehabilitation for adult OD differs in that most of these cases are surgical. The surgical procedure will have an impact on the rehabilitation guidelines but, generally, continuous passive motion is used very early after surgery, and, for minor lesions, immediate weight-bearing is possible. Larger lesions (over 3 cm) may demand weight-bearing restrictions for up to 6 weeks.9 Fortunately, the physical therapist or athletic trainer does not have the immobilization concerns that occur in the juvenile form. However, the overall prognosis is not as good in the adult OD patient.5,13 Crawford et al7 reported that only 30% of patients had successful spontaneous healing of stable lesions at the classic site when followed up 7.5 years after the initial arthroscopic diagnosis. Athletic activity may be restricted for up to 6 months and some repetitive trauma sports such as basketball and distance running may be discouraged by the physician due to the likelihood of reinjury. Regardless, a thorough rehabilitation program, such as that discussed for juvenile OD, should be developed and implemented to assist in the potential return to competitive athletics.

Acknowledgments
I would like to thank Joe Gieck, EdD, PT, ATC, and Doug Keskula, PhD, PT, ATC, for their assistance in reviewing and editing this manuscript for publication.

References

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Abstract: Orthotics are effective for altering compensatory motions which result from abnormalities in the foot and lower extremity. In specific cases, temporary use of an orthosis is beneficial for reducing abnormal stresses while allowing involved structures to heal. Additionally, a temporary orthotic may provide a trial period to determine if the athlete would benefit from a permanent orthosis. A step-by-step procedure is presented for the fabrication of a temporary semirigid orthotic. Used as an adjunct to the treatment and rehabilitation program, temporary orthotics are effective in encouraging early weight-bearing tolerance, while placing the foot near the subtalar joint neutral position.

Knowledge of abnormal foot biomechanics and their effect on lower extremity pathology require an appreciation of forces which occur when the foot hits the ground. As the trend continues toward closed kinetic chain rehabilitation, tolerance of weight-bearing activity is required without invoking undue stress to involved structures. Therefore, in order to provide comprehensive care, methods to control abnormal joint motion and enhance shock absorption must be addressed.

The relationship between abnormal foot biomechanics, lower extremity pathology, and orthotic intervention is well documented. James et al, in a study of injuries sustained by 180 runners, identified 83 subjects treated with orthotic devices; 78% (65/83) were able to return to their previous activity level. Eggold reported similar results in a survey of 146 runners regarding orthotic effectiveness in relieving symptoms associated with overuse and impact shock injuries. Comprehensive management requires the athletic trainer to identify the cause of injury (eg, muscle imbalance, muscle tightness, abnormal foot biomechanics) while treating the effect (eg, pain, swelling). Serving as one component of the treatment program, foot orthotics can improve efficiency by restoring normal foot function throughout the weight-bearing cycle while reducing abnormal stresses placed upon the joint capsule, ligaments, joint surfaces, or musculotendinous structures.

Normal Biomechanics

The subtalar joint functions to absorb shock and serves as a torque converter transmitting lower extremity transverse plane motion into the foot. Closed chain subtalar joint pronation, which consists of calcaneal eversion, talar adduction, and plantarflexion, aids in shock absorption and allows the foot to become a flexible structure that can adapt to changes in terrain. Pronation of the subtalar joint allows the midtarsal joint to pronate or “unlock,” making the foot a mobile structure. Closed chain subtalar joint supination consists of calcaneal inversion, talar abduction, and dorsiflexion. Subtalar joint supination causes the midtarsal joint to “lock,” which prepares the foot to become a rigid lever during the propulsive phase of gait.

Abnormal Biomechanics

As previously stated, maximal subtalar joint pronation occurs during the contact period of gait. Pronation which occurs beyond the midstance phase is referred to as “hyperpronation.” Hyperpronation results in an abnormal delay of lower extremity external rotation and supination, and a less efficient cuboid pulley mechanism. This absence of supination during the propulsive phase may be deleterious to the musculoskeletal system. Excessive pronation results in a hypermobile foot at push-off as opposed to a rigid le-
Fig 1.—An ink mark is placed proximal to the metatarsal heads, which, once transposed onto the orthotic, determines the length of the device.

Structural deformities, such as a forefoot or rearfoot varus, may result in compensatory subtalar joint pronation to get the medial column of the foot onto the ground. Tiberio suggested that it is the compensation, not the abnormality, which results in injury to the musculoskeletal system. If the subtalar joint and/or the midtarsal joint compensates for the deformity by pronating rapidly, excessively, or at the wrong time of the gait cycle, increased stress is applied to the related musculotendinous structures. Those muscles which decelerate subtalar joint pronation, eg, posterior tibialis, anterior tibialis, gastrocnemius, and soleus, receive repetitive excessive and prolonged eccentric loads which often result in overuse injuries. Treatment, therefore, should be dictated by the subtalar joint compensation that occurs secondary to the structural deformity.

Orthotics function by controlling excessive motion during the weight-bearing phase of the gait cycle. Bates et al conducted a study of six subjects filmed with a video camera under three conditions: barefoot, running shoe, and running shoe with orthotic. The amount of maximum pronation and period of pronation were significantly reduced with the orthotic device.

A temporary orthotic may be implemented prior to acquisition of a permanent orthosis or serve as an adjunct to a treatment program. A temporary orthotic is indicated as a readily available and inexpensive step to determine if the athlete is a candidate for a permanent device. Specific pathologies, such as acute inversion ankle sprains, may benefit from temporary use of such an orthotic to encourage early weight bearing tolerance by decreasing intra-articular pressure. Eyring and Murray determined that intra-articular pressure in the subtalar joint is decreased when the joint is in the neutral position. Orteza et al, in a study on acute inversion ankle sprains, demonstrated subjective reports of decreased pain, improved weight-bearing tolerance, and improved balance with the implementation of a temporary orthotic.

The goal of an orthotic device is to hold the foot near the neutral position of the subtalar joint, not entirely in subtalar neutral. The normal gait cycle requires approximately 6° of subtalar joint pronation during the contact period. The orthotic, therefore, should allow the necessary amount of pronation to maintain normal function.

Fabrication

The temporary orthotic is constructed from a semirigid thermoplastic material called Aquaplast. The following is a step-by-step procedure for the orthosis:

1. Position the athlete prone with one leg extended and other leg flexed, externally rotated, and abducted.
2. Draw a line proximal to the metatarsal heads on the plantar aspect of the foot (Fig 1).
3. Cut a piece of Aquaplast larger than the size of the foot. Place in the hydrocollator which maintains water temperature ranging from 149° to 160°F.
4. Once the material has turned clear, apply the Aquaplast to the plantar aspect of the foot, covering the calcaneus and sides.
5. Smooth material around the calcaneus (Fig 2).
6. With the athlete’s foot relaxed, place the foot in STJ neutral position (Fig 3). Locate the talus on the medial aspect of the foot by placing the thumb anterior and inferior to the medial malleolus. Grasp the fourth and fifth metatarsal heads with the other hand and passively pronate and supinate the foot. The medial talar head will retract with supination and become palpable with pronation. Maintaining the same hand position, palpate anterior to the lateral malleolus with the index finger to locate the talus dome. The talus will become palpable under the index finger with supination and will retract with pronation. To determine STJ neutral position, passively pronate and supinate the foot while locating that position in which the talus is equally palpable under the thumb and index finger or not palpable at all. Once determined, slightly dorsiflex the foot to resistance which will lock the midtarsal joint onto the STJ.
7. With the STJ neutral position, move the hand which was holding the metatarsal heads to the calca-
neus. Grasp the sides of the calcaneus. This will maintain the STJ neutral position. Now use the other hand to smooth the material against the plantar aspect of the foot (Fig 4).

8. Once the material hardens, remove it from the foot. The mark which was drawn proximal to the metatarsal heads should have transferred to the orthotic. Trim the edges of the orthotic along the sides, around the calcaneus, and the transposed metatarsal line. The depth of the heel cup determines the amount of rearfoot control. Greater rearfoot control is provided by a deeper heel cup. To encourage rearfoot motion, make a shallower heel cup (Fig 5).

9. If available, use a grinder to smooth the edges and plantar surface of the orthotic at the rearfoot (Fig 6). The orthotic may be covered with material such as mole-

10. If a rearfoot or forefoot deformity is present which requires posting, the grinder may be used to add an intrinsic post. Additional Aquaplast, Plastazoate, or other materials may be used to provide an extrinsic post (Fig 7). Posting is a wedge added to the medial or lateral aspect of the orthotic to provide additional support to the foot. The goal of posting is to bring the ground up to the foot. For example, if the athlete possesses a forefoot varus, additional material may be added to the medial aspect of the orthotic under the forefoot.

The device may also be modified for other structural deformities. If a plantarflexed first or fifth ray is present, the orthotic may be modified by cutting out the first or fifth ray area (Fig 8).

Additional Considerations

It is important to periodically examine the temporary orthotic for breakdown and to question the athlete regarding symptom recurrence. Depending on variables, such as activity, body weight, usage, and thickness of the material, the temporary device may last from 3 months to 1 year.

Prior to fabricating or prescribing an orthosis, a thorough biomechanical evaluation must be conducted. Though not in the scope of this paper, foot and ankle biomechanical evaluations are provided in the literature. The findings of this exam will dictate not only whether an orthosis is indicated but also will provide information to determine the type of orthotic device and necessary modifications.

Due to a concern of orthotic abuse, orthotics must be used in conjunction with, not in place of, a rehabilitation program. Encourage the athlete to perform rehabilitation exercises with the orthotic in the shoe. Exercises, such as calf stretching, should be performed with the orthotic in place. Not only does it position the foot near STJ neutral posi-
Fig 4.—Grasping the calcaneus helps maintain STJ neutral while smoothing the aquaplast against the foot. Be careful not to form indentations along the plantar aspect while constructing the device.

Fig 5.—Remove the device and cut along the edges, including the transposed line locating the metatarsal heads.
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EASY-TO-USE FLEXION AND EXTENSION STOPS

COLOR CODED CAM WASHERS

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Stops are set using the correct cam washers which are color coded. Each cam washer contains 2 stop settings.
mine if the shoe is constructed to provide stability or encourage mobility. A “slip last,” identified by stitching which runs from the rearfoot to the forefoot, provides flexibility and cushioning. A “board last” consists of a stiff fiber board which would provide increased stability to the foot. A “combination last,” which combines rearfoot stability and forefoot flexibility, is a combination of a board in the rearfoot and stitching in the forefoot area.

If the athlete possesses a pes planus foot or is a hyperpronator, he/she would benefit from a shoe which provides stability to the forefoot and rearfoot (ie, straight last mold and board lasted). An athlete with a cavus foot or a supinator would better tolerate a shoe which provides more shock absorption (ie, a curve lasted shoe with slip lasting). An individual with a neutral foot will tolerate a semicurve lasted mold and combination lasting.

Fig 8.—Other modifications, such as a first ray cut out, may be conducted to provide improved weight-bearing tolerance.

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Abstract: Contrast therapy, although having a long history of use in sports medicine and physical therapy, remains insufficiently researched. We investigated the thermal effects of contrast therapy on intramuscular temperature. We randomly assigned 28 college students to either a control or a contrast group, eight women and six men per group. We shaved and cleansed a 4 × 4-cm area of skin over the right medial calf and inserted a microprobe to a depth of 1 cm below the skin and subcutaneous fat in the center of the gastrocnemius. Each control subject immersed the treatment leg in a hot whirlpool (40.6°C) for 20 minutes. Each contrast subject first immersed the treatment leg in a hot whirlpool (40.6°C) for 4 minutes then into a cold whirlpool (15.6°C) for 1 minute. Contrast subjects repeated this sequence three additional times. We recorded intramuscular temperatures every 30 seconds over the entire treatment time for both groups. The control group had a temperature increase of 2.83 ± 1.14°C over the 20-minute treatment. The contrast group temperature increased 0.39 ± 0.46°C from baseline to the end of the treatment. The largest temperature change from the end of one contrast immersion to the end of the next was only 0.15 ± 0.10°C. None of the differences between the end of one immersion to the end of the next were significant. Conversely, all differences between the same time periods in the control group had significant temperature increases. Apparently contrast therapy, as studied, is incapable of producing any significant physiological effect on the intramuscular tissue temperature 1 cm below the skin and subcutaneous tissue. We recommend that further research be done to examine the effects of longer periods in both the hot and cold environments on the intramuscular temperature of the human leg. Further investigation of intra-articular or peri-articular temperature change produced by contrast therapy should also be undertaken.

Practice has preceded principle in many of the treatment protocols of therapeutic modalities. A lack of scientific understanding surrounds the use of contrast therapy during the subacute stage of rehabilitation of musculoskeletal trauma. Contrast therapy employs repeated alternation of thermotherapy and cryotherapy. In sports medicine, it is primarily used to treat ankle sprains, although it is often used in the treatment of more generic strains and contusions of the extremities. The efficacy of contrast therapy is largely empirical. Leading textbooks dealing with sports medicine and therapeutic modalities propose the following indications for, and physiologic effects of, contrast therapy:

1. facilitates a mild tissue temperature increase
2. stimulates circulation
3. increases circulation in the contralateral extremity due to the crossover phenomenon
4. produces increased blood flow to the involved area
5. produces hyperemia by alternating vasodilatation and vasoconstriction of the superficial blood vessels
6. relieves stiffness and pain
7. reduces necrotic cells and aids healing
8. reduces inflammation and pitting edema
9. decreases stasis and scar tissue
10. improves range of motion
11. provides a transition for tissue accommodation between immediate cryotherapy and later thermotherapy treatment

One protocol has not been established as the standard for contrast therapy. Traditionally, contrast therapy has begun and ended with heat. Others have suggested the opposite, to begin and end with cold. Still others begin with cold and end with heat. In sports medicine, it generally has been recommended to start with heat and end with cold to minimize the possibility of swelling and to allow for pain-free range of motion.

The ratio of minutes in heat to minutes in cold and total treatment time is also variable. The most accepted ratio appears to be 3 or 4 to 1 (heat to cold), with a total treatment time of 20 to 30 minutes. The reported temperature range of the water baths is 7°C to 20°C for the cold water and 34°C to 44°C for the hot water. Michloviz wrote in her concluding statement on contrast therapy, "No well-controlled studies, however, discussing the efficacy of contrast baths are available in the literature."

We propose that for most of the physiologic effects attributed to contrast therapy to occur, substantial fluctuations in tissue temperature must be produced with the alternations from the heat to the cold or vice versa. We designed this in vivo study to measure temperature change in intramuscular tissue during contrast therapy.

Methods

Twenty-eight healthy, uninjured students volunteered as subjects.
women, age = 22.7 ± 2.2 yr, wt = 63.5 ± 6.3 kg, calf skinfold = 21.6 ± 5.9 mm, calf girth = 36.3 ± 2.7 cm; 12 men, age = 23.4 ± 2.2 yr, wt = 74.0 ± 9.3 kg, calf skinfold = 10.5 ± 4.1 mm, calf girth = 35.9 ± 1.9 cm). Brigham Young University's Human Subjects Review Committee approved the study before we began and each subject signed an informed consent. We also screened subjects for, and found no history of peripheral vascular disease or allergy to Lidocaine® or cephalexin hydrochloride (Keftab®).

We randomly assigned subjects to either the contrast or the control group, eight women and six men in each group. Due to malfunctioning of the microprobes, we excluded two men as subjects in the control group in the data analysis. To minimize the risk of infection, we administered one 500-mg dose of cephalexin hydrochloride (Keftab) immediately before the experiment. Each subject took three similar doses at 6-hour intervals following the conclusion of the experiment.14 To further guard against any possibility of infection, we put 10 ml of Pharmadine (Sherwood Pharmaceutical Company, Mahwah, NJ) in each whirlpool each day to disinfect the water.

We measured the skinfold of the posterior right lower leg with a Lange Skinfold Caliper (Cambridge Scientific Industries, Ltd, Cambridge, MD). We divided this measurement by two to determine the depth of subcutaneous fat over each subject’s gastrocnemius.

Subjects assumed a prone position on a standard examining table. We shaved a 4- x 4-cm area of skin over the right medial calf. Then we cleansed the area thoroughly, first with a 10% povidone-iodine (Betadine®) scrub and then with a 70% isopropyl alcohol swab. Next, we administered a 1-cc injection of 1% xylocaine (Lidocaine) subcutaneously to anesthetize the area.

Before beginning the study, and after each use, we gas-sterilized the hypodermic needle microprobes (Physitemp MT-23/3, Physitemp Instruments, Inc, Clifton, NJ) in an autoclave for 30 minutes. We inserted the microprobe from the side into the right medial calf. We positioned the sensor tip in the center of the lower leg to a depth of 1 cm below the subcutaneous fat and skin. We measured with a caliper to ensure that the probe was inserted at the proper depth (Fig 1). We placed a level on the hypodermic needle as the microprobe was inserted to keep it parallel to the frontal plane. The microprobe was then connected to the digital monitor (Bailey Instruments BAT-12, Physitemp Instruments, Inc, Clifton, NJ) and, after 2 minutes, the baseline intramuscular temperature was reached and recorded.

Subjects sat at the end of an examining table at which two whirlpools were placed approximately 30 cm apart. This enabled each member of the contrast group to move the treatment limb from whirlpool to whirlpool quickly and easily. Each subject, in both the contrast and the control groups, immersed his/her right leg in the extremity whirlpool(s) to a depth of approximately 5 cm above the knee joint line. The lower leg remained 15 to 20 cm away from the airflow. The airflow setting (low) remained constant throughout all treatments for both the contrast and the control groups.

Each member of the control group immersed the treatment leg in a hot whirlpool (40.6°C) for 20 minutes. Each member of the contrast group first immersed the treatment leg in a hot whirlpool (40.6°C) for 4 minutes, then in a cold whirlpool (15.6°C) for 1 minute. They repeated this sequence three additional times. At the conclusion of each treatment, we removed the microprobe, dried the limb, swabbed the area with 70% isopropyl alcohol, and applied a bandage over the site.

We recorded intramuscular temperatures every 30 seconds over the entire 20-minute treatment time for both groups. The dry and wet bulb temperatures and relative humidity of the room were 25.17 ± 0.27°C, 13.44 ± 1.0°C, and 28.0 ± 4.7%, respectively, over the duration of the study.

We analyzed the effects of contrast therapy on intramuscular temperature by calculating the temperature changes from baseline to the end of each hot and cold immersion period. We analyzed the same eight points in time (4, 5, 9, 10, 14, 15, 19, and 20 minutes) for the control group.

We used a multivariate analysis of variance (MANOVA) to determine whether a significantly different pattern in the data existed between the contrast group and the control group with respect to temperature change from baseline. We used post hoc univariate analysis of variance (ANOVAs) to evaluate individual time points for temperature change from baseline between the contrast group and the control group.

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Fig 1.—Measurement of site of microprobe insertion 1 cm below one-half the skinfold of the calf.
We used paired t-tests to analyze temperature changes between time points (baseline to 4 minutes, 4 to 5 minutes, 5 to 9 minutes, etc) for both the contrast and the control groups. When significance was found in repeated paired t-tests, the Bonferroni adjustment to correct for inflated alpha levels was used.

We employed Pearson’s product-moment correlation to determine the relationship between intramuscular temperature change and gender, weight, calf girth, and calf skinfold in the contrast group and the control group.

**Results**

There was a significant difference ($F(1,24) = 28.4, p = .0001$) in the pattern of temperature change from baseline over the total treatment period (Fig 2) between the contrast group and the control group. There was, however, no difference at the end of the first 4 minutes ($F(1,24) = 1.09, p = .31$). Throughout the remainder of the treatment, a significant difference existed between the groups.

The control group had a mean temperature increase of $2.83 \pm 1.14^\circ C$ over the 20-minute treatment. The mean temperature change from baseline to the end of the next immersion was only $0.15 \pm 0.10^\circ C$. None of the differences between the end of one immersion to the end of the next were significant. Conversely, all differences between the same time periods in the control group had significant temperature increases (Table 1).

We found no correlation in either the control or the contrast group between intramuscular temperature change and gender, weight, or calf girth. We also found no relationship between intramuscular temperature change and calf skinfold in the contrast group. In the control group, however, a significant negative correlation or inverse relationship was reached ($p = .05$) by the 9th minute. This relationship remained throughout the remainder of the 20-minute treatment except at the end of the 10th minute (Table 2).

**Discussion**

Contrast therapy, although having a long history of use in sports medicine and physical therapy, remains insufficiently researched and understood. We discovered only one controlled study dealing specifically with its physiological effects. That work investigated peripheral vascular changes experienced during therapy in healthy and rheum-
Tooid arthritic patients by recording skin temperature change in the thumb. We could not find any studies regarding the effects of contrast therapy on intramuscular temperature.

Research investigating the physiological reactions to the independent use of superficial heat or cold is more prolific. There is a sufficient body of evidence to identify the factors that affect intramuscular temperature change with such treatment. We developed the following list of primary and secondary factors to provide a physiological framework for our discussion.

**Primary Factors**
1. The temperature of the agent applied and its variation from the temperature of the body surface to which it is applied—the greater the temperature gradient, the greater the heat transfer.
2. The region and surface area over which the agent is applied—the greater the area over which superficial heat or cold is applied, the greater the total heat transfer.
3. The duration for which the agent is applied—the longer superficial heat or cold is applied, the greater the heat transfer.
4. The depth at which the tissue is measured—for equal time exposure to superficial heat or cold, the deeper the tissue examined, the less temperature change will occur.

**Secondary Factors**
1. The rate of blood flow to the part and the local metabolic rate—generally, cold will lower intramuscular blood flow and local metabolic rates, whereas heat will do the opposite. Conversely, increased blood flow will increase intramuscular temperature, whereas decreased blood flow will lower it.
2. Individual variability—each person reacts somewhat differently.
3. The amount of integument surrounding the muscle—the integuments act as passive insulators of the muscle and the majority of the studies identify adipose, either site-specific or overall body fat, to be inversely proportional to intramuscular temperature change brought about by the application of superficial heat or cold.
4. The sympathetic vasomotor integrity—when overlying skin is cooled, sympathetic nerve fibers can cause vasoconstriction which reduces blood flow to the muscles.

Our control group’s mean temperature increase of 2.83 ± 1.14°C over the 20-minute treatment in 40.6°C water coincides with previous studies. One study investigated the effects of various water bath temperatures (13° to 45°C) on deep muscle temperature and blood flow in the human forearm. Barcroft and Edholm noted that as the temperature gradient between the baseline intramuscular temperature being assessed (brachioradialis muscle at 2.5 cm below the skin) and the water bath increased, the intramuscular temperature increased as well. They also reported increases in intramuscular temperature of approximately 2.75 and 3.0°C for 20-minute immersions in 40° and 42.5°C water baths, respectively. The authors of a similar study using 45°C water reported mean temperature increases, after a 20-minute treatment, of 1.4°C from a control level of 36.1°C. The average depth of the thermocouple in the brachioradialis muscle was 3.4 cm below the skin. The increased depth accounts for the reduced temperature change. Lehmann et al reported virtually no increase in tissue temperature below 1 cm until after 10 minutes of treatment. Our control group had a 0.89 ± 0.18°C increase at 1 cm into the muscular tissue after 4 minutes of treatment.

Some researchers of cold have reported rapid effects. They observed intramuscular temperature change of the biceps brachii. One reported an almost immediate reduction at 2 cm depth upon the application of ice massage for 5, 10, and 15 minutes. The decline was greatest during the first 2 minutes, followed by a less steep decline until the fifth minute, and an even slower decrease in temperature from 5 to 15 minutes. The second noted, “The mean deep temperature showed a steady decline, particularly after the first minute of cooling and the rate at which the muscle cooled appeared to increase rapidly after the first 90 seconds of skin cooling.” Some investigators reported decreases in intramuscular temperatures within the first 2 minutes of the application of superficial cold.

**Table 2.** Correlations of Muscle Temperature Changes From Baseline With Skinfold Throughout Treatment for Contrast and Control Groups

<table>
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* p significant at the .05 level

The critical question with regard to the efficacy of contrast therapy in the treatment of muscular tissue is: “Does the protocol used produce temperature changes necessary to cause the physiological responses stated in the introduction to occur?” Although there seems to be agreement on the factors influencing intramuscular temperature change produced by the application of superficial heat or cold, the literature shows conflicting reports on the time required to produce change. The authors of two studies on heat reported almost immediate increases in intramuscular temperature. Lehmann et al reported virtually no increase in tissue temperature below 1 cm until after 10 minutes of treatment. Our control group had a 0.89 ± 0.18°C increase at 1 cm into the muscular tissue after 4 minutes of treatment.

Some researchers of cold have reported rapid effects. They observed intramuscular temperature change of the biceps brachii. One reported an almost immediate reduction at 2 cm depth upon the application of ice massage for 5, 10, and 15 minutes. The decline was greatest during the first 2 minutes, followed by a less steep decline until the fifth minute, and an even slower decrease in temperature from 5 to 15 minutes. The second noted, “The mean deep temperature showed a steady decline, particularly after the first minute of cooling and the rate at which the muscle cooled appeared to increase rapidly after the first 90 seconds of skin cooling.” Some investigators reported decreases in intramuscular temperatures within the first 2 minutes of the application of superficial cold.
Based on the results of the studies cited, it is also highly unlikely that any other physiological effects were produced intramuscularly. We therefore recommend that further work is needed to see if more time, in both the hot and the cold environments, would cause any of the proposed physiological effects of contrast therapy to occur at the intramuscular level. We also suggest that, if the intent of the contrast therapy is to increase local circulation following cryotherapy, exercise is a more efficient way to accomplish this objective.\textsuperscript{15,20,21}

If accommodation of the intramuscular tissue from acute cryotherpy treatment to postacute thermotherapy is desired, our results indicate that perhaps a daily graduated increase in the temperature of a regular 20-minute hydrotherapy treatment would be more effective. As the focal point of the treatment is articular, as in an ankle sprain, investigation into intra-articular and periarticular temperature change due to contrast therapy is important. Further research to examine other contrast therapy protocols and anatomical sites is underway.

### Acknowledgments

We wish to express our sincere appreciation to Dr. Gilbert W. Fellingham for his assistance with the statistical analysis. We also thank Ben Zhou for assisting during the data collection process.

### References


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Temperature Changes During Therapeutic Ultrasound in the Precooled Human Gastrocnemius Muscle

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David O. Draper, EdD, ATC
Earlene Durrant, EdD, ATC
Gilbert Fellingham, PhD

Abstract: Therapeutic ultrasound is frequently employed as a deep heating rehabilitation modality. It is administered in one of three ways: a) ultrasound with no preceding treatment, b) ultrasound on preheated tissues, or c) ultrasound on precooled tissues. The purpose of this study was to investigate the effect of ultrasound treatments on the tissue temperature rise of precooled human gastrocnemius muscle. Sixteen male subjects had a 23-gauge hypodermic needle microprobe inserted 3 cm deep into the medial aspect of their anesthetized gastrocnemius muscle. Data were gathered on each subject for one of two randomly assigned treatments: a) ultrasound treatment on precooled tissue, or b) ultrasound with no preceding treatment. Each treatment consisted of ultrasound delivered topically at 1.5 watts/cm² in a continuous mode for 10 minutes. Ultrasound was applied in an overlapping longitudinal motion at 4 cm/s, with temperature readings recorded at 30-second intervals. We discovered a difference between the two treatment methods \( t(14) = 16.26, p < .0001 \). Ultrasound alone increased tissue temperature an average of 2°C, whereas ultrasound preceded by 15 minutes of ice did not increase tissue temperature even to the original baseline level. We concluded that, at a depth of 3 cm, ultrasound alone provided a greater heating effect than ultrasound preceded by an ice treatment.

Ultrasound is one of the most widely used deep-heating modalities. Therapeutically, ultrasound as a heating agent is applied in one of three ways: 1) with no preceding therapy to the treatment area, 2) heating of the treatment area before ultrasound, or 3) cooling of the treatment area before ultrasound. Numerous authors have documented the effects of ultrasound applied exclusively. Lehmann et al. reported that preheating tissue provided no advantage or disadvantage to ultrasound. We found no studies in the literature pertaining to the effects of ultrasound on precooled tissues. The clinical practice of precooling tissues before an ultrasound treatment is founded on the premise that ultrasound is most effectively transmitted through dense materials. The denser the medium, the greater the wave propagation. Thus, the application of cold to a treatment area before an ultrasound application should increase the tissue density because of the decreased tissue temperature.

Therapeutic modalities are of maximum benefit when used correctly and not operated on the basis of hypothesis or hearsay. The apparent absence in the literature of studies pertaining to the common clinical practice of precooling before ultrasound necessitates further investigation. Also, the application of cold before ultrasound is an ethical concern if the procedure is neither beneficial nor necessary to the patient. For these reasons, we conducted the following study to investigate the effects of an ultrasound treatment on tissue temperature rise in the precooled and uncooled gastrocnemius muscle.

Methods

This study was designed as a 1 × 2 factorial with tissue temperature as the dependent variable. Sixteen male students (24 ± 1.6 yr) volunteered to participate. The left gastrocnemius muscle of each subject had been free from ecchymosis, infection, swelling, or injury for the previous 6 months. Each participant gave informed consent after viewing a videotape demonstrating the investigation procedures. Approval for the study was granted by the Brigham Young University Human Subjects Institutional Review Board.

An antibiotic therapy program to reduce the risk of infection, using cephalixin hydrochloride (Keftab), was administered to each subject on the day of participation. One 500-mg dose of Keftab was taken before the experiment. After the experiment, three more doses were taken, one each at 6-hour intervals. We used the Sonicator 710 (Mettler Electronics, Anaheim, CA) ultrasound unit. The generator operated at a frequency of 1.0 MHz ± 5%. The transducer head was 7 cm in diameter and contained a barium titanate crystal. The ultrasound unit was recently calibrated. Our coupling medium was Aquasonic 100 Ultrasound Transmission Gel (Parker Laboratories, Orange, NJ) at room temperature (25°C). Ice bags (1 L of ice in 8" × 12" plastic bags) were the cooling agent.

We gas-sterilized the thermistor (Phystemp Instruments, Clifton, NJ) be-
fore the study, and after each use, in an autoclave for 30 minutes. We followed the methods developed and reported previously. The treatment assigned to each subject was determined randomly. A 10-cm-diameter treatment area on the left medial gastrocnemius muscle was shaved, cleansed thoroughly with a Betadine® scrub, and then swabbed with 70% isopropyl alcohol. A physician gave an injection of 1 cc of 1% lidocaine (Xylocaine) subcutaneously to anesthetize the area, and then inserted the thermistor into the center of the left medial gastrocnemius muscle belly, so that it was 3 cm beneath the area of application. The thermistor was then connected to a Bailey monitor (Physitemp Instruments, Clifton, NJ). After approximately 3 minutes, the temperature stabilized; we then recorded a baseline reading. We applied ultrasound to the posterior of the gastrocnemius muscle, perpendicular to the tip of the needle (Fig 1).

For all treatments, the subjects were lying prone. For the precooled tissue treatment, we placed an ice pack on the treatment area for 15 minutes and recorded the temperature every 30 seconds. Immediately after the 15-minute ice application, we applied 25°C ultrasound gel to the treatment area. We then delivered ultrasound in a continuous mode for 10 minutes, at an intensity of 1.5 watts/cm². The sound head was moved in a longitudinal overlapping manner at a speed of approximately 4 cm/s. The strokes were two to three times longer than the size of the soundhead and were applied in a 10-cm-diameter area. We recorded the temperature every 30 seconds.

The control followed the same parameters as the precooled tissue treatment with respect to ultrasound intensity, time, speed, and stroke movement of the soundhead, and the recording of temperatures. The only difference was the immediate, exclusive application of ultrasound after the baseline reading.

We removed the thermistor at the completion of each treatment and cleansed the area with 70% isopropyl alcohol and a Betadine scrub. We then applied a bandage to the injection site and excused the subject.

We analyzed differences in maximal tissue temperature rise between the two ultrasound treatment methods (ultrasound preceded by ice and ultrasound alone) with an independent t-test. Alpha was set at the .01 level.

The mean baseline temperature for each treatment was 35.8° ± 0.7°C. It increased as a result of the ultrasound treatment (37.8° ± 1.0°C) and decreased during the combined ice pack and ultrasound treatment (31.0° ± 0.8°C; t(14) = 16.26, p < .0001).

Discussion

If the purpose of the ultrasound treatment is to increase the tissue temperature at a depth of 3 cm, precooling the tissue for 15 minutes before ultrasound is an exercise in futility. In the clinical setting, ultrasound treatments are administered for 5 to 7 minutes, whereas in our study, the ultrasound was applied for 10 minutes and still the precooled tissues only rose an average of 0.6°C above the terminal ice temperature reading (Fig 2). The clinical supposition that precooling of tissues before an ultrasound treatment increases the peak temperature of those tissues is not true. The failure of the ultrasound to raise the tissue temperature of the precooled area, even back to the pretreatment baseline, is a result of the dominating effects of the ice.

We observed an interesting phenomenon in which the muscle temperature of the subjects receiving the ultrasound on the precooled tissue continued to decrease, on the average, during the first 2 minutes of the ensuing ultrasound treatment. These results suggest that the deep heating effects of ultrasound were not
strong enough to counteract the effects of ice. A future investigation could replicate our study, but could precool the tissues for a shorter period of time (eg, 3 to 5 minutes), thereby cooling only the superficial tissues. This might make the superficial tissue more dense, while not drastically cooling the deeper tissues. The ultrasound might then be able to affect the deeper tissues without having to contend with the persistent effects of the ice. It is thus possible that the increased density of the superficial tissues might allow the ultrasound to respond as was previously theorized.

Using an ice pack before ultrasound treatment is commonplace in many settings. Some clinicians charge up to $20 for a 15-minute ice pack application. Because there is no scientific evidence to date that ultrasound is effective when administered after an ice treatment, we suggest that this practice be re-evaluated. Future studies aimed at cooling only superficial tissues before ultrasound treatment are needed.

References
Leadership and Management: Techniques and Principles for Athletic Training

Stephen M. Nellis, MEd, ATC

Abstract: Leadership and management have become topics of recent interest in athletic training. These skills are distinct from each other and are vital to a successful and efficient athletic training room. Leadership is an influence relationship, while management is an authority relationship. Leadership is concerned with knowing yourself, your staff, your profession, and how to apply people skills. Management is concerned with organization, communication, and the development of your athletic training facility's mission. By applying good management and leadership skills, you can implement your mission statement, evaluate your results, and improve the performance of your athletic training facility.

Recentlly, a growing interest in the topics of Leadership and Management as they pertain to the profession of Athletic Training has developed. Having experienced and studied each skill, in both a military setting and an educational setting for 15 years, I feel I may be able to share some basic observations and lessons learned with those who may not have had the opportunity to gain insight into these topics.

We, in the world of athletic training, realize the work is hard. Rewards must often come from intrinsic satisfaction, and change has been fairly continuous and rapid. All of these factors combine to create an environment where good leadership and management skills are vital to maintain esprit de corps, teamwork, and efficiency in the modern athletic training room. Before you can delve into the intricacies of these two skills, you must gain a basic understanding of their definitions. Many people will consider leadership and management the same thing. I and others who have studied and practiced them realize that they are not. Some courses of study will lead you to believe that management is bad leadership. This also is not true. Both are separate skills, either of which can be conducted poorly or with excellence. With these concepts in mind, I will present definitions for each.

Leadership

"Leadership is one of the most observed and least understood phenomena on earth." In an in-depth study of the definition of the word "leadership," Rost discovered no less than 200 separate definitions. For this writing, I will use the definition developed by Rost: "Leadership is an influence relationship among leaders and followers who intend real changes that reflect their mutual purposes." Not all will agree with this definition (after all, there are already at least 200 others with a different idea), but it will provide a starting point for this article.

To lend credibility and congruence to this study, a definition of management must also be provided. Rost was also kind enough to develop one of these, and it will fit nicely with this topic. "Management is an authority relationship between at least one manager and one subordinate who coordinate their activities to produce and sell particular goods and or services." Again not everyone will agree with this definition. In fact, there are volumes written by some who do not. Further reflection on this point is another topic. This definition will provide a starting point.

The main points to be taken from this writing so far are that leadership and management are not the same skill. Leadership is an influence relationship, and management is an authority relationship. Leadership is concerned with real change, and management is concerned with goods and services. Both skills are mutually exclusive but are often practiced simultaneously. An athletic trainer who is knowledgeable and proficient in both will maintain a highly motivated and efficient athletic training room.

Assuming that your athletic training room is committing to a new paradigm, to continued progress, or to a change of any type, leadership will be required to ensure success. The application of leadership in a practical versus a theoretical manner requires the application of a few basic techniques and principles.

Know Yourself

The best place to begin leadership is with yourself. A leader must have a realistic, pragmatic understanding of his or her best-developed skills, underdeveloped skills, physical abilities, personal biases, and particular irritants which may cloud any judgments or affect any actions he or she may take. A good understanding of yourself will allow you to know when you must give extra consideration to a decision and how you will react under stress. It will allow self-confidence in those skill domains in which you are proficient. This knowledge is not easy to obtain, but through evaluation from others and by constant introspection, you can learn to know yourself.

Stephen M. Nellis is an athletic trainer at the University of San Diego in San Diego, CA.
Lead by Example

Once you are secure with yourself, you may begin to lead others. An excellent way to begin is by example. Example often becomes contagious. If you desire commitment, you must display commitment. There are a number of ways to set an example. What type of presence do you project? Are you professional in your dress, demeanor, and display of athletic training skills? Do you maintain your judgment and bearing during times of stress? Actions I consider to be of greatest importance include exemplifying initiative, enthusiasm, dependability, and moral courage. Moral courage is extremely important. All athletic trainers must establish a set of values for their athletic training domain which they will not allow to be violated. There will be times when you will be asked to make compromises when it is not appropriate. Compromise may be instigated by a parent, athlete, coach, or even fellow athletic trainer, and it is often very difficult not to give in. It is at these times that a leader rises above the circumstances, does the right thing, and exemplifies moral courage.

There are some methods of “example” which will quickly undermine all good efforts you may attempt. Many of these examples originate from the “I’ve done my time” attitude. Seniority definitely should carry some privilege, but this must be used with judgment. For example, a Head Athletic Trainer should not be the person sweeping floors and wiping tables. Obviously his or her valuable time could be used more efficiently. But when it comes to sharing long hours and covering inconvenient practice times, it will not provide the athlete with the best care, the coach with the best service, or the athletic training room with its peak operating efficiency.

Know Your People

A third principle of leadership is: know your people. In athletic training, “people” embodies staff, athletes, coaches, and anyone who conducts business with the athletic training facility. All individuals maintain certain personality quirks. To develop teamwork and efficiency, everyone in the team must have a basic understanding of how the other team members will react to different circumstances. It is especially important to understand the personalities of the athletes in your care. Quality performance in rehabilitation is crucial in determining the final outcome of recovery. Some athletes require very little external motivation and assistance, while others may require substantial assistance in many areas. An understanding of each athlete’s particular needs is integral to the success of his/her recovery.

Knowledge of your staff is also important. Knowing what motivates each individual, who needs close supervision, who has initiative and judgment, and whose personality works well in conjunction with another personality will allow a better deployment of your staff resources for higher quality service.

Loyalty Encouragement Reprimand

Besides knowing your people, there are three other people skills which are vital to successful leadership or management. These skills are enacting loyalty, encouragement, and reprimand.

All organizations require loyalty if they are going to be successful. The key notion to remember is that loyalty is a two-way street. Staff members are expected to work hard and promote a positive portrayal of the organization. At the same time, the organization should provide positive opportunities for each staff member. Examples of positive opportunities include allowing time for educational and professional development, ensuring exposure to all facets of athletic training, and providing adequate pay for the level of work, experience, and education.

The dictum “Praise in public and reprimand in private” will encompass the concepts contained in the next two principles. It is very easy to become myopic and see only the bad results. It is more of a tendency of human nature to correct than to congratulate. A constant awareness of this will develop the habit of providing rewards, awards, and gratitude. There are times, after many hours in an athletic training room, that a bright spot is hard to find. At these times, the voicing of a simple “thank you” may go a long way. As a leader you should ensure that rewards are seen and keep a log of good performances. This will remind you and others that good things do happen to a very real simulation. Creating a real cervical fracture, cardiac distress, or unconscious athlete has unacceptable ethical and legal drawbacks. A leader must strive for realism in drills, create stress by controlled means, and note and critique individual responses when real situations do occur. This will benefit staff members by increasing confidence in themselves and in other members of the team. Getting to know and understand others requires adaptability and effort, but the end results are worth it.
threats of punishment. Often your bluff will be called. If you cannot enforce your stated punishment, your credibility will be damaged. Document all infractions thoroughly. If the infraction is serious in nature, have the individual being reprimanded sign a form detailing the infraction and the fact that he or she was counseled. You may wish to sign the form also. Employing these simple steps will create a situation where all parties are aware of what the other is communicating. If the unfortunate circumstance arises where a suspension or termination is required, it can be administered without confusion or guilt.

Application of these leadership concepts will allow the execution of a more efficient management process and garner more support from those whom it affects.

Management

I will now present management tools and principles which have proven successful in the past. Application of these and the leadership concepts above will provide a solid base for organizational success.

Table 1.—Mission Statement Examples

1. Lockheed:

“Our mission is to meet the needs of our United States and foreign customers with high-quality products and services and, in so doing, produce superior returns for our shareholders and foster growth and achievement for our employees.”

2. Bread Loaf Construction Company:

“We are Bread Loaf, a family of building professionals dedicated to and empowered by the strength of our people.

We seek challenges to create innovative solutions which make statements demonstrating our commitment to excellence.

As we grow into the 21st century, we shall continually focus upon employee wellness, community responsibility and a sensitive balance between personal and professional fulfillment.”

3. Generic Athletic Training Department:

The Athletic Training Department, under the supervision of the Team Physician, will provide support for all athletes through the prevention, recognition, treatment, and rehabilitation of all athletic injuries. The department will assist in the education of the athlete by providing and coordinating educational and counseling programs which reflect the holistic approach to education established by the university.

Communication is very important when increased efficiency and sound management practices are desired. Communication must occur horizontally as well as vertically. Key individuals will include the athletic director, doctors, coaches, staff, athletes, parents, and possibly a principal or the Dean of Students.

Mission Statement

The first step in developing a communication network is to create a vision of what your athletic training room is to stand for, whom it will serve, and what will constitute its mission. This is accomplished by issuing a Mission Statement. A Mission Statement may range from a short paragraph to a single page. It is a statement which outlines the philosophy of the institution and its goals. It is developed with a long-range perspective but is not an edict written in stone. For an organization to ensure it is progressing and maintaining its desired objectives, a Mission Statement is updated every 1 to 5 years. A Mission Statement for an athletic training room can easily be developed by referring to the Mission Statement of the parent organization, the Domains of Athletic Training as defined by the NATA, state regulations and guidelines, and by conferring with staff members and administrators. Include as many as possible of those who will be affected by the statement in its development. This will prove beneficial when it is time to support and implement the plan. A well-designed Mission Statement will set the tone of the athletic training room, establish moral guidance, set the mission of the athletic training room, and delineate roles and priorities (Table 1).

Evaluation

Once the mission statement is created, you have established the standards the athletic training room should fulfill. Next you must discover if these standards are being met or not. There are a number of tests designed to do this and they may be obtained through a professional evaluation services company.
Help may also be obtained through the instructors of evaluation and statistics at the nearest educational institution. Some situations may not require a formal evaluation test. An informal questioning of staff members, coaches, athletes, and administrators may provide adequate feedback concerning the success of the athletic training room. Topics that may be of concern might include: 1) How does your facility meet your needs? 2) What is your patient population and how are their demands being met? 3) What services are required of your facility and how are they met? 4) What human resources are available and how may they be utilized to meet your needs? 5) How well does your present mode of operation meet the vision as established by your Mission Statement?

After your initial evaluation is complete, the Mission Statement will provide the guidance for two other crucial documents: a job description and a Policy and Procedures Manual. While the Mission Statement is fairly general and philosophical in nature, the job description and Policy and Procedures Manual are specific by design.

**Table 2.—Job Description Example**

1. The Head Athletic Trainer, under the supervision of the University Team Physician and reporting to the Director of Athletics, is responsible for all aspects of health care in the athletic environment, to include, but not limited to, the six domains, as outlined by National Athletic Trainers’ Association.

   - Prevention of Athletic Injuries (describe in detail).
   - Recognition and Evaluation of Injuries (describe in detail).
   - Management, Treatment and Disposition of Athletic Injuries (describe in detail).
   - Rehabilitation of Athletic Injuries (describe in detail).
   - Organization and Administration of the Athletic Training Program (describe in detail).
   - Education and Counseling of Athletes (describe in detail).

   The Head Athletic Trainer must also maintain on-going NATA certification by satisfying the requirements for obtaining Continuing Education Units.

2. Assistant Trainers will assist the Head Athletic Trainer in the prevention, immediate care, management, and rehabilitation of athletic injuries to the intercollegiate athletic teams. Assistants must be currently certified with the NATA and fulfill the continuing educational requirements to maintain certification.

A chain of responsibility and role delineations should be established. This will help eliminate redundancies in areas such as communication with coaches and doctors and performance of administrative chores. It will ensure that everyone knows what his/her primary responsibilities are, and with whom to coordinate other tasks. This should not restrict creativity or limit coworker assistance, but it should be concise enough to leave no doubt as to individual responsibilities.

Event-coverage standards should also be established. These will allow the coach to know what level of coverage he or she can expect, and the athletic trainer can avoid work overload by establishing what sports and hours he or she is expected to work. Things to consider here are: 1) What sports need coverage? 2) When are student athletic trainers allowed to provide coverage? 3) Is away-match coverage required, as well as home coverage?

Athlete physicals are another important topic which should be discussed. Some concerns here are: 1) Who will perform them? 2) What qualification standards are required for each sport? 3) Who has the final authority as to disqualification or return to play? 4) Who is required to receive a physical examination?

Student athletic trainer guidelines should be established. Prerequisites for acceptance to the program should be established, progress and continuing education requirements outlined, and roles and responsibilities detailed. These guidelines are of special importance because they will often create the first impression of athletic training to the student. Imprinting the proper moral and professional standards at this initial exposure will be integral to the success of the student in the future.

Medical insurance coverage requirements should also be explained. The insurance quagmire has become a large factor in sports today. Most institutions can no longer afford to cover the whole cost of athlete insurance coverage. It should be made very clear as to what type of insur-
ance the institution provides, what type of coverage the athlete is required to provide, and what exceptions will be allowed.

Media communications is a vital area of concern. The elimination of confusion and misinformation in this area is critical to an institution. Special areas of concern are the topics of athlete death or serious injury. The damage to institutional credibility and the emotional pain that can ensue when incorrect information is released or improper lines of notification are followed is incalculable and inexcusable. Liaison with the parent institution is recommended, because it often has guidelines concerning student mishaps and media relations. Related to this concern is the notification of parents. The guidelines for this will be different, depending on the institutional situation. For example, a high school athletic trainer may be required to contact parents in many more cases than a college athletic trainer whose athletes are not minors.

Emergency procedures should also be outlined. Topics of concern are: 1) When is ambulance coverage required? 2) When and how should the EMS system be activated? 3) Who should be notified of an emergency? 4) Where is the nearest phone to each venue that is used located?

Drug education and screening have also become important topics for athletic trainers to address. There are a number of resources which provide insight into the conduct of these programs. A good place to start is by contacting the NCAA (6201 College Boulevard, Overland Park, KS 66211-2422; telephone: 913-339-1906). The NCAA will readily provide information materials outlining drug testing legislation, student athlete consent forms, NCAA-banned drug classes, testing protocol, and guidelines for a drug screening program. Your parent institution may have established policies which must be considered in the development of a program. Many universities have a drug and alcohol counselor who may provide helpful advice and resource materials. Other resources include the legal advisors for the institution and the United States Olympic Committee Sports Medicine and Science Division (1750 East Boulder Street, Colorado Springs, CO 80909-5760; telephone: 800-233-0393).

Other topics that may require consideration are medical file handling procedures, OSHA requirements compliance guidance, and standards concerning the handling of medications.

**Implementation**

You are now ready to begin an organized implementation of your plan. The first basic decision to consider for implementation is whether to phase in the changes by stages or to employ a single overhaul. Either strategy may be viable, depending upon your situation.

Leadership and communication will again be key elements to employ. During the creation of your Mission Statement and Policy and Procedures Manual, you will have developed changes you wish to implement. Change represents the unknown, and few things will cause fear and rebellion like the unknown. By applying the leadership concepts previously established and ensuring clear communication, many obstacles to success may be avoided. If people understand what you are trying to accomplish and how it will benefit them, support will be much more forthcoming. If leadership and communication are not employed, rumors will develop and grudges and jealousy will create destructive interoffice politics.

The next important part of implementation will be education. You should start by ensuring that everyone involved has the same understanding of your Mission Statement. This should be easy if the proper liaisons were made during its creation. Once this is accomplished, you must provide the tools that will allow oth-
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ers to help you implement your plans. This may be done in a number of ways. Examples include: establishing scheduled in-services, providing constant practical application in the athletic training room, encouraging initiative and innovation, promoting the reading of professional journals, delegating responsibility, and supporting and providing time for outside continuing education. By employing these methods, you will discover the development of intellectual interchange, better coordinated teamwork, and improved performance.8,11,13

Education should be external as well as internal. By educating people outside of your department, you may gain surprise financial support or a political ally who will support and promote your cause in influential circles. Groups that should be included in your educational campaign are: alumni board members, faculty members, other health groups on campus or in the area, and community boosters. Many of the individuals in these organizations may have little knowledge of athletic trainer certification requirements or of the magnitude of services that the athletic trainer can provide.

Later, you will need to reevaluate your program. Some of your results will be excellent, and, in most cases, other results will require further refinement. The key to this evaluation is to not be concerned with placing blame for any failures, but to concentrate on developing a better solution. Once again, ensure that you obtain input from all levels horizontally and vertically. Employ the use of flow charts, graphs, and statistical methods. These will give you a better view of your results, delineate between good methods and good luck, and provide good tools to use to sell your plans and gain more support. Your evaluation should develop new ideas and methods for implementation which will allow you to start the process all over again.

Time-tested results of the above leadership and management techniques have repeatedly proven their applicability and dependability.5,6,8,12 They have created an atmosphere which allowed an increase in work quality, increased morale, decreased costs, and developed a proactive response capability. All of these may be combined to help an athletic training room progress toward its ultimate goal, the improved health care of our athletes.

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Injured Athletes and the Risk of Suicide

Aynsley M. Smith, RN, MA
Eric K. Milliner, MD

Abstract: Research on the emotional responses of athletes to injury shows significant depression that may be profound and may last a month or more, paralleling the athlete’s perceived recovery. Injured athletes cared for by athletic trainers are often between the ages of 15 to 24, the high-risk age group for suicide, which is currently a leading cause of death for young Americans. The purposes of this paper are to discuss postinjury depression, the incidence and risk factors of suicide, athletic injury as a psychosocial risk factor, the features common to suicide attempts in case studies of five injured athletes, and the motivation of athletes for sport participation. We also suggest ways in which athletic trainers can assess injured athletes for depression and risk of suicide. The five injured athletes who attempted suicide shared several common factors. All had experienced 1) considerable success before sustaining injury; 2) a serious injury requiring surgery; 3) a long, arduous rehabilitation with restriction from their preferred sport; 4) a lack of preinjury competence on return to sport; and 5) being replaced in their positions by teammates. Also, all were in the high-risk age group for suicide. As a primary care provider, the certified athletic trainer is in an ideal position to detect serious postinjury depression and to determine whether the injured athlete is at risk for suicide.

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Athletes’ Emotional Responses to Injury

Researchers have described the emotional responses to injury of runners, college athletes, injured sports persons, and competitive athletes. The Profile of Mood States (POMS), which has documented reliability and validity, was used in each of these five studies to measure postinjury tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. Use of this standardized measure of affect or mood has permitted between-study comparisons.

Chan and Grossman compared the mood state (POMS) and self-esteem (Rosenberg Self-Esteem Inventory) of 30 noninjured runners to 30 injured runners. Both groups consisted of 16 men and 14 women matched for age, weekly mileage, hours of exercise per week, racing frequency, and years of preinjury running experience. Injured runners showed significantly more depression, anger, confusion, and lower self-esteem than did the noninjured runners. Deprivation of consistent running may have resulted in the loss of a coping strategy for those runners who ran for stress management and who depend on running to stabilize their moods.

The emotional response to injury of 72 recreational athletes was studied using the Emotional Responses of Athletes to Injury Questionnaire (ERAIQ) (Fig 1) and the POMS. When injured athletes were divided into severity of injury groups based on the length of time they were out of sport, athletes with minor injuries experienced less mood disturbance than did the college student normative group to which they were compared. Conversely, the more seriously injured athletes experienced significant elevations in depression, anger, tension, and decreased vigor compared to the college norms. These mood disturbances persisted for approximately 1 month af-
How did it happen?

Relieved

Fig 1.—The emotional responses of athletes to injury questionnaire. (Adapted from Smith, et al.21 Sports Med. 1990;9:352–369 with permission of Adis International.)

ter injury (Fig 2). These more seriously injured athletes were out of sport from 4 to 22 weeks with torn ligaments, torn menisci, or fractures that often required operations, casts, and crutches. Mood disturbances decreased as the athletes perceived that recovery was occurring.20 A similar study to those above reported that five seriously injured collegiate athletes experienced significant depression, tension, anger, and decreased energy postinjury, a mood state that was statistically correlated to their rating of perceived recovery.8

Pearson and Jones14 compared a matched group of 61 injured and 61 noninjured recreational athletes or sports persons in Great Britain. Injured sports persons experienced more negative scores on all POMS scales than did those from the noninjured group. A qualitative interview portion of this study questioned injured athletes about their social support and the attitudes of their health care professionals. Suggestions for interventions that injured athletes believed would be helpful were also obtained.

A recently completed study of 13 athletic teams representing the sports of hockey, volleyball, and baseball compared the preinjury and postinjury mood state (POMS) and self-esteem (Rosenberg Self-Esteem Inventory)1 of injured athletes.22 It examined the presence of stress, social support, attitudes, sport preferences, and goals of athletes (ERAIQ21 Forms A, B, and C) and reported that severity of injury was the greatest predictor of postinjury depression.22 In this prospective, blinded study (performed with the assistance of certified athletic trainers), the researchers found significant preinjury and postinjury differences in mood state, suggesting that the experienced postinjury mood disturbance is likely attributable to the injury and not to a preexisting disturbed mood state.23

Overall, the results of these studies1,8,14,20,22 indicate postinjury mood disturbance, a finding most significant in the more seriously injured athletes.8,20,22 Although thoughts of suicide were not investigated in these reported studies, the large standard deviations reported for depression raises concern about the possible coexistence of thoughts or impulses toward suicide. The significant depression scores reported in the five studies1,8,14,20,22 prompted us to examine the incidence of suicide in adolescents to better understand the recent suicide attempts of several young athletes who had sustained serious athletic injury.

Incidence of Suicide

Suicide has tripled in the past 20 years and is currently the second leading cause of death in young Americans (aged 15 to 24 years). If the rate is adjusted for probable underreporting, the actual suicide rate may equal accidents as the number one cause of death in this age group,1 accounting for 42 to 64 deaths per
issues of homosexuality, drug use, pre­
family history of suicidal tendency/ genetic predisposition, and 5) a psychi­
atric disorder.16 Individuals dealing with chronic mental illness, 3) personality be proportionate to the degree of risk degree of overlap of the risk factors may 

(27x181)scribes the risk factors for suicide. We attempt to evaluate the psychosocial im­
pact of a serious injury on a young ath­
tletes have lost their ability to achieve in 
sport, postinjury depression may place 
them at an added risk for suicide, partic­
larly if other risk factors are present. 

Risk Factors for Suicide 
A model of five intersecting rings de­
scribes the risk factors for suicide. We have drawn the model to show that the degree of overlap of the risk factors may be proportionate to the degree of risk (Fig 3). These risk factors include 1) stressful psychosocial life events, 2) chronic mental illness, 3) personality traits consistent with maladjustment, 4) a family history of suicidal tendency/ genetic predisposition, and 5) a psychi­

410,000 in white men. Furthermore, members of this age group make 10 suicide attempts for each completed suicide.14 Many injured athletes belong to this high-risk age group. For example, in the study on recreational athletes, 33 of the 72 injured athletes were 16 years old.20 Because of the popularity of youth sport and the incidence of injuries sustained in contact sports,22 many injured athletes seen by athletic trainers are between the ages of 15 and 24. Consequently, athletic trainers and all members of the sports medicine team should be aware of some risk factors for suicide and should at­
tempt to evaluate the psychosocial impact of a serious injury on a young ath­
lete.

Common Factors in Attempted Suicides of Injured Athletes 
Initially, we considered presenting five case studies of athletes seen in our clinical practice who attempted suicide postinjury. To better protect patient con­
fidentiality, we decided instead to present the factors that were common to all members of this small group. All had 1) sustained a serious injury that required 
surgical intervention; 2) experienced a long, arduous rehabilitation that re­
stricted participation in their preferred sport for 6 weeks to 1 year; 3) experi­
cenced a deterioration in their athletic skills, despite adherence to a vigorous rehabilitation program; 4) felt they lacked their preinjury competence on re­
turn to the sport; and 5) been replaced in their positions by teammates, a devastat­
ing blow to self-esteem, which may have already been low. Furthermore, these in­
jured athletes were all in the high-risk age group (16 to 18 years) for suicide and had enjoyed considerable athletic success before sustaining their injuries.

The features shared by these injured athletes all related directly to injury, the risk factor identified in Figure 3 as a stressful life event. In some cases, al­
though we did not know the family psychiatric history, strained family dynamics and discord in the parent/athlete relationship were apparent.

Although the hypothetical model pos­
ted in Figure 3 may enhance the general practitioner’s risk assessment for suicide of adult nonathlete populations16 and heighten the athletic trainer’s awareness of the problem, it will need to be modi­
fied to accurately predict suicidal tenden­
cies in injured athletes.

The importance of team affiliation, the influence of a coach on self-esteem, the shattering of dreams, the blow sustained to invincibility when injury occurs in this high-risk age group of young athletes, and other adolescent stressors are not well accommodated by the model and probably need to be considered. It is to be hoped that, as empirical data appear on the psychosocial factors that influence the occurrence of injury and the athlete’s rehabilitation to injury, more insight into the prediction of suicide in injured ath­
letes will emerge.

Motivation for Athletic Participation 
To understand why athletic injury is a significant stressor capable of precipitat­
ing a reactive depression, it is necessary to consider why the athlete is involved in sport.

Conscious Motivation 
Children and high school students are involved in sport to have fun, to improve
Fig 3.—Each intersecting ring represents a risk factor for suicide. The degree of overlap may be proportional to the degree of risk.

their sport skills, to be with friends and make new friends, to find thrills and excitement, to succeed or win, and/or to become physically fit. Recreational athletes and competitive, college varsity athletes who were queried in various studies stated that they were in sport primarily for fun, pursuit of excellence, and competition. Recreational athletes 18 years or older also valued the fitness, stress reduction, and weight management afforded by exercise. Athletic values have been socialized by a culture that values fitness and achievement of the American sport dream, in which openly acknowledged, selfish, aggressive, and exhibitionistic motivations are unacceptable.

Unconscious Motivation
Other motivations may not be acknowledged, expressed, or easily researched, because either the athlete is not conscious of them, or they are socially unacceptable and are therefore retained as private thoughts and fantasies. Sources of these private and often unconscious motivating factors are usually related to either sexual, aggressive, or narcissistic drives and may all contribute to the athlete’s motivation for success in sport.

Sexual Motivation
The notion that some persons participate in sport consciously anticipating sexual success and gratification is supported by several publicized accounts of athletes who have recently reported their sexual prowess. High-rolling lifestyles may motivate some athletes and may represent one aspect of the loss experienced by athletes when injury occurs. For other athletes, the need for approval and acceptance by peers of the same gender may be satisfied during sport participation, which permits the expression of affiliation and affection (evidenced by the hugging and patting that occurs in football and hockey huddles in celebration of success).

Aggressive Motivation
Aggressive drives, which may stem from sources such as sibling rivalry, often find expression in sport. Sport not only allows a level of aggressive behavior not tolerated elsewhere, but, in addition, reinforces and rewards these behaviors. Injured athletes may not find socially acceptable outlets for their aggression, which may augment the depression and anger experienced postinjury.

Narcissistic Motivation
Athletes with low self-esteem may need to compensate for their perceived inadequacy by being the center of attention. These athletes may try to achieve high sport ideals while also fulfilling the expectations of their parents, coaches, and fans. When these athletes do not believe they have measured up to their ideals, slumps may occur. In addition, injuries frequently compromise the athletes’ performance and thwart the achievement of both conscious and unconscious goals, which further reduces self-esteem and contributes to postinjury depression.

Ideally, through the process of psychological growth and maturation, healthy athletes will participate in sport comfortably and without inhibition. Even when the inevitable injuries occur, athletes at this level of maturation are likely to take them in stride.

Although more research must be done before we can understand the mechanisms that prompt some injured athletes to consider suicide, consideration of both the athletes’ conscious and unconscious motivation for sport provides partial insight into the reasons that a serious injury may be deemed a significant psychosocial stressor and risk factor for suicide. Clearly, when injury occurs, the athlete is unable to experience the fun, competition, and camaraderie of sport participation; and outlets for the expression of sexual, aggressive, and narcissistic drives are thwarted, all of which may contribute to the postinjury depression.

Intervention
Athletic trainers might wish to use the ERAIQ as a guide for a structured interview, to assess the emotional responses of athletes to injury. The ERAIQ inquires about family support and pressure and can provide a lead into a more in-depth evaluation if the athletic trainer detects the presence of significant depression. The interview should be conducted privately and the athlete should be assured of confidentiality. Questions on the ERAIQ progress from a safe, nonthreatening nature to questions more directly assessing personal meaning and impact of injury.

Sometimes athletes who are malingering, using injury to avoid competition, demotion, or loss of a scholarship, or those displaying a lack of ability can be identified and assisted in a constructive way to disengage from sport.

On the other hand, those athletes who are seriously depressed can be asked about thoughts of suicide, potential risk factors, sources of social support, and their coping mechanisms for dealing with injury. Injured athletes who acknowledge suicidal ideation need to be asked whether thoughts of suicide are occasional or constant, whether the athlete has a plan, and, if so, whether or not the athlete has secured the means. If these answers are affirmative, the athletic trainer should suggest that the athlete promptly seek care from a psychiatrist or a psychologist. Although athletic trainers may not have received specific training in management of the suicidal patient, this brief assessment is comparable to the training that lay persons receive and is essential knowledge for all adults who work with young people in high-risk age groups.

Clearly, psychosocial stressors such as a serious athletic injury prompt depression and, on occasion, even suicidal ideation. It seems likely that serious athletic injury is a psychosocial stressor that is most ominous when it is in the presence of other risk factors. Learning about the athlete’s personality, his/her coping resources (friends, support systems), recent history of stress, injury severity, and team relationships as well as the athlete’s emotional response to injury will en-
hance the athletic trainer’s ability to discern which injured athletes are at risk.

In summary, although little is known about the frequency and specific risk factors for suicide in injured athletes, we do know that some athletes are in a high-risk age group and are very depressed. Studies on postinjury depression suggest that depression is apt to be most profound in the more seriously injured athletes. The common factors shared by injured athletes who have attempted suicide should alert athletic trainers to pay particular attention to young, successful athletes who require surgery or a long rehabilitation that necessitates being out of sport for some time, and who may find themselves replaced on the team at the time of their return. In this high-risk group, it is essential that the trainer assess the athletes’ motivation, support system, coping methods, and postinjury depression.

Close communication between the athletic trainer and the injured athlete will convey to the athlete that the trainer is concerned about both the physical and psychosocial consequences of injury. Confidential discussion between the injured athlete and the trainer demonstrates the willingness of the trainer to listen, assess, and, when appropriate, intervene or interact with other members of the sport medicine team to ensure that holistic rehabilitation occurs. The athletic trainer can also promote the athlete’s continued affiliation with the coach and the team during the athlete’s time out of sport because of the injury. As Frank Gifford commented on NFL Monday night football, “the athlete must heal not only the scar on the knee, but also the scar on the head” before returning to sport.

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References

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Abstract: The anterior cruciate (ACL) is the most frequently ruptured ligament of the knee. Some authors have suggested that excessive internal tibial rotation concomitant with hyperpronation of the subtalar joint during stance and inherent knee joint laxity may predispose an athlete to knee injury. Over a period of 2 years, we identified 14 ACL-injured football players and eight ACL-injured female basketball players and gymnasts. We matched them by sport, team, position, and level of competition with 22 athletes without history of ACL injury. Measures of navicular drop, calcaneal alignment, and anterior knee joint laxity with a KT-1000 were obtained from the uninjured knee of the ACL-injured athletes and compared with measures obtained from the ACL-noninjured athletes. **ACL-injured athletes had greater amounts of navicular drop, suggesting greater subtalar pronation and greater anterior knee joint laxity.** Discriminant analysis and multiple regression indicated that these variables correctly predicted injury status for 87.5% of the females and for 70.5% of all cases. These results suggest that the more an athlete pronates and the greater the anterior knee joint laxity, the greater the association with ACL injury.

The anterior cruciate ligament (ACL) is the most frequently ruptured ligament of the knee. The mechanism of ACL injury is often described as noncontact. Previous authors have reported that 78% and 71% of ACL-injured patients described noncontact mechanisms of injury. It has been suggested that excessive internal tibial rotation concomitant with hyperpronation of the subtalar joint during stance and inherent knee joint laxity may predispose an athlete to ACL injury.

While much has been written on injury to the anterior cruciate ligament, little attention has been devoted to understanding the mechanism of injury. A greater understanding of the mechanics of injury are needed as we work to prevent, and improve treatment of, injuries to the ACL. We conducted this investigation to develop a better understanding of the risks of ACL injury. For, if our efforts of prevention are to succeed to their fullest potential, we must be able to identify those athletes at greatest risk.

The purposes of our study were: 1) to determine if clinical measurements used to assess pronation and anterior translation of the tibia on the femur discriminate between-ACL injured and ACL-noninjured athletes matched for sport, team, and position, and 2) to identify those measures which are the strongest discriminators between the two groups.

Methods

We assessed the uninjured lower extremity of 14 ACL-injured male high school and college football players and eight ACL-injured female high school- and college gymnasts (n = 6) and basketball players (n = 2) using clinical measures indicative of pronation and anterior displacement of the tibia on the femur. All of the ACL-injured females and 10 of the males clearly described a noncontact mechanism of injury. We also selected an equal number of athletes, matched for sport, position, and playing time, without history of ACL injury, and assessed both lower extremities. All subjects provided informed consent in compliance with university guidelines.

Data collection was conducted in two phases during a 2-year period. In the first phase, 14 high school and college football players (19.1 ± 6.0 years, 73.2 ± 3.3 in, 211.0 ± 47.9 lb) with a history of unilateral ACL injury, confirmed arthroscopically or during arthrotomy, were identified. We matched the injured athletes with 14 football players (18.1 ± 1.6 years, 72.3 ± 2.9 in, 199.6 ± 36.6 lb) without history of a knee injury more severe than a first degree sprain, by team, position, and extent of participation.

In the second year of data collection, we identified and matched eight ACL-injured female athletes (six gymnasts and two basketball players) (19.5 ± 1.7 years, 64.6 ± 3.7 in, 128.0 ± 17.0 lb) with eight uninjured athletes (19.0 ± 1.2 years, 63.3 ± 2.6 ins, 126.9 ± 12.8 lbs) by sport, injured leg, and level of competition.

We obtained measures of calcaneal alignment changes in stance, navicular drop, and anterior translation of the tibia on the femur bilaterally from the ACL-injured athletes and from the ACL-noninjured lower extremities. All subjects provided informed consent in compliance with university guidelines.

Calcaneal alignment was assessed in a nonweight-bearing position by having the athlete lie prone and place the contralateral leg in the figure 4 position (see Figure). The lower one third of the leg was bisected from the musculotendinous junction of the triceps surae to the Achilles tendon. The medial and lateral tubercles of the calcaneus were...
Position for assessment of nonweight-bearing calcaneal alignment.

palpated, and the calcaneus was bisected. Subtalar neutral was identified by grasping the fourth and fifth metatarsal heads and palpating the talus as described by Magee.\textsuperscript{14} A standard goniometer was used to estimate, to the nearest degree, the angle between the bisection of the leg and bisection of the calcaneus. The angle between the bisection of the leg and calcaneus was then measured with the athlete positioned full weight bearing to assess change in calcaneal alignment during stance.

We measured navicular drop with Brody's\textsuperscript{5} technique; ie, measure the distance between the navicular tuberosity and the floor with the athlete sitting and the subtalar joint in neutral position and again with the athlete standing full weight bearing on the limb being assessed. The difference in the two measures is the navicular drop.

Using a KT-1000 knee arthrometer (MEDmetric Corp, San Diego, CA), we measured anterior displacement of the tibia on the femur. With the athlete positioned supine and the knee flexed approximately 20°, three measures of anterior drawer were obtained using 20 lb of force applied through the handle of the arthrometer, and three measures were obtained with maximal manual force applied to the posterior calf at the level of the proximal strap of the KT-1000. Means of the three measures with each loading force were used for further analysis. Within each phase, the same investigator performed all measurements with the KT-1000 in an effort to maximize the reliability of the measurements.

Data Analysis

In the first phase, we analyzed the data from the uninjured football players using analysis of variance with repeated measures to determine if significant differences existed between the right and left lower extremities. Measures of calcaneal eversion, navicular drop, and anterior translation of the tibia on the femur obtained using the KT-1000, were analyzed with discriminant analysis and multiple regression. Classification of results tables indicated whether injured and uninjured athletes were correctly classified, based on the discriminant analysis. Conical correlation between group membership and the discriminant score was .46 (\(p = .11\)). The classification of the athletes into ACL-injured and ACL-uninjured groups resulted in 71.4% being correctly classified (Chi-square = 7.43, \(p < .01\); Table 2). Regression analysis revealed that 22% of the variance in group membership was explained by the three predictor variables.

Discriminant analysis of the data from the female athletes indicated that navicular drop, anterior drawer with 20 lb of force, and maximum manual drawer were the best predictors of group classification. Group means and standard deviations appear in Table 1. Conical correlation between group membership and the discriminant score was .46 (\(p = .11\)). The classification of the athletes into ACL-injured and ACL-uninjured groups resulted in 71.4% being correctly classified (Chi-square = 7.43, \(p < .01\); Table 2). Regression analysis revealed that 22% of the variance in group membership was explained by the three predictor variables.

Discriminant analysis of the data from the male and female athletes using the statistical methods described above.

Results

There were no significant differences between right and left lower extremities of uninjured football players for calcaneal position, navicular drop (\(F(1,13) = .67, p = .43\)), or the KT-1000 measurements with 20 lb of force (\(F(1,13) = .12, p = .73\)) and maximum manual force (\(F(1,13) = 1.86, p = .20\)). However, two of the athletes had a difference in navicular drop greater than 2 mm and four had differences in KT-1000 measures greater than 3 mm at both loading forces. Because most of these athletes had minimal bilateral differences, right and left side values were averaged for data analysis.

Table 1.—Navicular Drop, KT-1000, and Calcaneal Eversion in Stance Values for ACL-injured and ACL-noninjured Football Players

<table>
<thead>
<tr>
<th></th>
<th>Uninvolved limb of ACL-injured</th>
<th>ACL-noninjured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navicular drop (mm)</td>
<td>8.4 ± 4.2</td>
<td>5.9 ± 2.4</td>
</tr>
<tr>
<td>KT-1000 maximum</td>
<td>6.5 ± 3.3</td>
<td>4.8 ± 2.2</td>
</tr>
<tr>
<td>Calcaneal eversion in stance (mm)</td>
<td>3.9 ± 2.8°</td>
<td>4.5 ± 2.4°</td>
</tr>
</tbody>
</table>

We analyzed the data from the female athletes indicated that navicular drop, anterior drawer with 20 lb force, and maximum manual

Injured Noninjured Total

71.4% were classified correctly. Chi-square = 7.43, \( p < .01 \).

**Table 4.—Classification of ACL-injured and ACL-noninjured Female Athletes Through Discriminant Analysis**

<table>
<thead>
<tr>
<th>Actual group</th>
<th>Injured</th>
<th>Noninjured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injured</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Noninjured</td>
<td>2</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Totals</td>
<td>10</td>
<td>18</td>
<td>28</td>
</tr>
</tbody>
</table>

87.5% were classified correctly. Chi-square = 9.00, \( p < .01 \).

**Table 5.—Classification of Football and Female ACL-injured and ACL-noninjured Athletes Through Discriminant Analysis**

<table>
<thead>
<tr>
<th>Actual group</th>
<th>Injured</th>
<th>Noninjured</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injured</td>
<td>15</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Noninjured</td>
<td>6</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>Totals</td>
<td>21</td>
<td>23</td>
<td>44</td>
</tr>
</tbody>
</table>

70.0% were classified correctly. Chi-square = 7.45, \( p < .01 \).

Discussion

The results of our study suggest that greater knee joint laxity and subtalar pronation may be associated with an increased risk of ACL injury. These results are in agreement with the report who reported that ACL-injured patients, regardless of mechanism of injury, had greater navicular drop measures than a randomly selected group of patients with no history of ACL injury.\(^3\)

Anatomical and biomechanical factors may increase stress placed on the ACL, thereby possibly increasing the risk of injury. Coplan\(^6\) demonstrated that subjects who pruned more had greater rotational motion of the knee, while Alm et al\(^1\) reported that as internal rotation or external rotation of the knee increases, the absolute strength of the ACL decreases.

A narrow intercondylar notch of the femur has also been identified as being a risk factor for ACL injury.\(^7,13,18\) We did not assess notch width. While a narrow intercondylar notch may increase the risk of ACL injury and knowledge of such a condition may cause an athlete to limit athletic participation, screening of all athletes would be expensive. It is also unreasonable to perform notchplasty in an attempt to minimize the risk of ACL injury. Measures of navicular drop and anterior knee joint laxity can be more easily obtained. Pronation can be limited by selecting appropriate footwear or through the use of orthotics.\(^3,19\) If joint laxity is of concern, a training program can be prescribed to strengthen the muscles surrounding the knee. Thus, the risk factors we have identified can be screened for during a routine physical exam and potentially mitigated through orthotic management and exercise.

When conducting a physical exam, the reliability of the clinical measurement is of concern. Mueller et al\(^16\) calculated intraclass correlations and reported the intratester reliability of navicular drop to be .78 and .83 for the left and right foot, respectively. Our average navicular drop measures were much lower than what Brody\(^5\) considered normal (10 mm) and abnormal (15 mm) in runners. However, Brody was discussing the effects of pronation on lower extremity overuse injuries in runners and presented the above values based on clinical experience as opposed to actual drop mean values. Mean navicular drop values of 7.58 and 7.10 mm for left and right foot, respectively.
right feet have been reported. These values are similar to those we measured on ACL-injured (8.4 mm) and ACL-noninjured (5.9 mm) football players. The lower values for our female athletes were probably because most of our female subjects were gymnasts. These athletes were characterized small in stature with low resting navicular tuberosity heights and less space for navicular drop.

Measures of calcaneal eversion in stance were not retained in the data analysis as predictors of ACL injury. While measures of calcaneal position in unilateral stance have been reported to have acceptable (ICC = .75) reliability, we found these measures are more difficult to obtain than measures of navicular drop. Therefore, it is reasonable to suspect that there was greater error when goniometric measures of rearfoot position were taken. Certainly greater measurement error could explain why navicular drop was retained in the analysis and goniometric measures of calcaneal position in stance were not.

The intratester reliability of measures of anterior knee joint laxity made with a KT-1000 has been reported to be good, while the intertester reliability is lower. In our study, the same clinician took all measures of anterior knee joint laxity within each phase. Our mean anterior knee joint laxity values are somewhat lower than, or similar to, those reported by others. Whether these differences are due to sampling or measurement technique cannot be determined. However, regardless of these differences, our subjects with a history of ACL injury had, on average, greater measures of laxity in their uninjured knee than did the matched counterparts.

In addition to pronation, anterior knee joint laxity, and intercondylar notch width, other factors, including playing surface and footwear, may affect the risk of ACL injury. Additionally, body weight, fitness level, and general athletic ability may impact upon the risk of injury. When data were combined, 20% of the variance in group membership (ACL-injured versus ACL-noninjured) was explained by measures of navicular drop and anteriorm knee joint laxity, while other factors, not assessed in this study, accounted for the remaining 80%. Discriminant analysis forced group membership to be predicted, based upon the measurements we obtained. There was an association between navicular drop, anterior knee joint laxity, and ACL injury. Therefore, this analysis predicted group membership significantly better than chance. Because of the retrospective methodology of our study, we were unable to control for the factors noted above. We also made the assumption, based upon the analysis of the measures obtained bilaterally from the 14 ACL-noninjured football players, that the uninjured lower extremity of ACL-injured athletes is representative of the injured limb prior to injury.

Despite these limitations, the descriptive data and discriminant analyses suggest there were differences in inherent knee joint laxity and foot biomechanics between ACL-injured and ACL-noninjured athletes. We agree with Beckett et al; further investigation is required to fully elucidate the impact of individual anatomical and biomechanical variations on the risk of ACL injury. If these results are substantiated by additional retrospective or large prospective studies, sports medicine practitioners may be able to reduce the incidence of ACL injury through preparticipation screening and use of exercise and orthotic devices to control knee and foot motion.

Acknowledgments

We thank Terry Breisinger, PT, and Erin Proctor, PT, for their work in developing this project and collecting data during the first year of the study and Ron Cigany, PT, and Pat Leamer, PT, for their contributions during the second year.

References

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Progressive Management of Open Surgical Repair of Achilles Tendon Rupture

Dirk H. Dugan, MD
Christopher K. Hobler, MS, ATC

Abstract: A 33-year-old man sustained an acute Achilles tendon rupture which was surgically repaired. Early nonweight-bearing range of motion and strengthening of the ankle and the repaired muscle unit was allowed at 4 weeks postoperatively, and closed-chain dorsiflexion was allowed at 6 weeks. Casts and/or ankle-foot orthoses were used to continue protection of the Achilles from reinjury and full body forces as the repaired muscle continued to heal. In this case, range-of-motion and strengthening exercises were initiated at an earlier stage in the treatment program without compromising the result. When indicated, this treatment will provide excellent posttraumatic function of the surgically repaired Achilles tendon in the motivated and compliant patient.

Rupture of the Achilles tendon occurs more often in men than in women, in the left heel more than the right, and most commonly between the ages of 25 and 45. It is thought to be more common in the left heel because most people are right-footed and push off with their left foot. These injuries are rare, but very debilitating. This case demonstrates successful application of more aggressive ambulation and rehabilitation for a surgically repaired Achilles tendon.

The patient presents with a history of forceful plantar flexion or dorsiflexion with the associated sudden snap in the posterior ankle and the inability to continue the activity. Physical examination reveals a palpable gap in the posterior leg. There is absence or a marked reduction in the power of plantar flexion. The Doherty-Thompson sign is positive in complete Achilles ruptures. In this test, the calf is squeezed and active plantar flexion is absent.

Prompt diagnosis of a ruptured Achilles tendon is imperative. Early diagnosis permits proper treatment and prevents prolonged disability; misdiagnosis can result in delayed or inappropriate therapy. Delay of more than 1 month before surgical repair will result in at least a 20% decrease in muscular endurance.

Presentation of Case

A 33-year-old man complained of posterior leg pain. Preoperative diagnosis was made, based on the medical history of forceful plantar flexion with an associated “pop” in the posterior calf. Physical examination revealed a palpable defect in the left Achilles tendon. The left leg demonstrated a positive Doherty-Thompson test in which squeezing the calf did not produce plantar flexion in the foot. Initial treatment consisted of application of a posterior splint to the affected extremity. We discussed operative versus nonoperative treatment of Achilles tendon rupture as well as the risks and benefits of both with the patient. Three days after the injury ruptured, the Achilles tendon was repaired.

The surgeon made a longitudinal medial incision, approximately 3 inches proximal to the heel, at the level of the rupture. He divided the skin, subcutaneous tissues, and the deep fascia, exposing the Achilles tendon. The rupture was at approximately the level of the musculotendinous junction. The ruptured ends of the tendon were frayed, although a few medial fibers were in continuity distally, and were about 1/4 inch in size. The tendon of the plantaris appeared to be intact.

Care was taken to bring the large distal bundle proximally. The ends were interdigitated in a horizontal mattress fashion with three mersilene sutures. Interrupted simple and mattress sutures overlapped the proximal and distal segments, using vicryl sutures.

Postoperatively, a short leg cast was applied with the ankle in a gravity equinus position. The patient crutch-ambulated with touch-weight-bearing and remained in the cast 14 days postoperatively. A short leg walking cast in slight equinus was then applied. Progressive weight bearing (25%) with crutches and cast isometrics began.

Four weeks postoperatively, the patient was placed in a rehabilitation brace. This device allowed plantar flexion and blocked dorsiflexion at neutral. Progressive weight bearing (50%) continued with crutches. He performed range-of-motion exercises and isometric exercises in all planes, resisted Theraband® (North Coast Medical Inc, San Jose, CA) strengthening exercises in all planes (except plantar flexion), and began closed-chain plantar/dorsiflexion movements, consisting of seated/standing heel slides. He performed these exercises out of the brace three times a day for three sets of ten repetitions. We used modalities such as cold whirlpool before exercise and ice postexercise to reduce swelling. At this time, the patient’s range of motion was within normal limits in inversion, eversion, and plantar flexion, but lacked 10° of dorsiflexion. There was moderate swelling at the repair site.

Six weeks postoperatively, a polypropylene ankle-foot orthosis was placed on the patient. At this time, the patient lacked only 5° of dorsiflexion. Strengthening exercises and closed-chain plantar/dorsiflexion continued. We initiated gentle plantar flexion strengthening exercises, including Theraband (100 repetitions per day) and stationary bicycling. Single crutch-assisted weight bearing.
tient had full active range of motion. (75%) was progressed over the next 6 weeks.

Three months postoperatively, the patient had full active range of motion. Ambulation without the ankle-foot orthosis was without limp or limitations. He began proprioceptive stork exercises, with the foot flat on the ground. He performed this exercise in three sets of 30-second increments. He also began assisted one-fourth squat and lunge activities on parallel bars. We substituted the ankle-foot orthosis with the Ankle Ligament Protector ankle brace (Smith & Nephew DonJoy Inc, Carlsbad, CA) for outdoor activities. This brace tends to allow unrestricted mobility and prophylactic efficacy. We initiated recreational bicycling and calf (gastrocnemius/soleus) progressive resistance exercises, to include bilateral toe raises. Toe raises were performed at ten repetitions, three times per day. The patient was to perform daily proprioceptive and strengthening exercises and continue walking only for 2 months.

Six months postoperatively, we performed an isokinetic evaluation. Using a Cybex II isokinetic dynamometer (Lumex Inc, Ronkonkoma, NY), we evaluated objective performance. Strength was tested at 60°/s. Power was tested at 120° and 180°/s. Endurance was tested at 180°/s. Isokinetic evaluation of the operated leg revealed strength, power, and endurance measurements to within normal limits of the unaffected side. Calf progressive resistance exercises were continued, including leg press, power and training squats, and single-leg toe raises. The patient was instructed to begin jogging while wearing the brace and to progress running activities over the next 10 weeks, to include sprinting and jumping activities.

Nine months postoperatively, the brace was discontinued for jogging. It was recommended, however, that the brace be worn for sprinting and jumping sports, such as basketball and volleyball. The patient was cleared for return to full athletic participation.

Discussion

Spontaneous rupture of the Achilles tendon is a rare injury most commonly seen in 25- to 45-year-old men. The specific etiology of Achilles tendon rupture is still unresolved. One theory is that repetitive microtrauma in an aging tendon causes chronic degeneration in the tendon. Fox et al. noted findings of chronic degeneration in Achilles ruptures in athletes occurring in an area above the os calcis. Lagergren and Lindholm described decreasing perfusion of the distal Achilles with advancing age, thus supporting the chronic degeneration theory. In contrast, Inglis and Sculco have shown no chronic degeneration but rather revealed the presence of acute hemorrhage and inflammation consistent with acute tendon rupture rather than chronic tendinitis. Additional evidence to dispute the degeneration theory is the lack of prodromal symptoms in most patients and the high incidence of unilaterality.

Inglis and Sculco introduced another theory that the musculotendinous unit that normally monitors force and prevents excessive tension or injury to the complex is abnormally inhibited. This theory postulates that the mechanism malfunctions and muscle power potentials of significant magnitude are released by sudden high velocity activities. Usually, patients with spontaneous rupture of the Achilles tendon can be segregated into one of two groups: sedentary, poorly conditioned weekend athletes in their late 30s and 40s, and active, well-conditioned athletes in their 20s. Perhaps the chronic degeneration and the malfunctioning inhibitor theories are both valid mechanisms of Achilles rupture and a combination of both play a greater or lesser role, depending upon the patient.

Although many authors have disputed whether surgical or conservative treatment should be used for a ruptured Achilles tendon, most authors agree that early treatment is far superior to late repair. Several authors proclaim that nonsurgical treatment offers a significant decrease in complications, while concurrently producing similar results. Recently, more emphasis has been placed on the proper selection of open versus closed treatment. Surgical treatment seems to be indicated in active older patients, those with chronic ruptures, young athletes, and elite athletes. Conservative cast treatment is usually reserved for patients who are older than 50, sedentary, chronically ill, or debilitated.

Conservative methods of treatment are often followed because of the possible complications (infections, skin sloughs, scar adhesions, and Keloid scarring) sometimes noted with surgical treatment.6,14,16,17 The virtue of the treatment is its simplicity. The patient is maintained in a long leg cast with the foot in gravity equinus for 6 weeks; a short leg equinus cast is then used for 2 weeks. This is followed by a short leg walking cast with the ankle in a neutral position for an additional 2 weeks. After removal of the cast, a heel lift is used for 2 to 4 months.

However, conservative management may have a higher incidence of reruptures than operative treatment. In one study, the incidence of rupture in nonsurgically treated patients was 17.7%, compared to 1.54% of the surgically treated patients. The difference is significant and implies that surgical repair provides a stronger tendon that is better able to tolerate weight bearing.

Surgical repair has been proven statistically to be more successful than conservative repair in prevention of rerupture. Generally, a patient who undergoes open repair wears a short leg cast that keeps the foot in gravity equinus for 3 weeks, followed by a short leg cast applied with less plantar flexion for an additional 3 weeks. A short leg walking cast is then applied 6 weeks postoperatively, and weight bearing is initiated. After cast removal, a heel lift is used for another 12 weeks. Rehabilitation begins following removal of the case and consists of range-of-motion exercises and progressive resistance exercises to improve plantar flexion, dorsiflexion, eversion, and inversion of the ankle.

Marti and Weber first described the idea of functional treatment after Achilles tendon repair. Their postoperative treatment included immobilizing the foot in a relaxed equinus position until the postoperative dressing was removed. Once removed, the patient was instructed to actively move the ankle to achieve 0° on ankle dorsiflexion. A short leg cast was applied with the ankle in neutral position and maintained for approximately 6 weeks. After cast removal, activity was
allowed as tolerated with no treatment recommended.

More recently, Carter4 introduced postoperative treatment with a functional orthosis rather than routine cast immobilization in compliant, motivated patients. This orthosis allowed unrestricted plantar flexion and limited dorsiflexion to neutral. Toe-touch weight-bearing crutch ambulation was allowed immediately and was gradually increased over the next 6 to 8 weeks of treatment.

In our case, early nonweight-bearing range-of-motion and strengthening exercises of the ankle and the repaired muscle unit was allowed 4 weeks postoperatively under supervision. Closed-chain ankle dorsiflexion was allowed at 4 weeks. Casts and ankle-foot orthoses were used to continue protection of the area from accident and full body weight forces as the repaired muscle continued to heal.

As shown by this study, range-of-motion and strengthening exercises can be initiated at an earlier stage in the treatment program while protecting the repair. We believe that this treatment will provide excellent posttraumatic functional of the surgically repaired Achilles tendon in the motivated and compliant patient. However, this treatment may not be appropriate for an unreliable, unmotivated patient.

References

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Rehabilitation Compliance in an Athletic Training Environment

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Teddy Worrell, EdD, PT, ATC
Julie Gahimer, MS, PT, HSD
Elizabeth Domholdt, EdD, PT

Abstract: The purpose of this study was to determine the relationship between the rehabilitation adherence of athletes and their self-reported assessment of six variables that might influence rehabilitation adherence: pain, support from others, exertion, motivation, and environment. Each of 44 Division II athletes sustained a musculoskeletal injury and was placed on a rehabilitation program. Adherence to the program was measured by attendance at and participation in scheduled rehabilitation sessions. Each athlete was classified as adherent \( (n = 27) \) or nonadherent \( (n = 17) \). Pain and support were significantly correlated to adherence. Pain and support from others were significantly different between the adherent and nonadherent groups. Principal components analysis was also performed and confirmed the t-test results that pain and support are the only subscales strongly associated with adherence scores. We conclude that controlling pain and providing emotional support is associated with sport rehabilitation adherence.

R ehabilitation adherence after musculoskeletal injuries is frequently a challenge for the health care professional. The clinician, whether an athletic trainer or a physical therapist, schedules patients for rehabilitation sessions. Not all patients, however, keep their appointments and participate fully in the rehabilitation session. Moreover, there is a paucity of literature concerning adherence to rehabilitation programs in the athletic training environment.\(^{4,5}\) Most literature about adherence concerns cardiac rehabilitation.\(^{1,10,13}\)

Only three studies have dealt with rehabilitation adherence in the athletic training environment.\(^{5-7}\) Therefore, additional research is needed to examine variables affecting athletic rehabilitation adherence. Consequently, the purpose of this study was to determine which of the following variables: 1) perceived exertion level, 2) pain, 3) self-motivation, 4) support from significant other, 5) scheduling, and 6) environmental conditions, are related to rehabilitation adherence.

A number of variables facilitate adherence to an exercise regimen.\(^{9}\) These include: age, sex, socioeconomic status, intellectual and educational level, medical knowledge, acceptance or denial of illness, time from onset of illness, memory of patient, self-motivation, and exercise goal-setting.\(^{9}\) In addition, over 200 variables have been reported that affect adherence due to physiological, medical, and psychological reasons.\(^{12}\) Thus, exercise adherence is a complex issue for the clinician and researcher.

Many factors are thought to influence adherence. One factor is reinforcement. Positive reinforcement from health or exercise professionals, peers, and family facilitates rehabilitation adherence and is important for continued participation in the rehabilitation program.\(^{3}\) A second factor is patient education. The educational component ensures that the athlete understands the nature of the injury, the treatment protocol, and the progression of recovery.\(^{7}\) A third factor is input from the athlete. Participation of the athlete promotes a sense of control and should help with the athlete’s dedication to the future.\(^{2}\) A fourth factor is self-confidence. Self-confidence entails the athlete believing that a task can be completed, taking charge of the task, and completing the task.\(^{4,5}\) Fisher et al.\(^{4,5}\) reported that self-confidence is the main factor in rehabilitation adherence. A fifth factor is social support. The support given to the athlete from the clinician, coach, teammate, and others closely associated with the athlete can improve adherence to the rehabilitation program.\(^{3,8}\)

Even with the information available, no one has been able to predict adherence to exercise or rehabilitation programs. High self-motivation has been reported to predict adherence but not dropout rate.\(^{3}\) Self-motivated individuals are also more likely to continue an exercise program without supervision.\(^{3}\) However, neither personality traits nor demographic variables are useful predictors of adherent behavior.\(^{4,5}\)

Methods

Forty-four Division II collegiate athletes, 5 women and 39 men between the ages of 17 and 25, were studied. Of these subjects, 31 participated in football, 4 in men’s basketball, 2 each in wrestling, women’s basketball, and volleyball, and one each in soccer, tennis, and swimming. The sample of subjects was one of convenience, meaning that the athletes were readily available to the researchers due to the nature of the study. For inclusion in the study, the athletes must have 1) sustained a musculoskeletal injury, 2) been evaluated by an athletic trainer, and 3) been scheduled for a rehabilitation program. Athletes’ length of rehabilitation ranged from 2 to 32 days.

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Julie Gahimer is an assistant professor at the University of Indianapolis.
Elizabeth Domholdt is Dean and an associate professor of the Krammer School of Physical Therapy at the University of Indianapolis.
Adherence and Participation Score

Each athlete in the study came to the training room for evaluation of a musculoskeletal injury resulting from involvement in Division II athletics. One of three certified athletic trainers performed the initial evaluation and scheduled the athlete for a specific number of rehabilitation sessions per week. Daily attendance records were kept. When the athlete passed a functional test and returned to sport, he/she was discharged.

The athlete could attain a score of two points for each day’s attendance. The first point was given for attendance at each scheduled rehabilitation session. A zero was given if he/she did not attend the rehabilitation session. In addition, a second point was awarded for participation. This was a subjective rating assigned by the athletic trainer. One point was given for completing 100% of the prescribed exercises, three-quarters of a point was given for completing 50% of the prescribed exercises, one-half point was given for completing 25% of the prescribed exercises.

Although this scoring was subjective, it was an attempt to differentiate between those who participated in their rehabilitation and those who attended and did not participate in their rehabilitation program. Daily scores were kept and averaged across sessions for each athlete to produce a single adherence score with a maximum score of 2.0 if the athlete attended and participated fully in each scheduled rehabilitation session. Athletes were divided into two groups based on adherence scores: athletes with scores of 1.75 to 2.0 were labeled adherent, those with scores of less than 1.75 were labeled nonadherent.

Questionnaire

Each athlete completed a questionnaire at the conclusion of the rehabilitation period. The questionnaire, developed by Fisher and colleagues, consisted of 40 four-foil (strongly agree, agree, disagree, strongly disagree) Likert-scale items. Each item was coded numerically, with the most positive response coded as “4” and the least positive response coded as “1”. The 40 items were collapsed into six subscales thought to represent the personal and situational factors encountered in the rehabilitation process. These subscales included perceived exertion level (2 items), pain (11 items), self-motivation (8 items), support from others (10 items), scheduling (6 items), and environmental conditions (3 items). Table 1 presents a representative item and its scoring within the questionnaire. The average score for each subscale represented within the questionnaire. The average score for each subscale was then calculated by adding the scores for the items in each scale and dividing by the number of items in the subscale. Thus, the average score for each subscale ranged from 1 to 4, with 4 representing the most positive responses to the subscale.

Data Analysis

Independent t-tests were performed to determine whether there were significant differences between adherent and nonadherent athletes for the six subscales. The probability level was set at .05 for each test. To provide us with a sense of the relationships between variables, we then calculated Pearson product-moment correlations between the adherence score and the six subscales. To further examine the interrelationships among the adherence score and the six subscales, a principal components analysis with varimax rotation was performed. This analysis identifies groups of highly related variables (factors) that are relatively unrelated to other factors.

Results

Twenty-seven adherent athletes (attendance and participation scores from 1.75 and 2.00) and 17 nonadherent athletes (attendance and participation scores of less than 1.75) were identified. Group means, standard deviations, and t-test results for six subscales are reported in Table 2. The adherent group reported significantly lower levels of pain ($t = -2.38, p = .022$) and significantly higher levels of support from others ($t = 2.66, p = .011$), than the nonadherent group.

Table 3 shows the correlation matrix for the adherence score and the six subscores. The correlations confirm the results of the t-tests in that pain and support from others are the only subscores that are significantly correlated with the adherence score. Squaring a correlation coefficient gives the coefficient of determination, which indicates the proportion of variability in one score that can be attributed to variations in the other score. Thus, the pain subscale accounts for approximately 16% of the variability in adherence scores and the support from others subscale accounts for approximately 15% of the variability in adherence scores. In addition, the subscores of self-motivation, environment, and scheduling are significantly related to one another, with coefficients of determination of 52% (scheduling and self-motivation),
Table 2.—Differences Between Adherent and Nonadherent Groups

<table>
<thead>
<tr>
<th>Score or Subscore</th>
<th>Adherent (Mean ± SD)</th>
<th>Nonadherent (Mean ± SD)</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduling</td>
<td>2.98 ± .49</td>
<td>2.90 ± .50</td>
<td>.52</td>
<td>.609</td>
</tr>
<tr>
<td>Pain</td>
<td>2.69 ± .25</td>
<td>2.89 ± .31</td>
<td>-2.38</td>
<td>.02*</td>
</tr>
<tr>
<td>Exertion</td>
<td>3.07 ± .47</td>
<td>2.79 ± .47</td>
<td>1.91</td>
<td>.06</td>
</tr>
<tr>
<td>Support</td>
<td>2.68 ± .31</td>
<td>2.42 ± .31</td>
<td>2.66</td>
<td>.01*</td>
</tr>
<tr>
<td>Motivation</td>
<td>2.92 ± .43</td>
<td>2.79 ± .40</td>
<td>.98</td>
<td>.33</td>
</tr>
<tr>
<td>Environment</td>
<td>3.09 ± .58</td>
<td>3.29 ± .47</td>
<td>-1.16</td>
<td>.25</td>
</tr>
</tbody>
</table>

*Statistically significant at .05.

Table 3.—Correlations Between Adherence Scores and Subscores

<table>
<thead>
<tr>
<th>Pain</th>
<th>Support</th>
<th>Exertion</th>
<th>Scheduling</th>
<th>Motivation</th>
<th>Environment</th>
<th>Adherence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support</td>
<td>-.1260</td>
<td>-.2210</td>
<td>.2813</td>
<td>.2381</td>
<td>.2385</td>
<td>.2813</td>
</tr>
<tr>
<td>Exertion</td>
<td>.1788</td>
<td>.3281*</td>
<td>.3219</td>
<td>.3200</td>
<td>.3200</td>
<td>.3200</td>
</tr>
<tr>
<td>Scheduling</td>
<td>.2410</td>
<td>.0204</td>
<td>.2813</td>
<td>.1200</td>
<td>.1200</td>
<td>.1200</td>
</tr>
<tr>
<td>Motivation</td>
<td>.1215</td>
<td>.2434</td>
<td>.2385</td>
<td>.0200</td>
<td>.0200</td>
<td>.0200</td>
</tr>
<tr>
<td>Environment</td>
<td>.1274</td>
<td>.2005</td>
<td>-.0209</td>
<td>.4072**</td>
<td>.3804*</td>
<td>.4072**</td>
</tr>
<tr>
<td>Adherence</td>
<td>-.4026**</td>
<td>.3907**</td>
<td>.1527</td>
<td>.1467</td>
<td>.1774</td>
<td>.0943</td>
</tr>
</tbody>
</table>

*p < .05.

Because simple correlation techniques can only examine two variables at a time, we used a third data analysis technique, principal components analysis, to examine more complex interrelationships among variables. Principal components analysis identified three factors with eigenvalues above 1.0. Factor loadings for these three factors are shown in Table 4. Factor I, which accounted for 33.1% of the variability in the data set, consisted of the scheduling, self-motivation, and environment subscales. Factor II, which accounted for 23.6% of the variability in the data set, consisted of the adherence scores and the pain and support subscores. Factor III, which accounted for 15.3% of the variability within the data set, consisted of the perceived exertion subscale. This analysis confirms the test results, in that pain and support are the only subscales strongly associated with adherence scores. It also confirms the correlation results, in that the scheduling, self-motivation, and environment subscores clustered together as a single factor.

Table 4.—Factor Analysis Results (Rotated Factor Matrix)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factors*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Scheduling</td>
<td>.8396</td>
</tr>
<tr>
<td>Motivation</td>
<td>.8306</td>
</tr>
<tr>
<td>Environment</td>
<td>.7611</td>
</tr>
<tr>
<td>Adherence</td>
<td>.8327</td>
</tr>
<tr>
<td>Pain</td>
<td>-.7538</td>
</tr>
<tr>
<td>Support</td>
<td>.5917</td>
</tr>
<tr>
<td>Exertion</td>
<td>.9081</td>
</tr>
</tbody>
</table>

*Factor loadings of .45 and above are reported.

Support From Others

Some researchers believe that people will adhere to a rehabilitation program if emotional support is received.3 There appears to be a positive relationship between social support and adherence.3,10,11 All three statistical analyses in our study supported a relationship between rehabilitation adherence and support from others. This finding agrees with Fisher et al,5 who reported that support from others was the most significant variable in differentiating between adherent and nonadherent athletes. Comments made by the athletes to the primary researcher indicate they are not happy when their teammates do not show support for them. In a survey, 60% of the athletes rated teammates’ support as important to adherence.6 Social support from others may promote adherence by providing an individual with feelings of success.10 This support from others may be received from the athletic trainer, teammate, coach, or significant other.

Because of the consistent relationship between adherence and support from others identified in this and other studies, we recommend that clinicians consider ways to maximize the support that injured athletes receive from others.

Pain Tolerance

The more pain experienced in the rehabilitation process, the less adherent the person was. This statement agrees with Fisher et al12 who reported that adherent athletes can probably reduce pain, whereas nonadherent athletes may amplify pain. Therefore, a person’s response to pain can influence adherence. An athlete’s pain response may be influenced by: 1) emotional arousal, 2) motivational drive, and 3) cognition.5 Therefore, the clinician needs to recognize the athlete’s pain and instruct the athlete on techniques of how to cope with pain.3

Clinicians should consider ways to minimize pain during rehabilitation. Athletes who experience pain during rehabilitation are more likely to be nonadherent. The athlete needs to be educated about the amount and type of pain that may be expected with the rehabilitation program. For example, exertion pain should be differentiated from pain resulting from an inflamed joint. In a survey performed by Fisher,6 94% of the athletes responded that pain must be interpreted correctly. The athlete needs to understand the difference between pain that may be detrimental and pain that is unavoidable, because some pain will more than likely be experienced during rehabilitation.

Therefore, a major component in the rehabilitation program should be pain...
control. Modalities may be implemented for pain control. Dissociation, another pain-control technique, eliminates the focus on pain by having the patient concentrate on other activities, such as breathing. In summary, rehabilitation programs should be based on pain-free progressions and techniques that control and minimize pain. Athletes should rate their pain during rehabilitation so that the clinician can modify rehabilitation based on their pain level.

Perceived Exertion
Both adherent and nonadherent athletes rated perceived exertion similarly, with the adherent group being slightly higher. This is in contrast with Fisher et al., who reported that adherent athletes perceived they worked harder at their rehabilitation than the nonadherent athletes.

Scheduling
Our results were in contrast to Fisher et al., who reported scheduling to be an important distinction between adherent and nonadherent athletes. However, Fisher did not state the hours the athletic training room was available to the athletes. The training room in this study may have had hours more amenable to the athlete. Also, appointments for rehabilitation sessions were made for specific times that were conducive to the athlete's schedule. The importance of convenient scheduling is supported by 95% of the athletes who responded to a survey indicating that rehabilitation schedules should be compatible with their schedules.

Future Research
The results of this study only report one specific athletic training environment. Therefore, caution should be used in generalizing these results to other environments. We do believe, however, that our statements concerning pain and support from others are appropriate and in agreement with Fisher et al., In addition, the small number of subjects precluded the use of multivariate analysis of variance techniques. We compensated for this by using three different statistical approaches (t-test, Pearson product moment correlation, and principal component analysis) appropriate to our sample size. Each analysis yielded conclusions consistent with the other analyses.

Since our results differ from Fisher in the relationship of perceived exertion, self-motivation, and scheduling, these areas should be studied further. Although pain and support from others have been consistently related to adherence in this study and in the work of Fisher, the effect on adherence of reducing pain or increasing support has not been studied experimentally. Future research might attempt to manipulate pain or support from others to see if predicted differences in adherence result.

Conclusion
The results of this study indicate that pain should be controlled to achieve better adherence to rehabilitation programs. In addition, athletes who received support from others were found to be more adherent. Therefore, the clinician should implement pain control strategies with the athlete and educate the athlete about the role of pain in the rehabilitation process. Secondly, the clinician should demonstrate support to the athlete and encourage peers and coaches to support the injured athlete. Overall, the clinician needs to educate the athlete concerning all aspects of the rehabilitation program.

References
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The hand is man’s prime tool. It is remarkably well designed to provide sensibility, mobility, and strength sufficient for an almost infinite number of tasks. The joints, though designed for stability and mobility, remain vulnerable to extremes of external force often experienced in athletics. Protecting an injured thumb while permitting the range of motion demands of sports is very challenging for the athletic trainer.

Rigid splints are impractical and sometimes dangerous in athletic competition and neoprene spicas provide only generic support. Traditional checkrein and spica taping procedures are not as effective because they limit function of the hand. The following procedure was developed to provide support to the ligamentous structure of the thumb without interfering with necessary function. The keys to this procedure’s success are that very little tape is applied on the palmar surface of the hand, no tape spans the width of the hand, minimal tape crosses the wrist joint, and a variation of the conventional thumb spica is used. This technique is effective in protecting the metacarpophalangeal (MP) joint while maintaining a full range of motion that can be used in sports where freedom of movement and protection are essential.

Supplies
1. Soap and water
2. Razor
3. Tape adherent
4. One roll of 1-1/2" athletic tape
5. One roll of 1/2" athletic tape

Preparing the Area
1. Clean the hand and wrist with soap and water.
2. Shave the wrist and dorsal surface of the thumb.
3. Apply tape adherent to the wrist and palmar surface of the thumb over the thenar eminence up to the interphalangeal (IP) joint.
4. Allow time for the adherent to dry and become tacky.

Steps in Taping Procedure
1. Apply a continuous anchor strip to the wrist using 1-1/2" tape.
2. Apply an anchor strip just distal to the IP joint of thumb using 1/2" tape, leaving the fingernail and fingertip exposed. Anchoring distally provides additional leverage without covering the tactile surface of the thumb (Fig 1).
3. Shake the athlete’s hand, positioning the hand in a functional position necessary for most sports and activities (Fig 2).
4. Apply two to three splint strips along the thenar eminence using 1/2" tape, overlapping by half (Fig 3).
5. Apply an anchor strip just distal to the IP joint of the thumb using 1/2" tape, leaving the fingernail and fingertip exposed (Fig 3).
6. Prepare two "V" strips of tape. Begin with two 12- to 14-inch-long pieces of 1-1/2" tape and make a 1" incomplete tear in the middle of each. This piece is called a "V" strip because the tear creates a "V" in the tape (Fig 4).
7. Apply the first "V" strip, bisecting the webbing between the thumb and index finger, stabilizing the MP joint (Figs 5 and 6).
8. The second "V" strip should be placed slightly higher once again, overlapping by half (Fig 7).
9. Apply a close off strip of 1-1/2" tape encapsulating the top of the thumb running distal to proximal (Fig 8).

Richard G. Deivert is Director of The Lipscomb Clinic Foundation for Research and Education at Saint Thomas Medical Plaza, 10th Floor, 4230 Harding Road, in Nashville, TN 37205.
10. Finally, close-off the wrist, anchoring the “V” strips with 1-1/2” tape (Figs 9 and 10).

Some athletic trainers may prefer using elastic tape to perform continuous closing distal to proximal, replacing steps 9 and 10. It is easier to disassemble this procedure in reverse than to attempt to cut about the thumb with bandage scissors or a tape cutter. Athletes can easily learn to disassemble it as well.

**Discussion**

Injuries to the hand and fingers are quite common in athletic activities.2,6,7 The phalanges, particularly the thumb, are prone to sprains caused by a blow delivered to the top or by a violent twist. Thumb mechanism of injury is usually a forceful abduction of the proximal phalanx, which occasionally combines with hyperextension.1,2 Injuries to the ulnar aspect of the thumb have been estimated to occur about ten times more frequently than radial injuries,7 the most common injury being the ulnar collateral ligament sprain.1,5,10,12,13 The stability of this joint is derived from the ulnar collateral ligament and the related musculotendinous insertion into the base of the proximal phalanx. This injury is frequently underestimated because there is usually only moderate local discomfort and no major deformity.

Because of its role in opposition and gripping, an injured thumb can easily sideline an athlete for several days. This injury, in most cases responding well to conservative treatment, occurs mostly in tackle football players, soccer goal keepers, skiers, wrestlers, and baseball players. Tape protection is offered for all future activities that might injure the thumb again.8

A few authors have described taping procedures for the fingers3 and variations on thumb taping.4,9,11 Other thumb taping procedures that either increase protection or limit use11 including a checkrein, which is not functional and somewhat dangerous9,11; anchoring the thumb proximally to the phalangeal joint; or encapsulating or “pancaking” the entire hand, which greatly limits function.6,9 Rigid splints inhibit normal use of the hand and thumb and are impractical for some activities. Neoprene spicas provide imprecise support. The technique presented in this paper uses the broad “V” strip, providing excellent support to the MP joint without pinching, binding, or compromising comfort. Many athletes participating in a wide variety of sports have been pleased with this functional thumb taping technique.

**Acknowledgment**

I would like to thank Scott Gardner, MS, ATC, for volunteering his photography skills to the technical development of this manuscript.
References


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5. Double space and begin typing the text of the abstract flush left in a single paragraph with no indentations. Do not justify the right margin.
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SPECIFIC CONTENT REQUIREMENTS:

Case Reports. This category of abstracts involves the presentation of unique individual athletic injury cases of general interest to our membership. Those interested in submitting a case report for the 1995 NATA Annual Meeting should contact Briana Ebmeier (214-637-6282, ext. 142) of the NATA Research and Education Foundation in Dallas to receive a separate two-page case report abstract form. Abstracts in this category must include the following information:

1. Personal data (age, gender, race, sport, or occupation)
2. Chief complaint (physical signs and symptoms)
3. Differential diagnosis (array of possible conditions or injuries)
4. Laboratory test results, diagnostic imaging, physical examination results
5. Clinical course (diagnosis, treatment, surgical technique, rehabilitation program, outcome)
6. Deviation from the expected (description of what makes this case unique)

Free Communication Abstracts. Abstracts in this category must include: the purpose of the study or hypothesis, a description of the subjects, the experimental methods and materials, the type(s) of data analysis, results of the study, and conclusion(s). Authors are asked to indicate a preference for oral or poster presentation of their abstract. Authors of free communications are required to categorize their abstract in 1 of the 5 specific areas of research funded by the NATA Research and Education Foundation, specifically:

- **BASIC SCIENCE**—includes controlled laboratory studies in the subdisciplines of exercise physiology, biomechanics, and motor behavior, among others, which relate to athletic training and sports medicine.
- **CLINICAL STUDIES**—includes assessment of the validity, reliability, and efficacy of clinical procedures, rehabilitation protocols, injury prevention programs, surgical techniques, and so on.
- **EDUCATIONAL RESEARCH**—a broad category ranging from basic surveys to detailed athletic training/sports medicine curricular development. An abstract in this category will generally include assessment of student learning, teaching effectiveness (didactic and clinical), educational materials, and curricular development.
- **SPORTS INJURY EPIDEMIOLOGY**—includes studies of patterns of injury among athletes. These studies will generally encompass large-scale data collection and analysis. Surveys and questionnaires may be classified in this category but are more likely to come under the Observational/Informational Studies category.
- **OBSERVATIONAL/INFORMATIONAL STUDIES**—Includes studies involving surveys, questionnaires, and descriptive programs, among others, that relate to athletic training and sports medicine.

The purpose of this study was to compare the effects of two semirigid prophylactic ankle stabilizers on vertical jump, 80-ft sprint, shuttle run, and four-point run performance. Eight male and seven female high school basketball players, who denied prior ankle injury and prophylactic ankle stabilizer experience, completed the four performance events under the conditions of Active Ankle Training Brace, Aircast SportStirrup, and nonbraced control. Data analysis consisted of four 1 × 3 Analysis of Variance (ANOVAs) with repeated measures on the independent variable of brace condition. Results of the analysis revealed no significant differences among the experimental conditions for any of the performance events tested. In conclusion, the Active Ankle Training Brace and Aircast SportStirrup did not facilitate or adversely affect performance involving speed, agility, and vertical jump of high school basketball players.

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The purpose of this case study was to determine the effect of patellar taping, patellar bracing, and control condition on: a) patellofemoral congruence angle (PFC), b) lateral patellar angle (LPA), c) lateral patellar displacement (LPD), and d) pain, as determined by the visual analog scale (VAS) during an 8-inch step-down. The subject was a 15-year-old male with a 3-year history of recurrent patellar subluxations and anterior knee pain syndrome. Results revealed the following: control condition PFC 41.4–1.1°, LPA 19.6–6.9°, LPD 118.6–8.3 mm, VAS 8.8 cm; tape PFC 46.2–2.3°, LPA 25.1–2.9°, LPD 24.2–7.5 mm, VAS 0.8 cm; brace PFC 3.4–16.5°, LPA 7.9–08°, LPD 9.4–4.7 mm, VAS 0.3 cm. Patellar bracing was effective in centralizing the patella as revealed by the PFC, LPA, and LPD measures; however, patellar taping did not improve patellar position, and, in some positions, taping actually worsened patellar position. A large reduction in pain as measured by the VAS occurred during an 8-inch step-down for both taping and bracing. More research is necessary to explain the pain reduction without a change in patellar position using tape.

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Closed kinetic chain and functional rehabilitation have received increased attention lately in the rehabilitation community. The purpose of this paper is to review biomechanical considerations applicable to the lower extremity, in a way that clearly justifies the use of functionally sound rehabilitation exercises. The origin of the kinetic chain concept is reviewed, and the differences in biomechanical events in the foot, ankle, and knee under open- versus closed-chain conditions are described. An analysis of these biomechanical events supports the notion that function results from the integration of muscles and joints to achieve desired outcomes. This leads to the conclusion that rehabilitation exercise, in order to be functional, must demand integration of muscular activity, must be of a closed kinetic chain nature, and must challenge the use of normal proprioceptive mechanics. Guidelines for the practical application of these principles are clearly outlined and examples of functional activities are described. Readers are encouraged to explore creative and challenging approaches to help clients achieve their highest level of function.

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Disorders of the rotator cuff constitute the most common source of shoulder pain. This article reviews the preoperative evaluation of full-thickness rotator cuff tears, the surgical management of primary rotator cuff repair, and the factors that influence the postoperative functional outcome. The presence of preinjury rotator cuff symptoms correlates with the degree of tendon generation and can be an important factor in predicting the outcome of surgical management. The primary goal of surgical intervention for the vast majority of patients with rotator cuff tears is to decrease pain, including rest pain, night pain, and pain with activities of daily living. Additional goals of surgery are to improve shoulder function and to limit the progression of rotator cuff tendinopathy. With a few exceptions, all optative procedures described in the recent literature for primary repairs of the chronic rotator cuff tears include the use of an anteroinferior acromioplasty to provide adequate decompression of the subacromial space. The overall clinical results with respect to shoulder pain have been reported to be satisfactory in 85% to 95% of patients who have undergone open repair of full-thickness tears. Analysis of the 7- to 15-year follow-up of patients who underwent primary rotator cuff repair demonstrates maintenance of satisfactory clinical results without significant deterioration of function or recurrence of shoulder pain. The principles of arthroscopically assisted rotator cuff repair and
subacromial decompression are the same as those of open procedures. The recently reported results of arthroscopically assisted techniques have been favorable. However, the results are not directly comparable with the results of traditional open surgery because studies involving open techniques include larger numbers of patients, many of whom have large chronic tears requiring extensive soft tissue mobilization. Clinical evaluation of patients with full-thickness rotator cuff tears can define many of the prognostic factors that influence the long-term functional outcome of rotator cuff repair.

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An injury to an athlete’s knees, particularly during his or her competitive season, requires urgent and appropriate care. Occasionally, magnetic resonance imaging (MRI) may be necessary to facilitate an accurate diagnosis. Meniscal tears or possible meniscal lesions represent a different set of challenges. MRI has the potential to help in the early management of this particular set of patients with a relatively immediate “need to know” the quickest route to resolution of their problem. This study was undertaken to determine whether early MRI is of benefit in the treatment of competitive athletes with clinically equivocal knee injuries. The study group consisted of 27 athletes involved in intercollegiate sports at the University of Utah. These athletes had bilateral knee problems resulting in a total of 30 knees included in the study. There were 20 men and 7 women, with a mean age of 20.6 years. This was not a consecutive series of athletes; as only certain knee problems were deemed suitable for inclusion in the study. All patients underwent imaging using a single 1.5 T GE Signa system with the standard GE extremity coil. The pre-MRI clinical assessment was then combined with the MRI finding, and the treatment plan was modified according to either arthroscopic surgery of a course of nonoperative treatment. The influence of the MRI on the athlete’s eventual course was judged as positive or negative according to an algorithm. Analysis of the cases showed that the accuracy rate was lower than is generally reported in the literature; this can be explained by the nonconsecutive and unique nature of the study population. In this study, MRI was helpful in the management of 77% of this specific group of patients. The results of this study emphasize the importance of using selectivity in increasing the cost effectiveness of MRI. The patient’s clinical condition is the most important factor influencing the decision to proceed to arthroscopy, and a negative MRI in the face of persistent symptoms should not necessarily mandate against arthroscopy. This study found that, with certain limitations, MRI can be helpful for many athletes with acute knee injuries and clinically suspected, but equivocal, meniscal lesions.

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The Center for Hip and Knee Surgery
Mooresville, IN

The purpose of this case report is to familiarize the reader with the basic principles of the approach to manual therapy evaluation and treatment pioneered by Maitland, an Australian physical therapist. This approach involves a complete subjective examination to determine the severity, irritability, nature, and stage of the patient’s complaints. In this way, the therapist may reach conclusions as to the amount and vigor of the physical examination and proceed with treatment in an analytical manner. Methodical reassessment is used to justify treatment progression. Comprehensive treatment and the rationale for this approach are discussed. Although most physical therapists are familiar with the straight-leg-raising test as a means of assessing low back pain and chronic lumbar nerve root irritation, they are often not familiar with other tests that examine neural tissues, such as the slump test. The proposed anatomical and biomechanical bases for these tests are discussed. The patient in this case study was a 50-year-old man with a physician’s diagnosis of a chronic lumbar nerve root irritation. The patient was evaluated and treated in eight visits using techniques designed to evaluate neural tissues. Reassessment indicated significant symptom reduction, and the treatment was modified accordingly. Patient management, including home exercises, is discussed.

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**BACKGROUND AND PURPOSE.** Although surgical reconstruction of the anterior cruciate ligament (ACL) is commonly performed to increase stability of the knee, persistent changes in neuromuscular function have frequently been cited as contributing to disability. This study investigated single-leg standing balance in a sample of patients 10 to 18 months following reconstructive ACL surgery. In addition, the effect of leg dominance on standing balance was analyzed in a sample of subjects without knee injury. The validity and interrater reliability of a clinical method of measuring balance using observation were also determined. **SUBJECTS.** Seventy-eight subjects without knee injury and 17 patients following ACL surgery participated in the study after they had been screened for balance disorders. **METHODS.** Postural sway measurements were recorded during single-leg standing with the subjects’ eyes open and closed. Simultaneously, two physical therapists graded each subject’s performance using a simple ordinal scale. **RESULTS.** No differences were found between the dominant and nondominant legs of the subjects without knee injury or between the involved and noninvolved legs of the patients who had undergone ACL surgery. The interrater reliability was high, but limited concurrent validity was found.

**CONCLUSION AND DISCUSSION.** The findings suggest that single-leg standing balance can be reliably evaluated by physical therapists. The single-leg standing balance test, however, may not provide information that assists clinicians in determining clinical change or functional level for patients following rehabilitation for ACL surgery.

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**BACKGROUND AND PURPOSE.** The purposes of this study were: 1) to describe the characteristics of recovery of peak torque after a 1-minute bout of isokinetic exercise of the quadriceps femoris muscle, 2) to determine the short-term reliability of the recovery of peak torque, and 3) to determine whether the recovery of peak torque more closely associates with maximal endurance exercise capacity than does the decline in peak torque at the end of the fatigue test. **SUBJECTS.** Thirty-three nondisabled subjects, ranging in age from 23 to 34 years (27 ± 3.4 yr), participated in the reliability portion (phase 1) of the study. A different group of 21 nondisabled subjects, ranging in age from 21 to 47 years (27.5 ± 5.2 yr), participated in the correlational portion (phase 2) of the study. **METHODS.** The short-term reliability of percentage of decline in peak torque and recovery of peak torque was assessed in phase 1. Each subject performed two quadriceps femoris muscle fatigue tests (test-retest) on an isokinetic dynamometer. In phase 2, each subject performed a single fatigue test and a test of maximal oxygen uptake (Vo2max) to examine the relationships between Vo2max and percentage of decline in peak torque at the end of the fatigue test and recovery of peak torque. **RESULTS.** Intraclass correlation coefficient values at every 30-second interval during recovery were acceptable (ICC = .67-.87), indicating recovery of peak torque is a consistent measure of quadriceps femoris muscle performance. A high negative correlation (r = −.84) was found between the percentage of decline at 30 seconds of recovery and Vo2max, but a lower negative correlation (r = −.48) was found between the percentage of decline in torque at the end of the fatigue test and Vo2max.

**CONCLUSION AND DISCUSSION.** These results suggest that recovery of peak torque is a reliable measure of muscle performance and closely associates with maximal aerobic exercise capacity.

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Nineteen patients with the clinical diagnosis of anterior cruciate ligament injury were examined by KT-1000 arthrometry before arthroscopy in an effort to differentiate partial from complete tears. To this end, the KT-1000 arthrometer was equipped with a strain gauge and processor that permitted the required force to increase the anterior displacement by 1-mm increments, to be read on a light-emitting diode. The measured force has been plotted against anterior displacement expressed in nonlinear increments along the x axis to allow for the viscoelastic nature of the ligament. The results show that stress-strain diagrams of partially torn and completely torn ligaments are similar to those obtained by graded stress radiography. Using arthroscopy as the standard of measurement, partial tears can be differentiated from complete tears with a sensitivity of 80% and a specificity of 100%. The figures for complete tears versus partial tears are 100% and 80%, respectively. Graded arthrometry with x-y recording of the force-displacement relationship that allows for the viscoelastic qualities of ligament further extends the capabilities of instrumented arthrometry.

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Changes in axial tibial rotation after anterior cruciate ligament sectioning were evaluated in 14 fresh human knee joints. Simulation of vertical stance in a quadriceps-stabilized knee was performed. Internal and external rotational torques were applied before and after anterior cruciate ligament sectioning. Pivot shift tests were done in the intact and anterior cruciate ligament sectioned knee. Results of pivot shift tests were all negative before sectioning and positive after isolated sectioning. No significant change in axial rotation occurred between the intact and sectioned knee for external rotation (p = .24) or internal rotation (p = .12). Presence of a load at the femoral housing in both the intact and ligament-sectioned knees caused a significant change in external rotation (p < .0001). No significant change was noted in internal rotation between loaded and unloaded states (p = .70). Total tibial rotation in the intact knee was noted to vary between 31° at 0° of flexion and 42° at 60° of flexion. These results suggest that the anterior cruciate ligament does not play a significant role in limiting axial rotation and that rotational instability is not a major factor after isolated anterior cruciate ligament rupture.

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The purpose of this study was to describe the firing pattern of 11 hip and knee muscles during running. Thirty recreational runners volunteered to run at three different paces with indwellling electromyographic electrodes while being filmed at 100 frames/s. Results demonstrated that medial and lateral vasti muscles acted together for knee extension during terminal swing and loading response, possibly providing a patella stabilizing role. The vastus intermedius muscle functioned with the other vasti, plus eccentrically controlled knee flexion during swing phase. The rectus femoris muscle fired with the vastus intermedius muscle and assisted the iliacus muscle with hip flexion. The hamstrings fired primarily to eccentrically control hip flexion. The adductor magnus, tensor fascia lata, and gluteus maximus muscles afforded pelvic stabilization while assisting with hip flexion and extension. Forward propulsion was provided mainly by hip flexion and knee extension, which is contrary to the view that posterior calf muscles provide propulsion during toe-off. Faster running paces lead to increased activity in the muscles. This may lead to more injuries, primarily in the muscles that were contracting eccentrically.

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Eleven sprinters with recent hamstring injuries were compared with nine uninjured runners. The flexibility of the hamstrings and the eccentric and concentric muscle torque were measured in the hamstrings and quadriceps muscles at different angular velocities. Sprinters with a previous hamstring injury had significantly tighter hamstrings than did uninjured sprinters. The uninjured sprinters had significantly higher eccentric hamstring torques at all angular velocities. They also had significantly higher concentric quadriceps and hamstring torques at 30°/s but not at higher velocities. Sprinters with a history of hamstring injury thus differed from uninjured runners, being weaker in eccentric contractions and in concentric contractions at low velocities.

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Athletes from 20 Division I AA collegiate varsity sports and one club sport were followed carefully for the development of stress fractures during the 1990 to 1991 and the 1991 to 1992 academic years. During this period, among 914 athletes, 34 stress fractures were sus-
tained. Seven of these, or 20.6%, were of the femoral shaft. This represents a much higher incidence than previously observed in athletes. A new clinical test is described that significantly aids in the early diagnosis and follow-up treatment of femoral shaft stress fractures.

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The purposes of this study were to determine the effect of a rigid ankle orthosis (Aircast Air-Stirrup) and lateral ankle ligament anesthesia on ankle joint proprioception. Twelve noninjured subjects attempted to match nine reference ankle joint positions with their eyes closed before and after application of the ankle brace and before and after one or two of the lateral ankle ligaments (anterior talofibular and calcaneofibular) were anesthetized. Three-dimensional ankle joint orientations were recorded with a Motion Analysis system. No significant differences in the constant, variable, or absolute error were seen between subjects in the nonanesthetized and anesthetized conditions (p > .05), regardless of whether one or two ligaments were anesthetized. Thus, it appears that ligament mechanoreceptors contributed little to ankle joint proprioception, and that the afferent feedback from skin, muscle, and other joint receptors was adequate for the positioning task of the present study. Both the variable and absolute error in matching the reference positions were significantly less with the orthosis than without it (p < .05). Application of an orthosis may increase the afferent feedback from cutaneous receptors in the foot and shank, which may in turn lead to an improved ankle joint position sense.

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To evaluate the possible relationship between femoral intercondylar notch stenosis and anterior cruciate ligament injuries in pivoting and cutting sports, a 2-year prospective study was performed on intercollegiate athletes at a Division I university. Daily practice times and athlete participation in practices and games were recorded for each sport during the 2-year period. Bilateral intercondylar notch view radiographs were taken of all athletes enrolled in the study. The notch width index, a ratio that measures the width of the anterior outlet of the intercondylar notch divided by the total condylar width at the level of the popliteal groove, was measured for each knee. A total of 213 athletes, representing 415 anterior cruciate ligament-intact knees, were enrolled in the study. There were seven anterior cruciate ligament tears. Statistical analysis demonstrated a correlation between femoral intercondylar notch stenosis and anterior cruciate ligament injuries. No statistical difference was found between the sex of the athlete and notch width indices or rate of anterior cruciate ligament tears. Athletes with intercondylar notch stenosis appear to be at increased risk for noncontact anterior cruciate ligament injuries.

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The purpose of this study was to evaluate the sensitivity, specificity, negative and positive predictive values, and accuracy of the shoulder relocation test in 100 patients who underwent shoulder surgery. Based on operative data and examination under anesthesia, the diagnoses were grouped into six categories: anterior instability (without cuff disease), posterior instability, rotator cuff disease (without associated anterior instability), acromioclavicular disorder, osteoarthritis, and instability of the biceps tendon. The test was performed on the day of surgery by placing the arm in a position of 90° of humerothoracic abduction and 90° of external rotation (90°/90°). Patient responses of pain and apprehension (considered separately) were assessed in this position both with and without application of an anterior force to the proximal humerus. The relocation test assessed diminution of pain and apprehension after application of a posteriorly directed force to the proximal humerus relative to the position of 90°/90° alone and to the position of an anterior force being applied to the proximal humerus. Overall, 63 patients reported pain with 90°/90°; 74 reported pain when an anterior force to the proximal humerus was applied: the anterior instability group alone had 46 and 63 reports of pain, respectively; the rotator cuff group alone had 82 and 88 reports of pain, respectively. The only positive responses for apprehension were in the anterior instability group, of which 63% had apprehension with 90°/90° alone and 74 had apprehension when an anterior humeral force was applied.

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Over the past 30 years, hockey players have begun wearing helmets and face masks. Cervical spine injury, with an incidence of 15 cases per year, began to be reported in the 1980s. Cervical spine trauma had not been reported before then. A review of the literature seems to substantiate a consensus of opinion that the style of play that is allowed a player with head protection may actually
increase the chances of cervical spinal trauma.

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We evaluated the relationship of cervical spinal stenosis with the occurrence of stingers in collegiate football players who participated at our institution from 1987 through 1991. Preparticipation cervical spine radiographs of 266 players were used to measure Torg ratio. Forty players with stingers were identified: 34 had an extension-compression mechanism; 6 had a brachial plexus stretch mechanism. Time-loss neck injuries occurred in 31 players; the remaining 195 players were asymptomatic. The mean Torg ratio was significantly smaller for the stinger group (p = .02). The Torg ratio was less than .8 at one or more levels in 47.5% of the stinger group, 32.3% of the time-loss neck pain group, and 25.1% of the asymptomatic group. No player with a brachial plexus stretch mechanism had a mean Torg ratio less than .8, but 20.6% of the players with an extension-compression mechanism had a mean Torg ratio of less than .8. Players with a Torg ratio of less than .8 had three times the risk of incurring stingers. We conclude that cervical spinal stenosis increases the risk of having stingers with complicated clinical courses.

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The neuromuscular function of the lower extremity in 40 normal and 100 anterior cruciate ligament-deficient volunteers was evaluated by physical examination, KT-1000 arthrometer measurements, isokinetic strength and endurance testing, subjective functional assessment, and an anterior tibial translation stress test. A specially designed apparatus delivered an anteriorly directed step force to the posterior aspect of the leg while anterior tibial translation was monitored and electromyographic signals were recorded at the medial and lateral quadriceps, medial and lateral hamstrings, and gastrocnemius muscles. Testing was done at 30° of knee flexion with the foot fixed to a scale to monitor weight bearing, while the tibia remained unconstrained. Results indicate that muscle timing and recruitment order in response to anterior tibial translation are affected by anterior cruciate ligament injury. These alterations in muscle performance change with time from injury, correlate with an individual’s physical activity level, affect subjective functional parameters, and are directly related to the degree of dynamic anterior tibial laxity seen with stress testing.

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We conducted a prospective trial at a military medical center to determine which treatment for first-time ankle sprains, early mobilization or immobilization, is more effective. Eighty-two patients with a lateral ankle sprain were randomly selected for one of two treatment groups. The early mobilization group received an elastic wrap for 2 days followed by functional bracing for 8 days. Two days after injury, this group began weight-bearing and an ankle rehabilitation program. Patients in the immobilization group were placed in a non-weight-bearing plaster splint for 10 days followed by weight-bearing and the same rehabilitation program. Patients in the early mobilization group had less pain at 3 weeks (57% versus 87%, p = .02); otherwise, there were no significant differences between groups in the frequency of residual symptoms. Only one patient in each group had residual symptoms 1 year after injury. Three patients (8%) in each group resprained their ankles. Ten days after injury, patients in the early mobilization group were more likely to be back to full work (54% versus 13%, p < .001). We conclude that in first-time lateral ankle sprains, although both immobilization and early mobilization prevent late residual symptoms and ankle instability, early mobilization allows earlier return to work and may be more comfortable for patients.

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Five cadaveric ankles were used to determine the effects of prophylactic bracing and tape on resisting an inversion movement applied to the ankle. The ankles were tested in neutral flexion and 30° of plantar flexion and with both low- and high-top shoes. Eight different strap-on braces were studied. High-top sneakers significantly increased the passive resistance to inversion afforded by all braces and tape. Many of the braces functioned to resist inversion at a level that was comparable with or exceeded the capability of freshly applied tape. This finding was independent of the type of footwear. Braces that were not as effective as freshly applied tape, but nevertheless retained the advantage over tape in that they could be easily readjusted and their effectiveness restored, whereas the quality of the support provided with tape deteriorated with usage.

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In this prospective, multi-institutional analysis of medial collateral ligament sprains in college football players, we categorized 987 previously uninjured study subjects according to frequency of wearing preventive knee braces, studied the patterns by which 47 of 100 injuries occurred to unbraced knees, and identified several extrinsic, sport-specific risk factors shared for both braced and unbraced knees. The attendance, brace wear choice, position, string, and session of each participant were recorded daily; medial collateral ligament sprains were reported whenever tissue damage was confirmed. Both the likelihood of wearing braces and risk of injury without them were highly dependent on session (games/practices), position group (line, linebacker/tight end, skill), and string group (players/nonplayers). Subjects wearing braces often faced a high injury risk to their unbraced knees, a finding compatible with the opinion that braces were a necessary evil, best worn when concern over danger of injury outweighed desire for speed and agility. It is concluded that to avoid misinterpretations due to the confounding influence of brace wear selection bias, accurate investigation of daily brace wear patterns is required. Then, before considering the impact of preventive knee braces, a repartitioning of the data base is essential to ensure that only similar groups will be compared.

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This is the second of two articles on a 3-year investigation of medial collateral ligament sprains of the knee to assess the effectiveness of prophylactic knee braces in NCAA Division I college football players. Position, string, type of session, and daily brace wear were recorded. The injury rates for braced and unbraced knees were used to create an incidence density ratio. The data were stratified and simultaneously controlled for position, string, and session, and evaluated for their statistical significance. The 987 Big Ten players generated 155,772 knee exposures over the study period (50% braced). Noticeable differences existed in the rates of injury for the braced and unbraced knees in almost every position during practices, depending on player or nonplayer status. When the influential factors of position, string, and session are considered, there is a consistent but not statistically significant tendency for the players wearing preventive knee braces to experience a lower injury rate than for their unbraced counterparts. For starters and substitutes in the line positions, as well as for the linebackers and tight ends, there was a consistent trend toward a lower injury rate in both practices and games. The braced players in the skill positions (backs/kickers), at least during games, exhibited a higher injury rate.

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Evaluation, Treatment and Prevention of Musculoskeletal Disorders, 3rd Edition, Volume 1—Spine
Editors: Saunders HD, Saunders R
Educational Opportunities
Bloomington, MN
1993
396 pages, illustrated
ISBN: 1-879190-06-0
Price: $59.95

The purpose of this text is to further expand and detail information from the second edition of Evaluation, Treatment and Prevention of Musculoskeletal Disorders relating specifically to the spine. In the third edition, information has been updated and reorganized into Volume 1—Spine and Volume 2—Extremities. The major focus of this text is to improve the problem-solving skills of the reader through providing a common sense approach to evaluation and treatment intervention.

Volume 1 is divided into four sections and fourteen chapters. Section 1 contains general evaluation techniques and other introductory material. Neural Tension Tests are an intriguing addition to the usual material. Section 2, Evaluation of the Cervical and Upper Thoracic Spine, has changed very little from the second edition. Section 3 includes Chapters 5 through 13 and is really the innovative portion of this text. Chapters 5 and 6 provide the reader with two different approaches to treatment, one based on the assessment and the other based on the problems that are identified. Chapter 7 is an excellent focus on common pelvic girdle dysfunctions. Evaluation and management of the TMJ are presented in Chapter 8. This information has changed very little from the first and second editions. Chapters 9 through 13 discuss joint mobilizations, spinal traction, spinal orthoses, exercises, and rehabilitation. The book concludes with Chapter 14, which includes preventive philosophy and techniques for industry.

The real strength of this book is that it tries to teach you to think, problem-solve, and understand. Chapter 7 is a must for those of us who struggle to truly understand the pelvic girdle. Throughout the text, the organization and open-minded philosophy is as “refreshing” as the authors intended. Soft tissue and neural tension releases, muscle energy, and joint mobilization techniques and movement facilitation are all presented and discussed objectively and appropriately.

The only minor weakness of this text is in its presentation of manual muscle testing. Most of the illustrations are not up to the standards set by Kendall and McCreary. The majority fail to demonstrate basic fixation when the test is applied.

Volume 1—Spine accomplishes what it intended. It is similar in many ways to the first and second edition, but it is also significantly improved. This text is less like a cookbook and is written more specifically for physical therapists than are most other evaluation and treatment texts.

I would highly recommend this text for all athletic trainers and physical therapists who wish to develop a problem-solving approach to understanding and treating the spine. It would be an excellent text for undergraduate or graduate courses that are clinically oriented.

Bob Stahara, ATC, PT
AN KLE


FOOT


HEAD


KNEE


MISCELLANEOUS


**PSYCHOLOGY**


**SHOULDER**


**TENDON**


**WOMEN**


**WRIST**


TheraPro™: A New Injury Management and Sports Medical Software Application

TheraPro™, a powerful, integrated software program from CAP Sports Research, is designed to support the sports medical professional by providing high quality medical documentation, injury management, and treatment and rehabilitation tracking. TheraPro is the first component in the CAP Pro Series™, a powerful suite of software applications that will also include exercise prescription, strength and conditioning, and physical testing and measurement.

TheraPro provides a complete injury recording system that you can configure. Injury statistics can be customized sport by sport, creating a powerful research and statistical database that you can use to extract and analyze injury data. TheraPro also uses a unique user-definable template system for rapidly producing SOAP notes and patient evaluations. Examination templates can be created by body part, increasing both the speed of data entry and thoroughness of medical records. An unlimited number of body parts and injury diagnoses can be associated with a single injury case. The system provides full, yet optional, support for the ICD-9 diagnosis coding system.

Treatment tracking has been designed to provide a rapid data entry system. Complete patient progress notes and individual modalities can be recorded for each treatment session. Treatments can also be entered for patients with no open injury cases, ensuring that all treatments rendered can be documented. TheraPro supports CPT procedure codes.

TheraPro also provides a comprehensive athlete/patient database including multiple addresses per patient, unlimited emergency contacts and insurance carriers, multiple sports per athlete, a complete referrals/contact management system, medical histories, and personal physician data. An on-line Help and Security system makes the system easy to use and protects sensitive medical records.

The CAP Pro Series runs on Windows and Macintosh computers. For more information on TheraPro, call 1-800-883-1330 or write to CAP Sports Research, 1401 Hawthorne Terrace, Berkeley, CA 94708-1803.

CYBEX Introduces the Multi-Column for Clinical Strength Development

The Multi-Column, a unique combination of a pressing station and a cable station connected to a single weight stack, offers clinicians complete open and closed chain exercises in an easy-to-use, space-efficient package.

The Multi-Column can be used to train virtually all major body parts, with special emphasis on the upper body. The adjustable pulley on the column allows the pulley height to be positioned for precise alignment with the patient’s body and tailored to individual exercise patterns. The addition of a pressing station allows total body conditioning without moving from machine to machine.

“The Multi-Column was developed in response to the increasing need for strength training equipment designed specifically for the Rehabilitation market that is functional, versatile, and efficient,” said Greg Highsmith, Strength Systems Product Manager for CYBEX. “The Multi-Column is a cost-effective investment that is safe and effective for rehabilitation, work conditioning, and sports-specific training.”

To increase ease of operation, the Multi-Column requires no cable changes, enabling clinicians to perform pattern “set-ups” in a matter of seconds. Additionally, the Multi-Column provides the functionality of at least six traditional single stations, to offer clinicians all of the exercises of a standard cable station, with the added benefit of a pressing station for chest, shoulder, and incline presses.

The Multi-Column requires a minimum amount of floor space, as it fits comfortably in a 9” × 8” area. Its unique design also allows the Multi-Column to be placed in a corner, freeing up valuable floor space.

Additionally, an adjustable bench, that is conveniently placed on wheels and easily movable for use throughout any facility, comes standard with the Multi-Column. The bench adjusts from flat to 30°, 40°, 60°, and 80° for the flexibility of performing a variety of exercises with one bench.

“The unique design of the Multi-Column allows clinicians to perform unlimited closed kinetic chain and functional patterns with both concentric and eccentric loading,” Highsmith continued. “Therefore, it easily accommodates both real life multijoint movements, as well as isolated joint exercises for patients”.

For more information on the Multi-Column, or any CYBEX product, please contact CYBEX, 2100 Smithtown Ave, PO Box 9003, Ronkonkoma, LI, NY 11779-9003; Tel: 1-800-645-5392. Fax 516-585-9741.
3M Active Strips Bandages With Extra Sticking Power for Damp or Perspiring Skin

3M Active Strips Flexible Foam bandages, which provide excellent adhesion in challenging conditions such as for patients with diaphoretic or damp skin, are now available.

Unlike many conventional bandages that can curl up, fall off, or chafe the skin, 3M Active Strips bandages stretch and conform to the skin—making them ideal for protecting venipuncture sites, finger sticks, small surgical procedures, and minor wounds.

3M Active Strips bandages offer patient comfort and protection as well as excellent moisture resistance. Hypoallergenic Active Strips bandages are easy to apply and provide adhesion around the wound to help keep dirt or other contaminants out of the site. Their soft, absorbent pads won’t stick to wounds.

In addition to 3M Active Strips bandages, 3M Health Care now offers 3M Flexible Fabric Adhesive bandages with a traditional fabric backing, and cosmetically pleasing 3M Sheer Adhesive bandages.

Competitively priced, all three varieties of bandages come in four sizes: 5/8" x 3" strip; 7/8" x 3" strip; 7/8" spot; and a 1-7/8" x 3-7/8" patch. The 3M Flexible Fabric bandages also are available in an H-shaped knuckle size.

The strip and knuckle bandages are packed 100 per box with 12 boxes per case. The spot bandages are packed 100 per box, with 18 boxes per case. The large patch-sized bandages are packed 50 per box with 18 boxes per case.

For more information, write to 3M Health Care, P.O. Box 33275, St. Paul, MN 55133-3275.

EnduraSplint2® Splinting System

EnduraSplint 2® offers the strength of fiberglass without the mess. The prepped splints feature a soft polypropylene padding on the patient side with a low-profile back cover that allows easy “no gloves” handling. EnduraSplint 2 is available in both continuous rolls and pre-sized splints to expedite application, reduce handling, and eliminate waste.

EnduraSplint 2 Splinting System is indicated for all trauma and secondary splinting applications where quick rigid immobilization is desired.

One-sided Polypropylene padding is “hydrophobic”; it sheds moisture faster and stays drier than open cell foam. “Breathability” is improved to reduce the possibility of maceration. The padded side provides a soft, comfortable surface, with superior protection from sharp edges. The nonpadded side is a protective barrier of nonwoven material laminated to highly breathable DuPont® Hytrel®. One-sided padding makes a lighter, lower profile splint that dries more quickly. The 5-minute set time allows enough time for working and molding the splint, yet the splint sets quickly enough to provide security, with less chance of wrinkles or other pressure areas. The seven-layer construction provides strength equivalent to other eight-layer splints, yet it’s lighter in weight and more comfortable.

EnduraSplint 2 offers a choice of delivery in either precut splints or roll form. Presized, individually packaged splints are conveniently packaged in the most frequently needed sizes for fast “no fuss” application.

Continuous roll form splints are continuous 15 ft lengths of EnduraSplint 2 splinting material in 2", 3", 4", 5", and 6" widths. Roll-form splints allow you to cut the exact amount of material for each splinting application, improving adaptability while reducing waste.

For more information, contact Carapace, Inc., 12262 E. 60th St., Tulsa, Oklahoma 74146; Tel. 918-252-7266.

VHI Exercise and Rehabilitation Prescription Kit

Visual Health Information (VHI) has just produced a 1994 Update for the VHI Exercise & Rehabilitation Prescription Kit. This Update of 71 new exercises includes PNF, resistive band and tubing, lifting simulation, pushing and pulling simulation, cervical spine self-mobilization, and much more. The Update has two special features: it comes housed in a large, new box designed to hold the entire VHI Kit, both updates, and many more cards. The second feature is a new Visual Index for quick reference. This index displays miniature versions of all the exercise illustrations. A fully revised text index is also included. Both indexes include the entire kit and both updates.

Now you can choose exercises either by picture or text. This 1994 update continues the tradition of one-time purchase, giving rights to create and photocopy as many routines as are needed for patients. No reordering is necessary.

To order the 1994 Update (Price: $59.95), contact VHI, P.O. Box 44646, Dept. 939, Tacoma, WA 98444, Tel: 1-800-356-0709, Ext 939.

Dynatronics’ “50 Series,” One Solution to Cost Containment

Dynatronics’ new “50 Series,” a line of electrotherapy and ultrasound equipment, significantly decreases both the price and the size of the devices while still offering top-of-the-line features. This new product line provides all the state-of-the-art features customers have come to expect from Dynatronics, and, thanks to revolutionary technology, at nearly half the price of traditional top-of-the-line electrotherapy and ultrasound equipment.

Dynatronics calls this technology “microsize technology,” because not only do the 50 Series products cost far less, but also each device is substantially smaller, allowing the practitioner to take the 50 Series anywhere—the clinic, the home or the hospital. The company first revolu-
tionized the market in 1987 when Dynatronics was the first company to use microprocessor technology in electrotherapy devices with the Dynatron 100 and Dynatron 500. With the 50 Series, Dynatronics has once again revolutionized the physical medicine marketplace.

The first of three new products comprising the 50 Series, the Dynatron 150 portable ultrasound, was released in February. The Dynatron 550 (interferential, microcurrent and muscle stimulation) and the Dynatron 850 (combining multi-frequency ultrasound with all the features of the Dynatron 550) was released in August. Each unit has basically the same features of the Dynatron 300, 500, and 800, but the size is dramatically reduced. For example, you can fit two Dynatron 850s in less space than you could fit one Dynatron 800. The Dynatron 850 also weighs one-third of the Dynatron 800’s weight. The 50 Series has all the preferred features of the Dynatron 500 and 800, such as multi-frequency ultrasound and the patented Target feature. Optional carrying cases and wall brackets are available for each device in the 50 Series.

Most features can be modified during treatment. With interferential treatment, you can change between Target and Target Sweep, and among High, Low, and High/Low Alternating. Russian and Bi-Phasic allow you to treat with normal, co-contraction, or reciprocal modes at a variety of contraction/rest cycles and ramp speeds. Microcurrent gives practitioners the capability to treat with either pads or probes and to change polarity of treatments.

With ultrasound, practitioners are able to use up to three frequencies (1, 2, and 3 MHz) on any of four different-size sound heads (1, 2, 5, or 10 cm²). Frequency can be changed during treatment, along with duty cycles of 20%, 50%, and continuous. Power can also be modified in either watts/cm² or watts/cm.

For more information on the new 50 Series, contact the sales department at Dynatronics at 1-800-874-6251.

New Thero-Skin Gel Padding
Moisturizes as It Protects

Thero-Skin, a new gel padding that moisturizes the skin by slowly releasing a medical-grade mineral oil, is available from Sammons, Inc, the company that introduced healthcare professionals to Thero-Gel® brand protective gel paddings.

Conventional moleskin and light foam paddings don’t measure up to Thero-Skin. The thin gel padding—it’s just 1/32”—can be applied to splints and orthotic materials before placing them in hot water to form.

But that’s not all. Thero-Skin provides exceptional comfort. It conforms beautifully to all body contours, effectively absorbing shock and eliminating friction. And because repeated washings won’t affect its strength or moisturizing properties, Thero-Skin lasts up to 4 weeks. Available in handy, 36" rolls in two widths, it can be cut easily with scissors to fit any shape.

To order Thero-Skin, call Sammons at 1-800-323-5547 or Fax 1-800-547-4333. In Canada, phone 1-800-665-9200 or Fax 613-392-4139. Specify Dept. F19, and #8339-01 for the 4"-wide roll or #8339-02 for an 8"-wide roll. (Free samples are available upon request).

Ferno Ille Model 918 Four-Pack
InFerno™

Ferno Ille, a division of Ferno-Washington, Inc, announces the introduction of the Model 918, Four-Pack InFerno™, designed to heat packs used in moist-heat therapy.

The InFerno holds up to four hot packs, sized 10" × 12". In addition, it features a thermostatic control that permits variance of water temperature up to 168°. Both the unit and the removable rack are constructed of satin-finish stainless steel, renowned for its sanitary qualities and corrosion resistance.

Available accessories include Ultra-Pac Hot Packs in standard, cervical, and oversized sizes, Ultra-Pac covers in white or tan, and Sanizene® Hard Surface Disinfectant.

For more information, contact Ferno-Washington, Inc, 70 Weil Way, Wilmington, OH 45177-9371, Tel: 513-382-1451, Fax 513-382-5724.

“Wraparound” Playmaker™ Knee Brace

Smith & Nephew DonJoy has introduced a “Wraparound” version of the Playmaker™, the convertible, hinged neoprene brace designed for moderate instabilities of the knee.

The Playmaker is designed to provide medial/lateral support during the transition from the postop period to the activities of daily living. Especially suited for those who have trouble applying a sleeve-style or slip-on brace, the new Wraparound Playmaker allows adjustment of the brace for a more custom-like feel. The IROM Playmaker is also suitable for use during rehab aqua therapy.

Introduced in 1992, DonJoy’s Playmaker line is used by several thousand patients each year. The brace features 1/4” or 1/8” neoprene, polycentric bar hinges or an IROM hinge, a variety of color options, popliteal, and patella donut versions. Dubbed the “Swiss Army Knife” of bracing, the Playmaker may be used with or without the IROM or polycentric hinges as the rehab process progresses.

For more information, contact Smith & Nephew DonJoy, Inc, 2777 Loker Ave, West, Carlsbad, CA 92008-60001; Tel: 1-800-336-5690.
The Journal of Athletic Training welcomes the submission of manuscripts that are of interest to persons engaged in or concerned with the progress of the athletic training profession (athletic injury prevention, evaluation, management, and rehabilitation; administration of athletic training facilities and programs; and athletic health care counseling and education). Manuscripts should conform to the following:

**SUBMISSION POLICIES**
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   a. Title page
   b. Acknowledgements
   c. Abstract and Key Words (first numbered page)
   d. Text (body of manuscript)
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   f. Tables—each on a separate page
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11. Titles should be brief but descriptive (limits a 16-word maximum is recommended). The name of the disability treated should be included in the title if it is the relevant factor. A technique or type of treatment used is the principal focus of the report, it should be in the title. Often both should appear.
12. The title page should also include the names, titles, and affiliations of each author, and the name, address, phone number, and fax number of the author to whom correspondence is to be directed.
13. A comprehensive abstract of 75 to 200 words must accompany all manuscripts except A Tip From the Field. Number this page one, type the complete title (but not the author’s name/s) on the top, skip two lines, and begin the abstract. It should be a single paragraph and succinctly summarize the major intent of the manuscript, the major points of the body, and the author’s summary and/or conclusions. It is unacceptable to state in the abstract words to the effect that “the significance of the information is discussed in the article.” Also, do not confuse the abstract with the introduction.
14. List three to six key words or phrases that can be used in a subject index to refer to your paper. These should be on the same page as, and following your abstract. For A Tip From the Field, the key words should follow immediately after the title on the first numbered page.
15. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the development and stated. Tell why the study was needed to be done or the technique written and culminate with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In the one to two paragraphs that follow, identify and develop and the magnitude and significance of the controversy, pointing out differences between others’ results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in brief specific statements and reference them. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction.
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The NATA Board of Certification accepts this continuing education offering for .5 hours of prescribed CEU credit in the program of the National Athletic Trainers’ Association, Inc, provided that the test is used and completed as designed.

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This CEU Credit Quiz contains questions drawn from the following articles:

- Byerly et al. Rehabilitation compliance in an athletic training environment.
- Deivert RG. Functional thumb taping procedure.
- Massie DL. Use and fabrication of temporary orthotics.
- Nellis SM. Leadership and management: techniques and principles for athletic training.
- Pitney/Bunton. The integrated dynamic exercise advancement system technique for progressing functional closed kinetic chain rehabilitation programs.
- Sailors ME. Recognition and treatment of osteochondritis dissecans of the femoral condyles.
- Smith/Milliner. Injured athletes and the risk of suicide.

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**Instructions**

1. Photocopy these pages and write on the copy.
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3. Answer the questions.
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**JAT—CEU Quiz**

Department of Athletic Training
Indiana State University
Terre Haute, IN 47809

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**Answers to September '94 CEU Quiz**

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Circle the correct answer.

1. Orthotics:
   a. are ineffective in altering compensatory motions which result from abnormalities in the foot and lower extremity.
   b. are beneficial for temporarily reducing abnormal stresses while allowing involved structures to heal.
   c. should not be used to encourage early weight-bearing in rehabilitation.
   d. may be used in place of a rehabilitation program.
   e. b and c.

2. In planning a closed kinetic chain rehabilitation program, keep in mind that:
   a. the environment must deliver the expected biomechanical response.
   b. functional objective measurement is unimportant.
   c. the athlete's subjective reports should be considered.
   d. All of the above.
   e. a and c only.

3. Ways athletic trainers may be able to reduce the incidence of ACL injuries might include:
   a. orthotic devices to control knee and foot motion.
   b. exercise.
   c. preparticipation screening.
   d. All of the above.
   e. b and c only.

4. Rehabilitation for immobilized juvenile osteochondritis dissecans patients might include:
   a. cardiovascular exercises.
   b. stretching of every major muscle group of the lower extremity.
   c. “four-way” straight leg raises.
   d. neuromuscular electrical stimulation to the quadriceps and hamstring strings for coactivation contraction.
   e. All except b.

5. Leadership and management skills:
   a. are not distinct from each other, yet vital to a successful and efficient athletic training room.
   b. differ in that leadership is an influence relationship while management is an authority relationship.
   c. differ in that leadership is concerned with development of your athletic training facility's mission, while management is not.
   d. differ in that management is concerned with knowing your staff and how to apply people skills, while leadership is not.
   e. Both b and c.

6. In assessing an athlete's potential risk for suicide, the athletic trainer would be wise to assess the athlete's:
   a. motivation.
   b. postinjury depression.
   c. coping methods.
   d. support system.
   e. All of the above.

7. A study in which tissues 3 cm deep were precooled before ultrasound treatment proved that:
   a. precooling increased the peak temperature of the underlying tissues when ultrasound was applied.
   b. ultrasound failed to raise the tissue temperature of the precooled area even back to pretreatment baseline.
   c. precooling superficial tissues raised tissue temperature; precoothing deep tissue did not.
   d. temperature of precooled tissue increased only during the first 2 minutes of ultrasound.
   e. None of the above.

8. Which of the following statements are true about thumb taping?
   1. A checkrein is functional and not dangerous.
   2. Some thumb taping procedures and encapsulate the entire hand and limit function.
   3. Neoprine spicas provide imprecise support.
   4. Use of a broad “V” strip provides support to the MP joint without compromising comfort.
   5. Rigid splints are practical and do not inhibit normal use of the hand and thumb.
   a. 1, 2, and 3.
   b. 2, 3, and 5.
   c. 2, 3, and 4.
   d. 3, 4, and 5.
   e. 1, 2, and 4.

9. While contrast therapy (ie, repeated alternation of thermotherapy and cryotherapy) has been proposed for many uses, researchers claim that it is incapable of producing any significant physiological effect on the intramuscular tissue temperature 1 cm below the skin and subcutaneous tissue.
   a. True
   b. False

10. Types of conditions that might benefit from a temporary orthotic include:
   a. patellofemoral pain.
   b. acute inversion ankle sprains.
   c. metatarsalgia.
   d. posterior tibialis tendinosis.
   e. All of the above.

11. Spontaneous rupture of the Achilles tendon is:
   a. common.
   b. most commonly seen in men past the age of 45 years.
   c. of unresolved specific etiology.
   d. definitely associated with chronic degeneration in the tendon.
   e. None of the above.

12. Which of the following variables are most strongly associated with rehabilitation adherence?
   1. perceived exertion level
   2. pain
   3. self-motivation
   4. support from significant other
   5. scheduling
   a. 1 and 3
   b. 2 and 4
   c. 2, 3, and 4
   d. 2, 4, 5, and 6
   e. 1, 2, 3, and 4

13. Wilson's test for osteochondritis dissecans:
   a. is usually negative for adult patients.
   b. demonstrates an increase of pain at 45° knee flexion if there is a lesion at the classical site.
   c. demonstrates pain disappearing when the tibia is externally rotated.
   d. is a positive and confirming diagnosis and can be used with certainty without other diagnostic tools.
   e. Both b and c.

14. Ways to develop good management skills include:
   a. develop a communication network and a mission statement.
   b. develop job descriptions, yet leave enough latitude so the employee can exercise initiative and judgment.
   c. develop a Policy and Procedures Manual.
   d. All of the above.
   e. b and c only.

15. How can the clinician help to encourage rehabilitation adherence?
   a. Implement pain control strategies with the athlete and educate the athlete about the role of pain in the rehabilitation process.
   b. Demonstrate support and encourage peers and coaches to support the athlete.
   c. Educate the athlete about all aspects of the rehabilitation program.
   d. All of the above.
   e. None of the above. There are too many variables affecting rehabilitation adherence to tell.
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