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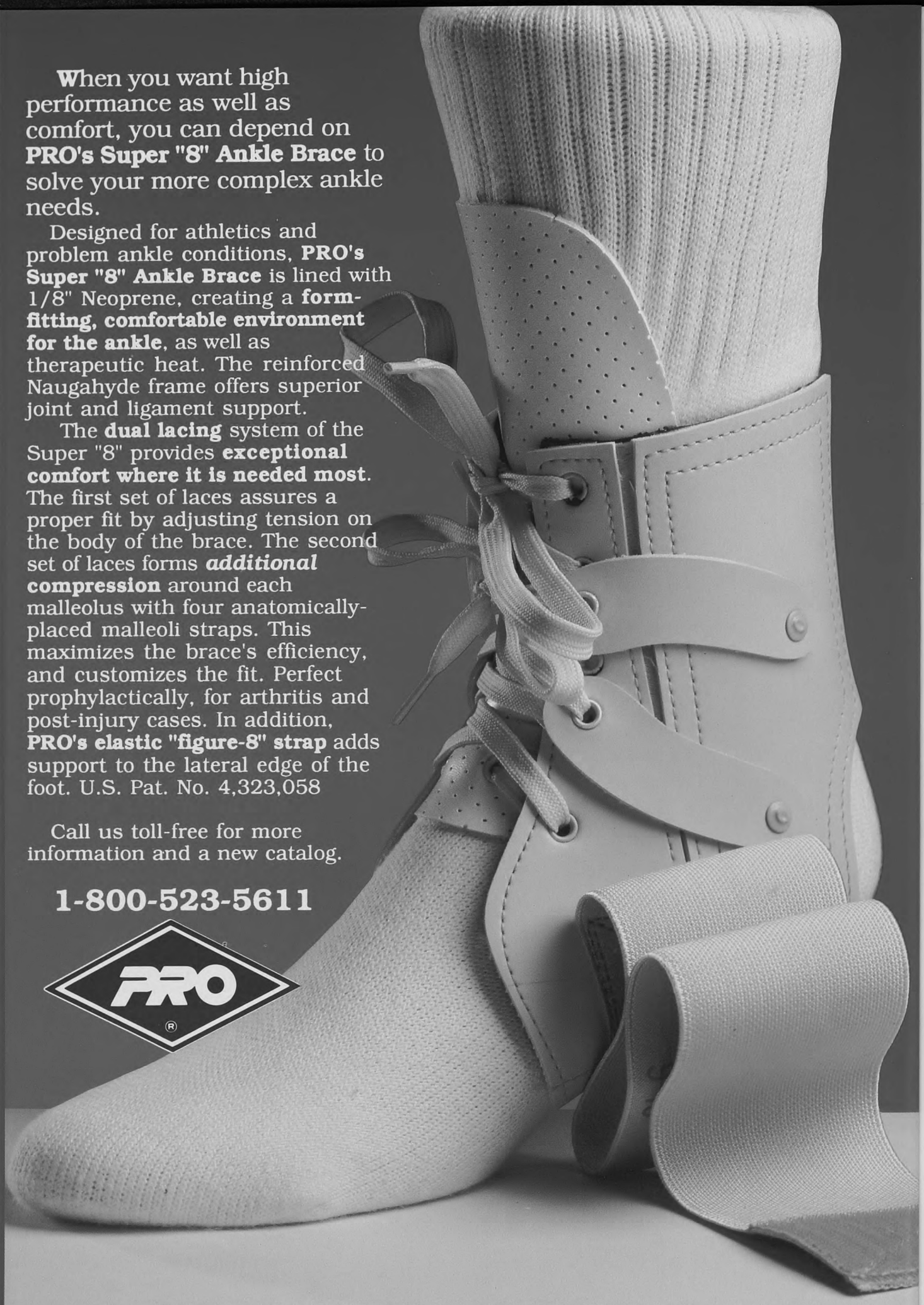

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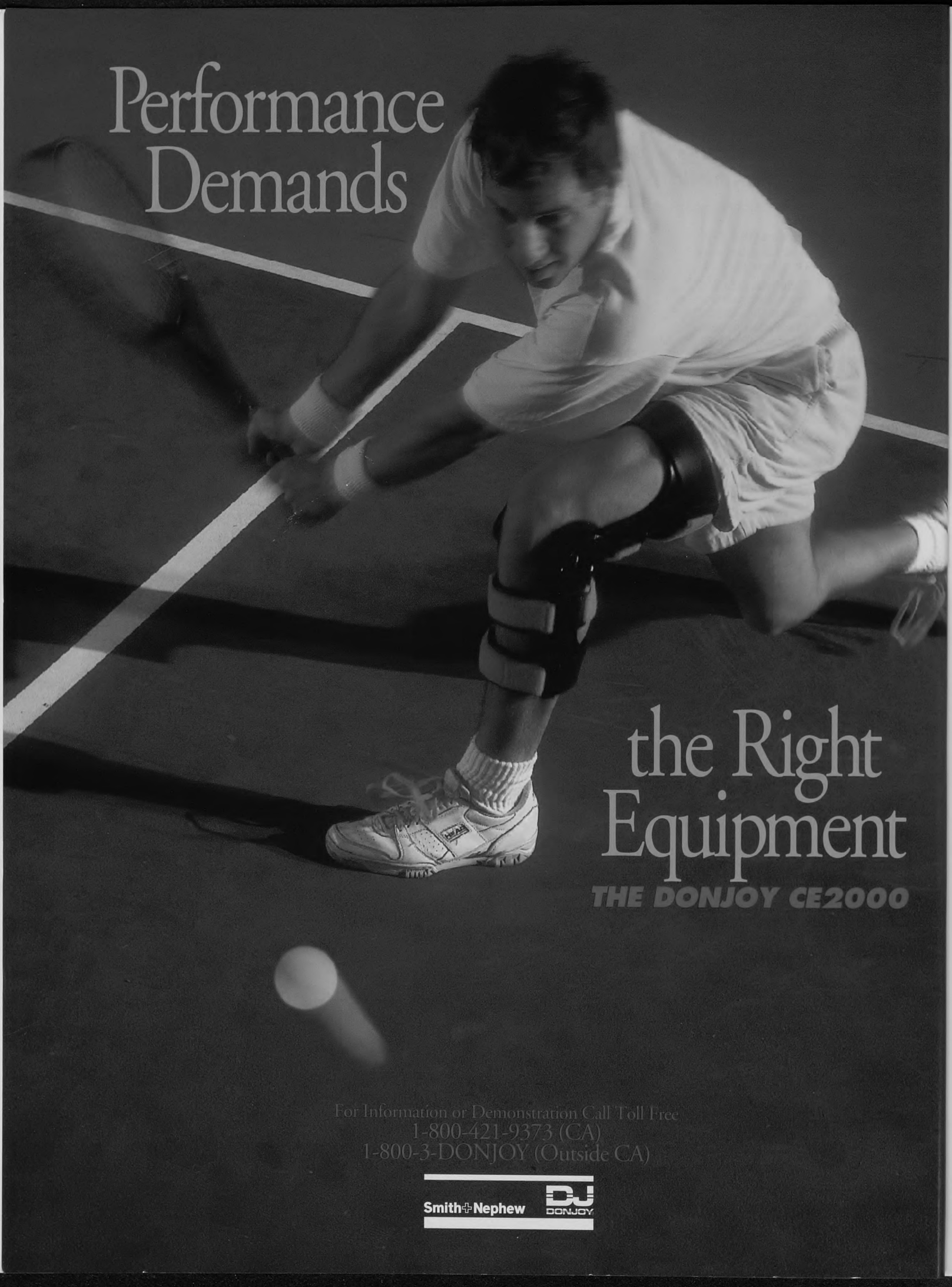
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CEU CREDIT QUIZ

ARTICLES

TIPS FROM THE FIELD

STUDENT ATHLETIC TRAINER FORUM

DEPARTMENTS

Letters to the Editor

After reading the recent article by Moss and Parks in the Summer 1991 issue of *Athletic Training, JNATA*, I was angered to learn that two thirds of all newly certified athletic trainers were employed in settings other than the "real world"—schools and colleges. I find this to be a disturbing "trend" and a real slap in the face for those of us who have worked all of our professional lives in the trenches. Please understand, I acknowledge the need for athletic trainers in a clinical setting. I do not, however, believe that they should acquire their initial experience in such a sterile environment.

J. Terry Parker, PhD, ATC-L
Waxahachie Independent School District
Waxahachie, TX

Because I am a strong advocate of high schools having a certified athletic trainer on the faculty, I would like to make a few comments and observations concerning two Letters to the Editor in the Summer 1991 issue of *Athletic Training, JNATA*.

Regarding Mr. Whieldon's and Mr. Cerny's letter concerning their research, the reason an investigation or research is conducted is not necessarily dictated by the method. Research, scientific or otherwise, certainly can be used to justify the hiring of certified athletic trainers for high schools. In fact, research findings have been used to show the need for an athletic trainer on the faculty of high schools, and can be used to show that this position is more cost effective than any other faculty position.

Next, if research is being conducted on high school athletes, but the research is not for the benefit of the athletes, the school system, or the justification of having a certified athletic trainer, then I believe that the research would be better conducted on college/university athletes. Injuries to 14, 15, and 16 year old athletes are handled differently from injuries to the college-age athlete. The cause of an injury to a young athlete may not injure an older, more mature athlete.

In response to Dr. Grana's letter, I believe that it is totally within reason to expect all high schools participating in football, baseball, softball, basketball, track, and other sports to have a certified athletic trainer on the faculty. For this to happen, however, many things have to happen. One of these is that the NATA must make a concerted effort to help high schools to hire athletic trainers. Even now, there is not much done to involve the high school athletic trainer in the NATA.

Also, there are very, very few legitimate alternatives to having a full time athletic trainer on the faculty of high schools. A high school athletic trainer is more than just an athletic trainer. He or she is part of the school and there for the students, faculty, and parents all day, every day. He or she is along the side lines during practice and games, and feels the sadness of losing as well as the joy of winning. The high school athletic trainer is a highly visible person in daily high school activities, and is the best public relations and advertisement that the NATA has.

Henry L. Stroud, ATC
Prince Edward County High School
Farmville, VA

I just read a great article, "Rehab Team Functioning" (*Rehab Management*, Jun/Jul, 1991) authored by Harold Egli, Genie Strakal, and Michael Long; though I am disappointed by an insert, authored by T. Pepper Burruss, that appeared in the article highlighting the NATA. While I am not directing my discontent toward Mr. Burruss, who does a fine job of summarizing what can be found in many of the NATA documents, I feel that a correction is in order.

The insert attempts to describe the NATA and athletic training as an occupation. Therein lies the problem. I took exception to the first line of the description, "Athletic training is the art and science of caring for injuries that occur in sports." The explanation goes on to emphasize that our skills as Certified Athletic Trainers are directed towards sports injuries and athletes in particular. While this is certainly true, it fails to mention one of the most exciting and fastest growing segments of the NATA, Corporate/Industrial Athletic Training.

Corporate/Industrial Athletic Training has been in existence for many years. Occupationally, as well as non-occupationally injured employees are treated on-site in company owned rehabilitation centers. Treatments are conducted under the supervision of both corporate and community physicians. There is absolutely no billing for any services rendered by the athletic training staff. There are some who feel that athletic trainers have no business working outside sports, and should be caring for athletes only. In fact, intimidation is so great that the term "Industrial Athlete" was coined to provide a direct link with athletic trainers. Nothing could be farther from reality. I have yet to witness any athlete who trains or competes for eight to 12 hours a day, five to seven days per week, 49 weeks per year, for 30 or more years doing redundant, sometimes menial, tasks. Though well intentioned, it is time to put this concept to rest.

Those of us who work in industry are continually having to justify our existence to others in our own professional association and to other allied health professionals. It is obvious that this is as natural an environment for trainers as athletics is, with over 70 percent of the work-related injuries in the U.S. consisting of strains, sprains, and fractures. The main difference is the mechanism of injury and the age of the patient.

There are those who may say, "If you don't want to work with athletes, why did you enter the field of sports medicine?" Well, it is not as though I don't enjoy the work with athletes and the excitement of sports competition. I have experience with high school, college, clinic, and professional sports. But with

all factors considered in job satisfaction, such as: base salary, benefits, work schedule, job-site conditions, personal fulfillment, and opportunity for advancement, I, along with many others, have chosen Corporate/Industrial Athletic Training.

Many of the duties and techniques that we have learned as athletic trainers, have been presented to us as treatment and care for athletes. When in retrospect, most of what we have learned can be generalized to the human animal. A strained muscle or sprained ligament is physiologically the same in an industrial worker as it is in an athlete. And, for the most part, treatment and rehabilitation remain the same, too. I suspect that a majority of athletic trainers have treated a non-athletic injury at some point in their career, perhaps without a physician's order. Industrial athletic trainers work under the direct supervision of the treating physician, and always with a written script.

In conclusion, I would like to offer a suggestion to our membership. I urge you not to limit the scope of professional practice for athletic trainers. This is currently being done in two ways: by reference to the background and practice of athletic trainers (i,e. publicity information as I previously mentioned and NATA documents), and through state licensure legislation (examine your respective state bill). In these times of high unemployment and economic uncertainty, I don't feel that any of us can afford to become complacent and limit the potential employment opportunities available to athletic trainers.

I, as well as the other Corporate/Industrial Athletic Trainers, would be more than happy to answer questions that the NATA membership may have regarding this very rewarding avenue for athletic trainers (Contact Greg Zimmerman, Saginaw Division - General Motors, 3900 Holland Avenue, Saginaw, MI 48601-9494, (517) 757-4656.).

Greg Zimmerman, MSA, ATC

CEU Credit Quiz

Clinical Use of Continuous Passive Motion in Athletic Training

Patrick C. O'Donoghue, MS, ATC
Michael R. McCarthy EdD, ATC, PT
Joe H. Gieck, EdD, ATC, PT
Carlan K. Yates, MD

ABSTRACT: This review examines the current literature concerning the historical perspective on therapeutic motion, the description of the continuous passive motion (CPM) modality, the clinical relevance of CPM, and its use in the field of athletic training. Continuous passive motion has become a commonly-used modality in the rehabilitation of athletes who encounter orthopaedic problems. We conclude that there is little clinical research that evaluates the efficacy of the various protocols for CPM or its numerous applications for orthopaedic problems. We recommend that further studies regarding the efficacy of treatment be initiated.

Following traumatic or overuse injury to soft tissue, athletic trainers are well aware of the importance of applying motion to a joint soon after the injury, within the safe limits of tissue healing. The potential advantages of early motion include: applying controlled forces on healing collagen tissues, maintaining articular cartilage nutrition, reducing disuse effects, and retarding capsular contracture (6,7,32,36,40) and joint stiffness (6,7,12,32,36,40,41,42,43).

Continuous passive motion (CPM) is a modality that employs passive motion in the management and rehabilitation of a variety of orthopaedic problems. The therapeutic use of CPM is indicated following knee manipulations, stable fixation of intraarticular and extraarticular fractures of most joints, soft tissue surgical procedures about the knee, joint sepsis, knee arthroplasty, anterior cruciate ligament reconstruction, and operative procedures involving the knee extensor mechanism (10,31,38).

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Continuous passive motion has been shown to have distinct physiologic effects on soft tissue (6,7,12,32,33,36,40,41,42,43,44,51) and joint surfaces (6,7,11,32,33,34,35,36,40,41,42,43,44,51). The potential benefits observed in the laboratory need to be implemented in clinical practice in order to quantify the parameters associated with therapeutic CPM. Important questions which have not been answered scientifically include: What range of motion is required to reduce the effects of disuse and promote healing?; How should CPM best be applied?; What is the optimal duration of CPM treatment?; Is the addition of CPM to the treatment regimen a benefit to healing?; Is CPM an alternative to immobilization?; Are there detrimental effects from the use of CPM? This paper reviews the current literature on the historical perspective of therapeutic motion, the description of the CPM devices, the clinical relevance of CPM, and the potential applications of CPM for athletic trainers.

HISTORICAL PERSPECTIVE

Athletic trainers strive to shorten recovery time and enhance the healing process of athletic injuries. Many of the "new" trends in the treatment of athletic injuries can be traced back to early medicine. The decision to use rest or motion following nonoperative treatment for musculoskeletal injuries and diseases has always been controversial (39).

2500 years ago, Hippocrates believed that proper healing of the body required one to "lay up and rest" (39). In contrast, Aristotle maintained that movement was essential to life (39). These differing opinions regarding the therapeutic application of movement or rest appear responsible for the creation of the controversy that persists today.

The controversy between movement and rest was nearly settled during the 19th century, with rest being the choice of many physicians (39). In 1852, the advocates of rest were aided when the Flemish surgeon, Mathijsen, developed the plaster cast by soaking gauze bandages in plaster of Paris (39). Rest as a form of treatment gained greater acceptance in the practice of medicine during the 1860s through another advocate of rest, Hilton, who was with the Royal College of Surgeons in London. His lectures on the influence of mechanical and physiological rest gave a boost to the presumed benefits of rest.

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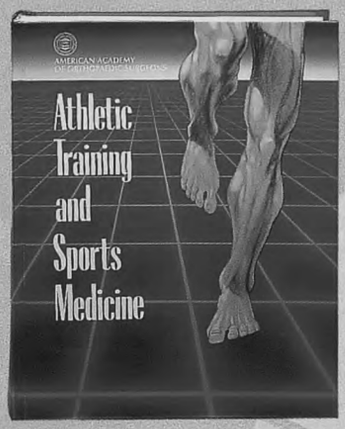

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Hilton's lectures later were published as the classic book, *Rest and Pain* (24).

The therapeutic use of rest became further entrenched in the practice of medicine by the adamant teaching of Hugh Owen Thomas, one of the fathers of British orthopaedic surgery. Thomas emphasized that rest, or immobilization, must be complete, prolonged, uninterrupted, and enforced (49).

The support for rest was virtually unchallenged as the practice of medicine entered the 20th century. Champonniere, a French surgeon, criticized his predecessors and challenged his contemporaries to accept his contention that massage and motion were alternatives to immobilization (39). This minority position, upholding "movement" as the modality of choice, was furthered by Perkins, a British surgeon and professor, who challenged the accepted standard of immobilization (37). Perkins believed that traditional training of the physician biased his or her therapeutic choice between rest and motion (37).

During the 1950s, the Association of Osteosynthesis (AO) was formed in Switzerland by a group of surgeons whose guiding principle for fracture care was that, "Life is movement; movement is life" (28). The Association was formed to propagate and address the problems of internal fixation in the treatment of fractures (28). This group of medical practitioners questioned the conventional orthopedic treatment of fractures. The AO advocated open reduction, rigid internal fixation with compression, and no casting (28). This treatment of fractures offered the potential for a more rapid return to full activity (39).

In the 1960s, scientific research provided objective data on the deleterious effects of immobilization, which led in the 1970s to a surge of research activity on the effects of motion. The original biologic concept of continuous passive motion of synovial joints was proposed by Salter (44), who hoped to stimulate the healing of articular tissue and to avoid the ill effects of immobilization.

Salter's application of CPM in the treatment of orthopaedic problems gained great acceptance in the 1980s (39,40,41,42, 43,44). His findings from animal research were applied clinically, and CPM gained acceptance as an alternative to the deleterious process of immobilization (6).

CONTINUOUS PASSIVE MOTION

Therapeutic continuous passive motion is produced by application of an external force and not by the actions of the muscles of the extremity. From its controversial beginning, CPM has become widely recognized as a modality that facilitates soft tissue healing. The application of early motion has been shown to stimulate an intrinsic healing process (26). Tissues subjected to this early motion develop increased tensile strength, reducing the length of recovery (26). The low load stretching provided by continuous passive motion has a beneficial effect on collagen remodeling, joint dynamics (42), and pain reduction (8).

Perhaps the most effective use of continuous passive motion may be in the prevention of the deleterious effects of immobilization. The effects of prolonged immobilization include joint contracture, relative inhibition of normal healing processes, and neuromuscular degeneration (16). Early use of CPM, combined with supervised active motion, may be the best option for maintaining range of motion (5).

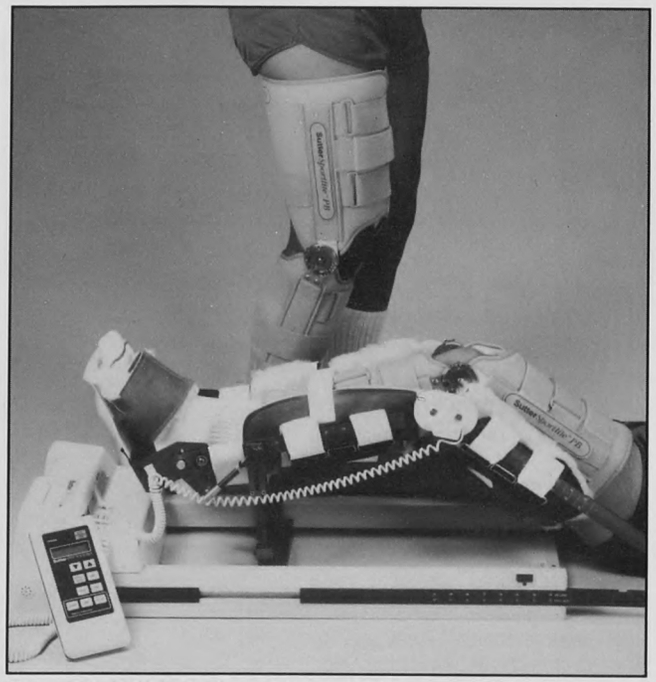


Figure 1. CPM designed to assist knee motion

CPM: THE DEVICES USED

At the end of the 19th century, Champonniere, a proponent of massage and motion, developed the first mechanical device to assist in the application of passive motion (39). This device initially gained some attention, but soon fell into disfavor (16). Nearly a century passed without further development of passive motion devices or additional therapeutic uses of CPM. In 1960, in Downey, California, Vernon Nickel, M.D., used a mechanical device to treat rheumatoid arthritis patients following surgical synovectomy of the knee (6). This was the first modern clinical application of CPM. Following Salter's experimental observations, from 1975 to 1981, and prior to commercial availability of a CPM unit, Coutts (6) developed his own device to test the efficacy of continuous passive motion in the treatment of patients with total knee replacements.

Today, the steadily increasing use of CPM has created a growing market for a variety of devices. Continuous passive motion devices have been designed for the hand/wrist, knee, hip, shoulder, elbow, and ankle (13). The knee joint has received the most attention, with more than 20 CPM devices available (Figure 1) (8). As of this writing, six CPM devices have been designed for the upper extremity (shoulder and elbow), and four CPM devices have been designed for the hand (13).

There are two basic types of CPM devices: an anatomical design (Figure 2), and a free-linkage design (13). An anatomically designed CPM device moves the joint in a manner similar to the natural anatomic motion of the joint. A free-linkage CPM machine provides motion to the structures adjacent to the joint, and allows the joint to seek its own anatomical motion. When evaluating patient comfort, the anatomical design is preferred, whereas the free-linkage design ranks higher in ease of operation (13).

According to Coutts (6), a CPM device should: be adjustable to the patient's anatomic requirements, provide a large support surface, impart a force over a large surface area to ensure comfort, and move the extremity through the desired

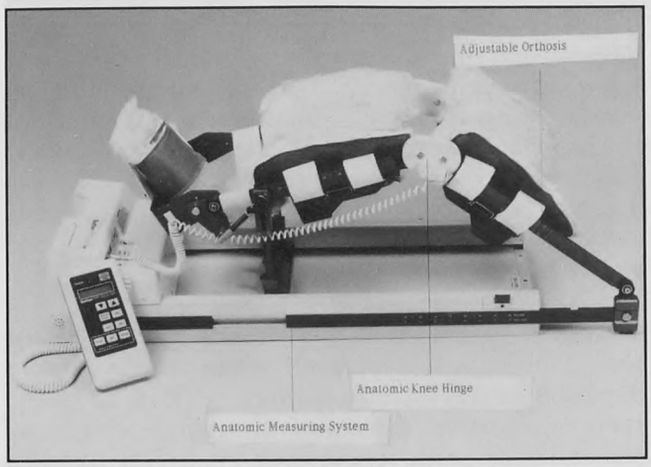


Figure 2. CPM: The anatomical design

range of motion. The more anatomically correct the design, the more time it takes to attach the CPM device, because it must be aligned to the patient's anatomy, and because the alignment must not change during the treatment session (5).

All lower extremity CPM devices are, by necessity, stationary, while CPM devices for the upper extremity allow the patient to ambulate (13). These portable upper extremity units are battery operated, whereas the stationary units use standard household alternating current. In general, the control systems of CPM devices provide three basic variables and three control designs. These variables include the size of the motion arc, the position of the motion arc in relation to the normal motion arc of the joint, and the rate of motion (6). The three control designs typically include a separate hand held unit, a desk top or floor mounted module, or a control system incorporated into the unit (13). Some devices have additional variables, including neuromuscular electrical stimulator current for active muscle contraction, load setting for "auto-reverse," pause intervals for stretching at the extremes of motion, and auto/manual mode to control CPM travel, i.e., the position of the support surface (13).

CLINICAL AND EXPERIMENTAL STUDIES

Evidence in support of the clinical effectiveness of CPM includes both subjective and objective parameters. Research performed on humans has examined the effects of CPM on joint effusions, wound edema, restoration of the range of motion, and pain (4,7,21,30). Clinical studies have evaluated the effectiveness of CPM in treating a variety of conditions (Table 1). The clinical application of CPM began with experimental studies of immobilization and passive motion (1,2,3,11,14, 15,17,18,19,20,32,33,34,35,36,39,40,41,42,43,44,45,46,50,51). The majority of the clinical CPM studies that have been published have used bilateral comparisons of joint range of motion to objectively assess the effectiveness of CPM (4,7,21,25). Published protocols for the application of CPM vary greatly (4,5,7,9,21,47,52).

Clinical Studies

Coutts et al. (7) reported that 82 patients who received at least 20 hours of CPM daily, following a total knee arthroplasty, had a significant increase in range of motion and absence of edema and effusion (7). Evaluation of ROM in these patients showed that the knees which received the CPM treatment had 22° more flexion 14 days postsurgery, and 15° more flexion a year post surgery when compared to the knees of the 30 patients in the non-CPM group (7).

Table 1. Medical conditions treated with CPM

Total Knee Replacement	(4,7,10,21,52)
Hand Burns	(9)
Knee Flexion Contractures	(52)
Painful Hemiplegic Shoulder	(5)
Knee Sepsis and Effusion	(5)
Chondromalacia Patellae	(22)
Intraarticular ACL Reconstructions	(31)
Intraarticular Elbow Fractures	(22)
Intraarticular Knee Fractures	(22)
Intraarticular Ankle Fractures	(22)

Davis (10) compared a group of patients (n=9) who used CPM for at least 18 hours a day, with another group of patients (n=20) who had been immobilized for 48 hours after a total knee replacement. The CPM group differed significantly from the non-CPM patients in their ability to ambulate earlier, perform a straight leg raise earlier, and attain a greater increase in the active range of motion on the seventh postoperative day. An increase in the amount of suction drainage also was noted in the CPM group (10).

Two individual case studies have reported improvement in patient range of motion through CPM use (5,47). Stap and Woodfin (47) reported successful treatment of a patient with a severe flexion contracture of the knee. Initially, their patient was treated with CPM for six hours a day for three weeks and gained 40° of motion (47). The use of the CPM was then reduced to three hours a day for four weeks and the patient gained an additional 13° of movement, leading the authors to conclude that CPM usage may be beneficial in the treatment of flexion contracture (47). In another case study, Bohannon (5) discussed the use of CPM in the treatment of a patient with a septic knee. In this case, CPM was applied whenever the patient was in bed. After nine days of CPM, the patient made gains of 26° of active range of motion and 21° of passive range of motion (5).

Noyes et al. (31) reported that CPM following open and arthroscopic anterior cruciate ligament (ACL) reconstruction did not cause the ACL reconstructions to stretch out, when evaluated 12 months postsurgery. They employed immediate range of motion following ACL reconstruction through an arc of 0 to 90° of flexion. These authors suggested that the use of CPM can help avoid problems of postoperative stiffness and the lack of knee extension, which in turn would significantly lessen the complications associated with intraarticular ACL reconstruction.

Duration of Treatment

In the initial years of CPM use, passive motion was measured by duration (4,7). Numerous researchers have reported the effectiveness of CPM at various durations of treatment per day and have compared the effectiveness of fixed durations of treatment (4,5,6,7,10,21,47,48). Durations of longer than 16 hours have been reported in postsurgical management (6,7,10) and durations of less than six hours have been reported when CPM is used in addition to other treatment

protocols (5,21,47). It has been recommended that CPM be used whenever the patient is in bed (5).

Gose (21) reported that patients receiving CPM one hour, three times a day, have a shorter postoperative hospital stay ($p<.001$) and fewer complications ($p<.05$) following total knee replacement (TKR) than patients not receiving CPM . Basso and Knapp (4) reported comparable results when using CPM either 20 hours a day, or five hours a day, for patients who received a TKR. Shimizu et al. (45) and Mooney (48) suggested that immediate motion was far better than delayed motion, and also stated that eight hours of CPM per day was as good as 24 hours. A difference was seen in the repair of articular cartilage between CPM of eight hours and CPM at two and four hours in rabbit knees (45).

Delay of Treatment

Postsurgically, CPM devices have been applied in the recovery room (6,7), while others have adopted a delayed application policy (52). Researchers (45,48) have suggested that immediate motion was far better than delayed motion. Shimizu et al. (45) reported that CPM performed following one week of immobilization was not effective in protecting articular cartilage against, or reversing the harmful effects of, immobilization.

Noyes et al. (30) examined early knee motion with CPM following open and arthroscopic anterior cruciate ligament reconstruction. The authors noted that with CPM initiated on the second postoperative day, there was no increase in joint effusion, hemarthrosis, or soft tissue swelling. Young and Kroll (52) investigated the effectiveness of CPM following a delay of CPM application until the third postoperative day. These authors concluded that the delayed application of CPM postoperatively did not result in a significant difference compared to conventional therapy.

Speed of Motion

Continuous passive motion should be applied through an adequate range of motion without causing distress (5). The speed of movement through the range of motion should be based on patient comfort and the desired number of repetitions in a unit of time (5). Salter (40) concluded that the ideal frequency of repetition is one cycle every 45 seconds, based upon both laboratory and clinical research. Additional studies are required to quantify the clinical effects and the dose-responsiveness of the different CPM treatment regimens.

Rationale

Frank et al. (16) postulated that CPM represents a clinical application of Wolff's law of bone remodeling to soft tissue. Briefly defined, Wolff's law states that the internal and external architecture of bone is directly related to the mechanical stresses placed on that bone, i.e., "form follows function." Forrester et al. (15) reported that healing skin wounds in rats appear to respond as does bone to Wolff's law. The rats' collagenous architecture responded to functional demands with collagen fibers that are better aligned, more "mature," and of a higher tensile strength (15).

In canine studies of healing flexor tendons, researchers compared range of motion after treatment with immobilization and controlled passive motion (17,18,19,20,50). Woo et al. (50) observed that controlled passive motion developed significantly greater tensile strength ($p<.001$) in canine flexor superficialis tendons. Gelberman et al. (18,20) observed an improved gliding surface in tendons treated with controlled passive motion. Other studies have reported that healing canine flexor tendons subjected to passive motion demonstrated a higher DNA content ($p<.05$) (17) and increased tendon excursion (18), and described improved vascularity (17,19) and a repair process that differed from the repair process in immobilized healing flexor tendons (20).

The soft-tissue corollary of Wolff's law implies that healing soft tissue (collagen) will be laid down in a pattern dictated by the stresses imposed upon it, i.e., along the lines of stress (16). If the soft tissue is not stressed, as occurs during immobilization, newly-formed tissue will be laid down in a disorganized fashion. To optimize the appropriate pattern of newly organized tissue, continued stress in the form of passive motion is of benefit (16).

The success of CPM lies in its ability to move a joint with relatively little pain (46). The explanation for this phenomenon may be related to the gate control theory of pain that has been proposed by Melzack and Wall (27). The modulation of the sensory input that CPM generates by moving the knee joint may bring pain relief (27). Harris (23) suggested that stretching is the best stimulus for obtaining relaxation of a given muscle or muscle group. Passive range of motion exercises may assist in maintaining the normal stretch receptor sensitivity by preserving normal elasticity of the intrafusal muscle fibers on which the stretch receptors are maintained (23).

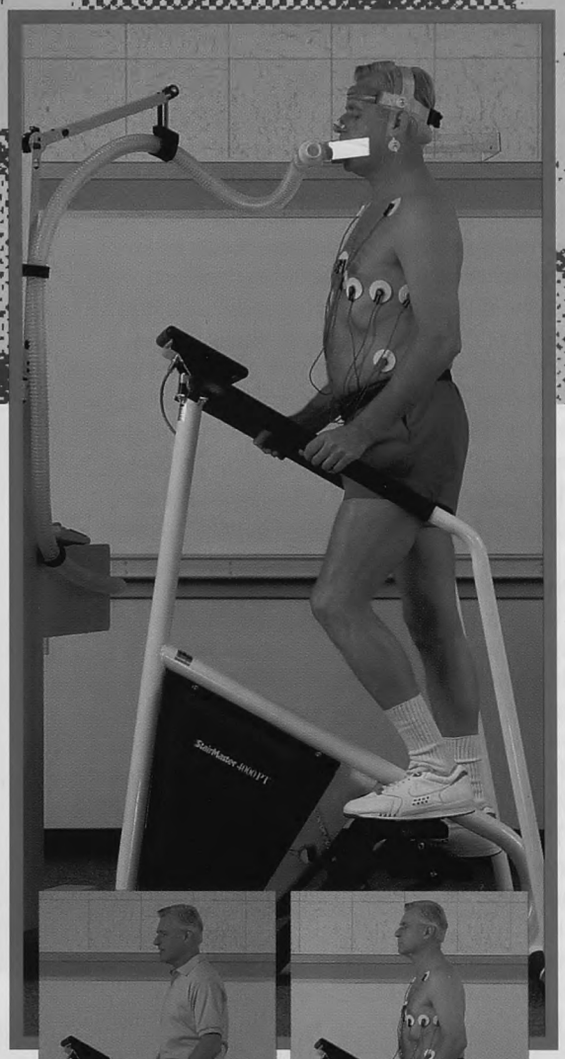
The rhythmic joint movements of CPM protocols also retard the pain-spasm reflex (16). Harris (23) theorized that these movements exerted a more direct effect on pain feedback loops, perhaps by competitive interference and alleviation of pain perception at its source. This may account for patients' common subjective perceptions of decreased pain with increases in ROM during CPM therapy (16,42).

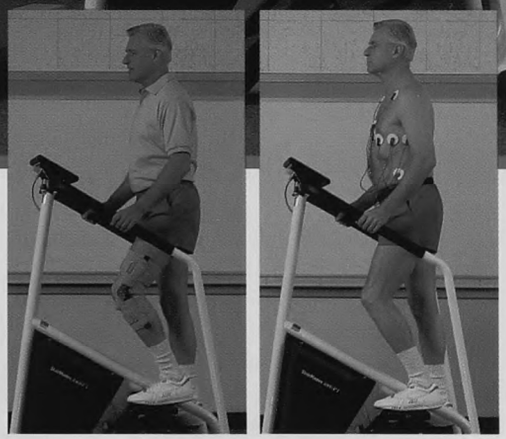
THE IMPLICATIONS OF CPM FOR ATHLETIC TRAINERS

Immobilization of the knee impairs the normal function of the synovial membrane (40). In rabbits (1,2,3) and humans (14), joint contracture, or the stiffening of a joint, takes place as a result of the changes in both the intra- and extraarticular structures of a joint, secondary to immobilization. With immobilization, the fibrofatty tissue proliferates within the joint and forms adhesions as it matures into scar tissue (14).

Enneking and Horowitz (14) observed changes within the knee secondary to prolonged immobilization. In the area of cartilaginous contact, hyaline cartilage cells die and the articular surface breaks down. With continued immobilization, the ligament insertions are weakened as the mineral salts are resorbed (14). The decrease in the water and the glycosaminoglycon content allows closer contact between the collagen fibrils, impairing their normal gliding properties. Thus, the chemical and the mechanical changes make the injured joint stiffer and lead to a joint contracture (1,2,3,11,14,29,31).

The use of CPM could reduce the duration of recovery and decrease the joint stiffness that may be encountered during immobilization of many sports-related injuries (38). Continuous passive motion has been widely prescribed following





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numerous surgical procedures and conditions that are commonly seen in athletics. These include: following an ACL reconstruction; allowing motion in a safe and specific range; assisting in maintaining range of motion following injury to soft tissues surrounding a joint; following an arthroscopic lateral release; following the manipulation of a knee; following fixation of intraarticular or extraarticular fractures of the tibia or femur; following operative procedures on the knee extensor mechanism, when active motion is contraindicated; and allowing movement of a joint with relatively little pain (38).

A physician's prescription is typically required for a certified athletic trainer to treat athletic injuries with the use of CPM. Further, the application of CPM by an athletic trainer is dependent upon individual state regulations governing the practices of physical therapy and athletic training. In some cases, the athletic trainer may have an athlete who is receiving CPM from another allied health professional, and the athletic trainer should be aware of this circumstance in order to observe the effect of CPM on the rehabilitating athlete.

The potential advantage of CPM following surgery is in obtaining an early functional range of motion. Continuous passive motion is generally well tolerated, postoperatively, as perception of pain is diminished (16,42). Overall, the use of CPM as an alternative to immobilization and as a postoperative adjunct to rehabilitation appears advantageous.

CONCLUSION

The use of continuous passive motion is increasing in the treatment of orthopaedic problems. Since Nickel's initial application of CPM, the use of CPM following total knee replacement surgery and the variety of conditions treated has grown with the number and variety of CPM devices available. Today, the majority of devices are designed to treat the knee, but other joints are receiving increased attention.

The debate between the use of motion or immobilization is long-standing. This debate will be settled by continued research into the effects of immobilization and motion on healing. The study of immobilization has revealed undesirable effects. The advent of CPM may provide the answers to reduce the ill effects of immobilization.

The clinical investigations of the use of CPM have yielded promising results. The focus of the research upon the parameters of CPM treatment has been limited to the onset of application and the duration of treatment. There is a clear need for more extensive examination of the parameters of CPM treatment.

Athletic trainers should be well-informed about CPM and its potential use in the treatment of athletic injuries. The expanded application of CPM, to include use by athletic trainers in traditional settings, will depend upon the findings of future research, the perspective of the team physician, and the state regulations governing the practice of athletic training.

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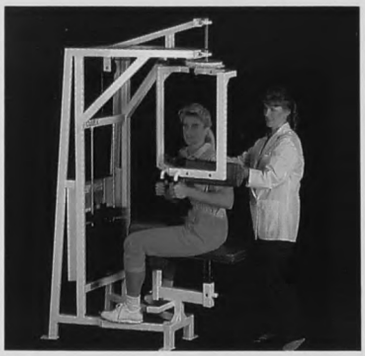

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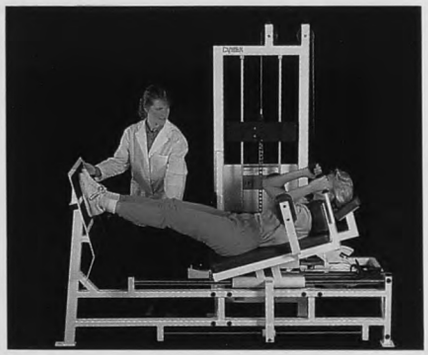

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CEU Credit Quiz

Clinical Use of Continuous Passive Motion in Athletic Training

Patrick C. O'Donoghue, MS, ATC • Michael R. McCarthy, EdD, ATC, PT
Joe H. Gieck, EdD, ATC, PT • Carlin K. Yates, MD

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Questions	a	b	c	d	e
1. Which of the following are potential advantages of early motion after injury? a. application of controlled forces on healing collagen tissue b. maintenance of articular cartilage nutrition c. reduction of disuse effects d. retardation of capsular contracture e. all of the above					
2. Continuous passive motion has shown no demonstrable physiologic effects. a. True b. False					
3. Following nonoperative treatment of musculoskeletal injuries, rest is the optimal modality. a. True b. False					
4. Therapeutic continuous passive motion is produced by: a. application of external force b. torque c. intrinsic muscle activity d. electrical stimulation e. cortical control					

	a	b	c	d	e
5. Continuous passive motion provides a low load stretch which has a beneficial effect on: a. collagen remodeling b. systemic tone c. joint dynamics d. pain reduction e. a, c, and d					
6. The most effective use of continuous passive motion may be: a. facilitation of collagen remodeling b. reduction of pain c. prevention of the negative effects of immobilization d. preservation of joint dynamics e. normalization of systemic tone					
7. Stap and Woodfin reported _____ following treatment with continuous passive motion and concluded that continuous passive motion may, therefore, be beneficial as a treatment modality. a. decreased systemic tone b. increased ACL laxity c. decreased quadriceps strength d. decreased knee flexion contracture e. increased hamstring strength					

	a	b	c	d	e
8. Noyes et al. reported that the use of continuous passive motion after open and arthroscopic ACL reconstruction can help avoid: a. postoperative stiffness b. postoperative pain c. lack of knee extension d. lack of knee flexion e. a and c					
9. Work by Frank et al. suggests that continuous passive motion represents a: a. clinical application of Wolff's law of collagen remodeling b. research application of Wolff's law of collagen remodeling c. clinical application of Wolff's law of bone remodeling to soft tissue d. research application of Wolff's law of bone remodeling to soft tissue e. clinical application of Wolff's law of soft tissue remodeling to bone					
10. The rhythmic movement of continuous passive motion may retard the pain-spasm reflex by exerting a direct effect on pain feedback loops. a. True b. False					

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1. This contest is open to all undergraduate student members of the NATA.

2. The topic of the paper must be germane to the profession of athletic training. It can be a case report, literature review, experimental report, analysis of training room techniques, etc.

3. Entries must not have been published, nor be under consideration for publication, by any journal.

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5. Entrants must submit the paper written in journal manuscript form and must adhere to all regulations set forth in the "Guide for Contributors" section of this issue of *Athletic Training, JNATA*. Before you begin writing, it would be helpful to read: Knight, KL: Tips for scientific/medical writers. *Athletic Training, JNATA* 25:47-50, 1990—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 2, 1992. An announcement of the winner will be made at the NATA Annual Meeting and Clinical Symposium in Denver, CO, in June, 1992.

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A Study of Career Pathways of NATA Curriculum Program Directors

John S. Leard, MEd, PT, ATC
Cynthia "Sam" Booth, MS, ATC
Jay C. Johnson, MS, ATC

ABSTRACT: This study provides information to athletic trainers who may choose to become program directors at some point in their careers. We developed a survey to examine the career pathways of NATA program directors. Questions were developed to reveal the perceptions and opinions of the respondents. Eleven NATA program directors participated in twenty-minute telephone interviews and each answered thirteen questions regarding their positions and career choices. The survey results revealed a high degree of job satisfaction, and referred to possible improvements in the position. Suggested preparation for a career as a program director included a terminal degree and a varied experiential background.

Athletic trainers dealing with student athletic trainers often find themselves discussing students' professional career goals. One possible career choice would be that of an approved NATA curriculum program director. A survey was developed and performed to provide more information to those who may be contemplating this career choice.

The position of program director was developed in the early seventies and has changed considerably over the years. Originally, the head athletic trainer assumed this position in addition to his or her other duties without any precise job description.

As athletic training continued to grow, more institutions became interested in developing athletic training curricula. Better regulation of the programs was needed to uphold the quality of education that the NATA demanded. Therefore, the Professional Education Committee (PEC) of the NATA developed a role delineation of the program director's position.

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Jay Johnson works as an athletic trainer with Delaware Sportscare Physical Therapy, Newark, DE 19713.

The program director must be a member of the teaching faculty of the institution in which the athletic training program is housed. The program director must "have current NATA recognition as a certified athletic trainer and possess a minimum of three years of full-time experience as an NATA certified athletic trainer, including at least one year of full-time experience in the clinical supervision of student athletic trainers" (2,3).

Also, the program director must be involved in athletic training through public speaking engagements, publications, research, and membership in professional organizations. This is not only encouraged by the NATA Professional Education Committee (2,3), but is often required by the institution employing the program director (4).

The program director must serve as an educator, clinician, faculty member, recruiter of students, supervisor of clinical assignments, coordinator of the educational experience, and liaison between the athletic training curriculum and the PEC (2,3). The job has evolved into an administrative position requiring the management of the didactic and clinical domains of the athletic training program.

Little information regarding the role and function of the program director was found in the literature. Sciera (5) attempted to define the role of the program director as that of clinician and educator. Even though the PEC guidelines (2,3) have stipulated the requirements necessary to qualify as a program director, the position is still unique and difficult to define. In addition, no information was found in the literature regarding the career pathways of program directors.

This study researched the career pathways of several program directors of NATA-approved undergraduate and graduate athletic training curriculums. In addition, the authors investigated the reasons that cause people to become program directors. With this information, we hope that potential program directors will be able to make more informed decisions regarding their career choices.

METHOD

Subjects

A sample of program directors (n=11) was asked to participate in this study. Selection was based upon availability,

geographical location, and leadership roles in the profession. An overview of the program directors' backgrounds revealed that the directors' experience at their present institutions ranged from 3 to 20 years with a mean of 10.04 years. Five of 11 program directors were from NATA-approved undergraduate curriculums, while 6 of 11 were from NATA approved graduate curriculums. Ten of the program directors were from NCAA Division I schools, and one was from an NCAA Division II school. Ten males and one female were represented in the study; seven had obtained terminal degrees and four were at the master's degree level. They were given a choice of either a twenty-minute phone call, or two calls lasting ten minutes each. All participants chose a single twenty-minute interview. The telephone interviews took place between September 1989 and January 1990.

RESULTS AND DISCUSSION

The telephone interviewers gathered interesting information from each of the program directors. The following is a summary of answers to the questions.

What led you to become an NATA program director?

Many responded that their love of teaching was the primary reason for becoming a program director. Some were attracted to the research aspect of the job, while others wanted to decrease travel responsibilities and time away from home. Some began as an assistant or head athletic trainer, then became the program director when their school developed a new curriculum.

When did you decide to become a program director?

Several program directors knew while they were in undergraduate or graduate school that they wanted to choose this option; another made the decision after working long-hour days as a clinical athletic trainer. Another program director sought this route because of unanswered professional questions.

What characteristics of the program director's position attracted you?

Teaching students and being able to influence/mold students were common answers to this question. Other aspects mentioned included interacting with students, watching people grow personally and professionally, promoting athletic training, conducting research, doing administrative work, and traveling less.

How did you become the program director for your institution?

Some program directors felt that this question was answered in the first question (i.e., the chair of the department wanted to develop an athletic training program). In addition, "falling into the position" was another common answer given. Others mentioned that the job required assuming the responsibilities of program director when they applied for the position.

What aspects of your present position attracted you?

The move from the undergraduate level to the graduate level attracted one individual to the present position. The transition from an internship program to an NATA-approved curriculum program attracted several others. Other aspects mentioned were the support from athletics, the physical education department, and the medical community; the ability to promote athletic training as a viable educational field; and the ability to work clinically, to teach, and to perform research. Others sought a position of assistant athletic trainer that was combined with the program director's position.

How long do you plan to remain a program director?

Eight of the eleven program directors answered "until retirement," while two answered that they would remain for an average of four more years. One program director, serving as both the head athletic trainer and program director, stated that "the day will come when you cannot do both" and concluded that the duties of head athletic trainer would then be relinquished.

If you decided to relinquish your position as program director, what would be your next position? Why?

When asked this question, all hesitated in answering because they had no desire to relinquish their position as program director. However, when pressed for an answer, they mentioned the following career changes:

- Concentrate on academics and research
- Remain involved as a clinical instructor, because the paperwork load would not be as heavy
- Conduct research in private industry to bolster the family finances
- Move into an administrative position in private industry
- Serve as program director at another institution

What do you consider the optimal pathway to becoming a program director?

This question elicited a variety of answers. Some program directors felt that one should have experience as a student in an athletic training curriculum program, then serve as a curriculum staff member for several years prior to serving as a program director. Several other program directors felt that one should experience an approved curriculum program, pursue a master's degree, and work three to five years before seeking a position as a program director. It also was noted by several program directors that a terminal degree was important for academic respect. One respondent felt that one needs to serve as a head athletic trainer and experience the bureaucracy of athletics and education, then teach at the collegiate level prior to becoming a program director.

What would you consider to be the perfect job for the program director?

This question provoked some idealistic and some realistic responses. Several program directors indicated that a reduced teaching load (one to three classes per year) would allow more laboratory and research involvement. One person felt that teaching and administrative work should comprise 50 percent of one's time, while research and service should comprise the other 50 percent. Another felt that this position should require faculty ranking and tenure for academic recognition. This person felt that the position also should include one sport assignment to help maintain clinical involvement. However, one respondent stated that the perfect job would be a position

where one determined his or her involvement clinically with either one sport or training room supervision, but not both. Another 'perfect" position would be to serve as coordinator/ head athletic trainer with a $50,000 salary and a work day ending at 5:00 p.m. Having a large, well-qualified staff, working with football, then devoting time to curriculum after football season was another "perfect" job described. One program director felt that it was important to have the administrative support of a department chair or a dean who understands the uniqueness of athletic training and knows how clinically oriented it has become important.

Do you think that the program director should be the head athletic trainer?

Six program directors answered "no." They felt that there is too much work involved in both areas to do justice to both. They also felt that there was not enough time to do both. Contrary to this view, several program directors felt that the dual position could work, depending on the situation. One person felt that the dual position would assist in negotiations with budgets because you would have two funding sources, athletics and education.

What are the differences between the roles of the program director and the head athletic trainer?

The majority of the responses indicated that the program director is more academically oriented, while the head athletic trainer is more concerned with athletics. The program director is interested in education in the training room, and in making every practice and game an educational experience, whereas the head athletic trainer might not view the experience in that way. One program director could not really define a "head athletic trainer," and stated that there should not be any conflict.

What are the similarities between the roles of program director and head athletic trainer?

Many stated that both the program director and head athletic trainer should: be involved with the clinical setting, evaluate students, serve as role models for students, and serve as educators. Both should be concerned with the quality of health care delivery. The program director's position and the head athletic trainer's position are both people-oriented jobs. One program director felt that the similarities are diminishing, and the differences are growing. This director felt the educational goals are diminishing, that athletics is affecting that decline, and that athletics is too "business-oriented."

CONCLUSION

Over the past 22 years, since the first NATA-approved program was established (1), the role of the program director has changed dramatically and so have the career pathways. The Professional Education Committee of the NATA, through its guidelines and supervision of programs, has increased the program director's administrative role. Institutional expectations of the program director have changed. In order to receive tenure, more program directors have completed, or are working toward, a terminal degree. An increased number of program directors are spending more time with academic pursuits and less in the athletic arena. For those interested in pursuing a career as a program director, this article should provide enlightenment into the various backgrounds, challenges, and benefits of this position. This study indicates a high degree of career satisfaction and identifies aspects of the position that would make it even better. Suggested preparation for a career as a program director includes a terminal degree and a varied experiential background.

Be aware there is no right or wrong way to become a program director. Our survey found a variety of career routes to this position that we believe are the result of growth of the position. Job pathways often were determined by circumstances rather than planning. This study made an effort to define who the program directors are and what pathways they have taken to their positions.

ACKNOWLEDGEMENTS

We wish to thank Dr. Robert Behnke, NATA Professional Education Committee Chairman, and Dr. Dana Brooks, Associate Dean of the School of Physical Education, West Virginia University, for their assistance in this study.

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"T-Band Kicks" Ankle Proprioception Program

Donald Tomaszewski, MS, ATC

ABSTRACT: Reestablishing proprioception is an essential component of injury rehabilitation. There are numerous devices and techniques for training ankle proprioception. With the exercises outlined in this article, Theraband™ rubber tubing can be a proprioception modality. It is inexpensive, lightweight, and can be used almost anywhere.

Impairment of proprioceptive coordination is a primary cause of ankle reinjury (4). An ankle sprain not only causes some degree of laxity in the ligaments, but also results in damage to the sensory nerve fibers within the ligaments, capsule, and muscles (4,5,6). These sensory nerve fibers serve reflexes, which help to stabilize the foot during locomotion (3,4). Thus, rehabilitation of ankle injuries should stress proprioceptive function as well as reflex activity of the surrounding muscles.

A functional approach to ankle rehabilitation involves specific activities in all planes of movement, specific muscle functions (balance, acceleration, deceleration), and neuromuscular coordination drills (3,5). The "Four Square" ankle exercise program explained by Toomey (7) and the "Ankle Disk" exercise program explained by Cooper and Fair (2) are examples of functional activities that stimulate sensory feedback and motor response in the lower extremity. There are various devices, such as balance boards and slide boards, that can be used to stimulate proprioceptive pathways in the lower extremity (1). This tip explains how Theraband™ latex rubber can be used in such a way as to stimulate neuromuscular reflex activity of surrounding ankle muscles. The following is an explanation of the "T-Band Kicks" ankle proprioception program.

PATIENT POSITIONING

Attach about three feet of Theraband rubber around the leg of a treatment table and tie off a loop with a square knot (Figure 1). The patient places the uninjured foot through the Theraband loop and moves into a position that puts the Theraband under tension, but does not inhibit static balance. The injured foot is firmly planted on the floor, parallel to the other foot (Figure 2). The patient then kicks forward and backward using quick and short oscillations. The kicking action creates a changing center of gravity of the body. The proprioceptors around the injured ankle are stimulated by these changes (4). In response to the proprioceptive input, the muscles around the injured ankle contract and relax to maintain the balance of the body over one foot.

Figure 1. Theraband tied to the table leg

This exercise is performed in four positions. The first position involves kicking away from the table leg. In the second, the patient kicks perpendicular to the table leg (Figure 3). In the third position, kicking is performed perpendicular to the table leg, while facing in the opposite direction (Figure 4). Notice that in this position, the Theraband loop is kept in front of the injured foot. In the fourth position, the patient kicks toward the table leg (Figure 5) making sure that the Theraband loop remains taut. In each position, the knee of the injured leg must be kept in slight flexion in order to use the proper segmental alignment for maintaining balance.

Donald Tomaszewski is Assistant Coordinator of the Valley Hospital Sports Institute, Ridgewood, NJ 07450.

Figure 2. The injured foot is planted on the floor, while the patient kicks with the uninjured foot.

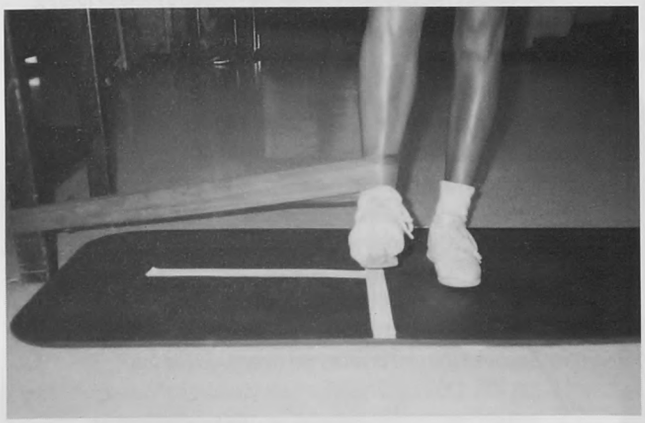

Figure 3. Position #2 - Kicking perpendicular to the table leg

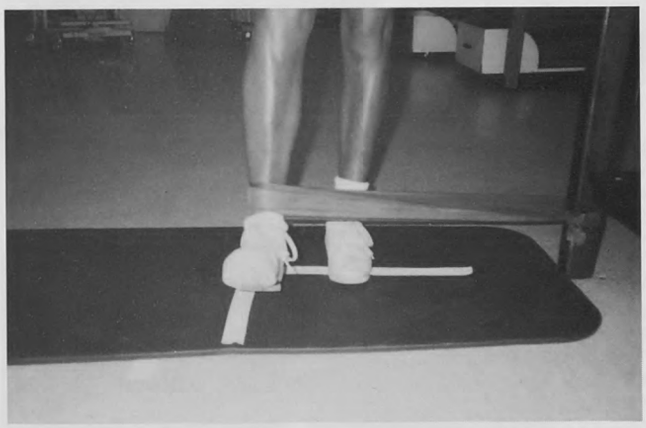

Figure 4. Position #3 - Kicking perpendicular to the table leg, while facing the opposite direction

To provide more proprioceptive stimuli, the patient performs all four positions with his or her eyes closed. Another variation would be to kick diagonally to the left and right of each position (Figure 6).

PROGRAM VARIABLES

The "T-Band Kicks" program variables should be set according to the patient's stage of rehabilitation, and should be modified as the patient progresses.

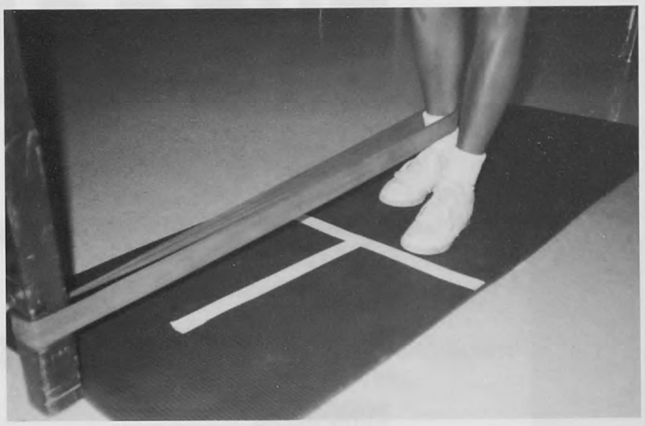

Figure 5. Position #4 - Kicking toward the table leg

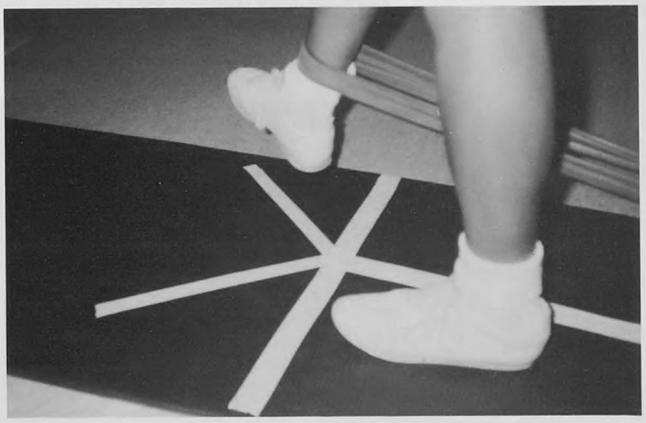

Figure 6. Variation - Kicking diagonally to the right

Criteria to Begin

The patient should be full weight bearing and able to balance on the injured foot for at least 30 seconds.

Repetitions

In the early stages of rehabilitation, the patient should perform one set of 10 repetitions in each of the four positions, and in later stages, progress to one set of 50 repetitions in each position.

Resistance

When the patient can perform 50 repetitions in each position with a low resistance Theraband, he or she should progress to a higher resistance. The Theraband resistance progression, from lowest to highest, is: yellow, red, green, blue, black, grey. If all six Theraband colors are not available, the patient should move to a position that puts greater stretch on the Theraband, or should use an additional loop to increase the level of resistance.

Frequency

The program should be performed daily in conjunction with other components of the individual rehabilitation program.

Once an athlete is able to return to full activity, an ankle maintenance program should be initiated with emphasis placed

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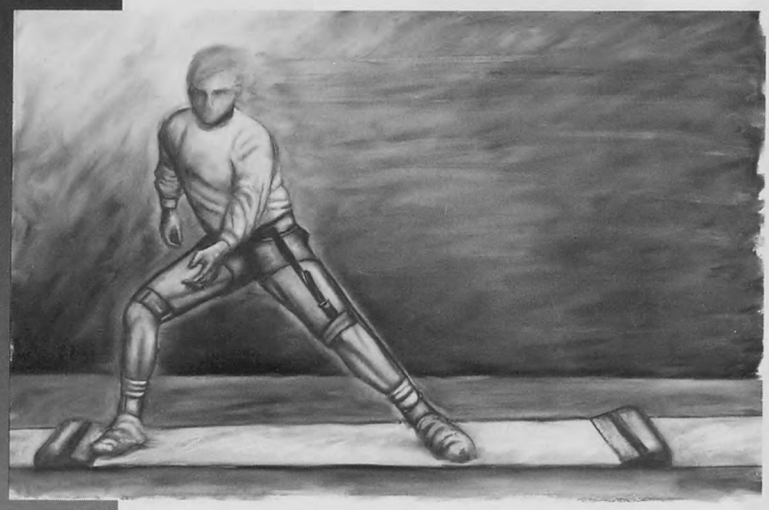

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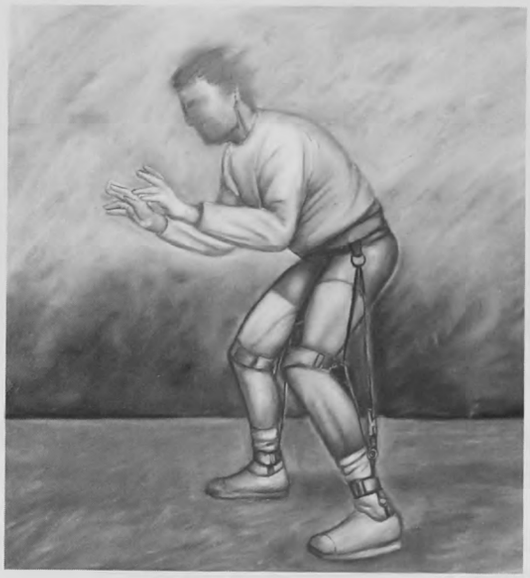

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on functional proprioceptive activities (5). Proprioceptive exercises such as the "T-Band Kicks" program can be performed regularly, before or after practices. They require only minimal equipment, space, and time.

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Treatment of the Inversion Ankle Sprain Through Synchronous Application of Focal Compression and Cold

Gary B. Wilkerson, EdD, ATC

ABSTRACT: Following an inversion ankle sprain, edema may contribute to prolonged functional impairment. Rapid restoration to a high level of ankle function may be accomplished through the early initiation of therapy that controls edema and suppresses the inflammatory response to injury. Assuming that damaged ligaments are adequately protected from excessive tensile stress, early use of the injured ankle may greatly increase the rate of recovery of pre-injury function. The theoretical basis for this aggressive approach to ankle sprain management, a review of pertinent literature, and a case history are presented. Control of edema around the periphery of the fibular malleolus certainly appears to facilitate a rapid recovery. The therapeutic techniques described may also enhance ankle ligament healing, and thereby decrease susceptibility to chronic functional impairment.

The inversion ankle sprain, which results in varying degrees of injury to the components of the lateral ankle ligament complex, is one of the most common athletic injuries. Despite general agreement among practitioners that neglected ankle sprains often result in chronic functional disability, the literature contains little specific information concerning therapeutic measures that optimize ankle ligament healing. Several authors have suggested that the ankle is one of the most poorly understood and inadequately treated sites of injury (8,31, 47,51,60,69). Probably the most common approach to ankle sprain management consists of the application of an elastic wrap, periodic application of cold, avoidance of weight bearing for several days, and gradual resumption of use. This approach often fails to produce good results, and re-injury of the affected ankle is common.

The clinical management of ankle ligament injuries should be based on a thorough understanding of the physiology of connective tissue repair. Unfortunately, ligament healing is a complex process that has been inadequately studied and is therefore poorly understood (2). There is a tendency to think of the healing process in strictly positive terms, but it has many negative aspects (76). The goals of a treatment program should be: 1) modification of the negative effects of the healing process, and 2) facilitation of the positive aspects that lead to ligament repair.

The healing process has been divided into three distinct phases, which vary in duration depending on the nature and extent of the injury (18). The initial "inflammatory phase" is characterized by pain, edema, redness, and heat. Before the inflammatory phase has ended, a "repair phase," characterized by proliferation of fibroblasts and a high rate of collagen synthesis, begins. A prolonged "remodeling phase" begins as the newly synthesized collagen is organized and integrated into the ligament substance.

INFLAMMATORY PHASE - IMMEDIATE CARE

The body's inflammatory response is a non-specific reaction to tissue damage that is initiated by the release of chemical mediators from the lysosomes of damaged cells. With disease or infection, this response may have the positive effect of inactivating or isolating a noxious agent; however, the inflammatory response appears to have few beneficial effects in the case of joint trauma, and it delays ligament repair (26, 28, 76). The inflammatory phase usually lasts for 24 to 72 hours, but may persist for up to 7 days (2).

Although the combination of ice, compression, and elevation is widely recognized as the standard treatment for ankle sprains during the inflammatory phase, the mode of application varies. A thorough understanding of the mechanisms by which cold, compression, and elevation modify the inflammatory response is essential for optimal results.

Edema affects the rate and possibly the extent of ligament healing. Therefore, edema control should be the primary objective of early treatment (6,27,58). Although direct hemorrhaging into traumatized tissues contributes to swelling, the majority of excess fluid results from the leakage of plasma proteins from undamaged capillaries. Leakage is caused by the action of chemical mediators (e.g., histamine and serotonin) that are released from damaged cells. The combination of hemorrhaging, cell/matrix degeneration, and leakage of plasma proteins produces an osmotic effect that draws fluid out of the capillaries and overloads the lymphatic drainage mechanism

Gary Wilkerson is Director of Sports Medicine Education and Research at Trover Clinic in Madisonville, KY.

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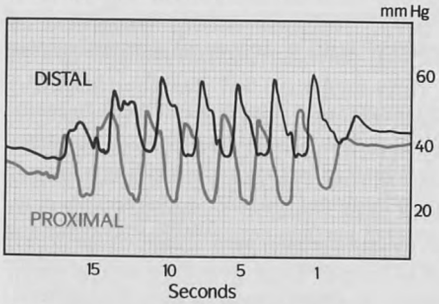

Weight bearing and muscle contraction during walking causes aircell pressure to rhythmically pulsate. This massaging compression is believed to reduce swelling[1,2,5,6,7] and enhance comfort, mobility and healing.

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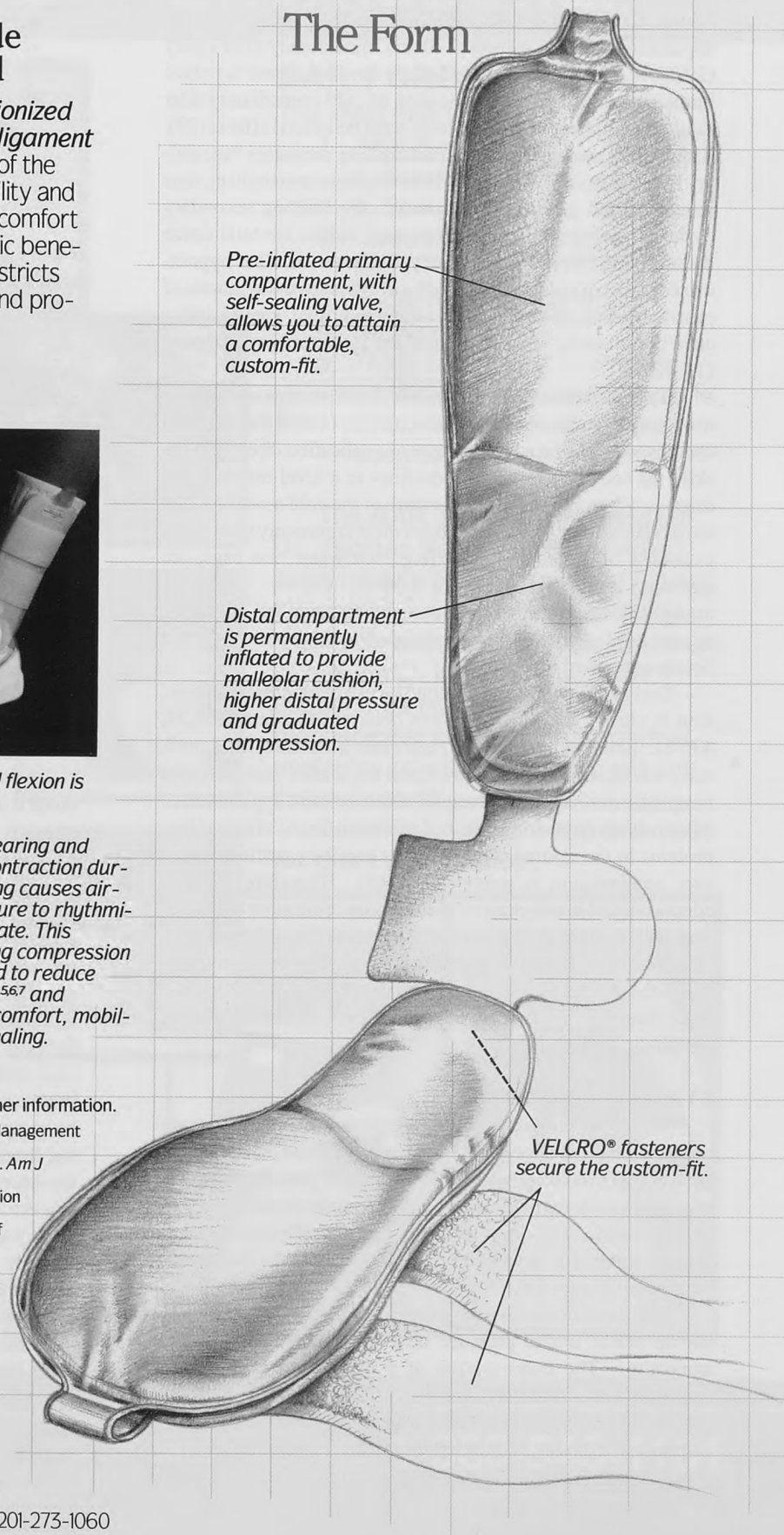

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(12,15,25). In general, the greater the amount of tissue damage, the greater the amount of chemical mediators released from damaged cells (37).

Contrary to popular belief, no scientific evidence supports the theory that cryotherapy reduces edema immediately after injury. In fact, the results of several studies indicate that cold application actually increases edema immediately after injury (19,33,44,46). Although cryotherapy does not appear to reduce immediate swelling, the application of cold immediately after injury does appear to provide long-term beneficial effects (29). Knight (37) has hypothesized that chilling decreases "secondary hypoxic injury" to cells by lowering their metabolism, thus reducing their oxygen requirement. By limiting secondary hypoxic injury, early cryotherapy may reduce the total tissue damage, and thereby reduce delayed edema. Another hypothesized effect of cold application is a decrease in the synthesis of prostaglandins, hormone-like compounds that greatly influence the intensity and duration of the inflammatory response (11, 72).

The exact degree of cold and the duration of its application necessary to realize maximum therapeutic benefit has not been established. Within a few minutes of application directly to the skin, the surface temperature declines to a level that is a few degrees warmer than the temperature of the cold modality. The temperatures of the cold modalities most commonly used in the treatment of athletic injuries (e.g., ice water, ice bags, ice massage) typically range from 0 to 20° Celsius. Although many different cryotherapy protocols are used, the 20- to 30-minute cold application recommended by McMaster (45) has become standard.

Early application and continuous use of external compression is clearly the most effective deterrent to edema (17,37, 43,71). External compression increases interstitial fluid pressure, which decreases outflow from capillaries and increases lymphatic drainage. The benefit of intermittent application of compression is questionable, because the osmotic effect of free proteins in the injured tissues causes capillary outflow whenever compression is removed (38,43). Therefore, optimal edema control is achieved by maintaining continuous compression on the injured tissues until the excess free proteins have been removed by the lymphatic system. Elevation complements the effects of compression by decreasing the hydrostatic force that contributes to capillary outflow, and by enhancing lymphatic drainage (38).

TYPES OF COMPRESSION

The effect produced by compression depends on the manner in which it is applied (55). Circumferential compression, such as that produced by an elastic wrap or a pneumatic sleeve, provides a uniform pressure around the entire circumference of the extremity. The cross-section of a circumferentially compressed extremity tends to remain circular, but its diameter is decreased (Figure 1a).

Collateral compression, such as that produced by an ankle stirrup brace, exerts pressure only against the sides of the extremity. The cross-section of a collaterally compressed extremity tends to deform from a circular to a more elliptical configuration, as the soft tissues are compacted between the compressive device and underlying bone (Figure 1b).

The pressure exerted between a compressive device and

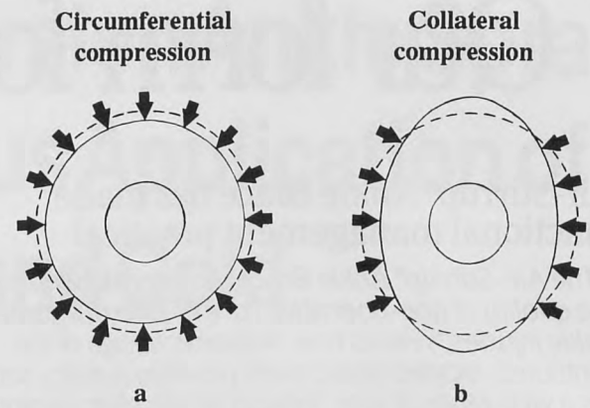

Figure 1. Cross-section of a cylindrical limb subjected to: a) circumferential compression, and b) collateral compression

the external surface of the body may be uniform or variable. For example, an elastic wrap can be applied in a manner that produces variable pressure longitudinally, while the pressure will be uniform circumferentially. Centripetal compression refers to the application of pressure to an extremity in a graduated manner, such that the level of pressure is greatest distally and least proximally (68). The extent to which collateral compression produces a centripetal effect depends upon the three-dimensional configuration of the compressive device.

Focal compression consists of pressure application to surface concavities, while adjacent proximal convex bony prominences are left uncompressed. This technique greatly increases the centripetal effect of collateral compression. An example of focal compression is the application of a U-shaped pad around the periphery of the fibular malleolus. Alone, a U-pad does not produce pressure. A wrap applied over the U-pad holds it in position and applies pressure to its external surface, which it transmits to the concave body surface. Thus, focal compression is combined with a degree of circumferential compression.

Circumferential compression is most effective in reducing edema when it is applied in a centripetal manner to a cylindrical segment of a limb. It is least effective in controlling edema in areas that have irregular contours (34,42). As edema develops within soft tissues, normal surface concavities disappear and the skin "balloons" outward. Under normal conditions, surface concavities are created by negative (i.e., sub-atmospheric) pressure within the tissues, which causes their solid elements to be compacted upon themselves (Figure 2a). When the interstitial fluid volume increases to about 30 percent above normal, the interstitial fluid pressure equals atmospheric pressure (26) (Figure 2b). As further edema develops, it exerts an increasingly positive omnivectorial pressure that distends the overlying skin and causes the tissue elements to be separated from each other by fluid (Figure 2c). This effect may be particularly pronounced in the case of tissues that normally adhere tightly to an underlying bony concavity. The anterior talofibular ligament, the ankle ligament most frequently damaged by excessive inversion of the foot, is normally compacted against the concavity created by the sunken neck of the talus. Because the anterior talofibular ligament is confluent with the antero-lateral capsule of the ankle joint, the accumulation of fluid within the capsule

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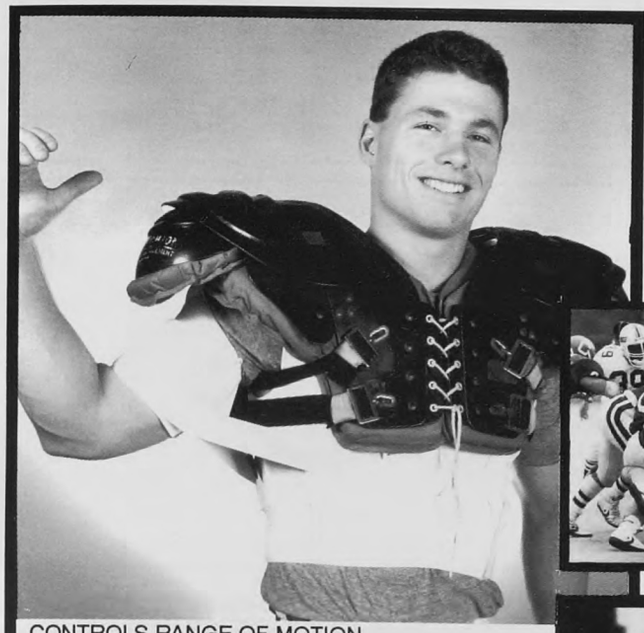

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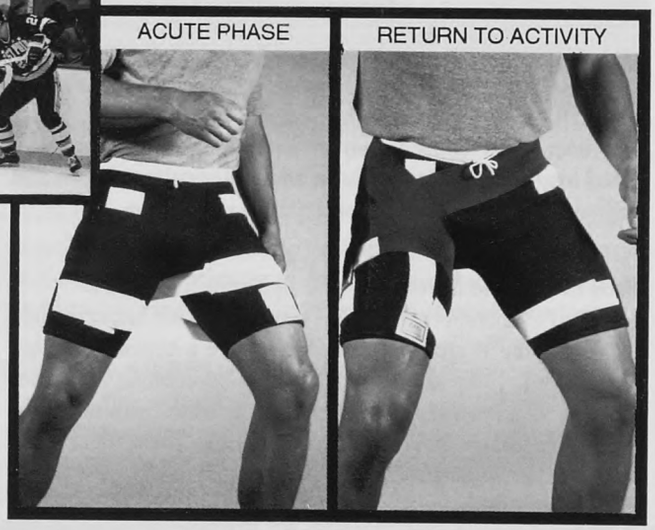

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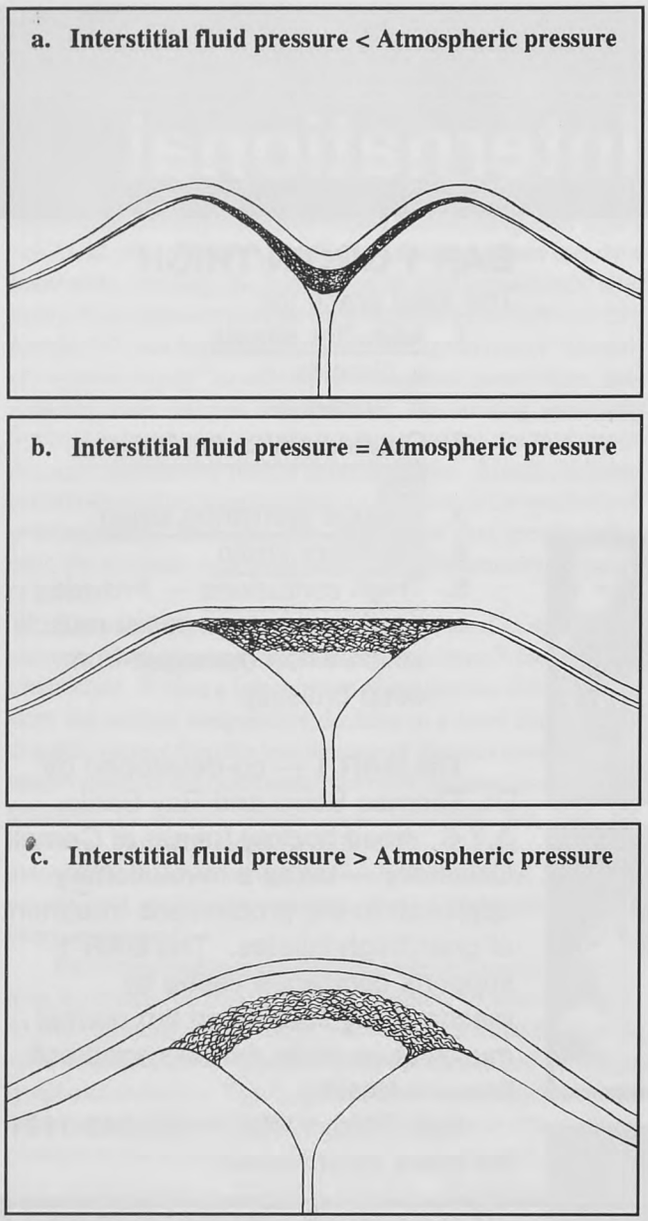


Figure 2. Effects produced by changes in interstitial fluid pressure: a) compaction of soft tissue elements against bony concavity when negative, b) absence of surface concavity and decreased compaction of soft tissue elements when equal to atmospheric pressure, and c) distention of skin and distraction of soft tissue elements when positive

tends to separate the ends of torn ligament fibers (35).

Uniform compression will not prevent or disperse fluid accumulation in areas that normally have a concave contour (Figure 3a). The solid elements of non-edematous tissues adjacent to an "edema pocket" resist the movement of excess fluid. This resistance is increased by the application of uniform compression, which compacts the solid tissue elements near a concave edematous area. Under such circumstances, the tissue elements within the edematous area still will be separated by fluid, and the interstitial fluid pressure within the edema pocket may rise to a level that causes collapse of lymphatic vessels and capillaries (5). Fluid stasis within the concave area will increase the tendency for coagulation of proteins, which further impedes lymphatic drainage.

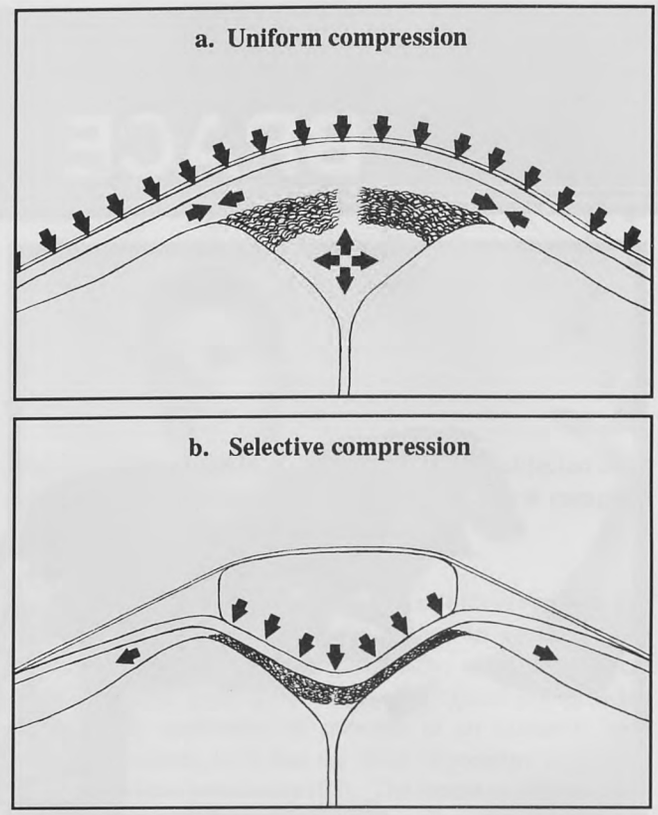
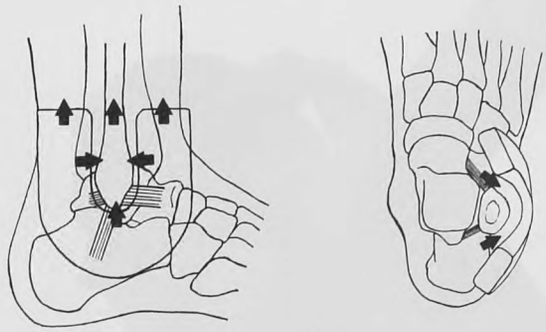


Figure 3. Effects produced by the application of external compression over an edematous area that normally has a concave surface contour: a) uniform compression, and b) focal compression

Focal compression over the surface concavities of an injured limb inhibits fluid accumulation within them, and greatly enhances edema resolution. Soft tissue elements beneath the compressed area are compacted, as excess fluid is translocated to adjacent non-compressed tissue spaces where pressure is lower and resistance to fluid movement is minimal (Figure 3b). A U-shaped felt or foam rubber pad, held in position against the lateral aspect of the ankle beneath adhesive tape or an elastic wrap, "fills" the concavities around the fibular malleolus, and thereby inhibits fluid accumulation within the spaces that surround the lateral ankle ligaments (4,7,9, 40,54,61,69,73). The non-compressed area over the fibular malleolus serves as a drainage channel that facilitates proximal translocation of edema (Figure 4), which greatly enhances its resolution by increasing the number of lymphatics involved with its removal (38,50).

Compaction of the soft tissue elements within an area that normally has a concave surface may enhance the nutritive state of the damaged tissues (68). Intraligamentous blood vessels are relatively sparse, and midsubstance cellular nutrition normally depends upon some degree of diffusion from capillaries into surrounding tissues (2). Secondary hypoxic injury may result from rupture and subsequent thrombosis of tenuous vascular connections within and around the ankle ligaments. Edema may compound this problem by greatly increasing the distance between the capillaries and the hypoxic cells (37). Compaction of the soft tissues would improve perfusion of the hypoxic tissues, if the pressure exerted against the blood vessels does not impede the local micro-circulation.



a b

Figure 4. Direction of edema translocation produced by the application of a U-shaped pad around the periphery of the fibular malleolus: a) lateral view, and b) superior view

The uniform circumferential compression produced by an elastic wrap or pneumatic sleeve can produce a tourniquet effect if its magnitude exceeds a critical level (30,56,63,64). Yagamuchi et al. (75) studied the effect of uniform compression on gross circulation in the legs of rabbits and humans. They found a significant reduction in peripheral circulation at 70 mmHg, but not at 30 mmHg. The minimum level of continuous compression necessary to prevent edema has not been clearly established, and it may vary among individuals. The findings of Yagamuchi et al. suggest that 30 mmHg may be an optimum level and that continuous pressure of more than 70 mmHg should be avoided.

Duffley and Knight (17) studied the variability in compression that resulted from repeated applications of various devices to human ankles by different athletic trainers. They found significant differences among devices, among athletic trainers, and among repeated applications of a given device by a given athletic trainer. The pressure exerted by an elastic wrap against the antero-lateral aspect of the ankle was found to range from 27 to 94 mmHg. The pressure exerted by a U-shaped foam pad beneath an elastic wrap was not found to be significantly different from that exerted by an elastic wrap alone. The least variability in pressure measurements was found for a pneumatic stirrup brace (Air-Stirrup, Aircast, Inc. Summit, NJ 07901), which produced pressure that ranged from 29 to 50 mmHg.

No studies have compared the effects of collateral compression on peripheral circulation with those of circumferential compression. In the case of an injured ankle, the collateral compression of a stirrup brace probably presents less risk of circulatory impairment than the circumferential compression of an elastic wrap. Because a stirrup brace does not compress the anterior and posterior surfaces of the leg, restriction of gross circulation to and from the foot seems unlikely. An additional advantage offered by a pneumatic stirrup brace is rhythmical variation in the pressure exerted on the sides of the leg during ambulation, which may facilitate lymphatic drainage. Stover (62) reported that the pressure exerted by the Aircast Air-Stirrup Ankle Brace is 25 mmHg at rest, 50 mmHg during weightbearing, and 75 mmHg during active dorsiflexion of the ankle.

COLD AND COMPRESSION

In terms of limiting the inflammatory response of damaged connective tissue, the beneficial effects of cryotherapy and external compression appear to be synergistic (59); however, applying cold and compression in a manner that optimizes the benefits of both is difficult to achieve, because the material used to compress the soft tissues also insulates them from externally applied cold. One solution is to use a specially designed U-pad, which consists of a compartmentalized polyurethane cell (Cryo/Strap Aircast, Inc.) (Figure 5). When the liquid in the pad is frozen, a viscous non-freezable liquid in the inner compartments conforms to the concave contours of the ankle, and ice in the outer compartments chills the adjacent layer of non-freezable liquid. To reduce the risk of excessive skin cooling, the frozen device is applied over a cotton sock. An attached elastic strap holds the U-pad against the ankle, and provides circumferential compression to the forefoot. Compression of the tissues beneath the U-pad and those on the medial aspect of the ankle is accomplished through the application of a modified Aircast Air-Stirrup Ankle Brace (i.e., the lateral-distal air cell is removed to accommodate the U-pad).

The pressure exerted against the lateral aspect of the ankle by the integrated Cryo/Strap and modified Air-Stirrup is consistent with that reported by Stover (62) and Duffley and Knight

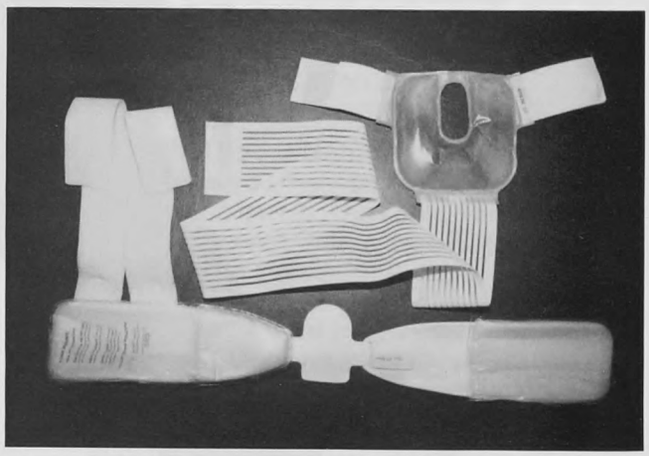


Figure 5. U-shaped liquid filled compression device and modified pneumatic stirrup brace

(17) for the standard Air-Stirrup. Ankle surface temperature beneath the frozen Cryo/Strap has been found to decrease to 16° Celsius within six minutes of application and to remain within the 12 to 16° range for up to 90 minutes after application (1).

REPAIR AND REMODELING PHASES

The distinction between the repair and the remodeling phases of healing is defined by the relationship between collagen synthesis and the tensile strength of the tissue. The rate of collagen synthesis in the damaged tissue rapidly increases during the latter stages of the inflammatory phase, reaching a peak in two to three weeks, and gradually decreasing to a normal rate over a period of several weeks (2). Depending on the severity of the injury, the repair phase may last from 48 hours to six weeks (36).

Although ligament tensile strength is related to collagen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1. R. Murray et al. Med. Sci. Sports Exerc; 19 (6): 597-604, 1987.
2. D.L. Costill. Int J. Sports Med 9: 1-18, 1988.
3. J. Ivy et al. J. Appl. Physiol 64: 1480-1485, 1988.

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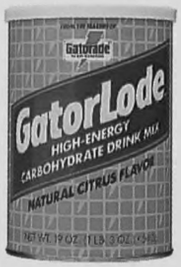

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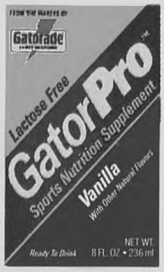

Nutritional Supplement

Although ligament tensile strength is related to collagen content, tensile strength continues to increase for many weeks beyond the point at which collagen content plateaus. During the remodeling phase, tensile strength is enhanced by: 1) an increase in the number of intra- and inter-molecular crosslinks within the collagen, 2) greater interaction between collagen fibrils and the proteoglycans that comprise the ground substance that surrounds them, and 3) a re-orientation of collagen fibrils from a random distribution to a more closely packed and parallel orientation (65). The results of animal experiments suggest that collagen remodeling may continue for as long as six to 12 months (20,48,66).

Very little is known about the specific mechanism by which collagen fibrils are organized into spatial patterns (23,39). A greater than normal rate of collagen degradation appears to play a central role in the remodeling of collagen fibrils within a damaged ligament. In experiments on rabbits, Amiel et al. (3) found that collagen turnover (i.e., synthesis plus degradation) in the medial collateral ligament peaked three to six weeks after the injury and remained elevated for 14 weeks.

Amiel et al. (2) also found that total collagen mass and concentration continued to increase beyond the point at which total dry ligament mass had peaked and had begun to slowly decrease. This suggests that some noncollagenous substances contribute to the total dry ligament mass during the period immediately following injury, and are subsequently removed during the latter stages of healing. The identity of these substances has not been established (16). They may be accumulations of fibrin, plasma proteins, and necrotic tissue debris within the area surrounding the ligament defect. Fibrin deposition within the damaged tissues results when fibrinogen leaks from hyperpermeable capillaries. Fibrin filaments entrap necrotic tissue and form a coagulated mass, the size of which may be influenced by the amount of edema and the extent of secondary tissue death. Limiting the size of this necrotic mass through the early application of cold and focal compression may provide long-term benefits that extend to the repair and remodeling phases.

Akeson et al. (2) emphasized the contribution to ligament healing made by surrounding connective tissues. Compaction of the soft tissues by focal compression may facilitate the chemical interactions associated with ligament repair. The most effective and economical mode of interaction is via intercellular contacts, during which an effector substance is presented to a target cell (57). Tissue compaction may facilitate cell-to-cell, cell-to-matrix, and inter-tissue interactions by decreasing the distance that cells must migrate, or the distance that soluble mediators must diffuse, to reach target cells.

By facilitating lymphatic drainage of excess proteins from the interstitium, focal compression also contributes to the re-establishment of negative tissue pressure. Negative pressure has been referred to as "tissue glue," because its effect causes the tissues to adhere tightly to one another (26).

FUNCTIONAL ACTIVITY

Both the repair and remodeling phases appear to be highly responsive to the opposite effects of stress and stress deprivation (10,74). Activities that subject damaged ligaments to moderate tensile stress appear to enhance collagen content and positively influence the orientation of newly synthesized collagen fibrils (65,66,67). Thus, early initiation of functional activities may serve to merge the repair and remodeling phases, thereby increasing the rate at which an injured ligament regains tensile strength (36).

An important benefit of aggressive edema control is that it permits early initiation of weightbearing activity. Assuming that injured ligaments are protected from further insult, the maintenance of ankle function appears to have numerous beneficial effects on the healing process. Gardner et al. (21) reported the discovery of a powerful "venous pump" in the foot that is activated by weightbearing. They suggested that depression of the longitudinal arch during weightbearing causes longitudinal stretching of the venae comitantes of the lateral plantar artery, which empties the veins. Sudden increases in venous pressure produced by walking may cause a reflux of blood into the venous limbs of closed capillary loops, which opens them, and thereby, facilitates venous osmotic resorption of interstitial fluid. Another possible benefit of sudden increases in venous pressure is the liberation of endothelial derived relaxing factor (EDRF), a substance produced by endothelial cells in the walls of blood vessels. When liberated, EDRF relaxes the smooth muscle of arteriolar resistance vessels, which results in improved tissue perfusion (21). Weightbearing activities also produce a dramatic increase in lymph flow, which is essential for removal of free proteins and re-establishment of negative tissue pressure (26).

Ankle edema and avoidance of weightbearing may act together to impede ligament repair and rapid return to function. When using a "swing-through" crutch gait, there is a natural tendency for the patient to allow the foot to drop into a gravity-dependent position of plantar flexion. When edema occurs within the capsule of the plantar-flexed ankle joint, the normal range of motion is restricted, because dorsiflexion of the foot increases intra-articular pressure and discomfort.

A patient with this condition tends to allow the foot to remain in a plantar-flexed position for a prolonged period, which may result in the development of contractures within the posterior connective tissues of the ankle (i.e., joint capsule and musculotendinous units).

Even after resumption of weightbearing, many patients avoid dorsiflexion during walking by using an abnormal gait characterized by knee flexion and heel elevation.

Several authors have suggested that chronic ankle instability may result from poor apposition of torn ligament fibers during healing (13,14,31,51,61). Trauma to torn ligament fibers may be caused by joint positions that stretch the ligament (60), or by distention of the joint capsule by intra-articular fluid (28,49). The anterior talofibular ligament is confluent with the talocrural joint capsule, and it is stretched by plantar flexion (35). Thus, ankle ligament healing may be optimized through edema control and maintenance of dorsiflexion, both of which contribute to good apposition of torn ligament fibers.

With a normal heel-to-toe gait, dorsiflexion of the foot is maintained and rhythmical variation in the pressure exerted against lymphatic vessels and veins facilitates edema resolution (21, 26). Many patients who are unable to walk with a heel-to-toe gait in an unsupported condition are able to do so when wearing a stirrup brace or tape. If crutches are necessary, a "walk-through" gait should be encouraged. When the patient is unable to dorsiflex the foot to a neutral position, or cannot stand

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without heel elevation, a walking splint that fixes the foot in a neutral position should be used.

In addition to facilitation of edema drainage and maintenance of dorsiflexion, early initiation of activity also minimizes muscle atrophy and loss of proprioception (36). Joint range of motion, muscle strength, and joint proprioception are much easier to maintain than to restore. During weightbearing activity, a complex interaction between static joint structures and dynamic neuromuscular mechanisms controls ankle function and maintains ankle stability. The reflexive neural mechanism that links the static and dynamic stabilizers deteriorates rapidly with inactivity, and a prolonged re-education process may be required for full restoration (53).

The muscles and joints of the ankle and foot function differently in weightbearing and non-weightbearing conditions. During weightbearing, the function of each individual joint is influenced by the function of one or more adjacent joints. This integrated function of adjacent joints is referred to as a "closed kinetic chain." Many of the exercises that have traditionally been used to rehabilitate the functional deficits that result from inactivity are performed in a non-weightbearing or "open kinetic chain" condition. Closed-chain rehabilitative exercises, which duplicate the specific stresses on the ankle ligaments during athletic participation, appear to be essential for optimal restoration of dynamic joint function (36,41). An ankle rehabilitation program that consists primarily of open-chain exercises may leave athletes particularly susceptible to re-injury upon return to athletic activities.

RETURN TO ATHLETIC ACTIVITY

When edema is controlled, progression from walking to straight-ahead jogging, to multi-directional drills, to sport-specific practice drills, to full athletic participation may be made very rapidly. The inherent danger in rapid resumption of highly stressful functional activities, such as jumping, cutting, and pivoting, is the possibility of additional damage to the injured ligaments. Therefore, protection from excessive inversion stress is absolutely essential (32).

Some type of ankle support should be worn as long as discomfort is experienced during normal walking, and whenever the individual is participating in athletic activity. Considerable controversy exists among practitioners concerning the relative effectiveness of various ankle braces and adhesive taping techniques (22,24,52,70). An ankle support system that provides adequate protection during normal daily activities may not be adequate to prevent re-injury during participation in stressful athletic activities. The rate at which an athlete is allowed to progress to highly stressful activities depends on the degree of confidence that the supervising physician and athletic trainer have in the protective effect of a particular brace or taping technique.

Some type of U-pad should be used continuously as long as fluid tends to accumulate around the fibular malleolus. The pad may be removed periodically after the inflammatory phase has subsided. Minimal bulkiness of the U-pad/ankle support system is highly desirable for optimal fit within an athletic shoe. A U-pad constructed from 1/4-inch high-density foam is the least bulky focal compression device (Figure 6). Following activity, the application of a cold-gel U-pad provides simultaneous treatment for post-exercise soreness and swelling.

CASE HISTORY

A 21 year old college football player sustained an inversion sprain to his right ankle when he slipped on a wet stairstep in his

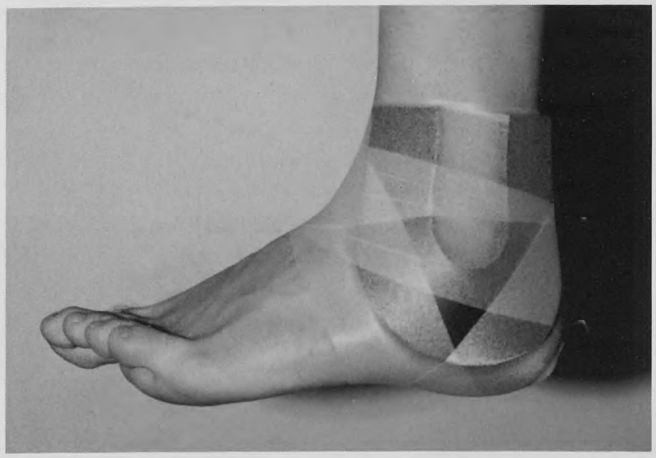

Figure 6. U-shaped foam rubber pad applied beneath tape (for use during athletic activity)

dormitory. Self-administered treatment immediately after the incident consisted of ice pack application for approximately 20 minutes. He then went to the emergency room at a local hospital, where his injury was evaluated by a physician. He was told that his X-rays were normal, and was advised to avoid weightbearing for several days. An elastic wrap was applied and he was given crutches.

The athlete reported to the college training room the next afternoon, approximately 14 hours after the sprain had occurred. He entered with complete dependence on crutches and reported persistent aching pain throughout the previous night.

Significant edema was evident on the lateral aspect of the ankle around the fibular malleolus (Figure 7a). Palpation elicited extreme point tenderness over the anterior talofibular ligament. Active range of motion (ROM) was limited and painful in all directions. Manual inversion stress produced sharp pain, but no lateral instability was evident. The anterior drawer test was negative. Standing with his weight evenly distributed did not produce significant discomfort, but he was reluctant to attempt to walk unsupported. These symptoms warranted classification of the injury as a Grade II (moderate severity) inversion sprain. There was no history of previous injuries to his right ankle.

The athlete was very distressed about such an injury in the middle of the football season, and was highly motivated to return to participation at his fullback position. To facilitate resumption of weightbearing activity, a frozen Cryo/Strap was applied over a cotton sock, followed by a modified Air-Stirrup brace and the athlete's shoe (Figure 8). He was encouraged to use a "walk-through" crutch gait and to bear weight to the greatest extent tolerable. The support provided by the stirrup brace gave the athlete a sense of security that enabled him to bear weight to a much greater extent than when unsupported.

When the athlete reported to the training room on the following day, 36 hours post injury, he was bearing his full weight comfortably and walking with a normal gait. Visual inspection revealed that the Cryo/Strap had dispersed much of the edema proximally, and the contours of the lateral aspect of the ankle had assumed a more normal appearance (Figure 7b).

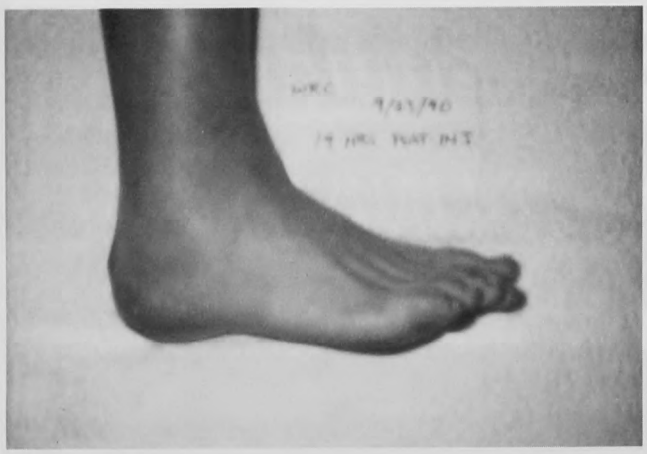

Figure 7a. Post injury appearance of Grade II inversion ankle sprain - 14 hours

Figure 7b. Post injury - 36 hours

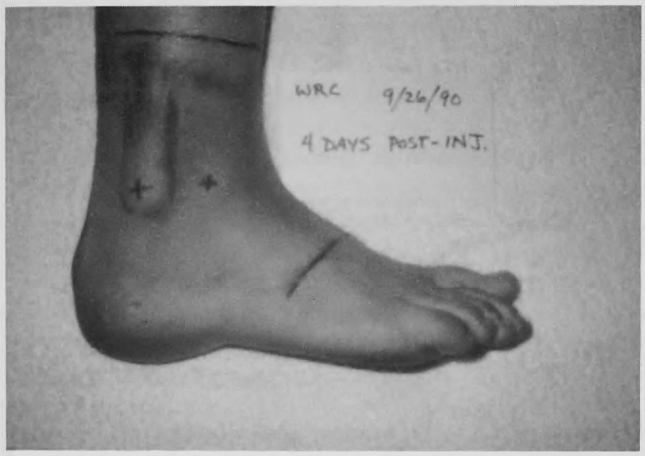

Figure 7c. Post injury - 4 days

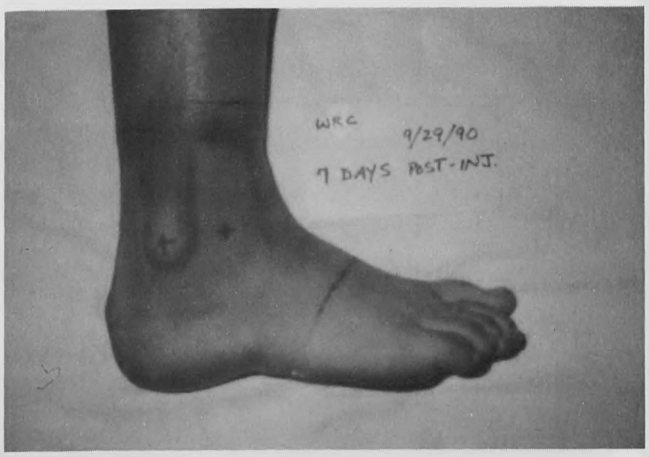

Figure 7d. Post injury - 7 days

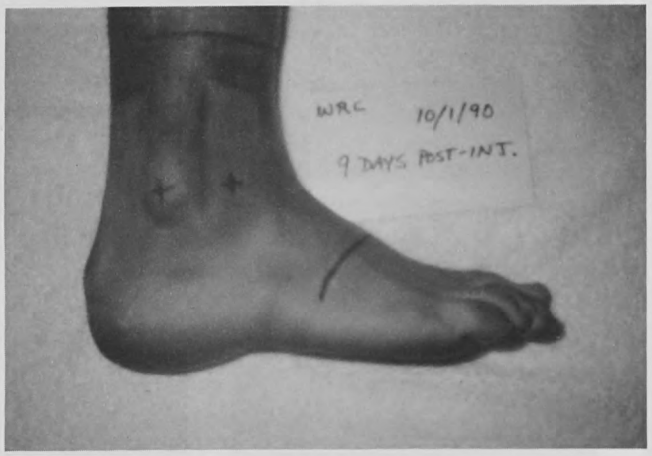

Figure 7e. Post injury - 9 days

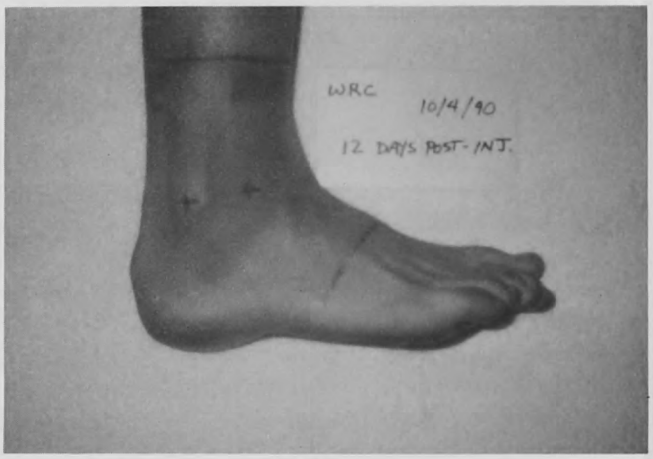

Figure 7f. Post injury - 12 days

A large bulge was evident on the lateral aspect of the leg above the area compressed by the Cryo/Strap, and a slight amount of ecchymosis was evident within the non-compressed channel created by the U-shaped configuration of the device. Plantar flexion and dorsiflexion ROM was normal and painless. No significant difference in muscle strength was discerned between the injured and non-injured extremities when active ankle motions were manually resisted. Therapy consisted of 20 minutes of ice-water immersion, followed by an exercise session of straight-ahead jogging and walking over a distance of approximately 2 miles. During exercise, the ankle was protected by a highly restrictive taping procedure that was applied directly to the skin. A 1/4-inch thick U-shaped foam rubber pad was held in position around the fibular malleolus beneath the tape. Following the exercise session, a frozen Cryo/Strap and modified Air-Stirrup brace were applied to provide cryotherapy, edema control, and ankle support.

On the third post-injury day, increased ecchymosis was evident along the margins of the non-compressed area over the fibular malleolus. Although palpation elicited extreme point tenderness over the anterior talofibular ligament, the athlete's functional capabilities had greatly improved. Pre-exercise

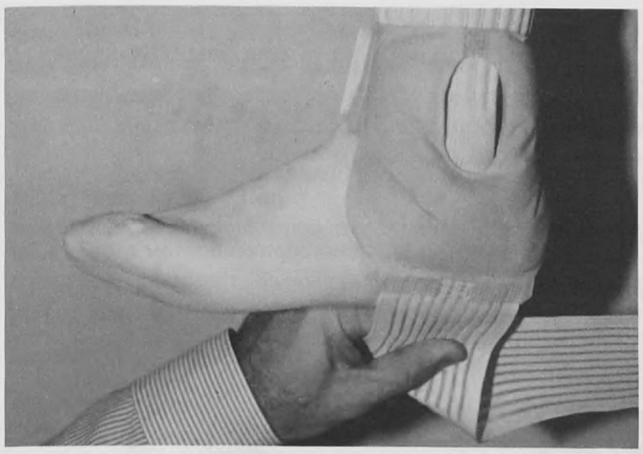

Figure 8a. Application of U-shaped compression device and stirrup brace overlapping leg straps secured on medial aspect

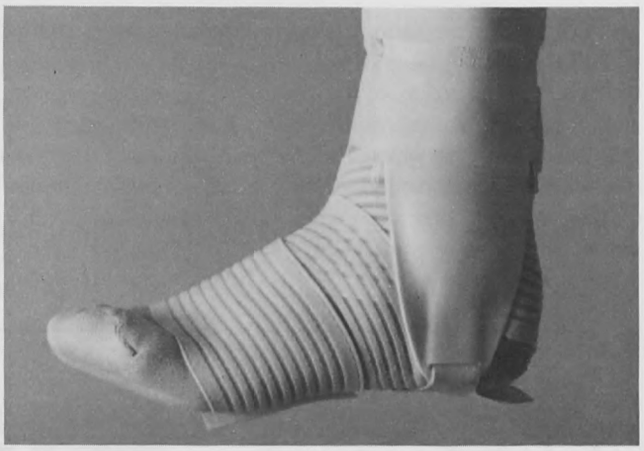

Figure 8c. Stirrup brace applied

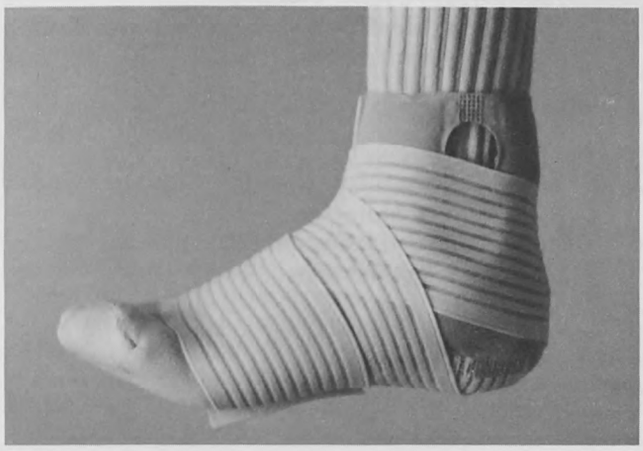

Figure 8b. Long elastic strap wrapped over U and around forefoot

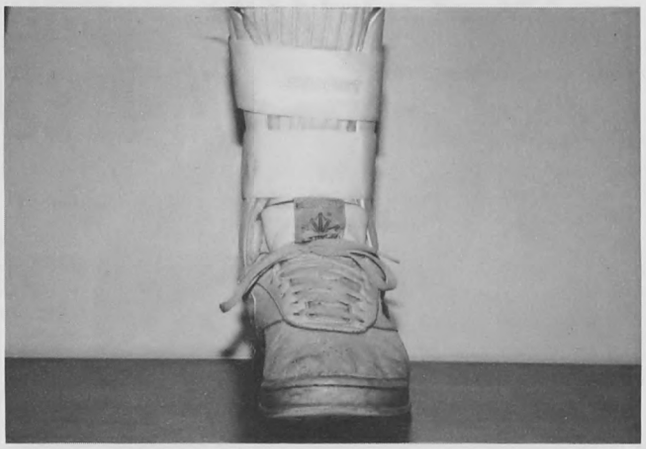

Figure 8d. Shoe applied

therapy consisted of ice water immersion for 20 minutes. With the ankle taped, the athlete demonstrated the ability to run straight ahead, sideways, and backward at 3/4 normal speed. Discomfort was experienced only when he attempted to execute pivoting and cutting maneuvers. His overall functional capability was sufficient to permit limited noncontact participation in a football practice session. Immediately after practice, a frozen Cryo/Strap and the modified Air-Stirrup brace were re-applied.

On the fourth post-injury day, the majority of the ecchymosis was located next to the area covered by the Cryo/Strap (Figure 7c). Because the contours around the fibular malleolus had assumed a normal appearance, pre-exercise warm whirlpool treatments were initiated. During the ensuing football practice session, the athlete participated in sport-specific activities to test his functional capabilities; they were greater than 90% normal. He resumed full participation on the fourth post-injury day, and continued to participate fully thereafter.

Pre-exercise warm whirlpool treatments and taping for football practices and games were continued for the remainder of the football season. Post-exercise application of a frozen Cryo/Strap and modified Air-Stirrup brace was continued for two weeks. Thereafter, a frozen Cryo/Strap was applied whenever the athlete experienced post-exercise soreness. Resistive dorsifexion and eversion exercises and proprioceptive balance board exercises were periodically performed after practice sessions for three weeks.

One week after the injury (Figure 7d), the athlete started and played an entire football game at the fullback position. He considered his level of function during the game to be near 100% normal, and his coaches judged his performance to be consistent with his pre-injury playing capabilities. Ecchymosis reached its peak on the sixth post-injury day, and had almost completely disappeared by the twelfth day (Figure 7f). Tenderness over the anterior talofibular ligament progressively decreased, and palpation produced only minimal discomfort after two weeks. The athlete completed the remainder of his football season without any limitations attributable to the ankle injury.

CONCLUSION

Many practitioners believe that avoidance of early weightbearing activity, combined with the application of an elastic wrap and periodic cold application, is an effective approach to management of the inversion ankle sprain; however, very little scientific information can be found in the literature to support this common approach. Numerous uncontrollable variables, methodological problems, and ethical considerations make scientific investigation of ankle-sprain treatment protocols extremely difficult.

Empirical observations of numerous cases similar to the one presented suggest that two interrelated factors determine the rate of restoration of function: 1) the exact mode of application of external compression, and 2) the degree of protected use of the injured ankle during the early stages of recovery. The combined physiological effects of uniform circumferential compression and complete avoidance of early weightbearing activity could adversely affect long-term functional results (Figure 9). Assuming that injured ankle ligaments are adequately protected from excessive inversion stress, the combined physiological effects of focal collateral compression, cold, and early functional utilization may enhance long-term functional results (Figure 10).

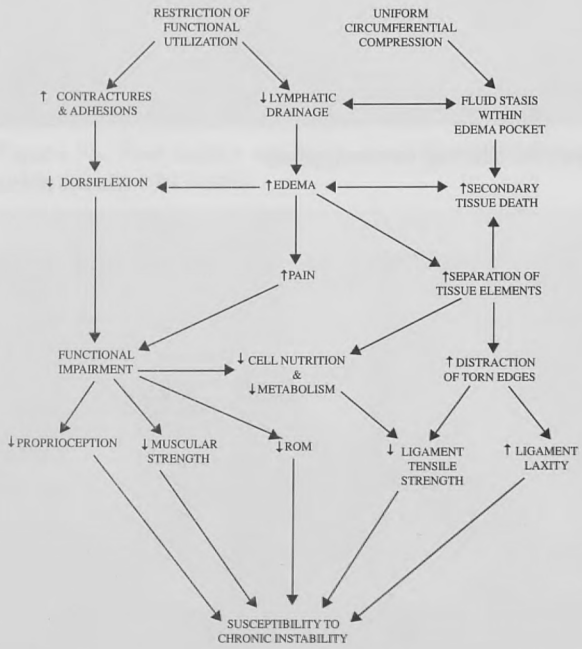

Figure 9. Theoretical interrelationships among factors that may adversely affect the rate of return to full ankle function and/or susceptibility to re-injury

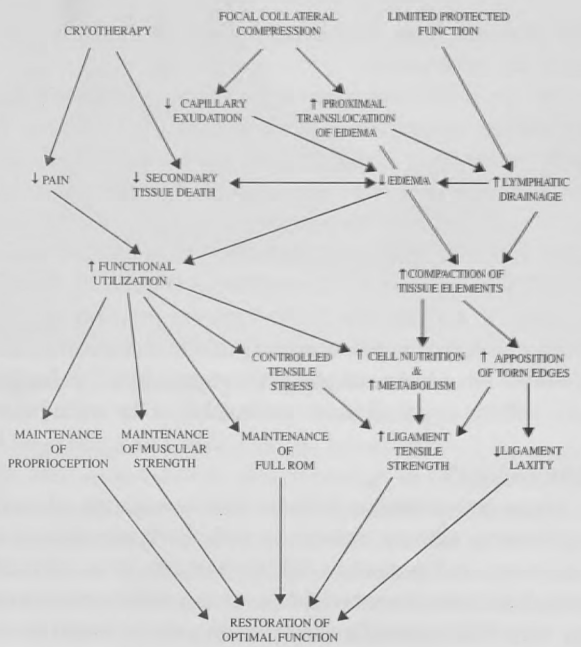

Figure 10. Theoretical interrelationships among factors that may facilitate a rapid return to full ankle function and minimize susceptibility to re-injury

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Sensations of Cold Reexamined: A Study Using the McGill Pain Questionnaire

Christopher D. Ingersoll, PhD, ATC
Brent C. Mangus, EdD, ATC

ABSTRACT: The purpose of this study was to use the McGill Pain Questionnaire (MPQ) to identify the most commonly selected descriptors of cold-induced pain during a 21 minute cold immersion followed by a 21 minute recovery period. Subjects were 28 volunteers (13 males and 15 females, age = 21.2 ± 4.0 yrs) without lower extremity pathologies. The MPQ was administered upon immersion in a 2°C ice bath, and then every three minutes up to 42 minutes. The foot and ankle were removed from the bath at 21 minutes. The terms selected most frequently during the test period were freezing, penetrating, sharp, stinging, cold, numb, tingling, and cool. The terms selected by our subjects differed from the terms typically associated with cold-induced pain. The descriptors selected are discussed, and the terms analgesia and pain are carefully examined. The presence of analgesia during cold applications is questioned.

When administering cold applications to an athlete, it is appropriate to briefly describe the sensations he or she can reasonably expect to feel during the treatment. The sensations felt during cold applications have been described by numerous authors (1,2,3,7,8,9,10,12,13,14,16, 17,18,19,20,21) (Table 1).

Grant (8) and Hayden (9), in their separate descriptions of cryokinetics, identified four sensations associated with cold applications: 1) appreciation of cooling, 2) burning, 3) aching, and 4) relative skin analgesia or anaesthesia. The basic scheme described by Grant (8) and Hayden (9) is followed by most authors (1,2,7,12,16).

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There are a number of other sensations that have been associated with cold applications in the literature. The term "numb" was reported by numerous authors (1,7,13,19). Terms such as "dull pain" (10), "radiating" (10), "throbbing" (19), and "pins and needles" (21) also were mentioned. None of the studies previously mentioned used a valid and reliable instrument from which to select their descriptors. Knight (12) and Nimchick and Knight (19) expressed the need for further research regarding the sensations felt during cold applications.

The purpose of this study was to identify the descriptors of cold-induced pain most commonly selected by normal subjects, during a 21 minute cold immersion followed by a 21 minute recovery period, using the McGill Pain Questionnaire.

METHODS

Twenty-eight volunteers (13 males, 15 females, age = 21.2 ± 4.0 yrs, ht = 68.3 ± 4.0 in, wt = 152.1 ± 32.6 lbs), from the student body of the University of Nevada, Las Vegas, gave informed consent to participate in our study. Subjects were excluded from the study if they had a history of hypersensitivity to cold, had known peripheral vascular disease, or had impaired sensation to the lower extremities. Subjects were informed that they were free to withdraw from the study at any time without prejudice.

A modified version of the McGill Pain Questionnaire (MPQ) was used to supply the subjects with terms to describe their pain. The modification was the replacement of the word "pain" with the word "sensation" in the instructions (11). The MPQ (Figure 1) is a valid (5) and sensitive (11) instrument.

When administering the MPQ, we told the subjects to choose one word from each category, and to choose a word from that category only if it described their current sensation.

Before testing, we acquainted the subjects with the MPQ to familiarize them with the descriptors before the actual test. Once the subjects were familiar with the instru-

Table 1. Reported sensations of cold applications

Author	Part Cooled	Temp (°C)	Time (min)	Sensations Reported/Described	Mode*
JOURNAL ARTICLES					
Abramson et al. (1)	Hand	11-14	60	coldness, burning, pain, numbness	II
Grant (8) Hayden (9)			5-7	cooling, burning, aching, analgesia or anaesthesia	IM
Hensel (10)				dull pain, radiating	
Kunkel (13)				deep ache, numbness	
Nimchick & Knight (19)	Ankle	0.1	20	pain, numbness, throbbing	II
Petajan & Daube (20)	Arm	10	15	severe pain, warmth	II
Wolf & Hardy (21)	Hand	18	6	deep aching pain, pins & needles, adaptation	II
TEXTBOOKS					
Arnheim (2)				cold, burning, aching, analgesia	
Downer (7)				cold, burning, aching, numbness	
Michlovitz (16)				cold, burning, aching, analgesia	

* II = ice immersion, IM = ice massage, G = general

ment and could verbally explain the proper procedure for completing the form, testing commenced. Although preloading the subjects with the adjectives on the questionnaire before testing may have affected their responses, pain cannot be measured without some type of intervention. We felt that familiarizing the subjects with the terms before testing would allow more frequent pain measurements, reduce confusion during testing, and give us more information about pain-term selection during immersion.

We first read the instructions to the subjects and answered any questions. We then instructed the subjects to immerse their right feet and ankles in the ice bath and to not remove them during the 21 minutes of immersion. Thirty seconds after immersion, we instructed the subjects to fill out the MPQ. The questionnaire was completed every three minutes after the initial immersion, up to 21 minutes. The foot and ankle were then removed from the ice bath. We allowed the subjects to dry off their feet and ankles, but did not permit them to leave their seats. The sequence of filling out the MPQ was continued every three minutes until 42 minutes had elapsed from the initial immersion, in order to examine a recovery period.

Water temperature upon initiation of the test was held constant at 2°C (±1°C). No attempt was made to maintain water temperature in order to simulate a clinical protocol. A standard 20 gallon cooler was used as the ice water container. Room temperature was kept constant at 25°C.

RESULTS

Twenty-three of the original 28 subjects completed testing. All subjects who withdrew did so during the first nine minutes of testing. The terms used to describe cold-induced pain were divided into three categories based upon the number of subjects who selected them during each three minute interval. A descriptor was deemed a major term if it was selected by more than 40% of the subjects. A descriptor was considered a minor term if it was chosen by more than 30% but less than 40% of the subjects. If a descriptor was selected by fewer than 30% of the subjects, it was not used in the final analysis. We selected these cut off points in order to make the number of terms considered more manageable.

The major and minor terms selected by our subjects are reported in Table 2. There were a number of descriptors that qualified as major and minor terms. The frequency that a descriptor was selected as a major or minor term is presented in Figures 2 and 3, respectively.

Some of the words below describe your *present* sensations. Circle *ONLY* those words that best describe it. Leave out any category that is not suitable. Use only a single word in each appropriate category - the one that best applies.

1. Flickering
   Quivering
   Pulsing
   Throbbing
   Beating
   Pounding
2. Jumping
   Flashing
   Shooting
3. Prickling
   Boring
   Drilling
   Stabbing
4. Sharp
   Cutting
   Lacerating
5. Pinching
   Pressing
   Gnawing
   Cramping
   Crushing
6. Tugging
   Pulling
   Wrenching
7. Hot
   Burning
   Scalding
   Searing
8. Tingling
   Itchy
   Smarting
   Stinging
9. Dull
   Sore
   Hurting
   Aching
   Heavy
10. Tender
    Taut
    Rasping
11. Tiring
    Exhausting
12. Sickening
    Suffocating
13. Fearful
    Frightful
    Terrifying
14. Punishing
    Grueling
    Cruel
    Vicious
    Killing
15. Wretched
    Blinding
16. Annoying
    Troublesome
    Miserable
    Intense
    Unbearable
17. Spreading
    Radiating
    Penetrating
    Piercing
18. Tight
    Numb
    Drawing
    Squeezing
    Tearing
19. Cool
    Cold
    Freezing
20. Nagging
    Nauseating
    Agonizing
    Dreadful
    Torturing

Figure 1. The McGill Pain Questionnaire - Categories 1 through 10 represent sensory components of pain, categories 11 through 15 represent affective components of pain, category 16 represents pain intensity, and categories 17 through 20 represent combinational terms (i.e., involving two or more types of pain).

DISCUSSION

Two terms typically used to describe cold-induced pain (burning and aching) were infrequently selected in our study. Both of these terms are mentioned by nearly all of the authors cited earlier. In our study, aching was not selected by more than 40% of the subjects (i.e., not a major term) and selected only three times by more than 30% of the subjects (i.e., a minor term). Burning was selected as a major term once, at minute 3, and as a minor term twice.

Term	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42
Freezing	■	■	■		■		■	■							
Penetrating	■			■											
Sharp	■	■	■												
Burning		■													
Intense		■													
Piercing			■												
Pricking			■												
Stinging			■	■	■	■	■								
Cold				■	■	■									
Numb								■	■						
Tingling										■		■	■	■	
Cool												■	■	■	■

IMMERSION | RECOVERY

Figure 2. Time intervals for major terms - Major terms are those terms selected by 40% or more of the subjects during each respective time interval.

Term	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42
Aching	■		■	■											
Grueling	■														
Stabbing	■														
Stinging	■	■													
Cold		■					■	■	■		■				
Tight		■							■						
Agonizing			■				■								
Burning			■		■										
Hurting			■		■	■									
Freezing				■		■									
Sharp				■		■	■								
Annoying					■										
Numb					■	■				■	■		■		
Penetrating						■									
Pressing						■									
Miserable								■							
Dull									■	■		■			■
Cool										■	■				
Tingling											■				■

IMMERSION | RECOVERY

Figure 3. Time intervals for minor terms - Minor terms are those terms selected by greater than 30% but less than 40% of the subjects for each respective time interval.

Other studies (2,21) have associated the terms burning and aching with the first seven minutes of immersion. In our study, this time period was dominated by the terms freezing, penetrating, and sharp.

Another typically used term to describe cold-induced pain, numbness, did appear as a major term, but during an unlikely time period. The term "numb," usually reported anywhere from seven to 20 minutes after initial cold exposure (2,13), was selected as a major term for minutes 21 and 24, and as a minor term during minutes 12, 15, 27, 30, and 36. It is interesting to note that numbness was only reported as a major term during the last time interval of immersion (minute 21).

In our study, the time period typically associated with numbness (seven to 20 minutes) was dominated by the terms stinging, freezing, and cold.

The appearance of numbness so late during the immersion has tremendous clinical impact. Because cold-induced pain descriptors were selected every three minutes, the sensation of numbness may have started shortly after the 18th minute. On the other hand, it may have started just before the 21st minute. If the latter is true, then 20 minute cold immersions may not result in adequate numbness for techniques such as cryokinetics.

Table 2. The sensations of cold

Time	Major Terms	(>40%)	Minor Terms	(>30%)
0	Freezing	85%	Stabbing	33%
	Sharp	54%	Stinging	33%
	Penetrating	42%	Aching	33%
			Grueling	33%
3	Sharp	54%	Stinging	33%
	Burning	42%	Tight	33%
	Intense	42%	Cold	33%
	Freezing	54%		
6	Prickling	46%	Burning	38%
	Sharp	42%	Hurting	33%
	Stinging	46%	Agonizing	38%
	Piercing	46%		
	Freezing	63%		
9	Stinging	42%	Sharp	33%
	Penetrating	42%	Aching	33%
	Cold	46%	Freezing	38%
12	Stinging	50%	Burning	33%
	Cold	42%	Hurting	33%
	Freezing	46%	Aching	38%
			Annoying	38%
			Numb	33%
15	Stinging	42%	Sharp	38%
	Cold	50%	Pressing	33%
			Hurting	33%
			Penetrating	38%
			Numb	33%
			Freezing	38%
18	Stinging	46%	Sharp	33%
	Freezing	46%	Cold	33%
			Agonizing	33%
21	Numb	46%	Miserable	33%
	Freezing	42%	Cold	38%
24	Numb	42%	Dull	33%
			Tight	38%
			Cool	33%
27	Tingling	42%	Dull	33%
			Numb	38%
			Cool	33%
30			Tingling	33%
			Numb	33%
			Cool	33%
			Cold	33%
33	Tingling	46%	Dull	38%
	Cool	63%		
36	Tingling	46%	Numb	33%
	Cool	58%		
39	Tingling	42%		
	Cool	63%		
42	Cool	75%	Tingling	33%
			Dull	38%

Of particular interest in our study was the fact that analgesia was never demonstrated - not even 21 minutes after the foot and ankle were removed from the ice bath. Several authors (2,8,9,16) have identified analgesia as the final sensation associated with cold applications, probably because of an improper use of the term "analgesia." Analgesia is the "absence of sensibility to pain, particularly the relief of pain without the loss of consciousness" (17). Since our subjects selected terms to describe their pain during the entire immersion, we could not conclude that pain was absent. Therefore, we do not believe that analgesia was achieved. In fact, some subjects even reported a return of pain, usually using the terms coolness and tingling, several hours after immersion.

Another possible source of confusion regarding the use of the term "analgesia" stems from the typical understanding of the pain experience. Pain is actually a multifaceted experience (15) that includes intensity, sensory, and affective components.

The sensory component of pain includes temporal, spatial, pressure, thermal, and other qualities (categories 1 to 10 in Figure 1). The affective component of pain represents tension, fear, and autonomic properties (categories 11 to 15 in Figure 1). The evaluative component describes the overall intensity of the pain experience (category 16, Figure 1). The McGill Pain Questionnaire also includes combined terms. These terms have properties of two or more components of the pain experience (15).

Those clinicians who consider only the intensity of pain are ignoring a large portion of the pain experience. Pain cannot be described in terms of its intensity only. Barely perceptible pain does not necessarily mean that pain is absent, i.e., that there is analgesia.

We did not use neurophysiological tests to evaluate analgesia because these tests typically do not describe the entire pain experience. Such tests evaluate analgesia using methods such as pin pricks (4) or even cold pressor tests (6). It is questionable whether these tests are appropriate for evaluating cold-induced analgesia. While pain intensity may decrease or even diminish during and after cold applications, most tests for analgesia will not detect other qualities of pain. This study indicates that subjects will continue to select sensory and combined terms on the McGill Pain Questionnaire even after the intensity of pain is diminished. Therefore, based on the definition of analgesia cited earlier, the subjects could not be experiencing analgesia. We recommend the use of the term hypalgesia, "diminished sensibility to pain" (17), to describe this phenomenon.

Caution must be used when interpreting the results of this study. Our subjects were normals in a laboratory setting. The response of subjects with preexisiting painful conditions may be quite different. Cold applications may act as a counterirritant in this situation. Future research into this area should focus on the descriptors of pain selected by injured subjects. Also, we recommend a more stringent interpretation of the term analgesia, and a more comprehensive interpretation of the pain experience. Using the "classical" terms to describe the pain experience during cold applications may not be accurate. Because of the wide variety of terms used to describe cold-induced pain, it may not be possible to provide the athlete with a concise,

accurate list of descriptors that will define the pain. It is appropriate to tell an athlete that the intensity of pain will diminish over time.

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Pressures Exerted by Elastic Wraps Applied by Beginning and Advanced Student Athletic Trainers to the Ankle and The Thigh With and Without an Ice Pack

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ABSTRACT: Compression is a common part of the immediate care of acute athletic injuries, but little has been done to validate this commonly accepted procedure. Forty-six subjects applied elastic wraps four times each to four individuals' thighs and ankles, with and without ice, to study the application of pressure and consistency of application. Subjects were 23 beginning and 23 advanced student athletic trainers (12 males, 11 females in each group). We measured pressures exerted over the anterior thigh and the anterior talofibular ligament with a closed system air cell attached to a pressure gauge. There was no difference in pressure exerted by elastic wraps applied by beginning and advanced student athletic trainers, applied by males and females, or applied with and without ice. Elastic wraps applied to the thigh exerted significantly more pressure than those applied to the ankle. Female advanced athletic trainers were most consistent in the application of the wrap. Though the mean pressure exerted by the elastic wraps was within the range of recommended values thought to be safe for external compression, individual pressures exerted by the wraps were frequently above this range. Pressures above this range have been found to compromise circulation or damage the compressed area. If these values hold true for acute injuries (no evidence exists for or against these values), there is cause for concern.

The immediate care of acute musculoskeletal injuries includes the application of ice, compression, and elevation. Elastic wraps are commonly used to apply compression and to hold the ice against the damaged tissue in an effort to prevent and/or reduce the formation of swelling around the injured area (3,10,12,13,14,22,25). Little is known, however, about the amount of pressure exerted by these wraps.

Most previous research has been done with chronic edema (4,5,8,9,15,16,17,18,19,20,21,24,26). The effects of compression on acute edema have yet to be quantified. A previous study from our lab revealed variance among athletic trainers and from application to application by the same athletic trainer, but these conclusions were based on only four subjects (11). Is there a difference between body parts? Does an elastic bandage applied over an ice pack exert as much pressure as when applied directly to the skin (6)? This research was designed to examine the application of elastic wraps using a large group of subjects with varying experience, using different body parts, and applying the elastic wrap directly against the skin or over an ice pack.

METHODOLOGY

Forty-six subjects applied elastic wraps under four conditions on each of four days. We measured forces exerted by the wraps over the anterior talofibular ligament and the anterior thigh with a closed air cell attached to a pressure gauge. The experimental design was a 2 X 2 X 2 X 2 X 4 factorial design with repeated measures on one factor. The dependent variable was the pressure exerted by the wrap. The five independent variables studied were: gender (male and female),experience (beginning and advanced student athletic trainers), body part (ankle and thigh), ice pack (used or not), and trials (four applications). The order of application of the elastic wraps under the different conditions was determined with a four by four Balanced Latin Square within a four by four Balanced Latin Square.

Subjects initially filled out a profile form. It provided background information concerning how they were taught to apply elastic wraps and their impression of whether they applied adequate pressure for acute injury care.

All subjects volunteered and gave informed consent. They consisted of 23 advanced and 23 beginning (or non) student athletic trainers (12 males, 11 females in each group).

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The beginning student athletic trainers (age=20.5 ± 3.6 yrs; maximum of one year athletic training experience) included 19 students enrolled in an introductory undergraduate athletic training course and four physical education students who had no background in athletic training. The advanced student athletic trainers (age=24.4 ± 2.5 yrs; minimum of 1200 (avg 1745) clinical hours of athletic training experience) had completed four graduate athletic training courses. Ten were certified and 13 were eligible for certification by the National Athletic Trainers' Association.

We measured pressure with a pressure gauge attached to a three centimeter air cell with a small piece of foam rubber inside (Air Cast, Summit NJ, USA). The air cell was placed over the anterior talofibular ligament on the lateral side of the ankle and 15 cm above the patella on the anterior thigh. Double-sided cellophane tape placed between the air cell and the skin held the air cell in place. The athletic trainer could not see the pressure gauge while applying the wrap. There was no interaction between the subject applying the wrap and the individual being wrapped.

Two sizes of elastic bandages (Depuy, Warsaw, IN, USA) were used: 15 cm X 1.34 m for the ankle; and 15 cm X 4.25 m for the thigh. The ice packs applied to both the ankle and the thigh were 1 kg.

All testing was to the right legs (foot length =24 to 27 cm) of a group of individuals (2 males, 2 females). The athletic trainers were divided into four groups so that they used the same individual (and limb) each day (11). The individual being wrapped either sat on a table with the right leg extended and the right foot dorsiflexed at 90° (during ankle application) or laid supine with the right foot on a table and the right knee flexed at 90° (during thigh application). The angle of the ankle and knee was measured before and after each application with a goniometer.

Each subject wrapped the ankle using a combination of circular and figure of eight patterns. They began the circular patterns at the toes and moved toward the knee. Two figure of eight patterns surrounded the ankle. The thigh was wrapped with a circular pattern that began above the knee and covered 20 cm of the anterior thigh. Two metallic clips held the wraps in place.

Each subject had a practice session on the first day in order to become familiar with the procedures.

Means for pressures exerted by elastic wraps for each condition for the four groups of subjects and the entire group were determined and compared. Consistency of pressures exerted by the elastic wraps was found by analyzing the means of the standard deviation for each group under each condition and among the four trials. The data were analyzed with ANOVAS with repeated measures (on trials).

RESULTS

Both beginning and advanced student athletic trainers felt that they applied elastic wraps with adequate pressure (Table 1). There was a difference in the way they were taught to apply elastic wraps. Advanced student athletic trainers frequently mentioned stretching the wrap 50 to 75% of its length (48%), while the beginners most frequently mentioned that they could not remember how they were taught (57%).

We found no significant difference ($p \geq .05$) between the pressures exerted by the elastic wraps applied by beginning and advanced student athletic trainers ($F(1,42)=.02$, $p=.19$), those applied by males and females ($F(1,42)=.02$, $p=.89$), or those applied with and without an ice pack ($F(1,42)=.37$, $p=.55$) (Table 2). The elastic wraps applied to the thigh exerted significantly more pressure than those applied to the ankle ($F(1,42)=118.7$, $p=.001$) (Table 2).

Table 1. Subjects' perceptions of their elastic wrap application technique

	Advanced	Beginning
In your opinion, how much pressure was exerted by the elastic wrap that you applied?		
adequate	21	17
too much	2	4
not enough	0	1
no response	0	1
TOTAL	23	23
How were you taught to apply an elastic wrap so that it exerted adequate pressure?		
stretch wrap 50 to 75% of its length	11	1
check circulation after wrap applied	3	0
to insure support, not too tight	4	7
instruction made no reference to pressure	4	2
cannot remember	1	13
TOTAL	23	23

Most two-, three- and four-way interactions were not significant. The exceptions follow. The interaction between application of elastic wraps with and without ice, gender, and experience was significant ($F(1,42)=5.39$, $p=.03$). Elastic wraps applied with ice to the thigh by experienced male student athletic trainers exerted the highest pressure, while those applied by male beginning student athletic trainers to the ankle with ice exerted the lowest (Table 2).

The interaction between body part and elastic wraps applied directly to the skin or over an ice pack was significant ($F(1,42)=9.50$, $p=.001$). Elastic wraps applied to the thigh with ice exerted more pressure than those applied without ice, but more pressure was applied to the ankle without ice than when the elastic wrap was applied over an ice pack (Table 2).

While no overall trial effect was evident, five interactions involving trial were significant: limb by trial ($F(3,126)=3.55$, $p=.02$), gender by trial ($F(3,126)=3.04$, $p=.03$), ice pack by gender by trial ($F(3,126)=3.21$, $p=.03$), ice pack by gender by limb by trial ($F(3,126)=2.67$, $p=.05$), and ice pack by experience by limb by trial ($F(3,126)=3.94$, $p=.01$). These interactions are evident in Table 3, which contains the average of the standard deviations of the four trials.

Elastic wraps were applied to the thigh more consistently (i.e., with less variation between trials) than those applied to the ankle, and advanced female athletic trainers applied elastic

Table 2. Pressure (mmHg) exerted by elastic wraps on a body part after being applied by beginning and advanced student athletic trainers (means and standard deviations)

	N	Thigh		Ankle	
		With ice	Without ice	With ice	Without ice
ADVANCED					
male	12	49.0 (6.9)	45.9 (6.6)	33.4 (9.8)	35.6 (8.4)
female	11	47.0 (7.3)	47.8 (16.1)	33.5 (10.7)	39.4 (12.6)
both	23	48.1 (7.0)	46.8 (11.9)	33.5 (10.1)	37.5 (10.6)
BEGINNING					
male	12	47.9 (7.4)	47.9 (9.6)	27.9 (9.1)	34.2 (5.7)
female	11	47.0 (8.2)	40.0 (8.1)	32.3 (10.8)	32.6 (6.2)
both	23	47.5 (7.6)	44.1 (11.1)	30.0 (9.9)	33.4 (5.8)

Table 3. Consistency of four trials of wrap application (means and standard deviations of the standard deviations of four trials)

	N	Thigh		Ankle	
		With ice	Without ice	With ice	Without ice
ADVANCED					
male	12	7.3 (3.6)	4.1 (2.2)	14.6 (3.4)	6.0 (3.3)
female	11	5.8 (4.1)	4.9 (2.0)	10.9 (6.0)	6.7 (2.6)
both	23	6.6 (3.8)	4.5 (2.1)	12.8 (5.1)	6.3 (2.9)
BEGINNING					
male	12	6.0 (2.8)	6.6 (2.5)	10.6 (4.7)	7.4 (3.1)
female	11	7.1 (2.4)	6.9 (2.6)	12.8 (5.8)	6.6 (3.3)
both	23	6.5 (2.7)	6.7 (2.5)	11.7 (5.2)	6.8 (3.2)

wraps more consistently than others. Male advanced athletic trainers were the least consistent when the elastic wrap was applied over the ice pack to the ankle. The elastic wraps without ice were applied more consistently than those with ice.

Beginning student athletic trainers seemed to learn as the study progressed. By the fourth day, they applied the wraps quicker, neater, and with less attention, and pressure increased with each trial.

DISCUSSION

The significant variability found with the application of elastic wraps with and without ice by advanced student athletic trainers is not surprising. First, the subject profile forms revealed that no standard teaching protocol existed. Second, no standard exists for optimum external pressure in the application of elastic wraps for acute injuries.

These data support the variability in application among athletic trainers reported earlier from this lab, but not the differences between males and females (11). The first study involved only two subjects of each sex compared to the 23 subjects of each sex in this study.

Variabilities in the application of Lycra garments during pressure therapy for burn patients were similar to those in this study (2). Pressures exerted by the garments varied from 2 to 25 mmHg on eight different parts of the body. Available garments were used without alterations or fitting. Pressures exerted by the garments were seldom measured. Tension was assessed subjectively by checking comfort and tolerance of the patient wearing it. Cheng (2) reported a good response to the treatment, but he felt that standardization of a pressure range is needed for better clinical results. This may also be true when using elastic wraps for acute injury management.

Our finding that elastic wraps applied over an ice pack exerted forces similar to those of an elastic wrap applied alone has important clinical implications. A common practice in acute injury care is to apply elastic wraps over the injury and then place ice packs over the wrap, even though this results in less effective cooling of the tissue (19,23). The practice is defended on the basis that it provides greater compression. Our data suggest otherwise. Elastic wraps applied over ice packs (6,7,14) will give the benefit of the ice pack without compromising the amount of compression exerted by the elastic wrap.

The contact of the ice pack directly with the skin is important (1). The insulating effect of an elastic wrap between the ice pack and the skin (even when wet) may prevent the tissue from cooling enough to reduce the secondary hypoxic injury and the injury time. Cryotherapy's primary effect is to reduce metabolism, thereby preventing secondary tissue damage (7,9). It is essential that the tissue cool as quickly as possible. The sooner the metabolism is reduced, the greater the chance of reducing secondary tissue damage (10,13).

No recommended pressures exist for elastic wrap application to musculoskeletal injuries (2,4,5,15,18,19,24). Pressure recommendations in the literature are for lymphedema and thrombosis patients, and even these vary from 20 to 40 mmHg (4,8,15,16,17,20,26). Pressures above this range have been found to compromise circulation or to damage the compressed area (5,15,21). If similar pressure compromises circulation in acute injury patients, athletic trainers should be concerned. Forty-seven percent of the subjects in our study applied the elastic wraps with pressures exceeding 40 mmHg, and 23% of the total trials were applied with pressures over 50 mmHg. But, there is no evidence in the literature to indicate whether pressures this great are beneficial or harmful during acute injury care.

Certain body parts are more sensitive to external pressure. Blood flow at the knee can be obstructed at 10 mmHg of pressure applied by an elastic bandage with subjects standing, lying supine, or ambulating (4,15). The effects of external pressure on different body parts with acute injuries need further investigation.

The greater variabilities of pressure exerted by elastic wraps on the ankle compared to those pressures at the thigh may be caused by methodological error. We placed the ice bag on the side of the ankle, but on the top of the thigh. The ankle ice pack sometimes shifted, causing a change in the pressure.

Other factors may explain the difference between the forces exerted by elastic wraps on the thigh and ankle. The thigh wrap was longer. Therefore, the thigh had three to four layers of elastic wrap while the ankle only had two or three layers. Cheng et al. (2) reported a difference in pressures exerted by variable layers of Lycra garments. Elastic wraps with varying lengths would have to be studied to see if the construction of the wrap and the method of application affects the amount of force exerted.

Elastic wrap quality could account for the difference between the thigh and ankle. The elastic wrap used for the thigh had a higher thread count than the elastic wrap used for the ankle. Spiro (21) had 22 nurses apply two types of bandages to a leg. One was a crepe bandage and the other was a heavy web Bisgaard bandage. The crepe bandage exerted 13 mmHg, while the Bisgaard exerted 23.8 mmHg pressure. The differences observed between the thigh and ankle need to be further investigated with similar quality of elastic wrap.

Subjects may have thought that the larger limb segment required or tolerated greater pressure. But we did not ask them if limb size determined the way in which they applied the elastic wraps.

This research indicates that student athletic trainers applied elastic wraps with great variability among themselves, from application to application, and on different body parts. At present, no research has examined the effects of external pressure on acute injuries. This must be investigated to find out if athletic trainers apply elastic wraps effectively. The importance of external compression in reducing edema and enhancing recovery from acute injuries cannot be ignored.

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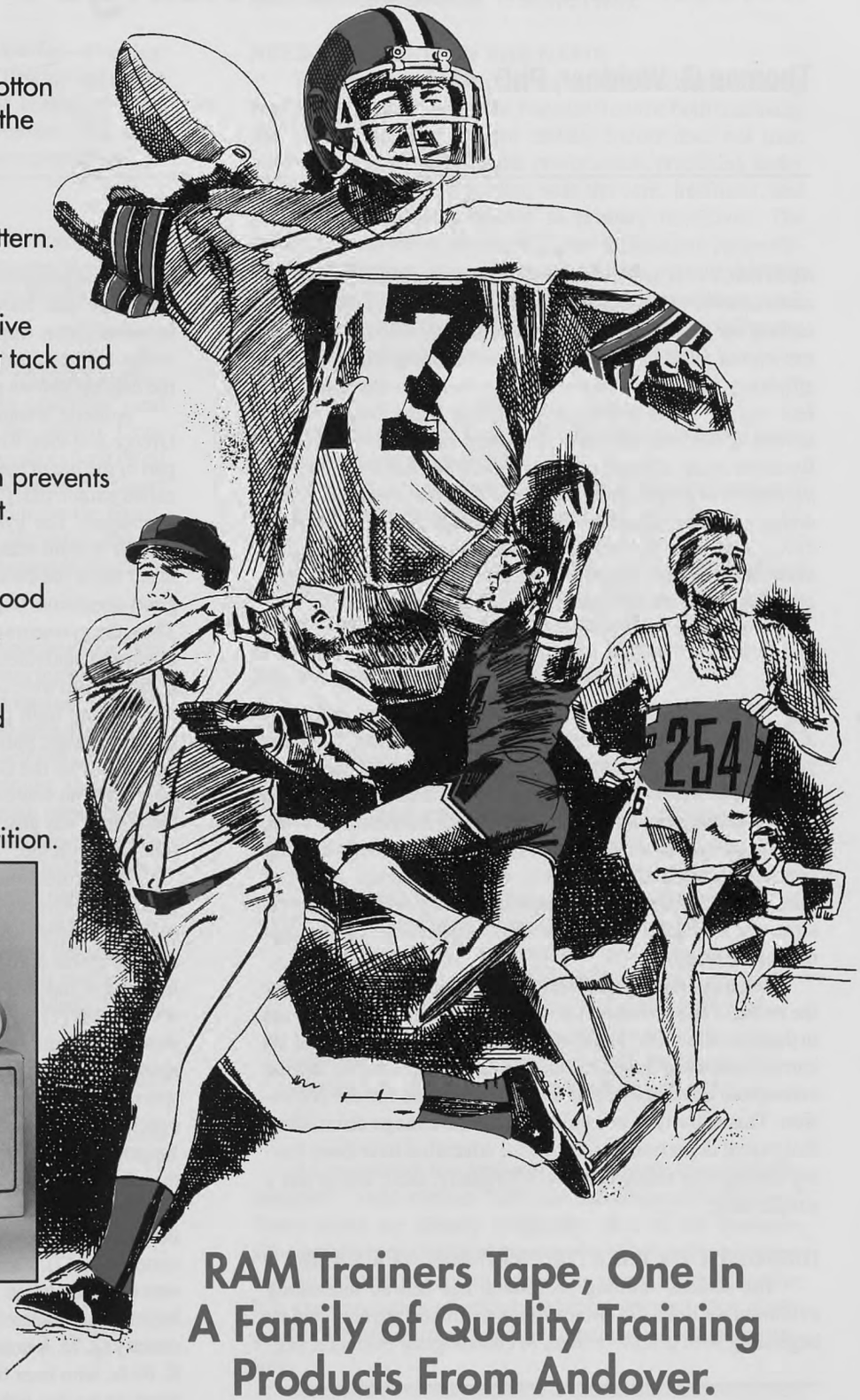

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Athletic Training: Time for a Name Change?

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ABSTRACT: It seems inappropriate to continue to use the name athletic training, because it does not clearly suggest the tasks of the profession. Historically, athletic training has been associated with conditioning and maintaining high physical efficiency in athletes. In the late nineteenth century, the athletic trainer's role still was regarded as limited to the conditioning of athletes; however, as indicated by a 1990 role delineation study, athletic training should be characterized as a paramedical profession, concerned with the care, treatment, and prevention of athletic injuries. As the field continues to evolve and earn respect as a legitimate scholarly pursuit, it must adopt a name which will be accepted and understood by both the public and the academic community.

All too familiar to athletic trainers is the frustration encountered in answering the simple question, "What is your profession?" Commonly, people do not understand what athletic training is by name alone. It becomes necessary to educate the inquirer about the various roles and functions of the athletic trainer. Even those once familiar with athletic training continue to associate it primarily with tape and ice. Aware of this, many athletic trainers respond initially with the general term, sports medicine, then develop and describe the concept of athletic training.

Athletic training professionals should consider whether the name of the profession is accurate and appropriate. To aid in this consideration, I shall discuss the history of the name, its current status and usage, the need to question the name, and the conceptual development of an alternate name for the profession. This activity is not unlike the name-change discussions that parent departments of physical education have been having during this entire century. Obviously, then, this is not a simple task.

HISTORY OF ATHLETIC TRAINING AS A NAME

The athletic training profession has had an interesting evolution. O'Shea (7) comments that athletic training had its beginning with primitive man. Archaeological evidence, suggesting the possible presence of an athletic trainer, was found on a vase (ca. 1600 B.C.) discovered on the Mediterranean island of Crete. Appearing on the vase were boxers with close-fitting helmets, padded hands, and forearm guards. These are the earliest known protective devices.

Athletic training became more identifiable in ancient Greece and then Rome (1, 2, 7). Athletics were an important part of the life of the Greeks. Athletes were assisted by trainers called *paidotribai* ("boy-rubbers"), *aleiptes* ("anointers"), and *gymnastes*. The *gymnastes* came into existence in Athenian society to train athletes in sports skills and techniques, and to teach them the basic knowledge needed to keep the body in good condition (e.g., anatomy, physiology, and nutrition). Thus, the *gymnaste* closely resembles the modern coach, or the European equivalent, "trainer." Later, the medical *gymnastai* appeared and were concerned with conditioning the athlete and maintaining high physical efficiency; they made use of hot baths, massage, pain-relieving drugs, and other measures. The greatest of all the Greek trainers was said to be Herodicus of Megara, who was considered a physician, as well as a trainer. Herodicus was also the teacher of Hippocrates, the "father of modern medicine."

The professional trainer continued to develop after the conquest of Greece by the Roman Empire. At that time, Claudius Galen (ca. 130-200 A.D.), considered to be the first athletic trainer and team physician, advised athletes to exercise in the gymnasium as a means of recovering from ills and weaknesses (7). In considering this history, it appears that the modern definitions of "athletic" and "trainer" more closely resemble the concept of the ancient *gymnastes* (teachers of sport skills and techniques, "training masters," and today's coaches), rather than the *gymnastai* (specialists in the medical aspects of training); however, it was the latter which spawned the athletic training profession.

From the time of Galen until the nineteenth century, literature dealing with the athletic trainer is almost completely nonexistent (7). The profession began developing some prominence in the United States with the establishment of intercollegiate and interscholastic athletics in the late nineteenth century (2, 7). A notable athletic trainer during that time was S. E. Bilik, who later became a sports physician. Considered by many to be the father of modern athletic training, Bilik (4) analyzed athletic training as divisible into the following three branches:

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Conditioning—Preparation of the aspiring youth for the intense muscular and neural exertions which are incidental to competitive athletics; development to the highest possible degree of strength, endurance, vitality, and resistance to injuries; and, finally, the progressive building-up of the heart, lungs, and the other vital organs to meet the strenuous demands upon them.

Diagnosis and Treatment of Athletic Injuries—Practical and efficient application of the principles of first aid and minor surgery. The athletic trainer's treatment of injuries is more drastic than a physician's, because the former deals with vigorous youth possessing great powers of recuperation, while the latter treats actual invalids.

Specialized Training—Development of the specific neuromuscular coordinations essential to the attainment of proficiency in a chosen field of athletic endeavor. No man is born an athlete. (4)

Bilik comments that the athletic trainer's primary responsibility is limited to getting athletes "into condition" and keeping them "in condition" throughout the season. Once again, this role now lies more with the modern-day coach. Well into the twentieth century, then, the role of athletic trainers followed that of the ancient *gymnastes*, including the conditioning of athletes. Since the adoption of the name athletic training, however, there have been major changes in the field.

CURRENT STATUS OF THE TITLE

Today the profession can be viewed according to a 1990 role delineation study (5). This study indicates the percentage of responsibility in six major performance domains (Table 1). The study seems to de-emphasize the athletic trainer's responsibility in the conditioning of athletes, and includes no responsibilities for teaching sports skills and techniques. The profession is clearly more concerned with the health care needs of athletes. In the summer of 1990, the American Medical Association recognized athletic training as an allied health profession. It seems inappropriate to continue to use the name athletic training, because it does not clearly suggest the tasks described in Table 1. A name which more clearly denotes the nature of our profession (i.e., an allied health care field) is needed.

Early in the modern development of the athletic training profession, the NATA Board of Directors chose to retain the current professional name, athletic training, and the practitioner's title, athletic trainer. They emphasized that the title should never be abbreviated and that both terms should always be included; however, according to Mark Smaha, NATA president, there is no official, definitive position paper on the issue (personal communication, 15 April, 1989).

Table 1. Major performance domains in the athletic training profession

Domain	Frequency (%)
Recognition and evaluation	21
Management/Treatment and disposition	21
Rehabilitation	19
Prevention	18
Organization and administration	12
Education and counseling	9

NEED TO QUESTION THE NAME

The need to question the name of the athletic training profession is readily apparent, because it can be both confusing and misleading. The modern athletic trainer does not train athletes, but is an allied health professional, practicing under the supervision of a physician, with the care, treatment, and prevention of athletic injuries as primary objectives. The current title, however, does not suggest this modern paramedical focus. Further, as a profession matures, it must develop from a trade into an applied academic discipline with research as one of its objectives. Osternig (8) presents the following three functional categories of a mature profession:

1. Practice, i.e., the application of a particular skill
2. Education, i.e., the formulation and transmission of a particular body of knowledge
3. Research, i.e., the systematic examination and testing of a particular discipline's methods and principles

It is doubtful that athletic training will be perceived as a legitimate field of study as long as neither word reflects an academic pursuit. Until a professional title is understood by the public and respected by those in higher education, the progress of the profession will be hindered.

ALTERNATIVE NAME

The athletic training profession should align itself with sports medicine. Many people have already adopted this umbrella term, which connotes both study and clinical application.

> [Sports medicine is] the study of the physiological, biomechanical, psychosocial, and pathological phenomena associated with exercise and athletics and the clinical application of the knowledge gained from this study to the improvement and maintenance of functional capacities for physical labor, exercise, and athletics and to the prevention and treatment of disease and injuries related to exercise and athletics (6).

As suggested by Arnheim (2), "sports therapy/sports therapist" could replace "athletic training/athletic trainer." These terms are already frequently used in the literature, although the connotation of "therapy" would need to be broadened to include prevention, as well as care and rehabilitation. It is the prevention of athletic injuries, after all, that distinguishes athletic training from any other sports-related profession.

The field of sports medicine is established and respected, and because sports therapy is an apt description, this term would be more readily understood by others, and would

strongly suggest a paramedical profession. The study of sport is recognized as being of academic interest (e.g., sport history, sport psychology, sport philosophy). "Sport," then, is apparently more appropriate than "athletic" in gaining recognition of the profession as an academic discipline. Interestingly, our colleagues in the American Physical Therapy Association (APTA) have already established a sports physical therapy division within their organization; however, not only is there an important difference in that name, but its emphases and applications differ as well. Sports physical therapy is primarily concerned with the rehabilitation of sports injuries and is not usually practiced in the sports setting (i.e., during practices and games).

It can be argued from a traditionalist point of view that until the terms athletic training and athletic trainer are used regularly and appropriately, the profession will not be recognized or respected. According to Aten (3), who argued for the use of current terminology, physical therapists in the 1960s were referring to themselves as "physical medicine specialists." Later, the simpler term "physical therapist" gained acceptance. A critical difference between the stories of the two professions is that the title "physical therapy" is both accurate and descriptive, whereas "athletic training" is not. The problem for the athletic trainer is magnified as other professionals choose to refer to themselves as trainers (e.g., personal exercise trainers). Although it may be further argued that the traditional terminology is already entrenched in the NATA, including its printed materials and public relations efforts, it is not established either in the minds of the general public or in the academic arena.

Now is the time to develop a title that will not hinder the rapid progress of this field. The title needs to be consistent with modern definitions and to reflect the major performance domains of the profession. A description of the field of study should be placed in the appropriate dictionaries. Athletic trainers are not suffering from an identity crisis; we know who we are and what we do. It can be argued, however, that our profession suffers from a "name crisis."

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Athletic Trainer Performance: Standards for the Development of Evaluation Systems

Richard Ray, EdD, ATC

ABSTRACT: The role of standards-based performance evaluation in an overall program of athletic trainer personnel management is poorly understood. Athletic trainer performance evaluation should: (1) facilitate professional development, (2) increase athletic trainer accountability, and (3) provide legal protection against unfair employment practices. This article contains a discussion of the theoretical basis for performance evaluation and guidelines for the development of systems of athletic trainer performance evaluation based on the 21 standards developed by the Joint Committee on Standards for Educational Evaluation.

Performance evaluation is the process by which organizations evaluate employee job performance (26). The practice of performance evaluation, although it can be traced to ancient China around 1000 B.C., has only been practiced in the field of health care since the 1960s (54). Performance evaluation in athletic training is a much more recent phenomenon and has not been widely implemented as a tool for quality assurance in the health care of athletes (48). Awareness of the role of performance evaluation in an overall program of personnel administration is lacking in the athletic training profession. Unfortunately, many athletic trainers view performance evaluation as nothing more than completing a yearly appraisal form. Informed practitioners recognize that effective performance evaluation is an ongoing process. The purpose of this article is to inform athletic trainers of the benefits of valid and reliable performance evaluation and to outline the essential components of effective performance evaluation systems.

PERFORMANCE EVALUATION THEORY

Little has been written on the evaluation of athletic trainer performance. Of the few printed resources intended for athletic training audiences, most advocate performance evaluation systems that are predominantly trait-oriented (40,41). Most theorists have indicated that this trait-oriented approach has many drawbacks (2,5,6,8,24). It can result in spurious conclusions regarding the effectiveness of an employee's performance because of the lack of validity and reliability inherent in trait-oriented systems of evaluation (14,15,20,22,23). Abstract personal traits such as loyalty, honesty, and neatness are difficult to define and document. For example, Cascio and Bernardin (10) surveyed 47 executives and discerned 75 different definitions of the construct "dependability."

The domains of athletic training were identified in the 1960s and refined in 1982 and 1990 (35). No standards for the evaluation of athletic trainer performance within these domains of practice have been investigated (31,38). The first and only published assessment of the quality of services provided by athletic trainers did not appear until 1989 (19). This topic has not received widespread attention in athletic training literature, though several unpublished investigations into the performance evaluation practices of athletic trainers have been conducted (45,46,47,56). In a survey by Ray (46), fewer than half of the athletic trainers who direct NCAA Division 1 programs indicated that they were formally evaluated at least once per year. Only 35% of the athletic trainers employed in professional athletics are formally evaluated (45,46,47). Steffen and Trostmiller (52) reported in their study of evaluation practices in physical therapy, a profession closely related to athletic training, that only 43% of those surveyed were satisfied with the performance evaluation practices that were part of the quality assurance programs in their facilities.

Evaluation of student and entry-level athletic trainers has been the focus of substantial investigation (7,13,17,27,28,29,30, 44,50,53). NATA has developed competencies for the entry-level athletic trainer (32). Similar efforts have been made to improve evaluation practices for pre-service athletic trainers (33,34). Despite the advances made in evaluating student and entry-level athletic trainers, no standards have been applied for evaluating athletic trainers beyond the entry level. This important responsibility has been left to the discretion of the institutions that employ athletic trainers. Many of these institutions evaluate the athletic trainer in a manner that is incongruous with accepted evaluation standards of practice, if they evaluate the athletic trainer at all (45,47).

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PERFORMANCE EVALUATION METHODS

Disagreement exists among practitioners regarding which methods are most effective for rating employee performance (48). The performance evaluation methods used should be appropriate for the purposes and defined uses of the evaluation (49). No single method of performance evaluation will match every setting or meet the need of every organization (48). Table 1 contains a summary of the potential weaknesses of the most common performance evaluation methods.

The seven most common performance evaluation methods are: (1) management by objectives, (2) written essays, (3) critical incident reports, (4) graphic rating scales, (5) weighted checklists, (6) ranking, and (7) behaviorally-anchored rating scales. Fowler and Bushardt (20) developed a method called task oriented performance evaluation system (TOPES), that is alleged to be a simple, job-specific method of measuring performance. Unfortunately, it has not been extensively field tested or validated in different settings or uses.

Hagerty, Chang, and Spengler (21) have described a performance evaluation method known as work sampling that may have possible applications to athletic training. They describe work sampling as, "a technique that can identify the types of activities that staff perform and the amount of time they spend on each activity." As such, it can be used both for performance evaluation and job analysis. Work sampling consists of logging the activities of employees at randomly selected times and analyzing the data to make judgments on the nature and the quality of the work being performed. Employee behaviors are then categorized as either appropriate or inappropriate. Appropriate behaviors are those activities that facilitate the goals and objectives of the institution. Inappropriate behaviors are those activities that duplicate effort, are extraneous to the purposes of the institution, are undertaken to fulfill only personal or social wants, or are not suited to the employee's qualifications (21). Keaveny and McGann (25), in their research into performance appraisal format and its influence on role clarity and evaluation criteria, determined that behaviorally-anchored rating scales were superior to various types of graphic rating scales in assisting higher education faculty members to understand: (1) the performance dimension being rated, (2) the perceived performance level for each rating dimension, and (3) the behavior changes that would be necessary to improve ratings for each performance dimension.

PERSONNEL EVALUATION STANDARDS

A publication that is likely to influence performance evaluation is *The Personnel Evaluation Standards* (24). The performance evaluation standards contained in this book represent the collective wisdom of 14 professional educational associations with more than three million members. The purpose of the book is to provide a group of widely accepted evaluation principles to which educational professionals can compare their present personnel evaluation systems. These standards may be adopted by policy boards as the official standards by which performance evaluation systems are judged. If this happens, it is likely that athletic trainers who work in educational institutions will be influenced.

Because the majority of athletic trainers are employed in educational settings (36), they should acquaint themselves with the principles of performance evaluation based on *The Personnel Evaluation Standards*. Although the standards were developed for educational applications, they are rooted in principles of valid and reliable evaluation and could be applied in non-educational settings. Athletic trainers who are employed in professional athletics, sports medicine clinics, and industry also will benefit from the application of these standards in their job settings.

Table 1. Common performance evaluation methods

Method	Potential Weaknesses
Written Essays	Validity is dependent upon the writer's perception, skill, and judgment.
Graphic Rating Scales	Scale elements often are not valid or job-related.
Forced Choice Rating	Fails to provide specific feedback; not useful in human resource planning; does not relate job performance to selection criteria
Critical Incident Reports	Can be subject to writer bias; often based on subjective data; negative incidents usually receive more notice than positive
Ranking	Difficult to discriminate performance levels on multitask jobs; discourages cooperation among work-group members
Management by Objectives	Tends to emphasize what can be measured over those job characteristics that cannot be measured
Behaviorally-Anchored Rating Scales	Most useful for employees who have identical job responsibilities; expensive and time consuming to develop; difficult to update as job responsibilities change

The four domains of personnel evaluation standards described by the Joint Committee on Standards for Educational Evaluation (24) are outlined below and in Table 2.

Propriety standards reflect the fact that personnel evaluations may violate or fail to address certain legal and ethical principles. Propriety standards are aimed at protecting the rights of persons affected by an evaluation.

Utility standards are intended to guide evaluations so that they will be informative, timely, and

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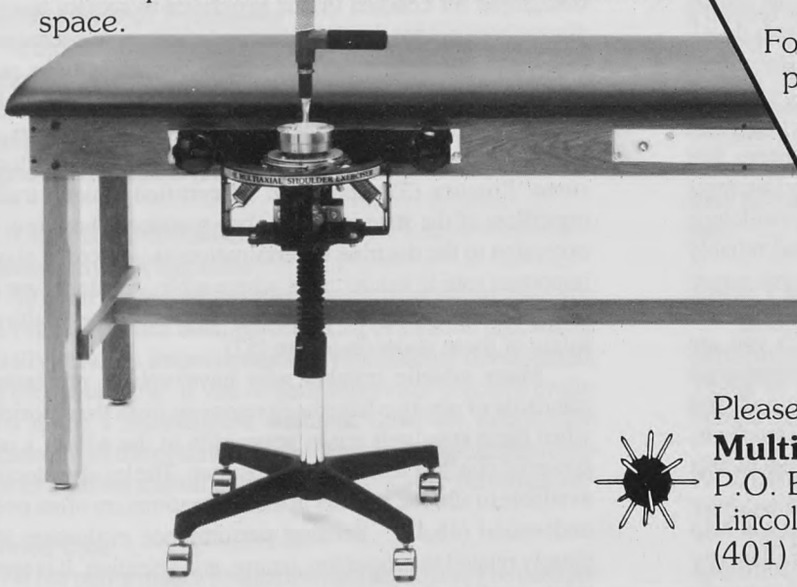

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Table 2. The personnel evaluation standards

Domain	Standard
Propriety	Service Orientation
	Formal Evaluation Guidelines
	Conflict of Interest
	Access to Personnel Evaluation Reports
	Interactions with Evaluatees
Utility	Constructive Orientation
	Defined Uses
	Evaluator Credibility
	Functional Reporting
	Follow-Up and Impact
Feasibility	Practical Procedures
	Political Viability
	Fiscal Viability
Accuracy	Defined Role
	Work Environment
	Documentation of Procedures
	Valid Measurement
	Reliable Measurement
	Systematic Data Control
	Bias Control
	Monitoring Evaluation Systems

influential. These standards require that evaluations provide information useful to individuals and to groups of educators for improving their performance.

Feasibility standards promote evaluations that are efficient, easy to use, and viable.

Accuracy standards aim at determining whether an evaluation has produced sound information about an educator's qualifications or performance.

There are three reasons why you should insist on having your performance evaluated according to the standards developed by The Joint Committee on Standards for Educational Evaluation. First, standards-based performance evaluation will help you improve your performance in a manner congruent with local institutional needs. An evaluation system that objectively documents strengths and weaknesses and attempts to mediate solutions in a collegial manner should be a welcome development. In addition, the ability to validly and reliably evaluate the performance of those employees whom you supervise is important if you are to demonstrate competence in the personnel management responsibilities with which you are charged (11). By understanding the state of performance evaluation in athletic training and comparing it to methods and techniques delineated in *The Personnel Evaluation Standards*, athletic trainers may be better prepared to succeed in this domain of professional practice.

Second, standards-based performance evaluation will help improve the quality of service that you render to your clients by improving your institutional accountability. Third, you can and should use valid and reliable performance evaluation as a legal shield against unfair employment actions. An increasingly sophisticated work force is using local, state, and federal statutes, as well as case law, to create a new and expanded doctrine of employee rights (51). The doctrine of termination-at-will, established by the U.S. Supreme Court in *Adair v. United States* (1), is being challenged successfully in many jurisdictions (4,6,12,42). The notion that employees, including athletic trainers, can be terminated without cause at any time is being subjected to legal criticism (10).

Several cases have demonstrated that medical and allied health professionals must act within their codes of ethics and strictly adhere to standards of professional practice (18, 43, 57). As allied health professionals, athletic trainers have a duty to uphold both the *Code of Professional Practice* and applicable state statutes under which they may be credentialed. Standards-based performance evaluation systems can help document that you are upholding these elements of public policy.

The California Circuit Court of Appeals (42) has defined public policy as, "that principle of law which holds that no citizen can lawfully do that which has a tendency to be injurious to the public or against the public good." The potential application to performance evaluation in athletic training stems from *Pierce v. Ortho Pharmaceutical* (43). In *Pierce*, the New Jersey Supreme Court recognized the right of a physician employed as a researcher at a pharmaceutical company to sue for wrongful discharge. The basis of the suit was that the plaintiff was terminated by the company for refusing to test a new drug on humans, a drug that contained a certain chemical in excess of the Food and Drug Administration guidelines. The court allowed the suit because it recognized the duty of physicians and other professionals to uphold both the statutes by which they are licensed and the code of ethics and standards of practice by which they are sworn to abide (18).

Statutorily-supported expressions of public policy are the most often recognized exceptions to the doctrine of termination-at-will. Such exceptions, however, are not always supported directly by state statute (4). Employees who have been discharged for conduct that is beneficial to society have not always been held to the rigid standard of showing a statutorily-defined public policy (39). Twenty-four states have established by statute a public policy to protect the health of athletic participants by regulating the practice of athletic trainers, and the National Athletic Trainers' Association's *Code of Professional Practice* (31) applies to all certified athletic trainers regardless of the state in which they practice. Therefore, this exception to the doctrine of termination-at-will could play an important role in future cases where athletic trainers are discharged for carrying out their duty to protect the health and safety of those under their care (57).

Many athletic trainers who have upheld professional standards of practice have been removed from their positions when these standards are in opposition to the will of a more powerful coach or athletic administrator. The legal protections available to athletic trainers in these situations are often poorly understood (46,47). Because performance evaluation is so closely related to promotion, tenure, and retention, it is appropriate, and in the best interests of the profession, that we

become more aware of how standards-based performance evaluation can provide legal protections against wrongful discharge and other unfair employment practices (9).

APPLICATION OF STANDARDS-BASED EVALUATION

The remainder of this article is devoted to specific suggestions that you and your supervisor should consider when developing, modifying, or evaluating performance evaluation systems. Recommendations are based on the 21 standards described in *The Personnel Evaluation Standards* (Table 2).

PROPRIETY STANDARDS

Service Orientation

Performance evaluation systems for athletic trainers should be designed so that they meet the needs of those persons whom they are intended to help, including you, your clients, and the institution that employs you. If any of these groups is neglected, the system should be reconfigured accordingly.

Formal Evaluation Guidelines

The procedures by which your performance is evaluated should be recorded as written institutional policy. These written procedures should be made available to you so you are aware of the process.

Conflict of Interest

Evaluation procedures should ensure that potential conflicts of interest are eliminated. For example, if you and your supervisor were both candidates for the same job promotion, your supervisor would have a conflict of interest when evaluating your performance. Formal evaluation procedures should contain clauses explaining how to avoid such conflicts.

Access to Personnel Evaluation Reports

Only those persons who have a legitimate "need to know" should be allowed access to your performance evaluation records. You should know who will have access to the information and under what circumstances such access will be granted.

Interactions with Evaluatees

You should be treated with respect and dignity when being evaluated. When your supervisor adopts a judgmental attitude, he or she is less likely to enhance your trust in the performance evaluation system. A counseling attitude is usually more helpful in this regard (16,55).

UTILITY STANDARDS

Constructive Orientation

In order for performance evaluation to be useful, both you and your supervisor must perceive that evaluation procedures actually result in improvements in professional development and accountability. If you or your supervisor perceive evaluation to be a meaningless waste of time, the information obtained from the evaluation is unlikely to be useful. Performance evaluation should help you improve your performance.

Defined Uses

Your performance evaluation data should only be used for the purposes for which it was collected. You should be informed of these uses prior to the collection of performance evaluation data. If the data is used for other purposes, it may not be valid. You also are likely to lose trust in the system if the information is used for other, unstated purposes.

Evaluator Credibility

The persons who evaluate your performance should have institutional authority and should be knowledgeable of your duties. In addition, they should be trained in the theory and practice of performance evaluation methods. The use of team physician and peer athletic trainer input can improve the credibility of your evaluation, because these persons are often more knowledgeable about your job responsibilities than coaches or athletic administrators.

Functional Reporting

In order for performance evaluation to be perceived as useful, you should be provided with both formal and informal feedback on job performance. This feedback should be job-related and timely and should contain specific suggestions for improvement of performance.

Follow-Up and Impact

The information derived from the evaluation of your performance should be used so that all recommendations promote professional development. An important component of the follow-up process involves the formation of a plan of professional improvement that focuses on identified weaknesses in your performance. This plan should be developed jointly by both you and your supervisor.

FEASIBILITY STANDARDS

Practical Procedures

Your performance evaluation should be designed so that evaluation procedures intrude as little as possible into the activities normally associated with your employment. Evaluation procedures that require you to direct significant energy and attention away from your clients will be viewed as impractical.

Political Viability

All users of the athletic trainer performance evaluation system should have input into its development so that the system will be accepted and used as intended. Evaluation systems that are designed without your input are unlikely to be effective tools for professional development, because they may be viewed as bureaucratic tools that interfere with your job.

Fiscal Viability

Institutions should recognize that effective athletic trainer performance evaluation systems require both time and money. Those in charge should build into the overall institutional budget the costs for evaluating your performance.

ACCURACY STANDARDS

Defined Role

You should be evaluated using job-related criteria for the specifically designed role for which you are responsible. This standard is especially important for athletic trainers because of

the wide variety of roles they often assume in addition to their athletic training duties. If evaluation data is collected and interpreted without regard to role definition, it is likely to lack validity in terms of evaluating your job-related performance behaviors. An important first step in defining your role is to develop a comprehensive job description (3,37). Also, your employer is likely to improve both the validity of performance evaluation and your understanding of their performance expectations if he or she assigns a weight to each task included in the position description (20). This procedure has the advantage of communicating to you those tasks that are considered the most important for a favorable review of performance.

Work Environment

The specific attributes of your work environment should be recorded during the performance evaluation process so that individual differences in working conditions can be considered in the final evaluation.

Documentation of Procedures

The procedures that are actually followed during the evaluation process should be recorded so that you and other users of the information can compare actual with intended evaluation procedures.

Valid Measurement

Procedures developed or adopted for the purpose of evaluating your performance should measure the job-related behaviors they are actually intended to measure so that accurate conclusions regarding your performance can be deduced. Institutions should be able to defend the accuracy of the procedures used to evaluate your performance.

Reliable Measurement

Institutions should ensure that methods used to evaluate your performance are consistent across time and for different evaluators. Use of multiple evaluators who are trained to follow specific evaluation procedures is a good way to build reliability into the evaluation system.

Systematic Data Control

The information collected during your performance evaluation should be recorded and stored to allow retrieval at a later date, so that future interpretations are similar to those conclusions drawn immediately after your performance evaluation.

Bias Control

All possible biasing factors should be eliminated from your performance evaluation so that accurate conclusions can be reached. The use of multiple evaluators is an effective technique to help reduce bias. In addition, only job-related behaviors should be included for evaluation. Personal traits that are unrelated to your actual job performance should not be considered in the performance evaluation.

Monitoring Evaluation Systems

Since the circumstances related to your job may change over time, the systems used to evaluate your performance should be modified as well. Institutional policies should require periodic evaluation and modification of performance evaluation systems.

CONCLUSION

Standards-based performance evaluation is important if athletic trainers and those who employ them are to validly and reliably assess the strengths and weaknesses of the post-entry-level practitioner. The practice of using biased, trait-oriented evaluation methods not only fails to adequately address our professional development needs, but also may do a disservice to the growing population of injured athletes who comprise our client base. The 21 performance evaluation standards identified by the Joint Committee on Standards for Educational Evaluation provide the basis for improvement of performance evaluation systems in every employment classification of our profession.

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1891, Dr. J. Naismith invents basketball.

1893, women begin to play.

1900, dribbling two-handed, first allowed.

1930's, underhand shot is common.

The sport has changed since we invented basketball, but our aim is still the same.

1936, Hank Luisetti, the one-handed shot.

1940's, George Mikan, the pro's first dominant "big man."

1962, Wilt "The Stilt" scores 100 points in one game.

1991, some guys can't stop reinventing the game.

Since Dr. James Naismith created basketball 100 years ago at the YMCA training school, our goal has been to help kids develop self-esteem and strong moral values. Because we believe that's what they need to take their best shot at life.

YMCA

A YMCA INVENTION BASKETBALL 100 1891-1991 CENTENNIAL

Tip From the Field

Spica Variation for the Hyperextended Thumb

Mark P. Doughty, MS, ATC

The thumb plays a vital part in the athlete's ability to catch, throw, and grasp. An injury to the thumb can seriously limit these integral actions associated with most athletic events. It is the role of the athletic trainer, following proper evaluation, referral, treatment, and rehabilitation, to protect this very functional part of the athlete's hand. If not effectively protected, an acute injury of the thumb can become a chronic instability.

The thumb differs from the other digits in that, functionally, stability is of more importance than mobility (1). Therefore, when faced with protecting an injured thumb during competition, the basic requirement is an adequate support that protects the joint and, at the same time, allows acceptable function with minimal discomfort to the patient (2).

Normal spica taping for metacarpal phalangeal (MCP) injuries of the thumb does not always supply adequate support (3). This past basketball season, I was faced with a straight extension injury of the MCP joint that involved a sprain of the volar capsule. Conventional spica taping did not give enough stability to the joint to prevent painful extension and to allow the athlete to perform with confidence. Increasing stability with a modified technique, which included taping through the hand, made it difficult for the athlete to catch. Therefore, an effort to minimize taping in the hand while maximizing support was necessary. A simple variation of the standard technique was applied with successful results.

MATERIALS

1 inch tape
tape underwrap
tape adherent spray

METHOD

- Spray thumb and wrist with adherent spray.
- Apply tape underwrap around wrist.
- Begin taping with several anchor strips around the wrist and an anchor strip around the thumb. The thumb anchor must be just proximal to the phalangeal joint to allow movement of the distal segment.
- Angle a strip from the palmar aspect of the thumb across the area of the pisiform at the wrist, pulling the thumb slightly into flexion (Figure 1).
- Apply a second strip beginning on the radial aspect of the thumb, crossing over the first strip (Figure 2).
- A third strip beginning on the ulnar side of the thumb is then applied, crossing the first and second strips (Figure 3).

Figure 1. Pull thumb into slight flexion with tape.

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- Next, apply two to three conventional spica straps (Figure 4). Continue to hold the thumb in slight flexion.
- Finish with strips beginning on the dorsal aspect of the hand and finishing on the palmar aspect, again supporting the thumb into flexion (Figure 5).

Figure 2. Begin second strip on radial side.

Figure 3. Begin third strip on ulnar side.

Figure 4. Add conventional thumb spica over supporting strips.

Figure 5. Apply final supporting strips dorsal to palmar.

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Tip From the Field

Reusable Slip-On Padding for Painful Foot Conditions

Steve Wilcox
David O. Draper, EdD, ATC

Commercial pre-cut pads are manufactured for almost every type of common structural foot condition. Typically these pads are used in the post injury stage (1,4). But, they can be used to help prevent injury as well. For example, a medial longitudinal arch pad can be used on a cavus foot. Although effective, their cost might be prohibitive if your program is on a limited budget. Also, unless the pad is attached to an orthotic, you have to tape it daily to the athlete's foot. If you or a student athletic trainer do not travel with a team, the athlete or coach will need to tape the pad to the foot, and may attach it in the wrong place. One solution to these problems is the slip-on pad.

MATERIALS NEEDED FOR MAKING THE SLIP-ON PAD

1) Sheet of 1/4" thick foam padding material
2) 3" wide Conform or Expandover elastic adhesive tape
3) Overhead projector felt tip marker
4) Scissors

METHOD

Draw the outline of the desired pad on the plantar aspect of the subject's foot (Figures 1,2). Lay the sheet of padding on a firm surface and have the athlete step on the padding (Figure 3). The ink will leave an impression on the padding (Figure 4). Cut out the pad. Depending upon the size of the treatment area, wrap one or two strips of elastic adhesive tape around the foot, with the adhesive side up (Figure 5). Place the pad in the desired area (Figure 6). Cover the pad with one to two strips of elastic adhesive tape with the adhesive side down (Figure 7). Trim away any excess tape, making sure to clean up any uneven edges. The encased pad may now be slipped off by the athlete and is readily available for the next practice (Figure 8).

When padding for sesamoiditis or metatarsalgia, the elastic adhesive tape is wrapped around the metatarsal arch; for a medial longitudinal arch strain, it is wrapped around the trans-

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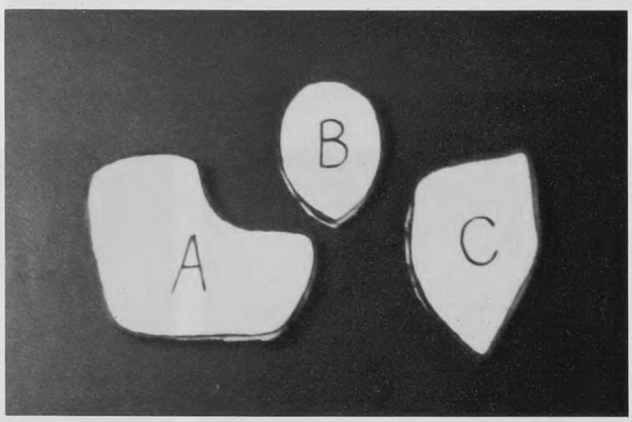

Figure 1. Padding for various foot conditions - a) sesamoiditis, b) metatarsalgia, c) medial longitudinal arch strain

Figure 2. Using an overhead projector marking pen, draw the desired pad on the foot.

Figure 3. The athlete steps onto the padding material.

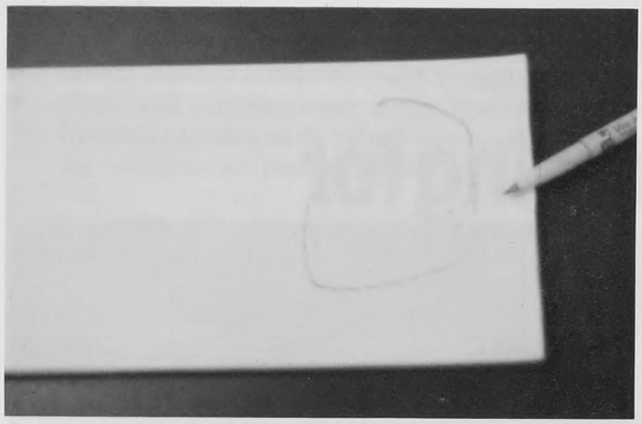

Figure 4. The ink on the foot will leave an impression on the padding.

verse arch. Also, if you are unaware of the design and placement of pads for various conditions, consult a text that covers this area before attempting to make a pad (2,5).

Under typical conditions, the pad should last about two weeks. When the athlete notices that the pad has lost its resilience, he or she should ask you to construct a new pad.

DISCUSSION

Some painful conditions of the foot are caused by biomechanical malalignment of the foot and ankle complex and may require a custom-made orthotic device (1,2). Minor problems often don't require an expensive orthotic and can be corrected or compensated for with a foam or felt pad. The treatment of sesamoiditis, metatarsalgia, and strained medial longitudinal arches should, in many cases, include protective padding. With little effort, you can construct effective slip-on

Figure 5. Wrap one or two strips of elastic adhesive tape around the foot with the adhesive side up.

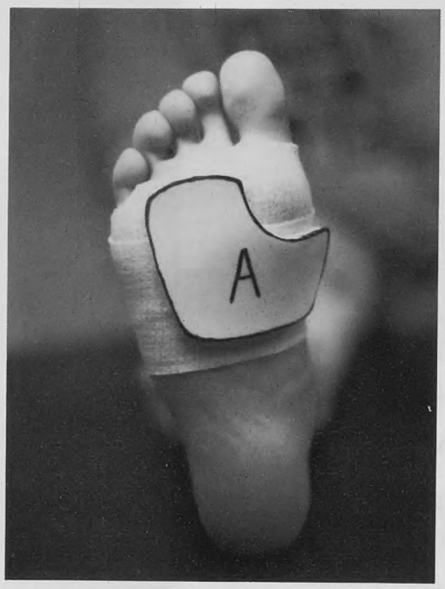

Figure 6. Attach the cut-out pad to the desired treatment area.

Figure 7. Cover the pad with one to two strips of adhesive elastic tape with the adhesive side down, and trim any uneven edges.

Figure 8. The encased pad can easily be slipped on for each practice or competition.

pads and show athletes how to position them correctly. The purpose of slip-on padding is to save money and time used in reconstructing a new pad every day. The pad also provides the athlete with a ready-made device for those events that you cannot attend.

Sesamoiditis, metatarsalgia, and medial longitudinal arch strain are three painful conditions of the foot (1,2,3). Treatment of these injuries often includes rest, cryotherapy, thermotherapy, and use of oral anti-inflammatory medication and protective padding (4). The primary purpose of protective foot padding is to reduce stress and friction, and to provide support to the affected area (5). Although not entirely scientific, there are opinions as to why padding for these three conditions might be effective (2,4,5).

Sesamoiditis is an inflammation of the tissues surrounding the sesamoids (1,6,7). A major contributor to this condition is a rigid first ray (6). The pad for sesamoiditis is thought to place the foot near its neutral position, while balancing the forefoot so

that the weight is taken off the painful sesamoid (6). We are of the opinion that the pad actually distributes some of the pressure to the lateral aspect of the forefoot while alleviating stress on the rigid first ray.

Metatarsalgia is a condition in which a weakened transverse arch allows the metatarsal heads to become depressed. Then, the metatarsal heads rub on the interdigital nerves, which can lead to neuritis (6). The rounded section of the teardrop-shaped metatarsal pad is placed under the metatarsal heads. As the athlete bears weight on this area, the metatarsal heads spread out and pressure is taken off the affected area (1,2,6).

Medial longitudinal arch strain is often a result of an inflamed plantar fascia or spring ligament (1,4). Whether the cause is prolonged pronation or a cavus foot, the end result is a painful medial longitudinal arch. The arch pad pushes the affected soft tissue up against the bony structures. This relaxes and takes the pressure off of the plantar fascia and spring ligament while supporting the bony arch (1,2,4,6).

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Tip From the Field

Using Standard Crutches for Persons Over Seven Feet Tall

Scott A. Street, MS, ATC
Walton W. Curl, MD

Athletic trainers are accustomed to dealing with many injured athletes. Athletes over seven feet tall are a challenge if their injury requires them to use crutches. Currently, there are no commercial crutches available that fit this group of individuals; neither standard, shepherd, or Luconex "push-button" crutches accommodate their needs. However, it is possible to create a proper-fitting pair of crutches by combining two pairs of standard wooden or aluminum crutches using the following steps.

Step 1. Remove the two height adjustment pieces from one set of the crutches (Figure 1).

Step 2. Fully extend the second pair of crutches and remove the rubber crutch tips (Figure 2).

Step 3. Attach the height adjustment pieces to the second pair of crutches using the screws and bolts from the first pair of crutches (Figure 3).

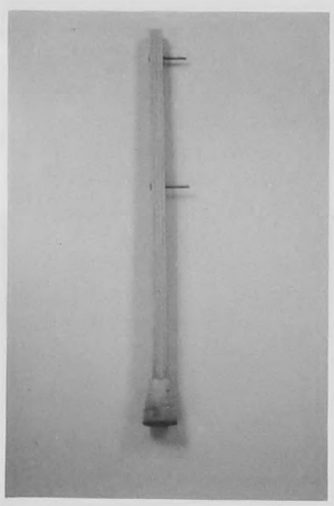

Figure 1.

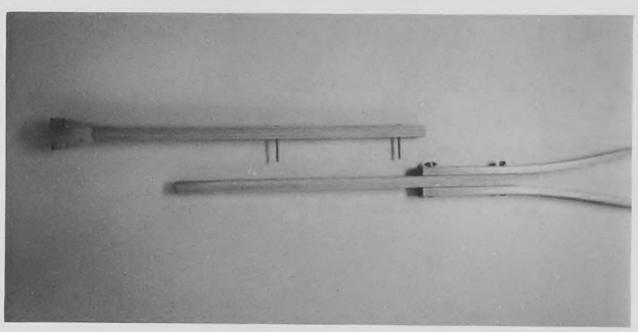

Figure 2.

Figure 3.

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Walton Curl is Director of Sports Medicine and Team Physician at Wake Forest University, and Associate Professor at the Bowman Gray School of Medicine.

Now you are ready to fit the crutches to the athlete. Place the crutch tip six inches from the outer margin of the shoe and two inches in front of the foot (Figure 4). Position the underarm crutch brace one inch below the anterior fold of the axilla (Figure 5). Place the hand brace even with the athlete's hand while the elbow is flexed approximately 30° (Figure 6). Once the crutches are properly fitted, the athlete can return to his or her daily activities, hampered only by the injury.

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Figure 4.

Figure 5.

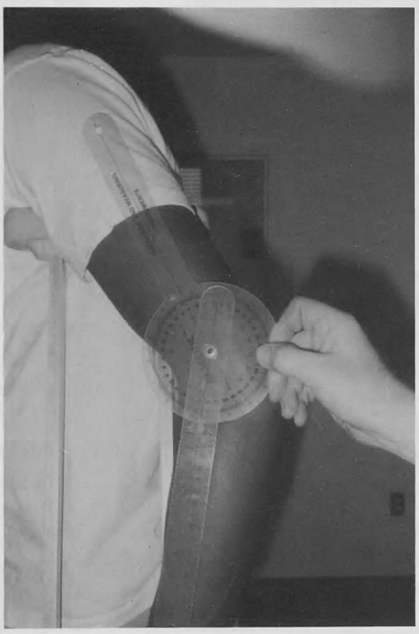

Figure 6.

Student Athletic Trainer Forum

Deloss Brubaker, EdD, ATC

Athletic Amenorrhea: Updated Review

Glendie Worthington

EDITOR'S NOTE: Congratulations to the winners of the Student Writing Contest. They were:

Glendie Worthington, Eastern Washinton University, winner
Hideyuki "E" Izumi, Ohio University, 1st runner-up
Lisa Johnson, James Madison University, 2nd runner-up
Jennifer Smith, Eastern Michigan Univerity, 3rd runner-up

Ms. Worthington received a plaque and an $800 prize at the Student Awards Banquet at the National Convention in New Orleans. Her winning paper is below.

ABSTRACT: Women recently have become more physically active in the world of competitive sport. This increase in sport participation has caused a parallel increase in the research of exercise-induced menstrual dysfunction, specifically amenorrhea. Factors such as intense training, diet, and body composition have been linked to amenorrhea, but no specific answers have been found. It is known, however, that endurance-type sports are more likely to produce amenorrheic women and that there could be associated long-term negative health effects Osteoporosis and stress fractures have been identified in women with previous histories of amenorrhea. The young amenorrheic athlete needs to be aware that her condition could be dangerous in the future. She can be treated for amenorrhea with either hormonal supplementation or counseling.

Over the past ten years, athletic participation has become exceedingly popular among the female population of the United States. Accompanying this boom in women's athletics is an increase in research covering the effects of strenuous exercise on the female body. Much of this research explores the possible causes and effects behind exercise-induced menstrual disturbances, the most common of which is amenorrhea.

Amenorrhea affects many female athletes for different reasons. Diet, intense training, body composition, and delayed menarche all may have a hand in the mysterious cause of amenorrhea. Evidence to date suggests that amenorrhea also may be linked to increased incidence in stress fractures and osteoporosis. Some doctors even believe that it could lead to infertility. Unfortunately, one single justification for the onset of athletic amenorrhea has not been found. The following review will examine the current literature relating to the potential causes and associated effects of athletic amenorrhea.

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THE MENSTRUAL CYCLE

In order to understand athletic amenorrhea it is imperative that one obtain a basic knowledge of the normal menstrual cycle. Average age of menarche (the beginning of menstruation) ranges from 12 to 13 years with the first few periods being sporadic. Ovulation will occur with the first surge of luteinizing hormone from the pituitary gland.

Following ovulation, a regular menstrual cycle will begin. This cycle should include 12 periods per year at 28 ±5 day intervals. Each menses lasts three to seven days (6). The menstrual cycle is regulated by a complex balance of hormone and other chemical secretions. If for any reason this balance is upset, disturbances in the cycle may occur. The most common of these is amenorrhea.

AMENORRHEA

Amenorrhea is the absence or abnormal cessation of menses. It is not, however, as simple as that. There are several categories and variations of amenorrhea. Primary amenorrhea is defined as an absence of menstruation in which menses have never occurred; the adolescent female has not begun to menstruate by age 16. Secondary amenorrhea is a condition in which menses appeared at puberty but since have been suppressed. This condition often affects female athletes. Some women experience a variation of amenorrhea called oligomenorrhea or infrequent menstruation (3).

With the many studies examining menstrual dysfunction, amenorrhea has been defined again and again. According to Drinkwater (6), classification of amenorrheic athletes should follow these criteria:

1. Athlete has had three or less periods in the past year (none in last six months).
2. Regular menses began within 18 months of menarche.
3. Training began before onset of amenorrhea.
4. No birth control pills were taken in the six months prior to onset of amenorrhea.

5. No signs of pregnancy, ovarian failure, pituitary tumor, hyperandrogenism, or hyperprolactinemia are present.

INCIDENCE

Amenorrhea affects many different women; however, nulliparous (having never been pregnant) athletes may be more susceptible to amenorrhea because they may have an immature hypothalamic-pituitary-ovarian axis. This possibility implies that pregnancy may protect against amenorrhea (6,12). Menstrual dysfunction is also more prominent in athletically-inclined females. According to current literature, the young, competitive female athlete is at greater risk for amenorrhea than her less active counterpart. In fact, amenorrhea has been shown to affect up to 50% of competitive runners, 44% of ballet dancers, 25% of noncompetitive runners, and 12% of cyclists and swimmers. Hence, amenorrhea has been associated more with running than with any other sport (6,17). With this information in mind, it is safe to say that a young, nulliparous runner will more often experience amenorrhea than the typical nonathlete (3).

POTENTIAL CAUSES

Body Composition

The lean look is in. In fact it is the one look for which most women, especially athletes, strive. Many sports these days identify closely with a requirement for low body weight (12). For the amenorrheic athlete though, this may present a problem.

Amenorrhea has been attributed to excessive weight loss, extremely low body weight, and a low percentage of body fat (2,6,10). Many studies support this premise with reports of high levels of menstrual disturbances, particularly amenorrhea, in lean female athletes. This indicates that fat content plays a major role in determining the menstrual status of an athlete (21). One study performed on 240 collegiate runners across thirty states revealed a connection between amenorrhea and low body weight (1). Of the athletes examined, 50% had a history of menstrual dysfunction. The average body weight of these runners was 113 lbs. Barrow and Saha (1) found that the incidence of amenorrhea in this case was closely associated with low body weight and high training mileage.

In extreme situations, weight loss of up to 13% of ideal body weight is usually accompanied by amenorrhea. Although low body weight may not be a problem for every amenorrheic athlete, a decrease in percent body fat as a result of weight loss can be. Weight loss generated by intense training usually stabilizes, but body fat can continue to decrease. This decrease in adipose tissue may have a negative effect on estrogen production; thus, amenorrhea may occur (6,12,18).

There is much speculation about low percent body fat being a cause of amenorrhea. Nonetheless, it is clear that low body fat appears more frequently in amenorrheic and oligomenorrheic athletes.

Diet and Eating Disorders

Diet is another factor directly affecting female athletes. Many athletes believe that attaining a slim body will improve their performance; therefore, this thought tends to rule their eating habits. Recent research indicates that nutritional status and diet can affect the reproductive system, but whether this is a cause of amenorrhea remains to be proven. It is known that the dietary intakes of amenorrheic athletes are, for the most part, inadequate (5,6).

Runners adhering to vegetarian diets report higher rates of athletic amenorrhea (19). Many women following a "no meat" diet do not receive enough protein. In fact, 82% of the amenorrheic runners observed in one study were below the United States Recommended Daily Allowance (USRDA) in protein levels (17). Along these same lines, results of a study performed by Carlberg (3) on intensely trained distance runners indicated significantly low caloric intakes in the amenorrheic group, as well as low protein, fat, and zinc levels. Another similar study exhibited the same results, but added that carbohydrate intake in amenorrheic athletes was lower than that of the control group (5). The combination of these reports suggests that low food and nutrient intake may be causally related to amenorrhea.

Prolonged amenorrhea also has been associated with eating disorders (2). In earlier mentioned research, 47% of the amenorrheic runners had previous histories of eating disorders (1)

According to Gadpaille et al. (9), anorexia seems to be an essential feature of amenorrhea. Of the 13 amenorrheic runners interviewed in their study, eight reported major eating disorders. Of the 19 regularly menstruating runners in the control group, none reported a history of eating disorders.

This correlation between anorexia nervosa and amenorrhea also has been closely affiliated with ballet. A study performed by Brooks-Gunn et al. (2) reported that 50% of the amenorrheic dancers examined had suffered either anorexia nervosa or bulimia. Parallels between amenorrhea and anorexia nervosa include low food intake, ritualized dietary habits, heightened energy and activity, and compulsive behavior (1).

Training Intensity

Exercise has been shown to increase the rate of amenorrhea and oligomenorrhea from 5% in sedentary women to 20% in female athletes (15). This fact does not include the intense training performed daily by a varsity athlete or Olympic marathon runner. Highet's (12) research indicated that numerous studies suggest that strenuous exercise rather than a lean/fat ratio is the major factor affecting the menstrual cycle (12). Two components can be directly correlated with this theory. These include the physical and psychological stresses associated with intense physical activity, and the hormonal imbalances known to occur during intense training.

Among distance runners who train intensively, the frequency of amenorrhea has been positively associated with the number of miles run per week. A 6% rate of amenorrhea was noted in distances of 10 miles per week. A higher percent (approximately 43%) was found with distances of up to 60 miles per week (6).

Evidence also exists that connects hard endurance training (such as distance running) with suppression of the hypothalamic pituitary-ovarian axis. This can result in a decrease in the pulsatile secretion of luteinizing hormone (LH), which in turn may cause menstrual disturbances (13,14).

Menarcheal Age

With the onset of puberty, the beginning of menstruation

approaches. Once the body has matured sufficiently, a female may reach menarche (the first menstruation). The average age for this is 12.8 years; however, certain factors may delay this time frame (22). Research has shown that intense physical training before puberty delays menarche. Studies also have exposed the possibility that delayed menarche may be related to amenorrhea (6,12,23).

As cited in Drinkwater (6), a study comparing the relationship of intense training prior to menarche with athletic amenorrhea was performed on swimmers and runners involved in strenuous training. The results were in agreement with other research studies. The premenarcheal trained athletes had four times the incidence of amenorrhea compared to the control group (6). In another survey of 55 ballet dancers, the mean age of menarche was 14.8 years (2). This is later than the average age of 12 to 13 years old. Because athletics favors those who are late in maturing, it is safe to say that strenuous training may delay menarche, which in turn may increase the risk of later menstrual problems in female athletes (12,23).

Related Sports

Amenorrhea was first recognized in female distance runners many years ago. Since that time, many more activities have been added to the list of sports directly associated with amenorrhea, most of which are endurance-type activities. The sports most commonly associated with amenorrhea are distance running, ballet, gymnastics, and cycling. However, Sinning and Little (21) state that the occurrence of amenorrhea is not consistent across sports. Runners and dancers have a higher incidence of amenorrhea than do cyclists and gymnasts. Even so, gymnasts and cyclists have a higher rate of amenorrhea than the nonathletic population (8,12). There are other sports in which strenuous participation may initiate amenorrhea, but most of the current research available lists the previous four as most common. Other activities occasionally mentioned in research regarding amenorrhea are rowing, tennis, track and field, and weight lifting (12).

ASSOCIATED EFFECTS

Osteoporosis

Osteoporosis is a decrease in the bone mineral density in the body that affects all postmenopausal women. As women age, their estrogen levels decrease causing an increase in bone sensitivity to parathyroid hormone. This process causes an increase in calcium ion release from the bone, which in turn results in decreased levels of bone mineral density. It is a normal process that all women must go through. However, studies show that amenorrhea may initiate early loss of bone mass (4,6). This decrease in bone density may not be important to a young athlete, but as she goes through life, this bone mass deficiency will increase her susceptibility to fractures (12). The fact that low bone mineral density increases the risk of fractures is a critical consideration for female athletes.

Stress Fractures

Studies have shown an increase in the rate of stress fractures in amenorrheic athletes (1). One case study examined the incidence of stress fractures in a 26 year old distance runner training for the Olympic trials. This particular woman ran 110 miles per week on the average. She had ceased menses at the age of 16 with no significant weight loss or diet change. Over a three year period, age 23 to 26, she developed stress fractures of the navicular, metatarsals, tibia, and four ribs. At the time there was no evidence of bone disease. The examiners linked the occurrence of these fractures in this particular athlete to her menstrual status (23).

Barrow and Saha (1) also noted a high prevalence of stress fractures in their study, mentioned earlier. The runners under examination were classified by menstrual status into three groups—regular, irregular, and very irregular menstruation. The results showed a 37% overall prevalence rate of stress fractures, most of which were in the tibia.

Results of another study of 267 collegiate female athletes supported the relationship between stress fractures and amenorrhea. The frequency of stress fractures in the amenorrheic group was four times that of the control group (15).

Infertility

Currently, there are no cases of amenorrhea that can be directly connected with infertility (3). However, anovulation and hypoestrogenemia both are closely associated with amenorrhea and also have been listed as causes of infertility (12,20).

The majority of female athletes, whether menstruating regularly or not, experience short luteal phases. In other words, the portion of the menstrual cycle following ovulation is shorter than 12 days. Recent studies show that as training increases, the length of the luteal phase decreases (3,6,20). This is usually accompanied by a decrease in progesterone and estrogen secretion called hypoestrogenemia. This reduction of progesterone may leave the endometrium unprotected, possibly leading to infertility.

Anovulation is a similar condition in which there is a continuous release of estrogen with little or no production of progesterone (12,20). Hypoestrogenemia can be hormonally treated, as can anovulation. These two conditions must be examined closely because they may lead to infertility.

MANAGEMENT OF AMENORRHEIC ATHLETES

The effects of short-term amenorrhea appear to be reversible. In fact, amenorrheic athletes who have decreased their training intensity and normalized their eating habits have been shown to return to normal menstruation (3,7,12,21). In most cases though, the answer to amenorrhea is not that easy.

According to Goldfarb (11), any woman who stops menstruating for two or more months needs to undergo a full physical examination. This physical should include a pelvic exam and blood tests (screening for hyperprolactinemia and primary or secondary hypothyroidism). Checks for ovarian failure and pregnancy also should be made. Pregnancy can surprise an amenorrheic athlete, because menses may resume spontaneously, returning ovulation to normal (11,20).

Highet (12) suggests following these steps in the management of an amenorrheic athlete:

1. Review the goals of the patient (competition, stress, diet).
2. Review the diet and exercise pattern (possibly refer her to a dietitian).
3. Evaluate her for other causes.
4. Evaluate bone mineral density.
5. Counsel the patient based on evaluation.

6. Ensure a calcium intake of 1500mg daily.

After all of these factors have been taken into consideration, it is necessary to treat the condition as secondary amenorrhea. Many doctors recommend the birth control pill to decrease estrogen levels in the body (1). Other gynecologists suggest a ten day course of medroxyprogesterone acetate to increase the progesterone levels in anovulatory women (20). Estrogen therapy is not advised for females under the age of fifteen because it suppresses the hypothalamic cycle, thus interfering with normal maturational processes (16,24). Whatever the situation, amenorrhea should be treated thoroughly and with great consideration for the athlete.

CONCLUSION

Amenorrhea is a problem that remains unsolved because many variables are associated with this condition. Strenuous exercise, dietary intakes, and body composition are associated closely with menstrual dysfunction. Therefore, common sense should tell us that a reduction in training intensity and a diet adequate in nutrients could control this problem.

A female athlete involved in an intense training regimen must be informed of the potential health risks, such as recurring stress fractures, early onset of osteoporosis, and infertility associated with prolonged amenorrhea. Realizing the severity of these effects may aid the athletic trainer and the athlete in the management of this condition.

Amenorrhea is a condition that may lead to decreased performance and potential health hazards for a female athlete. Amenorrheic athletes should be treated either clinically with estrogen supplementation or with counseling. An attempt should be made to treat this disturbance with as much concern as any other athletics-related injury or illness.

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The Tissue Injury Cycle and New Advances Toward Its Management in Open Wounds

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ABSTRACT: This paper explains the physiology behind the soft tissue injury cycle and the new advances in dressings that promote healing. The tissue injury cycle is divided into three phases of healing: inflammatory, proliferative, and remodeling. In the inflammatory phase, the wound is debrided of waste and toxic materials. In the proliferative phase, the wound resurfaces itself and gains 25 to 30% of its original tensile strength (8). Finally, in the remodeling phase, the scar matures and gains up to 80% of the original tensile strength.

A new type of dressing categorized as a hydrocolloid has been discovered, which seems to promote healing. Healing is accomplished by removing excess exudate and toxic components, by providing a moist healing environment that promotes cell migration, by maintaining an impermeable wall to bacteria unless its seal is broken, and by allowing easy dressing changes that prevent disruption of newly re-epithelized tissue. The disadvantages are the opaqueness of the dressing, the lack of anti-bacterial properties, and the inability to use this dressing with third degree burns.

This paper describes the normal tissue injury cycle without infection. The tissue injury cycle is important to the athletic trainer's rehabilitation protocol for open and closed wounds because treatments are specific to the stages of healing. Athletic trainers also have a responsibility to the athlete to return him or her to competition as soon as possible. The use of the appropriate protocol will expedite healing and return the athlete to practice more quickly and safely. This paper also describes different measures for treating the open wound. Hydrocolloidal dressings are of particular interest to researchers today. Finally, the features of the hydrocolloidal dressings are compared to the conventional occlusive wound dressings used before the discovery of the hydrocolloidal dressings.

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ANATOMY

Skin is composed of three main layers: the epidermal, the dermal, and the subcutaneous. The epidermis is subdivided into four layers: the stratum basale, the stratum spinosum, the stratum granulosum, and the stratum corneum (13). The stratum basale is the deepest. New epidermal cells are generated in this layer to replace the ones that are sloughed off at the most superficial layer. The stratum spinosum is located just superficial to the stratum basale and contains nerve endings sensitive to touch. The stratum granulosum is more superficial and generates the water-proofing agent in skin called keratin. Epithelial cells start to desiccate in this layer. The most superficial layer of the epidermis is the stratum corneum. It is constructed mostly of dead epithelial cells that encapsulate keratin. The dead epithelial cells are shed and eventually are replaced by new epithelial cells generated in the stratum basale. The stratum corneum serves as protection against light, heat, and bacteria.

The dermis is located just beneath the epidermis. It contains elastin and collagen fibers, blood vessels, nerves, sebaceous and sudoriferous glands, hair follicles, and corpuscles sensitive to pressure. The subcutaneous layer unites the dermis to organs, bone, and muscle. It is composed of sudoriferous glands, blood vessels, and adipose tissue. Healing may occur at any of the layers, dependent upon the depth of penetration of the trauma into the skin.

PATHOLOGY

There are six types of wounds ranging from an abrasion to a full amputation. An abrasion is the scraping of the first epidermal layer. The mechanisms of injury would include rug burns, turf burns, or any scrape caused by the friction of an abrasive surface against the skin. A laceration is the tearing of the skin that leaves an uneven periphery. An incision is similar to a laceration in depth and etiology; the peripheral edges, however, are smooth. These types of wounds can be incurred by a knife, a scalpel, a razor blade, a piece of glass, or anything that leaves a clean, even cut. A puncture wound is incurred from penetration by a pointed object. An avulsion is the tearing away of a patch of skin or other tissue that creates a loose, dangling piece of skin. An amputation is the complete removal of a body part caused by a shearing or tearing force (7).

PHYSIOLOGY OF HEALING

The tissue injury cycle is composed of three phases. They are the inflammatory phase, the proliferative phase, and the remodeling phase (1,12,13).

Inflammatory Phase

The classic signs and symptoms of the inflammatory phase are dolor (pain), calor (heat), tumor (swelling), rubor (redness), and, possibly, loss of function. The duration of this phase is four to five days, depending upon the severity of the wound (1,13). The healing processes in this phase are hemostasis and debridement of the wound. The first response to trauma is vasoconstriction, which endures for eight to ten minutes (13). During this time, hemostasis must be achieved. Fibroblasts create a fibrin lattice that is filled in by epithelial cells. The injured cells release vasodilators, histamine, and bradykinin. The vasodilation occurs locally and increases blood flow to the area, thereby transporting platelets that aggregate in the fibrin lattice to form a clot to eliminate hemorrhaging. The blood also transports leukocytes, complement, and antibodies, which combat any invading bacteria.

After the clot is formed, the first type of cell to enter the wound site is the polymorphonuclear leukocyte (PMN) (12). The PMNs attack, or phagocytize, any bacteria present. They have a short life span of approximately forty-eight hours because of desiccation on the wound surface (12).

Within five days, monocytes infiltrate the wound. Monocytes convert to macrophages, which have a long life span in comparison to the PMN (12). Macrophages debride the wound by phagocytizing necrotic tissue, foreign material, and dead cells. They recycle the wastes into products, such as amino acids and simple sugars, that are used in the wound repair. Macrophages also transmit chemotactic signals that recruit additional macrophages, causing fibroblasts to multiply and initiate the next phase of healing. Macrophages also initiate vascular growth or angiogenesis.

Exudate is formed during the inflammatory phase. It is composed of albumin, globulin and immunoglobulin, and cellular debris mixed with the intracellular fluid (12). Exudate has a synergistic effect on migrating leukocytes, which promotes debridement and phagocytosis in the wound.

Complement is composed of eleven proteins. It aids antibodies in the destruction of bacteria, thereby "complementing" their action. The complement system works in various ways by: causing cell lysis, perforating the plasma membrane of the microbe, and promoting phagocytosis by interacting with the phagocytes. Histamines, released from the mast cells, along with leukocytes, platelets, and complement, indirectly initiate the inflammatory phase. Histamine, through its vasodilatory effect, increases blood flow into the injury site, which brings leukocytes to combat bacteria. Further, histamine has chemotactic properties that recruit additional leukocytes into the wound.

A scab is formed during the inflammatory phase. Scabbing occurs when the fibrous tissue and the exudate interact with the blood clot. Scab formation hinders the healing process because it allows the wound surface to desiccate. In the proliferative phase, the epidermal cell will migrate over moist tissue only. Therefore, because a scab has formed, the cells must delve deep into the dermis until moist tissue is found. This prolongs the proliferative phase and delays healing.

Proliferative Phase

The proliferative phase is composed chiefly of three stages: epithelization, wound contraction, and connective tissue repair. The duration of this phase is approximately five to twenty days (1,13).

Epithelization. The primary purpose of epithelization is to resurface the wound (12). It is stimulated by trauma and provides the initial tensile strength of the wound. Epithelization involves mostly the basal layer and the cells superficial to the basal layer in the stratum spinosum.The basal cells at the edge of the wound contract and begin to resurface the injured area. Migrating epidermal cells are guided by the lattice of fibrin strands laid down during the inflammatory phase. Migrating cells are controlled by contact inhibition in the epidermal cells; for example, epidermal movement is inhibited when the epidermal cell is contacted on each side by another epidermal cell. Stationary cells divide to replace the migrating cells. These two processes occur until the wound is resurfaced with new cells. Once the wound is resurfaced, the cells furthest from the wound edges begin to multiply by mitotic division. The daughter cells derived from mitosis move vertically to re-establish the normal thickness of the epidermis. This process occurs most extensively during rest and inactivity.

Wound Contraction. This second stage in the proliferative phase results from the centripetal movement of skin and subcutaneous tissue. Tissue closes most rapidly where the edges of the wound are adjacent. This process is inhibited by any type of dressing and is accelerated by open exposure, unless infection pursues. The mechanism of wound contraction is a mystery; however, there are two theories available to research. One is that contraction is caused by the presence of actin and myosin at the edges of the wound. These are the same contractile elements found in the striated muscle (12). The second theory incorporates the idea of a specialized fibroblast called a myofibroblast. Myofibroblasts have contractile properties that originate in smooth muscle tissue. The myofibroblast is found in great abundance at the wound edges. Regardless of which structure is the functional unit, they provide the stress and strain that is required to gain additional tensile strength during the remodeling phase (1).

Connective Tissue Repair. During this final stage of the proliferative phase, fibroblasts synthesize collagen and release mucopolysaccharides, which aid in the arrangement of the collagen fibers (12,13). The tensile strength of the skin gained in the proliferative stage is no more than 25 to 30% of its original strength (1). The remainder of the strength is gained during the remodeling phase. Concurrently, as the fibroblasts synthesize collagen, capillaries begin to form anastomoses into the healing wound. As the wound heals, the need for oxygen decreases and collagen synthesis digresses; therefore, some of the anastomoses disappear because they are no longer necessary. This continues into the remodeling phase.

Remodeling Phase

The remodeling phase is the last in the wound healing process. This phase begins approximately on day twenty-one and may endure for a year or two. Eagelstein (3) says, "A most important feature of remodeling is that it is related to stress and strain" (12). Rest and immobilization are correct procedures to follow in the early phases of repair; however, to gain further

tensile strength, there must be stress and strain on the wound (12). During this phase, collagenous fibers are reorganized and mature. As the wound is almost healed, fibroblast formation decreases; therefore, collagen synthesis decreases. As mentioned previously, this decreases the vascularity of the tissue, and avascular tissue or a scar is formed. Scar tissue achieves only 80% of the original preinjured tissue strength (1). The scab is sloughed off with the restoration of the thickness and maturation of the epidermis.

MANAGEMENT

The appropriate treatment for an open wound that penetrates into muscular, tendinous, or bony tissue, or for a closed wound during the inflammatory phase, is rest and ice. Heat during this time will cause further irritation to the damaged tissues. Heat stimulates the release of histamines that cause additional swelling. After the inflammatory phase is completed, the use of heat will be appropriate because it will stimulate circulation and carry oxygen and nutrients to the re-epithelizing tissue.

Dressings

There are various dressings used to protect open wounds. The optimal wound dressing must, of course, provide the ideal healing environment that will expedite the rate and quality of the restoration of tissue to preinjury status. It must remove excess exudate and toxic components, provide a moist healing environment to advocate cell migration, and allow for gaseous exchange; yet, it must be an impermeable barrier to bacteria and other contaminants that may cause infection. Dressing changes must occur without re-traumatizing the skin. Finally, the dressing must be hypoallergenic (14). The following are examples of various types of dressings. Some are conventional and others are still under investigation.

Semipermeable Films. Semipermeablle film dressings, such as Op-site and Tegraderm, are permeable to water vapor, oxygen, and other gases, and impermeable to water and bacteria. They provide a moist healing environment, which is ideal for cell migration and allows excess exudate to escape through water vapor. Covering wounds with these films prevents dehydration twice as well as leaving them open to the environment. The use of semiocclusive hydrogels, along with the semipermeable films, will maintain the moist environment, as well as aid in the removal of toxic substances from the wound. Finally, there are the occlusive hydrocolloids. They are impermeable to gas and moisture, remove toxic components via their ability to stimulate further recruitment of macrophages, and conform to body contours (14). The difference between hydrocolloids and the other treatments is that exudate is absorbed rather than being allowed to evaporate.

Hydrocolloid. Hydrocolloid dressings are of particular interest. They seem to have all of the characteristics to protect and to provide the ideal healing environment. The also have been proven to expedite healing. They have a bilayer protection system: the outer layer is water resistant, while the inner layer is constructed of hydroactive particles interspersed among the inert, hydrophobic polymer stratum. Their water resilience is a remarkable feature in that it permits the dressing to stay in place during bathing, showering, and hydrotherapy without additional restraints. This is possible because of its ability to go through "phase inversion," which is the conversion of the dressing from "dry tact" to "wet tact" adherence. With conventional dressings, moisture destroys the bond of adherence to the skin. Hydrocolloidal dressings, however, have two types of adherence designated as "dry tact" and "wet tact." Dry tact is the same type of union as the conventional dressing. As the hydrocolloidal dressing reacts with the exudate from the wound, its hydroactive particles begin to distend, and the polymer stratum catabolizes into smaller particles. The supportive structure that the polymer once provided is now conquered by the hydroactive particles. This allows the dressing to remain in union with the wound as a result of the conversion of dry tact adherence to wet tact adherence (2). One example of this type of dressing is Duoderm.

Another extraordinary feature of the hydrocolloidal dressing is that it can remain intact, with no need for redressing, up to a period of seven days (2,14). When the hydroactive particles react with exudate, a gel is formed close to the wound. As a result, the penetration of fluid into the wound is slowed. This type of dressing is impervious to much fluid stress. However, its seal with the skin will break during extreme amounts of fluid pressure. The controlled absorption feature inhibits this process. To appreciate how remarkable this feature is, compare it to a band-aid or a gauze pad. Over a wound with minimal exudate, these two dressings may endure a day or two before the tape loses its ability to adhere to the skin or until the absorptive qualities are exhausted. On the other hand, hydrocolloidal dressings may be left intact for as long as seven days with minimal to moderate amounts of wound exudate. If excessive amounts of exudate exist, the seal of the hydrocolloidal dressing will be broken; therefore, the bandage may require changing before seven days.

The moist healing environment is important for several reasons. A moist environment is required for cell migration. Hydrocolloidal dressings maintain this moist environment and promote cell migration. As a result, re-epithelization is more expedient (2,14). Gauze and Tulle-Gras, conventional dressings, do not retain the moist environment. Instead, they allow the wound to desiccate, which impedes the healing process via a decrease in cell migration. The conventional dressings also allow scab formation, which delays healing. Once a scab is formed, the wound must heal from the bottom only; but with a moist environment, it can heal from the bottom and the edges simultaneously. The moist environment is also significant during dressing changes. Gauze and Tulle-Gras stick into the wound as it desiccates; therefore, when removed, some of the newly formed epithelium may be extracted. The gel formed by the hydrocolloidal dressings separates itself from the wound so re-injury is minimized.

The results of an experiment conducted at Cornell University Medical Center showed that a wound treated with a hydrocolloidal dressing (Duoderm) healed on the average of six days faster than a wound dressed with gauze (4). Another experiment challenged hydrocolloidal dressings (Duoderm) in opposition to silver sulphadiazine and human allografts on small burns. The burns varied in severity. Superficial partial thickness burns re-epithelized more rapidly with the hydrocolloidal dressing than with the silver sulphadiazine or the human allografts. Silver sulphadiazine and human allografts allowed healing at approximately the same rate. The deep partial thick-

ness burns showed a slightly different result. With these, human allografts permitted faster re-epithelization than silver sulphadiazine. The hydrocolloidal dressing maintained its superior healing rate, and seemed to give the patient an analgesic affect. Cosmetically, the hydrocolloidal dressing healed excellently with no trace of a scar (3). It was also more cost effective than human allografts. A disadvantage of hydrocolloids is that they cannot be used on an infected wound because they do not have any antibacterial properties. The dressing is also opaque, which renders detection of infection impossible. In the infected wound, silver sulphadiazine is the preferred solution (5).

Although hydrocolloids cannot fight infection, they provide a powerful barrier against bacterial invasion as demonstrated by an experiment conducted at the University of Pittsburgh. This experiment was designed to test the integrity of a hydrocolloidal dressing (Duoderm), a semipermeable hydrogel (Vigilon), and a semipermeable film (Op-Site) as barriers against invading bacteria. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were the strains of bacteria used to observe any penetration into the wound with the various dressings. *S. aureus* was recovered from 100% of the air exposed wounds and 50% of the Op-Site and Vigilon dressed wounds, but was not seen in the Duoderm covered wounds. *P. aeruginosa* was recovered from 100% of the air exposed wounds, and the Op-Site and Vigilon dressed wounds, while the Duoderm wounds revealed no trace of *P. aeruginosa*. This may lead one to conclude that Duoderm is impervious to invasion from *S. aureus* and *P. aeruginosa*, unless the seal is broken or the wound was infected prior to the application of Duoderm (11). The gel in Duoderm is acidic, which will deter some bacteria.

Hydrocolloids are impenetrable to atmospheric oxygen. At first glance, this may seem to be a detriment to the healing process. Hydrocolloids promote and enhance angiogenesis by cultivating the growth of the fibrin lattice (10). The fibrin can recruit macrophages that contain the angiogenesis factor (14). As a result of expanding capillary growth, many new sources of oxygen and nutrient transport are available to provide the necessary environment for healing.

Contraindications to the Use of Hydrocolloids. There are precautions which must be closely observed when using hydrocolloids. Their use is contraindicated when muscles, tendons, or bones are involved, when there is any sign of infection, and when the wound is a third degree burn (2). When observing the wound dressed with hydrocolloids, there may appear a pus-like material in the wound and a disagreeable stench. The material is only the gel formed by the interaction of the exudate and hydroactive particles. The wound may appear to be deteriorating as the necrotic tissue is being removed. When observing the wound bed, one should note an improvement that indicates healing.

SUMMARY

The purpose of the inflammatory phase is to bring about homeostasis and to debride the wound of waste and bacteria via the immune system. During the proliferative phase, the wound is re-epithelized and collagen synthesis occurs, which restores 25 to 30% of the tensile strength of the pre-injured tissue. The final phase, remodeling, reinforces the wound with 80% of its original tensile strength through the formation of scar tissue. The physiology of the wound healing is very intricate. Scientists are still investigating the mechanisms that lead to the restoration of tissue after trauma.

Hydrocolloids are extremely effective as occlusive dressings compared to other dressings. They provide almost all of the necessary factors to create a superior wound healing environment. Hydrocolloids have several important advantages over other conventional occlusive dressings. They provide a bilayer protection system. During dressing changes they do not disrupt the newly epithelized tissue, unlike other conventional methods. Their water resilience allows the patient to bathe, shower, or undergo hydrotherapy without disrupting the bandage. Most importantly, they are impermeable to bacteria, promote angiogenesis, and greatly increase cell migration, therefore healing.

While a rapid healing rate is important to all health care professionals, it is especially crucial to the athletic trainer, because it is his or her responsibility to return the athlete to play as quickly as possible. The hydrocolloidal dressings promote rapid healing while minimizing scarring and the risk of infection.

The disadvantages of using hydrocolloids are their opacity, lack of antibacterial properties, and contraindication with muscle, tendon, or bony tissue injury and third degree burns. These disadvantages are minimal when compared to dressings used in the past.

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Certificate and Plaque Order Form for NATA Certified Athletic Trainers

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Guide for Contributors

(Revised August 1991)

Athletic Training, JNATA 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 counseling and educating athletes concerning health care). Manuscripts should conform to the following:

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1. Submit one original and three copies of the entire manuscript (including photographs, artwork, and tables) to the editor.
2. All manuscripts must be accompanied by a letter signed by each author, and must contain the statements below. By signing the letter, the author(s) agrees to comply to all statements. Manuscripts that are not accompanied by such a letter will not be reviewed.
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4. *Athletic Training, JNATA* utilizes a double blind review process. Authors should take care that they are not identified in any way except on the title page.
5. Manuscripts are edited to improve the effectiveness of communication between the author and the readers, and to assist the author in a presentation compatible with the accepted style of *Athletic Training, JNATA*. The author agrees to accept any minor corrections of the manuscript made by the editors.
6. Published manuscripts and accompanying work cannot be returned. Unused manuscripts will be returned when submitted with a stamped, self-addressed envelope.

STYLE POLICIES

7. See Day (Reference b in #20 below) for elaboration of the following points.
8. Personal pronouns (I, we) and the active voice are preferred. Use the third person for describing what happened, "I" or "we" (if more than one author) for describing what you did, and "you" or the imperative for instruction.
9. Each page must be typewritten on one side of 8 1/2 x 11 inch plain paper, double spaced, with a 1 1/2 inch left margin and one inch margins elsewhere. **Do not right justify pages.**
10. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:
    a. Title page
    b. Acknowledgements
    c. Abstract and key words (first numbered page)
    d. Text (body of manuscript)
    e. References
    f. Tables - each on a separate page
    g. Legends to illustrations
    h. Illustrations - each on a separate page
11. Begin numbering the pages of your manuscript with the abstract page as #1, and consecutively number all successive pages.
12. Titles should be brief within 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; if the technique or type of treatment used is the principle reason for the report, it should be in the title. Often both should appear.
13. The title page should 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.
14. A comprehensive abstract of 75 to 200 words must accompany all manuscripts except **tips 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 succinctly summarizing 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.
15. 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 **tips from the field**, the key words should follow immediately after the title on the first numbered page.
16. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly developed and stated. Tell *why* the study needed to be done or the article 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 paragraph review of the literature, identify and develop 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.
17. The body or main part of the manuscript varies according to the type of article (examples follow); however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.
    a. The body of an **experimental report** consists of a methodology section, a presentation of the results, and a discussion of the results. The methodology section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics, and a few well-planned and carefully constructed illustrations.
    b. The body of a **literature review** article should be organized into subsections in which related thoughts of others are presented, summarized, and referenced. Each subsection should have a heading and brief summary, possibly one sentence. Sections must be arranged so they progressively focus on the problem or question posed in the introduction.
    c. The body of a **case study** should include the following components: personal data (age, sex, race, marital status, and occupation when relevant - but not name), chief complaint, history of present complaint (including symptoms), results of physical examination (example: "Physical findings relevant to the rehabilitation program were . . ."), medical history (surgery, laboratory results, exam, etc.), diagnosis, treatment, and clinical course (rehabilitation until and after return to competition) criteria for return to competition, and deviation from the expected (what makes this case unique). NOTE: It is mandatory that *Athletic Training, JNATA* receive, along with the submitted manuscript, a release form signed by the individual being discussed in the case study. Case studies cannot be reviewed if the release is not included.
    d. The body of a **technique article** should include both the *how* and *why* of the technique; a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations; and why the technique should be used. The discussion of *why* should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison to the other techniques.
    e. A **tip from the field** is similar to a technique article but much shorter. The tip should be presented and its significance briefly discussed and related to other similar techniques.
18. The manuscript should not have a separate summary section - the abstract serves as a summary. It is appropriate, however, to tie the article together with a summary paragraph or list of conclusions at the end of the discussion section.
19. Citations in the text of the manuscript take the form of a number in parentheses, (7), which indicates the number assigned to the citation. It is placed directly after the reference or the name of the author being cited. References should be used liberally. It is unethical to present others' ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.
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    a. Knight K: Tips for scientific/medical writers. *Athletic Training, JNATA* 25:47-50, 1990.
    b. Day RA: *How to Write and Publish a Scientific Paper.* 3rd ed. Phoenix: Oryx Press, 1988, pp. 54-55.
    c. Albohm M: Common injuries in women's volleyball. In Scriber K, Burke EJ (Eds): *Relevant Topics in Athletic Training.* Ithaca NY: Monument Publication, 1978, pp. 79-81.
    d. Behnke R: Licensure for athletic trainers: problems and solutions. Presented at the 29th Annual Meeting and Clinical Symposium of the National Athletic Trainers' Association. Las Vegas, NV, June 15, 1978.
21. Photographs should be glossy black and white prints. Graphs, charts, or figures should be of good quality and clearly presented on white paper with black ink in a form that will be legible if reduced for publication. Tables must be typed. Photographs cannot be returned if the manuscript is published. Please refrain from using paper clips, writing on photos, or attaching photos to sheets of paper. Attach a write-on label to the back of each photograph and label carefully so that the photograph is not damaged.
22. All artwork to be reproduced should be submitted as black and white line art with a Rapidograph, a velox stat, or PMT process. All artwork to be reproduced in black plus a second (or more) color should be submitted as black and white line art (see above paragraph). Clearly mark each area of color on a separate photocopy. Also, all areas of tonal value, shading, washes, or screening (a percent or tint of black or a color), should be indicated on a separate photocopy.

Abstracts

Clint Thompson, MS, ATC

Jackson BA, Swane J, Starcher BC: Effect of ultrasound therapy on the repair of Achilles' tendon injuries in rats. *Medicine and Science in Sports and Exercise* 23:171-176, 1991.

Ultrasound is a common modality employed in the clinical treatment of tendon injuries, with the objective being improved healing. Research findings on the effects of ultrasound on soft tissue healing have been conflicting. The purpose of this investigation was to determine the effects of selected regimens of ultrasound therapy on the rates of repair of injured Achilles' tendons of rats. Specific dependent variables examined were tendon breaking strength and rate of collagen formation following injury. The animals studied were 55 young Holtzman rats (51 males and four females; body weights = 97 to 414 gm).

The procedure of Frieder et al. for the partial rupture of the Achilles' tendon was used. The ultrasound head was held stationary, approximately 1.0 cm from the target area, during the sonication procedure. During each treatment session, continuous ultrasound was administered for 4 minutes at an intensity of 1.5 W/cm. Hydroxyproline is found almost exclusively in collagen and represents a postribosomal modification of proline. Therefore, collagen synthesis was determined by the conversion of labeled proline to hydroxyproline by tendon samples. To test the effect of ultrasound treatment on the breaking strength and collagen content, the measurements of treated tendons were compared with those of untreated tendons. The results support the hypothesis that ultrasound treatment increases the rate of repair of injured Achilles' tendons of rats, and specifically, that breaking strength increases during healing as a result of ultrasound treatment. Furthermore, the hypothesis that ultrasound accelerates the rate of collagen synthesis in injured tendons also is supported.

Mike Sullivan MS, ATC
Olivet College
Olivet, MI

Kannus P, Jarvinen M: Thigh muscle function after partial tear of the medial ligament compartment of the knee. *Medicine and Science in Sports and Exercise* 23:4-9, 1991.

A forceful abduction to the flexed or extended joint, the most frequent mechanism of knee injury in sports, results in damage in the medial supporting structure—the medial collateral ligament and the medial capsular ligament. Thigh muscle atrophy secondary to immobilization is one of the well recognized sequelae of treatment of knee ligament injuries. The purpose of this investigation was to determine the isometric and isokinetic strength and power profile of the knees of patients with a previous second degree sprain of the medial ligament compartment, the most commonly affected ligament complex of the knee. Forty-eight consecutive patients (27 men, 21 women) of our clinic participated in this study on isolated second degree sprains of the medial ligament compartment of the knee. The average time since injury was eight years. Before isokinetic measurement, the thigh circumference of both extremities was measured clinically. The isokinetic and isometric measurements of the quadriceps and hamstrings were performed with the CYBEX II isokinetic dynamometer. The general strength status of patients' knees was classified as excellent. Only mild (5%) average strength deficits were observed in quadriceps and hamstrings of the injured extremity. However, an interesting finding of this study was that the relative deficits in the more specific thigh muscle functions parameters on the injured side were systematically greater than the deficits in the previously mentioned strength parameters. In addition, both in extension and flexion the relative strength deficit increased with an increase in the speed of isokinetic movement. The present study confirms a previous finding that strictly standardized circumferential measurement of thigh atrophy correlates well with the overall deficit in muscle strength of an injured joint. The deficits increase with the speed of isokinetic movement. This may suggest that atrophy of Type II, fast twitch muscle fibers dominates in such knees; therefore, specific high speed extension and flexion exercises are recommended for rehabilitation.

Mike Sullivan MS, ATC
Olivet College
Olivet, MI

O'Shea P: The science of cross training: theory and application for peak performance. *National Strength and Conditioning Association Journal* 12(6):40-44, 1990.

Sports specific training has long been considered the cornerstone in improving sports performance. Peak performance, however, can best be achieved when sports specific training is used as part of a total training package including aerobic power, anaerobic power, muscular strength, technical skill, and maximal oxygen consumption achievement. Cross training, initially considered to be a training regime for triathletes, is becoming a widely used yet misunderstood method of athletic training. Holistic in nature, cross training is described as a "complex training prescription in which two or more sports are combined into either a single workout or a long-term cyclical program." Thus, multiple physiological variables are stressed during each training session. It is important to remember, however, that general physiological benefits such as cardiopulmonary adaptations transfer readily between endurance sports, while more specific adaptations such as peripheral circulatory and metabolic adaptations do not transfer as readily. Interval training (speed work) is suggested as the "backbone" of cross training and is quite readily transferable between sports. The fundamental physiological systems are stressed in interval training. Adaptations are made in strength, anaerobic power, and cardiovascular function. Sport physiologists still agree that the peripheral and metabolic adaptations are not readily transferable. The adaptations depend on the sports being transferred to and from. The transfer of training effects for strength athletes is considered to be greater than for endurance athletes. For example, Olympic lifts, power cleans,

squats, and snatchers are highly transferable to football, wrestling, and track and field events. Adolescent, multisport athletes present another problem because physical growth and maturity are factors to consider. A carefully planned program that includes periodization is imperative. To effectively implement cross training for the multisport high school athlete, a very cooperative arrangement must be made among all of the coaches of that athlete.

Gary Ball, EdD, ATC
Kean College
Kean, NH

Sartoris D: Magnetic Resonance Imaging of the musculoskeletal system, Part I. *The Journal of Musculoskeletal Medicine* 7(10):29-45, 1990.

Magnetic Resonance Imaging (MRI) has and will continue to revolutionize diagnosis. The detection of musculoskeletal disorders, soft tissue disease, and disc-related pathology can be readily and thoroughly detected with MRI. Although now a supplemental diagnostic tool, MRI will undoubtedly be used more frequently as costs are reduced. The primary advantages of MRI are safety and patient comfort. The method is noninvasive, and the patient does not have to be injected with a contrast dye or receive ionizing radiation. In addition, radiologic advantages include depicting bone marrow abnormalities, providing high contrast discrimination among soft tissue, and producing thin section images in any plane—all making it a diagnostic tool of choice. The mechanism of magnetic resonance depends on the alignment and the realignment of hydrogen protons in muscle following exposure to a magnetic field and radio frequency pulse. This process causes the protons to emit energy, which is recorded as the magnetic resonance signal. Images are projected as either gray, white, or dark, depending on the water content (the more water, the whiter the image). Indications for MRI include all those for traditional X-ray and CT imaging. The article offers suggestions on timing for use, and interpretations of many bony and soft tissue structures and pathological conditions. The author recognizes that the use of MRI is supplemental, yet encourages its use to complement those diagnostic tools that do not provide adequate information for thorough diagnosis.

Gary Ball, EdD, ATC
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Brian Barry, MA, ATC

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Potpourri

Dennis Aten, MS, ATC, RPT

Running Surfaces Affect Injury Risk

Fit News
October, 1990
A review from *Medicine and Science in Sport and Exercise*
Vol.21, No. 4, pp. 463-466

The surfaces you run on can have a significant effect on your injury risk. Hard surfaces, uneven ground, and surface camber (the upward arch of the outside of the road) can change your normal gait and increase your chance of injury. Camber is thought to have an effect on running style that is transferred to your knees. Does this really happen, or do you change your style to compensate?

Gale Gehlsen, Ph.D., and colleagues at Ball State University in Muncie, Indiana, measured three-dimensional knee movements when women and men ran on level and tilted surfaces. Cambers of 10 degrees caused an increased range of knee movement in all directions during running, and the effects were greater when running downhill than uphill. This may reflect a tendency to shorten stride on an uphill slope.

There is no direct study of an association between road cambers and incidence of injury, but this investigation proves that a tilted surface changes the biomechanics of running.

Editorial Board Member Paul Taylor, D.P.M., explains, "When you run against traffic, you run on a surface which cants upward to your right. This makes your right foot pronate more, and your left foot supinate more. This can bring on all the usual problems associated with excessive pronation or supination." Excessive movements in your foot can be transmitted up your leg to cause the increased knee motion discovered in this study.

The best surfaces for injury-free running are flat, even, and not too hard. But if you have to run on cambered surfaces, change directions during your run to avoid constant imbalances.

First Responder Test

AAOS Report
November, 1990

A new textbook for first responder training is now available from the Academy. *Your First Response in Emergency Care* was produced by the same editorial team that developed the authoritative text for emergency medical training commonly known as the "Orange Book." It follows the Department of Transportation training curriculum and the National Fire Protection Association standards for emergency medical care. For more information, contact AAOS customer service at (800) 626-6726.

National Safe Kids Campaign

Parents may breathe a sigh of relief as the school year approaches because their kids will have regular, supervised schedules. But the transition from summertime activities to new school routines also can pose possible dangers for kids.

Statistics show that motor vehicle accidents are the number one killer of kids who are one-to 14-years-old. Most of the injuries involve children as pedestrians, passengers, or cyclists. Every year, nearly 3,000 children nationwide die from motor vehicle-related incidents and thousands more are injured.

As kids head back to school, they need to be prepared for their new routine. Traffic safety education can help children develop adequate skills to avoid accidents as they travel to and from school.

The National Safe Kids Campaign has published many basic safety tips that may save a child's life. If you would like more information, please call Kathryn Kincaid or Ann Marie Lopes at (202) 939-4993.

Bike Safety

AAOS Bulletin
July, 1990

A report by the Academy's Committee on Trauma disclosed that in 1987, bicyclists sustained 562,000 injuries—and 1,000 persons died. Head injuries are the most common biking injury and accounted for 75 percent of the deaths that year. According to the report, the single most important item of preventative equipment is the bicycle helmet. The committee's report has been adapted as an article in this *AAOS Bulletin.*

To promote bicycle safety, fellows of the AAOS are urged to remove pages 21 and 22 of the July 1990 *AAOS Bulletin* and distribute copies to patients and others.

"Board" Not Authorized by AOSSM

AAOS Report
April, 1991

The American Orthopaedic Society for Sports Medicine has advised members that a group called the American Board of Sports Medicine, Inc. is not authorized by the AOSSM. In a letter to members, AAOSM president Frank J. Bassett, III, MD, said, "It [the American Board of Sports Medicine, Inc.] is not acting under the auspices of the American Board of Orthopaedic Surgery or the American Board of Medical Specialties (ABMS)." Thomas C. Nelson, executive director of

the American Academy of Orthopaedic Surgeons, said that the Academy is concerned about the proliferation of certifying boards that are not recognized by the ABMS. There are 23 boards recognized by the ABMS, of which the American Board of Orthopaedic Surgery is one, Nelson said.

Do You Have an Overuse Injury?

Fit News
February, 1991

Guidelines to consider for determining if you might have an exercise-related overuse injury were presented to the AR&FA by member John McDaniel from Mountain View, CA. There are other factors, but these are worth consideration.

To help spot an injury, do the following in the morning:
(1) As soon as you awake, check your resting pulse before you get out of bed.
(2) Weigh yourself.
(3) Note how many hours you slept the previous night.
(4) Determine if you met your workout goal the previous day, and finished in good form.

Warning signs that you may have an injury are:
(1) Your pulse is 10 beats per minute, or more, higher than normal.
(2) You lost 3%, or more, of your weight overnight.
(3) You slept 10% less than normal amount.
(4) You didn't meet your workout goal or finish in good form.

If you record one warning sign, you probably can work out as usual, but take it easy. If there are two warnings, reduce your workout or try a different exercise. Three or four signs mean you need rest to prevent an overuse injury. Don't work out at all until you're back to normal.

You don't need a crystal ball. Just listen to your body, and write what it tells you in your training diary.

Academy Will Register Research Studies

AAOS Report
September, 1990

The Academy is establishing the Musculoskeletal Outcome Research Register in order to form liaisons among research groups, to assist researchers in formulating projects, and to provide information to researchers and funding sources about the status of this type of research nationwide. Membership in the Register is open to all researchers in the musculoskeletal field, regardless of whether they are Academy members. Participants will receive periodic reports about the Register contents. The Academy will accept studies of any size or funding level. Contact Chad Munger, AAOS, 222 S. Prospect Ave., Park Ridge, IL 60068, (800) 346-2267.

Effects of Pain on Motor Performance

Journal of Sport & Exercise Psychology
1990, 12, pp. 353-365
Britton W. Brewer, Judy L. VanRaalte, and Darwyn E. Linder
Arizona State University

In this study, the effects of experimentally induced pressure pain on the performance of male college students during a weight lifting task, a simple golf putting task, and a complex golf putting task were examined. It was found that pain did not affect performance of the weight lifting task, slightly hampered performance of the simple putting task, and severely hampered performance of the complex putting task. Because the adverse effects of pain increased with task complexity, the findings are consistent with the notion that pain is a form of arousal, and that pain affects performance in a manner similar to arousal. Limitations of the present experiments and directions for future research are discussed also.

Academy Endorses Liability Reform Act

AAOS Report
September, 1990

The Academy has strongly endorsed the Health Care Access and Patient Protection Reform Act of 1990, which includes important reforms of the professional liability system. In a letter to Sen. Orrin Hatch (R-Utah), who introduced the legislation, John B. McGinty, MD, Academy president, noted that many of the important features of the bill already are Academy policy. The bill would provide grants to states in order to encourage them to implement innovative systems for compensating individuals who are injured while receiving medical care. States might receive grants to develop demonstration projects that establish alternative dispute resolution systems for handling medical liability claims.

Unless states enact provisions to achieve the same goals, the bill specifies reforms that would apply in all state and federal court medical malpractice actions. They are: mandatory periodic payment of all future damages exceeding $100,000; a $250,000 ceiling on non-economic damage awards; mandatory offsets of awards for collateral sources of recovery; a schedule of limitations for attorney contingency fees; and the requirement that state statutes of limitation run from the time of injury and, in the case of infant claims, can be suspended no later than the claimant's sixth birthday.

Book Review

Phil Callicutt, EdD, ATC

Rehabilitation Techniques In Sports Medicine
Editor: William E. Prentice, PhD, ATC, PT
Times Mirror/Mosby College Publishing
11830 Westline Industrial Drive
St. Louis, MO 63146
1990
380 pages, Illustrated

During my past five years of reviewing books, I have always taken pleasure in providing our readership with texts that I feel make worthwhile contributions to our body of knowledge. It is always a pleasure to receive the latest work of Dr. Bill Prentice, Associate Professor of Physical Education and Coordinator of Sports Medicine Specialization, University of North Carolina, Chapel Hill, NC. As in the past, Dr. Prentice has gathered an outstanding group of contributors to assist in presenting the complex and often misunderstood subject of rehabilitation techniques. A listing of the contributors is warranted because of their expertise and diversity: Gerald Bell, Don Chu, Marc Davis, Bernie DePalma, Dany Foster, Joe Gieck, Charles Henry, Skip Hunter, Scott Hunter, Julie Moyer, Greg Ott, Dave Perrin, and Rich Reihi. Dr. Prentice authors or co-authors five chapters in this latest work.

The purpose of the text is to provide the athletic trainer or sports therapist with a comprehensive guide to the design, implementation, and supervision of rehabilitation programs for sports-related injuries. The text essentially is divided into two sections. The first eight chapters discuss the various techniques and theories on which rehabilitation protocols should be based. Chapters 9 through 17 discuss the practical application of the theory, which forms the basis for rehabilitation as presented in the first half of the text, relative to specific regional anatomical areas.

Chapter 6, authored by longtime University of Virginia Head Athletic Trainer Joe Gieck, discusses in an exceptional manner how the athletic trainer or sports therapist should deal with the psychological rehabilitation of the injured athlete. He reemphasizes the fact that psychological rehabilitation may be as critical as physiological rehabilitation in achieving the long-term goals.

The timely topic of pharmacological considerations in a rehabilitation program is expertly explored by Dr. Bill Prentice in Chapter 8. He explains how various medications may be used to assist the rehabilitative process, as well as what the indications and contraindications are for their use in an athletic environment.

As the art and science of sports medicine becomes more sophisticated and specialized, the need arises for textbooks that deal with specific aspects of injury management. Rehabilitation is one of the major areas of responsibility for the athletic trainer and sports therapist.

This text fills a void that has existed for some time. It is intended for the sports medicine student who is interested in gaining more in-depth exposure to the theory and practice of rehabilitation techniques in a sports medicine environment.

There are many texts currently available that deal with the subject of rehabilitation of injury in various patient populations. However, this text concentrates exclusively on the application of rehabilitation techniques in a sports-related setting. The emphasis on sports medicine makes this uncommon and valuable.

Athletic Injury Assessment
Authors: James M. Booher, PhD, ATC, RPT, and
Gary A Thibodeau, PhD
Times Mirror/Mosby College Publishing
11830 Westline Industrial Drive
St. Louis, MO 63146
2nd Edition
1989
635 pages, 714 Illustrations

In 1985, I reviewed the first edition of this informative text authored by Drs. Booher and Thibodeau. At that point, I commented on the excellent scope and content of this newly published work. I recommended it as a worthwhile source of reference in the area of athletic injury assessment, and I personally used it on a regular basis when preparing lectures for symposiums and workshops.

Since the first edition, the authors have corresponded with a large number of athletic trainers, coaches, physicians, physical therapists, and students, who provided suggestions for change and improvement in this second edition.

Drs. Booher and Thibodeau have maintained their specialized focus with a revision effort that has produced an up-to-date, comprehensive, and very contemporary new edition. Additions of new text material and illustrations were highly selective, and in every case related directly to assessment goals.

Chapter 6, which is completely new, covers neurology and provides an overview of the nervous system to assist the reader in preparing for the many new areas dealing with neurologic assessment techniques, which are incorporated in subsequent chapters of the text. Neurology is a major new thrust in this edition, and additional information in this area can be found throughout the text.

New pedagogical aids include chapter objectives to reinforce important learning goals, annotated readings that suggest articles and books for additional resources, and a comprehensive glossary that now includes page coding, which enables the reader to locate these definitions in the text.

This new edition is divided into twenty chapters that are grouped into six organizational units. Introductory material is followed by information dealing with the body as a whole and gives concise reviews of basic anatomy.

Edition two has remained concise yet comprehensive, and

the information presented is closely tied to exceptional illustrations and photographic sequences. The major strength of *Athletic Injury Assessment* is the exceptional quality and accuracy of the illustration program. The truest test of any illustration is how effectively it complements and strengthens written information in the text and how successfully it can be used by the reader as a learning tool. Over 7000 illustrations and photographs represent an integral part of the learning process and should be studied carefully by the reader.

Drs. Booher and Thibodeau should be complimented on their success in the noted improvement of a work that was already a superior product. I recommend that all sports medicine professionals who have the first edition purchase the new second edition and share it with a young student trainer who will greatly profit from the latest work of these gentlemen.

ATTENTION NATA MEMBERS

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The NATA Publications Office can be reached at 1-800-800-NATA.

Video Review

Thomas V. Gocke MS, ATC, LAT

Basic PNF - Proprioceptive Neuromuscular Facilitation
Massage Therapy Series, Vol. 12
V.I.E.W. Video, Inc.
34 E. 23rd Street, New York, NY 10010
Telephone: (800) 843-9843
Color, VHS
Playing Time: 70 minutes
Price: $39.95

Basic PNF - Proprioceptive Neuromuscular Facilitation is "an introductory workshop on PNF stretching and its relation to athletics and sports massage." Patrice Morency, workshop lecturer, describes the therapeutic effects of PNF for rehabilitating injuries, facilitating an increase in joint range of motion (ROM), and reducing painful muscle spasms.

This video program divides the PNF concept into seven chapters. Each is devoted to helping the viewer gain a better understanding of muscle anatomy/physiology and specific PNF techniques by learning from demonstrations of actual PNF patterns. The chapters are listed as follows:

Chapter 1 - PNF Background Information
Chapter 2 - Spiral/Diagonal Pattern
Chapter 3 - The Muscle Spindle
Chapter 4 - The Golgi Tendon Organ
Chapter 5 - Techniques of PNF
Chapter 6 - Hands-on Demonstration
Chapter 7 - Step-by-Step Review

Basic PNF provides the viewer with the first elements needed to possess an understanding of proprioceptive neuromuscular facilitation. I found the initial "chapters" to be superficial in nature. The descriptions of the muscle spindle and the golgi tendon were correct, but lacked technical and scientific support. However, I did find that the description of PNF techniques (hold-relax, contract-relax, repeated contractions, rhythmic stabilization, and slow reversal) to be informative. The examples given for each technique were basic. The demonstration of PNF patterns by Ms. Morency provides visual reinforcement of the lecture portion of this program. The patterns demonstrated were correct for therapeutic effect and technique. It appeared that this program was designed solely for massage therapists and had no specific application to other sports medicine professionals.

Basic PNF - Proprioceptive Neuromuscular Facilitation would serve as a good introduction to PNF when augmented with a more detailed text or video program. The information in this program is easy to understand and would be of value to the novice viewer.

New Products

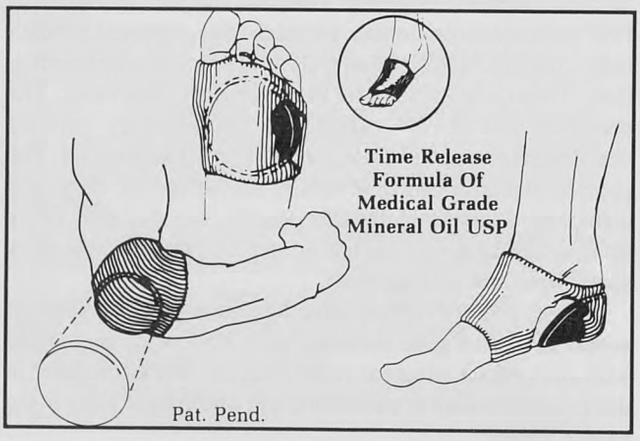
Barrie Steele, MS, ATC

Active Ankle "Acute"
with the
BubbleFlex ™
CUSHIONING SYSTEM

For acute injuries in which the patient or athlete displays soreness around the ankle, Active Ankle Systems introduces the new *Active Ankle "Acute."* The *Active Ankle "Acute"* has incorporated the new BubbleFlex™ cushioning system that provides a comfortable soft bubble cushion for the recently injured ankle. Layers of soft bubbles are surrounded by a vinyl covering that provides a constant bubble barrier between the ankle and the outer plastic shell.

Now your patients or athletes are able to have the unmatched performance and protection of the Active Ankle's hinged solid U-shaped design, with the soft comfortable feel of the BubbleFlex cushioning system.

Silopad™—Universal Gel Strap



Silipos, of Niagara Falls, NY, introduces its newest Silopad product, Silopad™—Universal Gel Strap. This unique device utilizes a patented cross-linked three dimensional polymer that can be used on various parts of the foot, hand, knee, and elbow. The gel pad has been designed to absorb shock and friction while simultaneously acting as a preventive and healing device.

The device consists of Medical Grade Elastic and a compound containing Medical Grade Mineral Oil under time release formalization that is molded to the elastic. It will not separate no matter how much pressure it absorbs. The gel compound dissipates abnormal amounts of shock and shear forces while the mineral oil disperses to lubricate and treat lesions, bruises, corns, blisters, and callouses.

This is a real breakthrough that is excellent for the prevention and treatment of sports or industrial injuries. For a free sample and product information, contact Silipos, 2045 Niagara Falls Boulevard, L.P.O. Box 320, Niagara Falls, NY 14304, Toll Free USA - (800) 626-2612, Canada - (800) 345-5103.

The Stretch Rite Stretcher

The Stretch Rite Stretcher is a new product for athletes involved in any sport. This is a screw-driven mechanical leg-stretching machine designed to fit people who are at least four feet tall, but less than six feet, six inches tall.

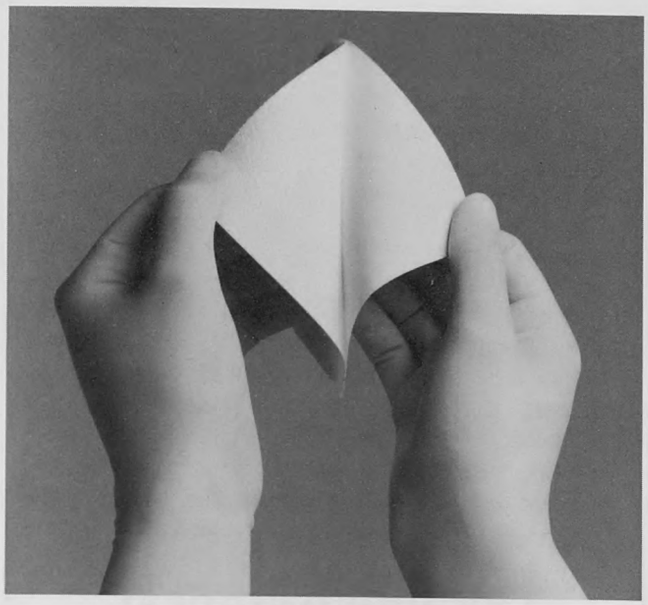
It has been known for many years that stretching leg muscles increases one's speed and performance as it decreases the chances of groin or hamstring injury.

More recently, it has been learned that conventional methods of stretching leg muscles can damage delicate knee joints by putting stress on the tendons that hold the knee joint in place. With the Stretch Rite Stretcher this is no longer a problem. This product places the majority of the pressure on

the upper thigh where it should be—not on the delicate knee joints.The Stretch Rite Stretcher is lightweight and durable, with solid steel construction, and it weighs just 19 pounds. It is sold with a two-year warranty covering material and workmanship. It easily can be disassembled to fit into a suitcase for out-of-town trips.

The Stretch Rite Stretcher has been approved by physicians and physical therapists. With the reward of better performance and decreased hamstring and knee injury, how can an athlete afford to be without one?

For more information, call Stretch Rite Corporation, 30905 North Little Squaw Bay Road, Worley, ID 83876.



Elantec's Surgical Tape Remover

A Safe, FDA-Cleared Tape and Rosin Remover

Elantec's Surgical Tape Remover is a new, patented effective tape remover that is kind to the athlete's skin because it contains only safe and gentle cosmetic type natural oils and emollients. This tape remover will penetrate up to six layers of tape for easy, safe removal and it is odorless, nonflammable, and less greasy. It contains no petroleum distillates, is non-aerosol, and is approved for air travel. This product is cost-effective and safe for athletes, athletic trainers, and the environment. Elantec's Surgical Tape Remover has been tested in hospitals and is currently in use at the USA Olympic Training Centers, and in many athletic departments. For information, contact Sportsline, P.O. Box 3370, Evergreen, CO 80439, (800) 444-2547.

Convenient Alternative to Traditional Thermoplastic Splint Materials

Carapace, Inc. has released a unique new low-temperature thermoplastic called CaraForm™, which features several benefits:

- Comes in a unique roll form instead of bulky sheets, which improves cutting and dispensing, reduces scrap, and is convenient for storage
- Features a fabric substrate that gives intimate conformability without excessive stretching
- Becomes transparent when heated, which provides a clear indication of complete and even warming and allows visualization of landmarks for improved control of application
- Self bonds; there is no need for solvents

CaraForm is available in three sizes: 1.2mm x 7 in x 20 ft, 2.4mm x 7 in x 20 ft , and 2.4mm x 12 in x 20 ft.

This product's versatility and improved handling make it an excellent choice for a multitude of splinting applications.

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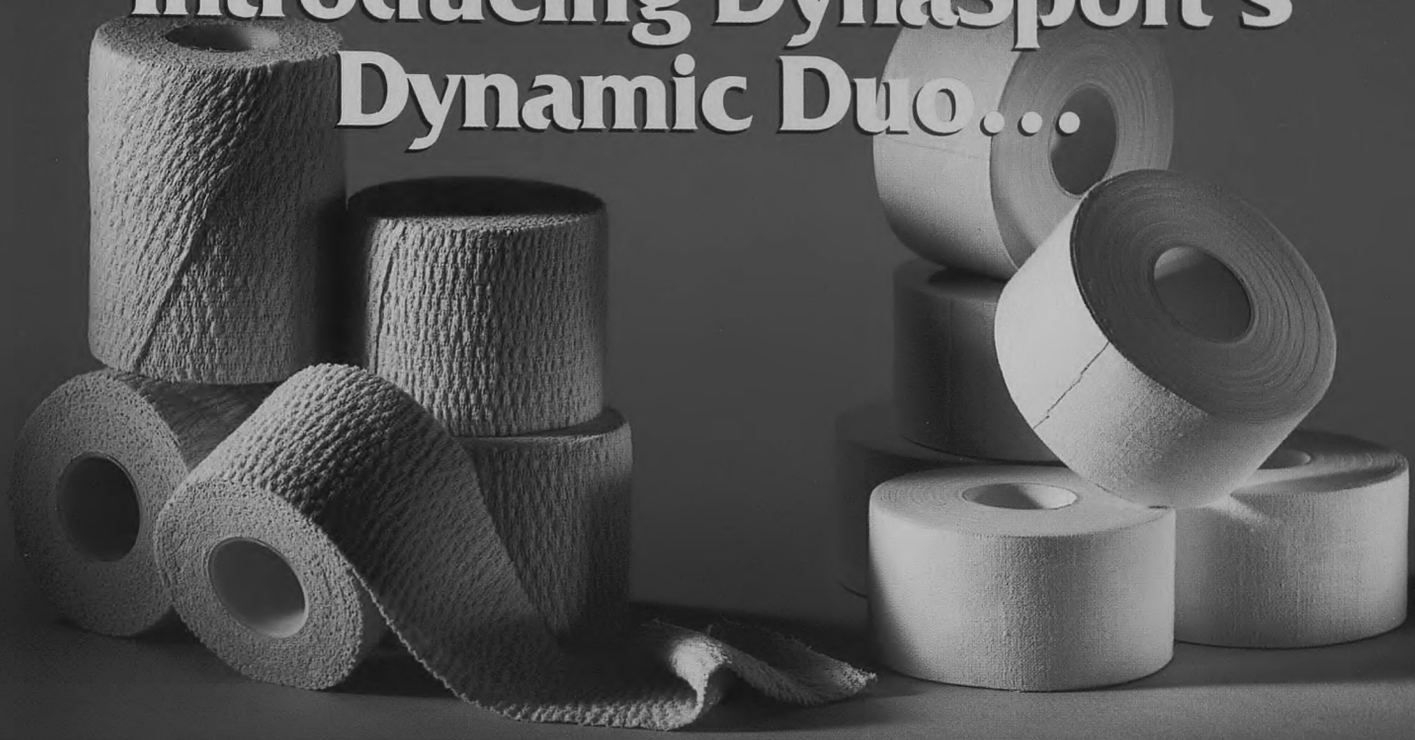

DynaWrap & SpeedWrap

DynaSport's new and unique "DynaWrap" rippable elastic bandage features:

- A porous all natural adhesive
- Strong and durable back cloth/adhesive provides excellent conformability
- Consistent unwind tension—no ballooning or gaping
- Moisture resistant

CATALOG NO.	SIZE	QUANTITY
#51-308-9	2" x 7½ yds	24 rolls per case
#51-309-9	3" x 7½ yds	16 rolls per case

DynaSport introduces "SpeedWrap" Athletic tape featuring:

- Consistent unwind tension to the core
- Superb tensile strength
- Extended shelf life
- Manufacturer direct

CATALOG NO.	SIZE	QUANTITY
#51-310-9	1½" x 15 yds	32 rolls per case
#51-311-9	2" x 15 yds	24 rolls per case

DynaPlast

This DynaSport elastic tape features an all natural, moisture resistant adhesive combined with a strong back cloth for optimum conformability and strength. DynaPlast's balanced adhesive gives it a smooth, consistent unwind tension for easy application.

Catalog No.—#51-313-9
Size—3" x 5 yds
Quantity—16 rolls per case

PreWrap

DynaSport's PreWrap underwrap is a highly porous underwrap designed to protect the skin from repeated tapings. It tears easily and conforms well to the skin.

Catalog No.—#51-312-9
Size—2¾" x 30 yds
Quantity—48 rolls per case

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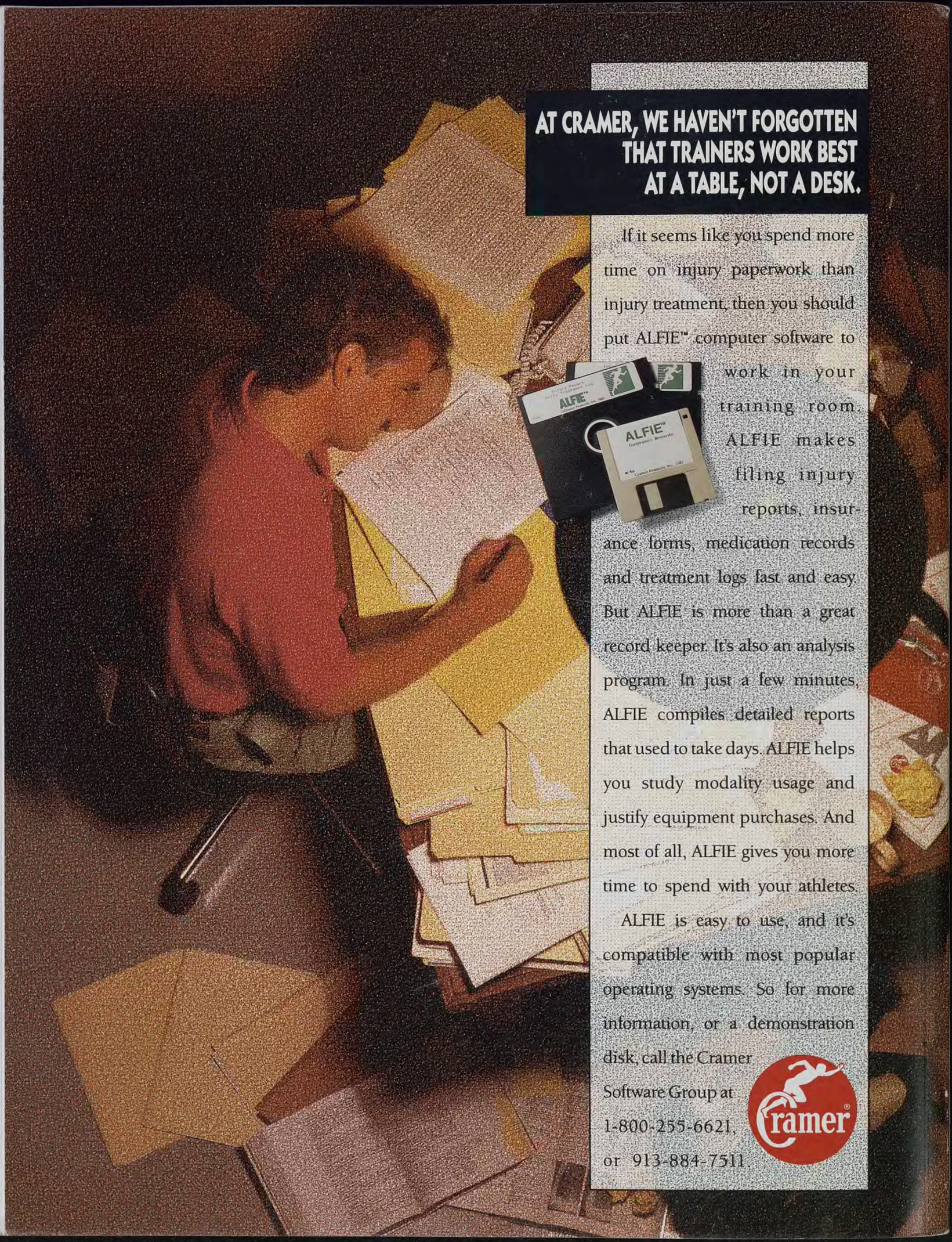
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