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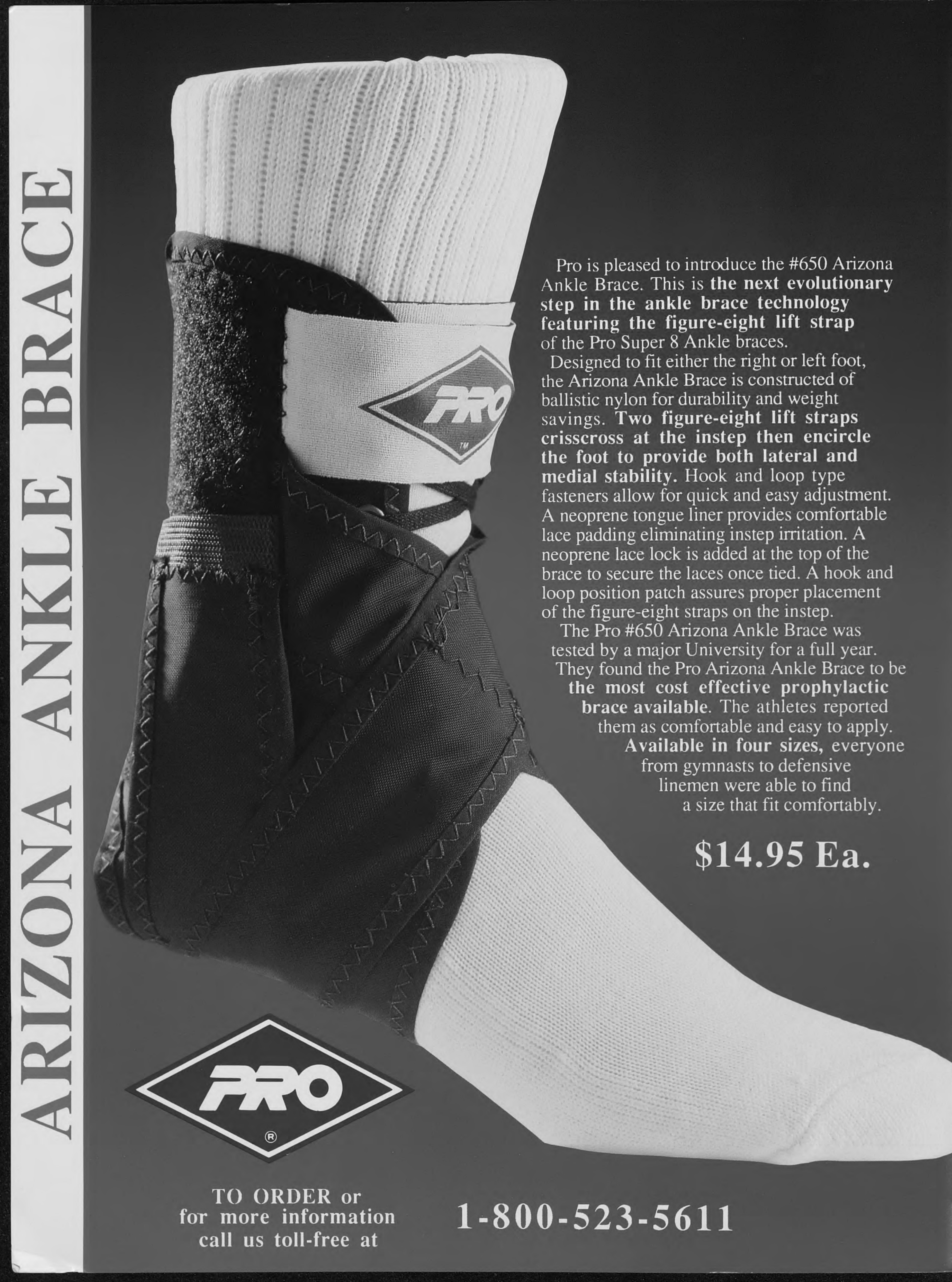
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Journal of Athletic Training

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Articles

Departments

■ Editorial ■

Kenneth L. Knight, PhD, ATC,
Editor-in-Chief

Removing Football Helmet Face Masks

Leah Putman's tip from the field in the last issue of the *Journal* has excited some people. She shared a new idea for removing football helmet face masks in an emergency. Three people have written to express their agreement with Putman that removing face masks is not as easy as most assume, and to offer alternative suggestions. (See letters to the editor, pp. 198-199.)

One letter writer (Clover) shared his conviction that every athletic trainer should be able to remove a helmet face mask in 30 seconds or less, and that this skill should be included as part of the oral/practical section of the certification examination. Not a bad idea.

The Board of Certification recently suggested that every athletic trainer should recertify in CPR each year, and has changed the CEU program so that all certified athletic trainers must keep their CPR skills current. We have a moral and legal obligation to keep our life-saving skills sharp. But the greatest CPR technician is of no value to a nonbreathing football player if the technician cannot get to the football player's mouth to administer rescue breathing. My purpose for these comments, however, is not to lobby for changing the certification exam. My intent is to point to a higher law than the certification exam.

Every athletic trainer who is covering football has a moral obligation to know that he or she can remove the face mask quickly enough to apply CPR when needed, whether or not the Board of Certification decides to make it a part of the oral/practical examination. And that knowledge should come from actual timed practice on the specific face masks his or her football team is using.

Every year, after the newly reconditioned helmets are returned, you should practice on them. For instance, this year, Indiana State's helmets came back from the reconditioner with new face mask attachments; they had double clips rather than single ones like in the past. And the second clip was of much harder plastic than the older ones that were underneath them. Paul Schiess, our football athletic trainer, who was competent a year ago, had to find a new tool for this year's helmets. (See his suggestion in the letters section.) Another letter from Desiree Baker, a student athletic trainer, told about a special tool needed to remove the face mask hardware on her high school's helmets.

Athletic training educational programs must ensure that their students actually practice taking off face masks; telling them how to do it is not enough. The cost of clips is less than $1 per helmet; a small investment for this vital skill.

Now, the number of deaths among football players from lack of breathing is extremely small. But one death is too many, especially if it could have been avoided.

Practice taking off football helmet face masks in 30 seconds or less. Do it because it is the right thing to do; because it may help you to save a life.

Letters to the Editor

Removing Football Face Masks

I enjoyed the article by Leah A. Putman, "Alternative Methods for Football Helmet Face Mask Removal" (*JAT*, 1992; 27: 170-172).

I have some comments regarding the article. (1) The electric screwdriver is a good idea if the backs are not rusted, just as the article stated. (2) The wire cutter "might" work okay. (3) The bolt cutters are too slow. (4) Trainers' scissors don't work. (4) Paramedic scissors don't work. (5) Scalpels don't work. (6) I spoke with one athletic trainer who said he used a small torch and melted the side attachments off.

The certified athletic trainer is evaluated and timed on the taping of an ankle. The skill of taking the face mask off a helmet also should be evaluated, timed, and included as part of the exam. This procedure should be practiced and evaluated with the same importance as the ankle taping.

When providing safety equipment for the players, procedures must be set up and practiced to remove it. If your team has more than one type of helmet face mask attachment, a procedure and practice must be established for each. If you are not comfortably able to get to the airway within 30 seconds, those attachments or the face mask should not be used.

There is no question that a standard of care in removing face masks should be established and that testing should be added to the certified athletic trainer exam.

Jim Clover, MEd, ATC
The S.P.O.R.T. Clinic
Riverside, CA

Recently I read the article by Leah A. Putman (*JAT*, 1992; 27: 170-172), and I felt that it was a very informative article. I realize that my credentials aren't exactly what you would consider to be important, but I felt that I must comment on a portion of the article. The author is correct in the information concerning face mask removal except for one vital point. In some schools, it is common practice to use a rectangular-shaped washer/bolt to hold the helmet screws in place. In fact, the helmets my high school received were assembled in that manner. I do not know if this is the practice in the United States and other countries, but it is vital to know that if you do not have a special wrench to hold the washer in place for removal, the screw will simply spin in the hole. The screw will not come out, therefore the face mask cannot be removed. When an athlete is unconscious and needs emergency care, this excess time could prove damaging or even fatal. I suggest that every athletic trainer be familiar with the removal procedures for their school helmets. Therefore, they can safely determine the fastest, safest way of face mask removal in an emergency situation.

Desiree A. Baker
Student Athletic Trainer
Tustin, CA

I agree with Putman (*JAT*, 1992; 27: 170-172) that it is extremely important to be able to remove the face mask from an injured football player as quickly and safely as possible. At my institution, we have tried using many of the devices listed in the article without much success. The problem with using scalpels or other sharp instruments is the possibility of excessive movement in the cervical spine area if the athletic trainer slips while cutting through the clip. The screwdriver also becomes useless when the screws are subjected to sweat and rain. They rust solid so that the equipment managers often resort to a hammer and chisel to remove them.

Another problem arose when our helmets were returned from the reconditioning manufacturer with an extra, very hard plastic clip over the traditional rubber plastic clip. We tried to remove the face mask with the previously mentioned methods with no success. In fact, the disposable scalpel broke during the demonstration.

I have found a tool, however, that works better than any device I have tried, an Anvil Pruner that can be purchased at Sears for less than $10. It has a spring-loaded handle, and so is very easy to squeeze in order to cut through both clips at the same time without cervical spine movement.

I bring this to your attention not to promote any company or device, but to share with other athletic trainers an alternative device to help our athletes in the event that a life-threatening situation occurs.

Paul K. Schiess, MS, ATC
Head Athletic Trainer
Indiana State University
Terre Haute, IN

Ohio AT Licensure

This letter is sent to you regarding the article, "An Overview of Selected State Licensure Athletic Training Laws" (*JAT*, 1992; 27: 162-169).

In the section entitled "Location of Employment" on page 162, the last sentence reads "Ohio (25) also places the athletic trainer under the direct supervision of a physical therapist." This statement is incorrect. The Ohio revised code does not require athletic trainers to be supervised to practice athletic training. Athletic trainers perform athletic training services upon the referral of a physician, chiropractor, dentist, podiatrist, or physical therapist. Once the referral is received, services (evaluation, treatment) are performed by the athletic trainer and supervision is not required.

It would be greatly appreciated if this clarification is printed in an upcoming issue of the *Journal of Athletic Training*. If you have questions regarding this matter, please feel free to contact the board office.

Rachel A. Mallory
Executive Director
Ohio Occupational Therapy, Physical Therapy, and Athletic Trainers Board
Athletic Trainers Section
Columbus, Ohio

Texas AT Certification

I am writing to express my concern about an issue raised in the article, "An Overview of Selected State Licensure: Athletic Training Laws," by Gary Morin (*JAT*, 1992; 27: 162-169) and was profoundly shocked to learn that the only state in the nation that does not recognize the NATA Certification Examination as criteria for licensure is Texas—the state in which our organization is headquartered.

This fact is more than a simple irony, it is a glaring statement on the NATA's sense of values or lack thereof. It is of paramount importance that we, as NATA members, address this issue. I urge the NATA and its executive board to take action to rectify this situation. As our profession still struggles to gain acceptance on a daily basis and push for even higher standards, we need the state of Texas—our headquarter's state—to be in compliance with NATA policies.

We need to use the influence of our membership to make Texas legislators, educators, and athletic training professionals aware of the problem. It is difficult to believe that they would be willing to accept lower standards for their state.

In closing, I would once again like to reiterate that this is an important issue. It requires all our efforts to rectify. If Texas cannot be made to accept the NATA standards, we should consider relocating our national headquarters.

Jennifer A. Moshak, MS, ATC
Head Women's Athletic Trainer
University of Tennessee
Knoxville, TN

AT Availability in Michigan

I was pleased to read Dr. Lynn Lindaman's paper about the availability of athletic trainers in Michigan, "Athletic trainer availability in interscholastic athletics in Michigan" (*JAT*, 1992; 27: 9-18). Dr. Lindaman's research will be useful to us in the state of Michigan as we work toward the goal of complete and competent medical care for our state's high school student athletes. In addition, his appended comments ring true for all of us who have worked so hard over many years to thwart the epidemic of high school injuries.

However, there is one point to which I feel compelled to respond. On page 10, Dr. Lindaman states that in my 1987 study of school superintendents' perception of the status of athletic health care that I did not report my definition of the term "athletic trainer" (Ray R. A survey of Michigan school superintendents' knowledge of and attitudes toward athletic injuries, athletic trainers, and legal liability. *Athletic Training, JNATA*. 1987; 22: 311-315). He uses this argument to suggest to readers that they employ caution in comparing the results of our research efforts in this area. Although the injunction to use caution in comparing the results of any two studies is prudent scholarship, the claim that I failed to specifically define the term "athletic trainer" is unfounded. The following statement can be found on page 312 of the 1987 paper:

"There were 70 school superintendents who indicated that their school district currently employs a certified athletic trainer (question 12a)."

Question 12a in Table 1 of the 1987 paper clearly uses the wording "National Athletic Trainers' Association certified athletic trainer." This is a very specific definition that leads me to believe that the comparability of our two studies is probably greater than he states.

Dr. Lindaman's assertion that I did not clarify the distribution of certified athletic trainers among different classes of school districts is true. His decision to stratify his report by school district size is a useful contribution to our understanding of the problem.

I hope this helps the readers of these two reports understand more clearly and completely the changes that have taken place in the health care system for high school student athletes in Michigan since I published my study in 1987. As Dr. Lindaman has so ably pointed out, there is much that still needs to be done.

Thank you for providing me with the opportunity to respond to Dr. Lindaman's remarks.

Richard Ray, EdD, ATC
Head Athletic Trainer
Assistant Professor of
Physical Education
Hope College
Holland, MI

I appreciate Dr. Ray's comments concerning my article. I am afraid I must plead "guilty" to Dr. Ray's claim about defining athletic training. All the other papers I cited could not define certified athletic trainer, and I am afraid I inadvertently "tarred him with the same brush" as the others.

Fortunately, I do not feel that this changes the credibility or validity of the paper. Also, my intent of the caution still remains the same. My caution to the reader was that there appears to be a 300% increase in athletic trainers employed by schools when comparing Dr. Ray's survey and mine. I feel that this represents more of our method of counting athletic trainers than a true increase in the availability of athletic training services to student athletes. While Dr. Ray *did* define certified athletic trainer, he did not specify what he meant by "employ."

I was exceedingly liberal in my definition of athletic trainer availability so as to potentially overestimate the athletic trainer availability. Even with this overestimation, the athletic trainer availability is still ridiculously low. I feel that the differences between Dr. Ray's survey and mine do not represent a true improvement in athletic trainer availability, only a difference in our methods of counting.

Lynn M. Lindaman, MD
Orthopaedic Center, P.C.
Des Moines, IA

Effect of Transcutaneous Electrical Nerve Stimulation, Cold, and a Combination Treatment on Pain, Decreased Range of Motion, and Strength Loss Associated with Delayed Onset Muscle Soreness

Craig R. Denegar, PhD, ATC
David H. Perrin, PhD, ATC

ABSTRACT: Athletic trainers have a variety of therapeutic agents at their disposal to treat musculoskeletal pain, but little objective evidence exists of the efficacy of the modalities they use. In this study, delayed onset muscle soreness (DOMS) served as a model for musculoskeletal injury in order to: (1) compare the changes in perceived pain, elbow extension range of motion, and strength loss in subjects experiencing DOMS in the elbow flexor muscle group following a single treatment with either transcutaneous electrical nerve stimulation (TENS), cold, a combination of TENS and cold, sham TENS, or 20 minutes of rest; (2) compare the effects of combining static stretching with these treatments; and (3) determine if decreased pain is accompanied by a restoration of strength. DOMS was induced in the non-dominant elbow flexor muscle group in 40 females (age = 22.0 ± 4.3 yr) with repeated eccentric contractions. Forty-eight hours following exercise, all subjects presented with pain, decreased elbow extension range of motion, and decreased strength consistent with DOMS. Subjects were randomly assigned to 20-minute treatments followed by static stretching. Cold, TENS, and the combined treatment resulted in significant decreases in perceived pain. Treatments with cold resulted in a significant increase in elbow extension range of motion. Static stretching also significantly reduced perceived pain. Only small, nonsignificant changes in muscle strength were observed following treatment or stretching, regardless of the treatment group. These results suggest that the muscle weakness associated with DOMS is not the result of inhibition caused by pain. The results suggest that these modalities are effective in treating the pain and muscle spasm associated with DOMS, and that decreased pain may not be an accurate indicator of the recovery of muscle strength.

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David Perrin is an associate professor and director, Graduate Athletic Training and Sports Medicine/Athletic Training Research Laboratory, Curry School of Education at the University of Virginia in Charlottesville, VA.

Athletic trainers and physical therapists have a variety of therapeutic agents available for treating musculoskeletal pain. However, there is limited evidence to substantiate the efficacy of some modalities and little research has been performed to compare the effects of various treatment protocols.

One of the problems facing those who investigate the analgesic response to treatment with therapeutic modalities is the difficulty of assembling a pool of subjects with similar conditions. Delayed onset muscle soreness (DOMS) has been used as a model of musculoskeletal injury (3,4) because it is a self-limiting condition characterized by symptoms similar to many athletic injuries.

Delayed onset muscle soreness is commonly experienced following novel physical exercise, especially when the exercise involves repeated eccentric muscle contractions. The soreness generally increases for the first 24 to 48 hours (26) and is associated with decreased range of motion (ROM) (3,4) and muscular weakness (7,15,16,20,26,27). Several authors (8,9, 15,16,26) have attributed the weakness associated with DOMS, at least in part, to inhibition caused by pain. Komi and Buskirk (15), after studying subjects performing either concentric or eccentric work, stated that "those in the eccentric group experienced soreness in their exercised muscles. This caused a concomitant drop in muscle strength." However, more recently, Newham et al (20) suggested that pain and strength loss result from tissue damage and that decreased pain would not result in a restoration of muscle strength.

This study was conducted in order to: (1) compare the changes in perceived pain, elbow extension range of motion, and muscle strength in subjects experiencing DOMS immediately following a single treatment with either transcutaneous electrical nerve stimulation (TENS), cold, a combination of cold and TENS, sham TENS, or 20 minutes of rest; (2) compare the effects of combining static stretching with the above mentioned treatments; and (3) determine if decreased perceived pain would be accompanied by a restoration in muscle strength.

Methods

Forty female volunteers (age =22.0 ± 4.3 yr, ht = 167.1 ± 5.5 cm, wt = 62.3 ± 8.6 kg) were advised of the purposes of the study and the method of inducing DOMS. All subjects provided informed consent in compliance with University Human Investigation Committee guidelines. The subjects had not been involved in upper body weight training within 6 months prior to beginning the study, denied a history of recent upper extremity injury, and were free from soreness in the nondominant upper extremity.

Pretest and Exercise

Subjects were required to report to the laboratory twice during the study. During the first session, we reviewed the investigational procedures, oriented them to TENS and the Kin-Com isokinetic dynamometer (Chattecx Corp., Chattanooga, TN), and recorded descriptive data. Normal elbow extension range of motion (ROM) was measured with a standard goniometer. Average concentric and average eccentric torque generated by the elbow flexor muscle group of the non-dominant arm were measured from 90° to 45° flexion at 30°/sec on the dynamometer. Subjects were seated with the shoulder flexed approximately 75° and the elbow aligned with the axis of the dynamometer. A limited ROM was selected for the testing, because previous research indicated that some subjects would lose up to 45° of elbow extension (3,4). The angular velocity of the dynamometer was selected, because we believed that higher velocities would increase the risk of additional muscle injury during eccentric contractions.

Each subject performed three near-maximal concentric and eccentric contractions (each concentric contraction was followed by an eccentric contraction) that were averaged by the computer software. The Kin-Com system samples at a rate of 100 times per second. The movement from 90° to 45° flexion at an angular velocity of 30°/sec required 1.5 seconds, permitting 150 samples. Thus, a mean of each sampling point from the three contractions was used to form a composite torque curve. The average torque value for the concentric and eccentric contractions was then generated from the means of each of the 150 data points. In a conversation with E. Dunlay of Chattecx Corporation (September 1991), it was confirmed that, in the method used by Chattecx to calculate average torque values, the average torque does not equal the sum of the peak torques divided by the number of contractions.

Then, each subject was assigned randomly to one of the five treatment groups: cold, TENS, a combination of cold and TENS, sham TENS, or control (no treatment). At the conclusion of the first session, subjects completed a series of eccentric exercises with the elbow flexor muscle group of the nondominant arm. The exercise protocol has been used previously to induce DOMS (3,4). Prior to returning for assigned treatments, the subjects were asked to refrain from using analgesic or anti-inflammatory medications, receiving physical therapy, or engaging in vigorous upper extremity physical activity.

Treatment and Retests

Forty-eight hours after the exercise bouts, subjects returned to the laboratory. Elbow extension ROM was measured at the point where volitional extension became limited because of pain. Average concentric and eccentric torque generated by the elbow flexor muscle group were measured as described above. Subjects were assessed for perceived pain in the exercised muscles with a graphic pain rating scale (Fig 1).

The graphic pain rating scale developed for this study was based on the verbal descriptive scale used by Talag (26) to assess DOMS. Graphic rating scales are similar to visual analog scales, but have descriptors spread across the scale in addition to those at the extremes. Verbal descriptive scales have been criticized for being insensitive to small changes, while visual analog scales are a robust, sensitive, and reproducible means of expressing pain severity (12). Jensen et al (13) suggested that graphic rating scales are easier to use and improve consistency for each respondent and between respondents. We believe that this adaptation of the Talag scale is a more sensitive measure of the pain associated with DOMS.

Perceived pain was quantified by measuring the distance (to the nearest ½ cm) from the extreme left of the graphic pain rating scale to the mark made on the 12 cm line to describe the pain. The measured distance was multiplied by 2 to yield perceived pain scores from 0 to 24. This procedure eliminated fractional scores. The subjects reported pain in the exercised muscles and demonstrated decreases in elbow extension range of motion, concentric average torque, and eccentric average torque consistent with DOMS (Tables 1, 2, 3, and 4).

Each subject then received her assigned treatment, which lasted 20 minutes. We applied cold treatments by securing

Graphic Pain Rating Scale

Name ______________________ Test Session __________

Dull Ache	A feeling of discomfort during activity
Slight Pain	An awareness of pain without distress
More Slight Pain	Pain distracts attention during physical exertion
Painful	Pain distracts attention from routine occupation such as writing and reading
Very Painful	Pain fills the field of consciousness to the exclusion of other events
Unbearable Pain	Comparable to the worst pain you can imagine

No Pain ____ Unbearable Pain

Dull Ache Slight Pain More Slight Pain Painful Very Painful

Fig 1.— Graphic pain rating scale with a 12 cm line between no pain and unbearable pain. Pain was quantified by measuring the distance (to the nearest ½ cm) from the extreme left to the mark made by subjects to describe their perception of pain. The length was multiplied by two, yielding scores from 0 = no pain to 24 = unbearable pain.

Table 1.—Perceived Pain Score (no pain = 0) (worst pain = 24) (Mean ± SD)

Group	Measurement Time			
	Before Exercise	Before Treatment	After Treatment	After Stretching
Cold	0 ± 0	13.1 ± 4.1	9.9 ± 5.2	6.6 ± 4.3
TENS	0 ± 0	13.3 ± 5.3	9.3 ± 5.8	6.4 ± 4.6
Cold & TENS	0 ± 0	14.6 ± 5.7	10.3 ± 6.2	7.5 ± 5.7
Sham	0 ± 0	12.5 ± 5.2	11.8 ± 4.3	8.5 ± 5.3
Control	0 ± 0	14.0 ± 4.5	14.3 ± 4.3	12.1 ± 4.9
Average	0 ± 0	13.5 ± 4.8	11.1 ± 5.3	8.2 ± 5.2

Table 2.—Elbow Extension Range of Motion (Degrees Extension, Mean ± SD)

Group	Measurement Time			
	Before Exercise	Before Treatment	After Treatment	After Stretching
Cold	8.3 ± 4.4	-21.5 ± 12.7	-15.3 ± 10.6	-7.0 ± 9.4
TENS	6.0 ± 3.5	-19.8 ± 12.8	-15.6 ± 14.2	-7.5 ± 12.1
Cold & TENS	7.1 ± 5.1	-18.8 ± 15.0	-11.9 ± 13.3	-5.4 ± 9.7
Sham	8.3 ± 2.7	-12.8 ± 12.0	-12.5 ± 11.3	-5.1 ± 8.9
Control	6.8 ± 5.3	-19.6 ± 12.1	-19.1 ± 11.0	-13.4 ± 9.6
Average	7.3 ± 4.2	-18.5 ± 12.7	-14.9 ± 11.8	-7.7 ± 9.9

Table 3.—Concentric Average Torque (Newton•Meter, Mean ± SD)

Group	Measurement Time			
	Before Exercise	Before Treatment	After Treatment	After Stretching
Cold	26.9 ± 3.2	16.5 ± 7.7	15.5 ± 6.7	17.0 ± 7.2
TENS	23.9 ± 6.4	12.9 ± 3.7	12.0 ± 3.2	11.9 ± 3.3
Cold & TENS	22.9 ± 3.6	11.9 ± 4.9	9.9 ± 3.2	11.1 ± 4.6
Sham	22.6 ± 6.9	14.6 ± 5.8	14.4 ± 5.6	14.1 ± 4.3
Control	23.4 ± 6.0	12.4 ± 3.5	11.1 ± 2.7	11.9 ± 3.3
Average	23.9 ± 5.4	13.7 ± 5.3	12.8 ± 4.8	13.2 ± 5.0

Table 4.—Eccentric Average Torque (Newton•Meter, Mean ± SD)

Group	Measurement Time			
	Before Exercise	Before Treatment	After Treatment	After Stretching
Cold	33.4 ± 7.5	20.9 ± 7.7	21.0 ± 6.9	21.1 ± 4.9
TENS	33.6 ± 7.4	17.5 ± 4.6	16.6 ± 4.5	16.6 ± 4.1
Cold & TENS	31.1 ± 4.3	15.6 ± 5.7	15.1 ± 4.9	15.0 ± 5.6
Sham	31.9 ± 8.5	19.8 ± 7.4	18.4 ± 7.4	19.1 ± 6.2
Control	32.6 ± 5.6	17.3 ± 6.8	15.3 ± 5.4	17.5 ± 6.5
Average	32.5 ± 6.6	18.2 ± 6.5	17.3 ± 6.0	17.9 ± 5.7

plastic produce bags filled with crushed ice over the elbow flexor muscle group. The bags were secured with an elastic bandage.

TENS was applied with a Neurotech NT-16 stimulator (Neurotech, North Andover, MA). A bipolar placement of two round, carbon, 50 mm diameter electrodes, which were treated with electrode gel and secured with elastic wraps, was used. One electrode was placed over the musculotendinous junction of the biceps brachii and the second over the area of greatest soreness, which was usually over the belly of the brachialis. The parameters of the TENS were: pulse rate = 90 pps, phase duration = 90 u sec, continuous duty cycle and intensity adjusted to provide a tingling sensation without visible muscle twitch.

The combination treatment consisted of a TENS treatment identical to the one described above with an ice bag secured over the electrodes.

Sham TENS was delivered with the NT-16 using the electrode placement described above. The parameters were set as follows: pulse rate = 2 pps, phase duration = 20 u sec, intensity adjusted to approximately 110 ma, and the duty cycle set for an "off" time of 99 sec and an "on" time of 1 sec. The control panel appeared similar for all TENS treatments.

Following the treatments, subjects were again assessed for perceived pain, elbow extension ROM, and concentric and eccentric average torque. Finally, all subjects completed a series of four 30-second static stretches with a 30-second rest between stretches. Following stretching, perceived pain, elbow extension ROM, and concentric and eccentric average torque were reassessed.

Statistical Procedures

We first analyzed the before exercise and before treatment data with a multivariate analysis of variance (MANOVA). Perceived pain, elbow extension ROM, concentric average torque, and eccentric average torque data were analyzed with separate 3*5 ANOVAs (three measurement times [before treatment, after treatment, after stretching] by five treatment groups) with repeated measures on one factor (measurement time). To control for inflated alpha levels resulting from repeated F tests, we interpreted the tests against a level of significance of .0125 (.05/4). An additional 2*5 ANOVA (2 measurement times [after treatment and after stretching] by 5 treatment groups) was conducted on the perceived pain and elbow extension ROM data. Tukey post hoc tests were used to carry out pairwise comparisons and a Scheffé post hoc test was used to determine if subjects who received cold, TENS, or the combined treatment had greater decreases in perceived pain than subjects who received sham TENS or no treatment prior to stretching.

Results

The cell means and standard deviations for the perceived pain, elbow extension range of motion, concentric average torque, and eccentric average torque are located in Tables 1 through 4 respectively.

Forty-eight hours after the exercise bout, subjects reported pain in the exercised muscles, and demonstrated decreased elbow extension range of motion, concentric average torque, and eccentric average torque (Wilks lambda = .086, $p < .01$).

Perceived pain decreased following treatment with cold, TENS, the combined treatment, and the sham treatment, as well as following stretching ($F(2,70)=96.75$, $p<.001$). However, not all groups experienced an identical response to treatment ($F(8,70)=4.45$, $p<.05$). Groups that received cold, TENS, or the combined treatment experienced greater decreases in perceived pain than those who received sham TENS or no treatment (Tukey post-hoc, $p<.05$).

Static stretching resulted in decreased perceived pain in all groups ($F(1,35)=76.7$, $p<.001$). However, subjects who received cold, TENS, or the combined treatment plus stretching had greater decreases in perceived pain than those who received sham TENS or no treatment prior to stretching (Scheffé post-hoc, $p < .05$).

Similarly, increases in elbow extension ROM were greater in some groups than in others ($F(8,70=3.06, p=.007)$). Subjects receiving cold as part of the treatment demonstrated greater increases in elbow extension ROM following treatment (Tukey post-hoc $p<.05$). As expected, stretching resulted in increased elbow extension range of motion in all groups ($F(1,35)=123.1$, $p< .001$).

Concentric and eccentric average torque generated by the elbow flexor muscle group was decreased 43% and 44%, respectively, 48 hours following the eccentric bout. Measurement time means found in Tables 3 and 4 demonstrate that concentric and eccentric average torque did not increase following treatment or stretching. Additionally, there were no differences between groups with regard to change in concentric ($F(8,70)=0.66$, $p=.723$) or eccentric ($F(8,70)=1.36$, $p=.211$) average torque following treatment or stretching.

Discussion

It is difficult to assess and quantify pain and the analgesic response to therapeutic intervention. However, the descriptive data and significant differences between treatment groups and the sham TENS and control groups indicate that the treatments had real (not placebo) analgesic effects. Interestingly, the sham TENS resulted in a greater decrease in perceived pain than no treatment, suggesting a small placebo response to TENS.

These data also indicate that static stretching resulted in decreased perceived pain and that static stretching combined with cold and/or TENS was more effective than static stretching alone. While these findings are consistent with what many clinicians observe when treating musculoskeletal pain, the results of this study provide additional objective data to assist the athletic trainer in establishing a rationale and demonstrating efficacy for these treatment approaches.

Significant increases in elbow extension ROM following treatments with cold and following stretching also suggest interruption of a pain-spasm cycle as proposed by deVries (5). Pain originating in the sensory motor chain leads to reflex muscular spasm (17). The elimination of pain has been associated with muscular relaxation (17,24). Stimulation of the Golgi tendon organ results in motor inhibition and decreased muscular tension (19). Harris (10) stated that "a slow stretch is the best stimulus for obtaining relaxation of a given muscle group." There is wide variation in the length of the hold phase used in clinical practice. The stretching protocol for this study was selected because it is sufficient to stimulate the Golgi tendon organ and approximates the length of stretch used by the authors in clinical practice.

The descriptive data suggests that treatments including cold have a greater effect on spasm than TENS alone, even though cold did not result in a greater analgesic response. This finding may be explained by a cold-induced decrease in muscle spindle activity (6,23). We did not measure intramuscular temperature. However, others have reported decreases in intramuscular temperatures following 15 minutes (18) and 22 minutes (11) of cold application, suggesting that superficial cold can reduce muscle spasm.

The weakness associated with DOMS was not ameliorated by the treatments, even though there were significant decreases in perceived pain. While the subjects were not rendered pain-free, our results suggest that the weaknesses associated with DOMS may not be caused primarily by inhibition resulting from pain. Several investigators have reported damage to contractile tissue in muscles suffering DOMS (1,2,7,14,15,21,22). If the weakness is not caused by pain, it seems reasonable that these symptoms occur in response to the tissue damage (20). While additional work is needed to substantiate this cause and effect relationship, our findings can be applied to clinical practice. Our results suggest that pain is not an accurate marker of recovery from the strength loss associated with DOMS. While physical activity tends to relieve DOMS, clinicians must realize that freedom from pain may not be accompanied by a complete return of strength. Although the pain associated with DOMS usually disappears within 1 week, isometric strength has been reported to return to only about 80% of normal 2 weeks following intense eccentric exercise, with recovery delayed by a second bout of eccentric work (20). The impact of maximum efforts on athletes experiencing DOMS has not, to our knowledge, been addressed.

DOMS may represent an end of a spectrum of muscle strain (25). If this is the case, it would seem prudent to assess the return of strength, in addition to pain and other symptoms, prior to permitting an athlete to return to unrestricted activity following muscle strains and bouts of DOMS that have clearly impaired performance.

The results of our study suggest that cold, TENS, and a combination of cold and TENS had a significant analgesic effect in subjects experiencing DOMS. The results suggest that cold is useful in treating the muscle spasm associated with DOMS.

Furthermore, our results suggest that the muscular weakness associated with DOMS may not be caused primarily by inhibition resulting from pain. Our results support the contention of Newham et al (20) that these symptoms occur in response to tissue damage. Additional investigation is needed to determine if the strength loss associated with DOMS poses a risk of increased injury to athletes. Our results also suggest that pain may not be a valid indicator of recovery from DOMS and, quite possibly, from traumatic muscle strain. If this is the case, clinicians need to be aware that analgesic therapeutic interventions probably do not influence the return of strength following injury. The strength of injured muscle should be assessed prior to returning an athlete to unrestricted activity and competition.

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The Effects of Ice Massage, Ice Massage with Exercise, and Exercise on the Prevention and Treatment of Delayed Onset Muscle Soreness

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Earlene Durrant, EdD, ATC
William Myrer, PhD
Shauna Anderson, PhD

ABSTRACT: We investigated the effects of ice massage, ice massage with exercise, and exercise on the prevention and treatment of delayed onset muscle soreness (DOMS). Twenty-two subjects were randomly assigned to one of four groups. Preexercise measures were recorded for range of motion (ROM), strength, perceived soreness, and serum creatine kinase (CK) levels. Subjects performed up to 300 concentric/eccentric contractions of the elbow flexors with 90% of their 10 repetition maximum to induce muscle soreness. Dependent variables were assessed at 2, 4, 6, 24, 48, 72, 96, and 120 hours postexercise. Significant differences occurred in all variables with respect to time (ANOVA($p<.05$)). However, no significant mode of treatment, or mode of treatment/assessment time interaction was present. Decreases in range of motion and flexion strength correspond with increases in perceived soreness. The nonsignificant mode of treatment/assessment time interaction suggests that the use of ice massage, ice massage with exercise, or exercise alone is not effective in significantly reducing the symptoms of delayed onset muscle soreness. In fact, though not statistically significant, the pattern of the data suggested the use of ice in the treatment of DOMS may be contraindicated. Further investigation is recommended.

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Exercise-induced muscle soreness can be classified as either acute onset or delayed onset. Acute onset muscle soreness occurs during exercise and may last up to 4 to 6 hours before subsiding. Delayed onset muscle soreness (DOMS) has onset 8 to 24 hours postexercise, with soreness peaking 24 to 48 hours postexercise. The etiology of DOMS has been the topic of numerous studies, from which several theories have evolved (3,5,18,32,39).

Despite differences in theories, the following factors have been documented:

1. Strenuous activity—especially eccentric exercise—causes injury or trauma to the muscle, its musculotendinous junction, or both (10,14,34,45,49,50).
2. Injury and/or trauma initiates an inflammatory response resulting in muscles feeling painful and swollen (8,10,23,28).
3. Pain occurrence is delayed approximately 8 hours postactivity and gradually increases, peaking 24 to 48 hours postexercise before gradually subsiding to preexercise levels (1-3,21,47).
4. Trauma results in significantly increased levels of muscle proteins and other breakdown products of muscle and collagen in the blood and/or urine (2,21,24,36,38,51,53,56,63,64).
5. Pain is associated with decreased range of motion (ROM) and strength (3,10,13,15,20).
6. Trauma or resulting pain may directly or indirectly result in muscle spasms and a pain-spasm feedback cycle (18,43).

Because of the presence of pain and other possible debilitating performance factors, preventing or minimizing the effects of DOMS should be a concern for coaches, athletic trainers, physical therapists, and other sports medicine personnel. Little research, however, exists on the prevention or treatment of DOMS.

Considering the biophysics of cryotherapy in relation to the pathophysiological effects of DOMS, one might expect cryotherapy and cryokinetics to be effective in reducing the symptoms of DOMS. In addition, several researchers suggest exercise as an effective mode of DOMS management (30,32).

The purpose of this study was to compare the effects of ice massage, ice massage with exercise, and exercise alone on the prevention and treatment of delayed onset muscle soreness. Criterion measures of delayed muscle soreness were: (a) decreased strength (13,14,32,39,47,62), (b) decreased ROM (4,9,13,15,20,34), (c) perceived soreness and pain (1,2,6-12,23,24,28,46,61,62), and (d) increased serum creatine kinase (CK) levels (3,5,9,21,28,42,45,46,55,62,63).

Methods

We selected twenty-two subjects (11 females, 11 males; age = 20.3± 2.1 years) from a group of volunteers participating in basketball activity classes. Subjects were

apprised of the procedure, possible risks, and benefits of participation in the study prior to giving informed consent. All subjects reported having no upper arm pain and had pain-free range of motion about the elbow joint.

This study had four phases: the preexercise measurements, the induction of delayed onset muscle soreness, the treatments, and the postexercise measurements. Our dependent variables, which were measured pre and post exercise, were: perceived pain, ROM, strength, and serum CK levels. Our independent variables—ice massage and exercise—were manipulated to form our treatment groups. We randomly assigned subjects to one of four treatment groups: (a) ice massage, (b) exercise, (c) ice massage plus exercise, or (d) control. We instructed the subjects not to stretch, massage, or engage in any other treatment or therapy and to abstain from taking any medication during the study.

A repeated measures analysis of variance (ANOVA) was used to measure differences between treatment and control groups. Pearson's product moment correlation coefficients were used to determine relationships between our dependent variables.

Preexercise Measures

We measured isokinetic flexion and extension torque, flexion and extension ROM, serum CK levels, and perceived soreness at rest and at work. Our isokinetic strength measurement protocol was similar to Davis (13). A Cybex II (Lumex Inc, Ronkonkoma, NY) isokinetic exercise dynamometer was set at an angular velocity of 60°/foot-pound scales of 30 and 160 foot-pounds, and degree scale of 150°. Subjects were positioned on the Upper Body Exercise Table as outlined for the Cybex II, elbow flexion/extension protocol.

Subjects performed 8 to 10 submaximal contractions to familiarize themselves with the machine and demonstrate their understanding of the testing protocol. Then they performed 8 to 10 maximal contractions (flexion and extension) through the full range of motion. Torque was recorded on a Cybex dual-channel multi-strip recorder. The average of the three highest peak scores was recorded for both extension and flexion.

Additional preexercise strength measures included using dumbbells, with 5 lb increments, to determine the amount of weight each subject could curl one time, the 1 repetition maximum (1RM), and the amount of weight they could curl 10 times, the 10 repetition maximum (10RM). We used 90% of each subject's 10 RM to induce muscle soreness. We used the 1 RM value to determine the amount of weight to lift during perceived soreness assessments.

We measured ROM preexercise with a plastic international standard full-circle goniometer. Subjects stood in anatomical position. The fulcrum of the goniometer was centered over the lateral epicondyle. The proximal arm of the goniometer was aligned with the lateral midline of the humerus, and the distal arm was aligned with the radius. The limbs were then marked with a permanent marker to ensure greater accuracy during measurement. Neutral was set at zero or 180° (arm straight). Movement of the forearm in an anterior direction from neutral was flexion, and posterior movement of the forearm from neutral was extension (beyond 180°, sometimes referred to as hyperextension). We recorded ROM of flexion, ROM in extension, and their sum gave us ROM total. For example, the control group had a mean flexion ROM of 134.5°, extension ROM of 5.8°, and a total ROM of 140.3° on the pretest. ROM end points were defined as the points at which no further active motion was possible.

We withdrew approximately 10 cc of blood from the antecubital vein for serum CK analysis. Serum samples were poured from separated whole blood samples and frozen until analyzed. The analysis was performed on a Multistat III instrument (Instrumentation Laboratory). Commercial control sera were analyzed with each assay batch to monitor procedural parameters. If the results of the control sera were within acceptable range (± 2 SD), the run was accepted. Medical Analysis Systems, Inc, MAS 207, 217 ml CK Liquid Stable Reagent Set kits were used as reagents.

Perceived pain or soreness was determined using the Talag Scale: (1) No Pain, (2) Dull Vague Ache, (3) Slight Persistent Pain, (4) More than Slight Pain, (5) Painful, (6) Very Painful, and (7) Unbearably Painful (61).

We incorporated methodology patterned after Tiidus and Ianuzzo (62) to determine perceived soreness. Subjects completed two repetitions of approximately 25%, 50%, 75%, and 90% of their 1RM in random order. Perceived soreness was recorded using the perceived soreness scale for each set of contractions. The soreness level indicated during each contraction was recorded. The average of these eight values was our value for perceived soreness during work. Perceived soreness during daily activities was assessed by asking each subject the level of soreness present, based on the soreness scale.

Induction of Delayed Onset Muscle Soreness

We induced muscle soreness in the nondominant arm using concentric and eccentric dumbbell curl exercises, in a manner similar to those outlined by Tiidus and Ianuzzo (62). The eccentric portion of each contraction was emphasized by allowing the subjects to raise the weight with the aid of the other hand if required; however, no aid was given during the eccentric phase. Each subject used 90% of their 10RM. Subjects performed 30 sets of up to 10 repetitions. Each set lasted 20 to 30 seconds and was separated by a 1-minute rest period. The total exercise time was no longer than 45 minutes.

Treatment Protocols

Treatment groups underwent eight 15-minute treatments. Treatments were administered at 0, 2, 4, 6, 24, 48, 72, and 96 hours postexercise.

The following protocols outline the treatment that subjects received in their respective groups.

1. Control—No therapy was administered during the 15-minute treatment time.
2. Ice massage—Ice massage was applied by the subject using an ice ball formed in an 8-ounce paper cup. They massaged the entire length of their biceps and the proximal portion of the brachialis lying above the elbow joint, using circular and stroking motions. The water was not wiped off as the ice melted. Treatment continued for 15 minutes.
3. Exercise—Mild full ROM elbow flexion and extension exercises were performed at the elbow, with only the gravitational pull on the hand and arm providing resistance. Subjects performed continuous repetitions during a 20-second period. Subjects then rested their arms for 40 seconds. Additional bouts of exercise/rest periods continued for 20 seconds of exercise, 40 seconds of rest for the 15-minute treatment time.

4. Ice Massage plus Exercise—Ice massage and exercise were administered exactly as described above, but were combined so that 20 seconds of exercise treatment was followed by 40 seconds of ice massage treatment. Treatment continued for 15 minutes.

Postexercise Measures

Postexercise measures for strength, ROM, perceived soreness, and CK levels were obtained using the same procedures outlined for preexercise assessments. Postexercise measures for all variables, except CK, were recorded at 2, 4, 6, 24, 48, 72, 96 and 120 hours postexercise. CK levels were not analyzed at 96 hours postexercise. Postexercise measures were obtained prior to treatment when treatment and assessment coincided.

Results

No significant mode of treatment or mode of treatment/assessment time interactions were found. However, flexion ROM approached significance between mode of treatment ($F(3, 18)=2.66$, $p=.08$). The interaction of serum CK levels and mode of treatment also approached significance ($F(24,142)=1.50$, $p=.076$). At 120 hours postexercise the ice group had much higher CK values than the other groups (Fig 5).

Despite lacking significant differences in the main effects, various comparisons within and between specific groups were interesting. Figures 1-5 show the pattern of change in total range of motion (ROMT), flexion strength (FS), extension strength (ES), perception of soreness at rest (PSR), and serum CK levels with respect to treatment and time.

Our protocol for inducing delayed onset muscle soreness resulted in significant changes over time in the variables illustrated in Figures 1-5: ($F(8,142) > 6.70$, $p<.01$).

Soreness during work was localized to the insertion of the biceps brachii and was most severe at terminal extension.

The peak values of our dependent variables of DOMS generally followed the same time course. Peak decreases in total ROM occurred at 48 hours for all groups except the control group where it occurred at 72 hours (Fig 1). Peak decreases in flexion strength resulting from DOMS also occurred at 48 hours for all groups except control, which had peak decreases at 24 hours (Fig 2). Peak decreases in extension strength resulting from DOMS occurred at

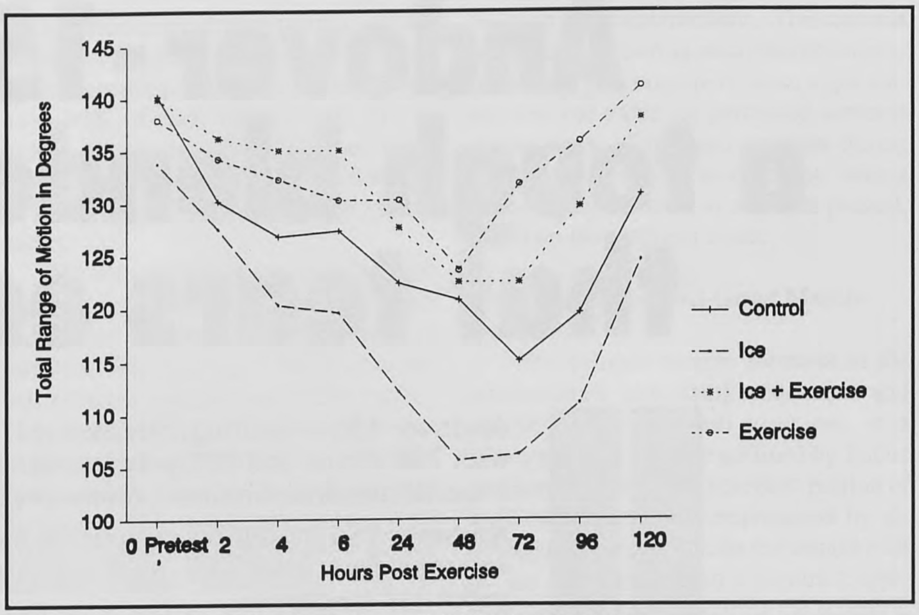

Fig 1.—Change in range of motion with respect to treatment groups

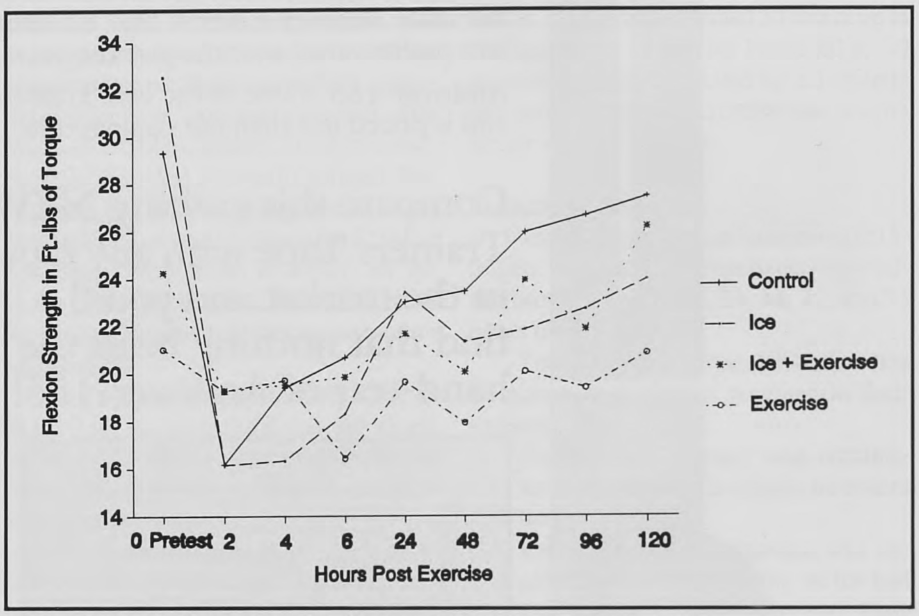

Fig 2.—Change in flexion strength with respect to treatment groups

24 hours in all groups except the exercise group that experienced its peak decrease at 48 hours (Fig 3). Soreness values at rest associated with DOMS peaked at 48 hours for the ice and the ice and exercise groups. Soreness reached its peak at 24 hours in the exercise group, but maintained that level until the 48-hour assessment. The control group did not reach its soreness at rest peak until 96 hours (Fig 4). CK levels increased rapidly in all groups at the 24-hour mark and they at least doubled by the 48-hour period in the control, ice, and ice and exercise groups. Only the exercise group maintained low levels of CK beyond the 72-hour mark. The mode of treatment and time interaction for serum CK means approached significant levels at 72 hours and continued to show dramatic increases at 120 hours, particularly in the ice group ($F(24,142)=1.50$. $p=.076$)(Fig 5).

The Table illustrates the correlations between the dependent variables. Total ROM and ROME were highly correlated ($r=.84$, $p<.01$), as were muscle soreness at rest and muscle soreness at work ($r=.88$, $p<.01$; Table). There were moderate correlations between ROMT and ROMF, perceived soreness at rest, perceived soreness at work, and serum CK; between ROME and serum creatine kinase, and perceived soreness at rest, and between flexion and extension torques (Table).

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Pearson Product Correlations

	ROMF	ROME	ROMT	FS	ES	PSR	PSW
ROME	0.186						
ROMT	0.631**	0.844**					
FS	0.018	0.023	-0.004				
ES	-0.339	-0.231	-0.354	0.672**			
PSR	-0.214	-0.571**	-0.575**	-0.142	0.099		
PSW	-.217	-0.487*	-0.505**	-0.194	0.085	0.879**	
CK		-0.515**	-0.540**	0.013	0.0389	0.455*	0.430*

ROMF = Range of Motion Flexion
ROME = Range of Motion Extension
ROMT = Range of Motion Total
FS = Flexion Strength
ES = Extension Strength
PSR= Perceived Soreness at Rest
PSW = Perceived Soreness at Work
CK = Serum Creatine Kinase Levels

*Significant at (P<.05)
**Significant at (P<.01)

Discussion

The mechanisms producing delayed muscle soreness are vaguely understood, making information concerning prevention and treatment scarce. Previous studies have tried to isolate specific mechanisms (4,6,7,11,25-27,35,46,48), while other studies have attempted to prevent and treat the symptoms (9,13,16,17,19,22,31,57,60, 62,66). We attempted to prevent and treat muscular soreness through the use of ice massage and exercise.

Data from previous studies (13,15,29,37,40,52,66) combined with our understanding about cryotherapy biophysics (41,44,54,58,59,65) suggest that ice therapy might be beneficial. In addition, researchers have supplied evidence showing that high speed voluntary muscle contraction limit the degree of delayed muscle soreness and associated symptoms (30,32,33).

Neither Yackzan (66) nor Davis (13) found significant differences in their criterion indicators of DOMS resulting from the use of ice massage or cold hydrotherapy in treating DOMS. We felt, however, that they began treatment too late and did not treat often enough. In addition, the treatment effect outlined by numerous researchers (11,22,33,34,55,57) may have confounded Davis' results. Our study addressed these weaknesses by using immediate and repeated ice application. Despite these changes, the nonsignificant findings of treatment and assessment time interaction parallel those of Yackzan (66) and Davis (13).

Because of the lack of significant evidence, we cannot say with certainty that ice or exercise or the combination of ice and exercise does or does not help or hinder the prevention and treatment of DOMS. Although not statistically significant, the data as illustrated in Figures 1, 4, and 5 indicate a pattern that is very interesting and certainly begs further investigation.

Although not statistically significant, it is interesting to note that the ice group had the highest peak soreness at rest scores, the highest serum CK levels, and the lowest low peak total ROM of all the groups. Conversely, the exercise group had the lowest peak soreness at rest scores, the lowest serum CK levels, and the highest low peak total ROM of all the groups. This suggests that the mechanisms responsible for muscle adaptation and repair and subsequent relief from DOMS symptoms may center around physiological responses that are adversely affected by cold application.

Peak soreness at 48 hours in the ice and ice and exercise groups and 24 to 48 hours in the exercise group concur with others (46,55,61,62,66) who have shown maximum readings ranging between 24 to 48 hours postexercise. Discrepancy between time of maximal occurrence (24 or 48 hours) may be attributed to the different types of exercise performed, the intensity of exercise, muscle groups involved, and other factors such as gender, age, previous conditioning levels, and overall strength levels of the subjects.

The relatively high correlation between perceived soreness at work and perceived soreness at rest (r=.88, Table) indicates that the mechanism of pain manifests itself in resting muscles and is not isolated to the contractile process. In fact, there is some indication that muscle contraction seems to decrease the soreness as indicated by the exercise group's reduced CK levels (Fig 5) and having the lowest peak soreness at rest scores (Fig 4). The exercise group performed mild isotonic contractions as treatment. Although nonsignificant, the pattern of change for the exercise group appeared favorable with respect to soreness levels as compared to the other groups (Fig 4). The negative correlation between ROMT and perceived soreness at rest, and ROMT and perceived soreness at work indicates that there is a tendency for the total ROM to increase as the pain decreases (Table).

Significant increases in extension strength over time has not to our knowledge been reported. Mean extension strength was lowest at 24 hours postexercise in all groups except the exercise group and exhibited significant increases as time postexercise elapsed (Fig 3). Reasons for this increase may include a training effect gained from repeated bouts of exercise on the Cybex II isokinetic machine. This training effect results in greater coordination and familiarity with the machine. This, in turn, allows for increased strength recordings.

Reciprocal inhibition of the biceps muscle also may play an important part. Neurologically, when the triceps receives a stimulus to contract, the biceps receives a stimulus inhibiting contraction to a certain degree. A number of the biceps fibers do contract, acting against the triceps, providing coordinated extension movements in the arm (6). Perhaps, due to the biceps' high degree of fatigue, weakness, and soreness, some of the opposing force usually generated against the triceps contraction is lost, allowing the triceps to work more efficiently.

Structural changes occurred, evidenced by the significant increases in serum CK levels over time. The elevated levels of creatine kinase appear to be quantitative markers of muscle damage (26,36). Others have shown that muscle damage exists immediately after exercise (25,45,49), but several hours may pass before pain is felt, and damage continues to increase for about 48 hours. Strength decreases result because of the reluctance to use sore muscles and from the loss of inherent force-producing capacity within the muscle (24,46-50). Despite

large increases in serum CK levels in all groups, extremely large levels existed only in the ice group (Fig 5).

Observations have varied concerning the time of peak CK values and its relationship with factors such as ROM, strength, and soreness. Some report peak CK values as early as 24 hours postexercise (55,62). Others have observed peak CK values during 24 to 48 hours postexercise, thereby concomitant with the usual maximum soreness and decreased ROM and strength (11). Yet others have reported peak CK values occurring long after pain has decreased and ROM has improved (45,55). Our investigation supports the latter view.

The patterns of change shown in Figures 1-5 somewhat support the argument of exercise as an effective method of reducing DOMS. The exercise group had the smallest decreases in ROM and strength and the smallest increases in soreness and CK. This agrees with recent research that reported that high speed voluntary muscle contraction is effective in decreasing muscle soreness (31). The combined ice with exercise group provides additional data supporting the use of exercise. Although the subjects from the ice with exercise group had greater decreases in ROM and strength, and greater increases in soreness and CK than the exercise group, the changes in these variables were more positive than those of the control or ice only groups. This suggests that the use of ice in the ice with exercise group may have been detrimental to the otherwise successful exercise treatment as evidenced by the exercise group.

In summary, this study provides additional support that repeated strenuous concentric-eccentric exercise produces DOMS. Decreases in strength and ROM from 24 to 48 hours correspond with increases in pain suggesting similar etiology. The significant increases in serum CK levels provide support for the torn tissue theory (32) of DOMS. The therapeutic use of ice and exercise, combined or used separately, was not effective in reducing the symptoms of DOMS. Though not statistically significant, the patterns in the data suggest that ice application may be contraindicated in the treatment of DOMS. Additional research with a larger sample size is needed before we can know for sure how effective ice and exercise are for treating delayed onset muscle soreness.

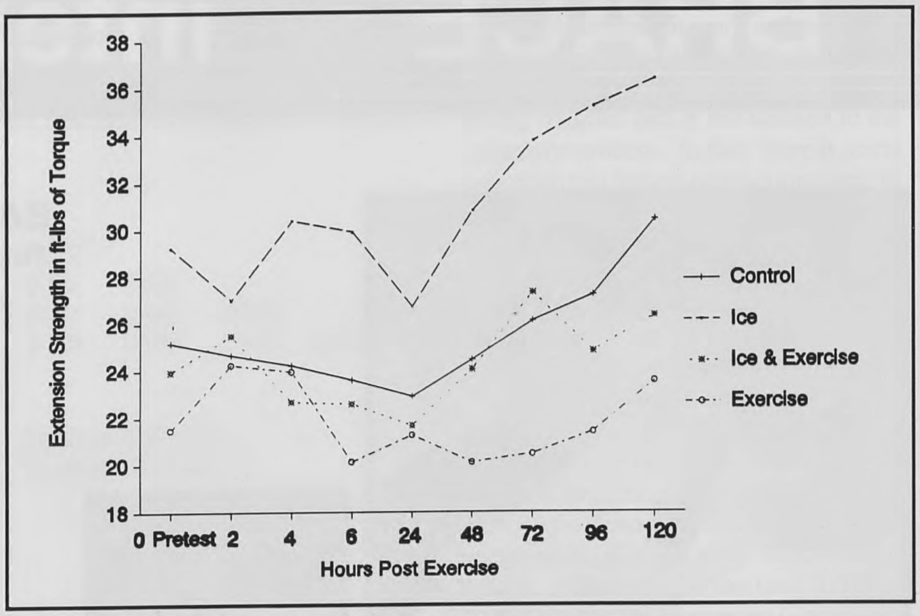

Fig 3.—Change in extension strength with respect to treatment groups

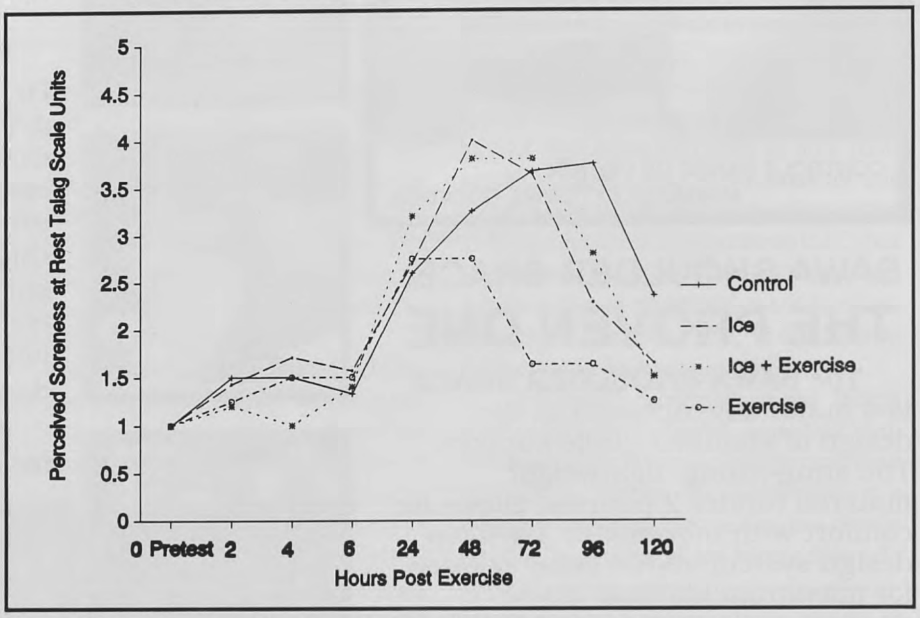

Fig 4.—Change in perceived soreness at rest with respect to treatment groups

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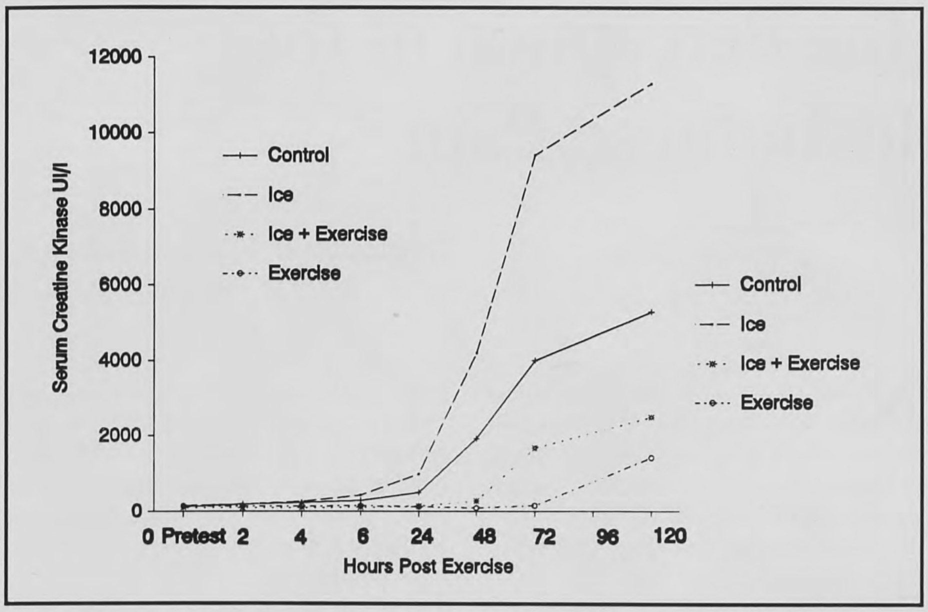

Fig 5.—Change in serum creatine kinase levels with respect to treatment groups

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Habituation to the Perception of the Qualities of Cold-Induced Pain

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ABSTRACT: This study was conducted in order to measure the reported pain caused by cold immersions over a 5-day period to determine if habituation to the perception of cold pain occurs. Numerous authors have described a habituation phenomenon to therapeutic ice bath immersions. Athletic trainers often explain to athletes that their perceptions of the pain induced by a therapeutic ice bath will decrease each day as they proceed through therapy. Essentially, it is assumed that there is a habituation to the perception of cold-induced pain shortly after initiation of the treatment regime. The subjects were 22 male and female college students who had limited experience with cold immersion. The subjects' right feet and ankles were immersed in an ice bath for 21 minutes on 5 consecutive days followed by a 21-minute recovery period. The McGill Pain Questionnaire (MPQ) was used to measure pain during the immersions. Sensory, affective, evaluative, and miscellaneous qualities of pain were determined from the MPQ. During the testing session, each subject completed the MPQ 30 seconds following immersion and then every 3 minutes until completion of the test. Repeated measures analyses of variance (ANOVAs) adjusted according to the Bonferroni correction revealed no significant differences for any of the qualities of pain over a 5-day period. The subjects' perception of cold-induced pain did appear to decrease during the immersion and there was a trend towards decreasing pain during day five, but a habituation effect was not documented in this study.

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Numerous authors (2,14,15,16,21) have described a habituation to cold pain. Pain measures used for these experiments have been primarily focused on the intensity of pain (1,2,7,25). Only Strempel (23,24) examined different qualities of pain associated with cold.

The purpose of our study was to measure the qualities of cold-induced pain (using the McGill Pain Questionnaire (MPQ)) over a 5-day period to determine if habituation to the perception of the qualities of cold-induced pain occurs.

Methods

Informed consent was obtained from 28 volunteers (13 males, 15 females, age = 21.2 ± 4.0 yr, ht = 68.3 ± 4.0 in, wt = 152.1 ± 32.6 lb) from the student body of the University of Nevada at Las Vegas. Subjects were excluded from the study if they were hypersensitive to cold, had known peripheral vascular disease, or had impaired sensation of the lower extremities. Subjects were told that they were free to withdraw from the study at any time without prejudice.

A modified version of the MPQ (18) was used to measure the pain experience. The modification replaced the word "pain" with the word "sensation" (13). The MPQ is a valid (3) and sensitive (13) instrument.

The MPQ (Fig 1) consists of 76 pain descriptors arranged into 20 categories. The words in each category appear to be synonymous, but are arranged in order of increasing severity. The pain experience is divided into four major classifications: sensory pain, represented by the categories numbered 1 through 10; affective pain, represented by the categories numbered 11 through 15; evaluative pain, represented by the category numbered 16; and miscellaneous pain, represented by the categories numbered 17 through 20. Upon completion of the questionnaire, scores representing sensory, affective, evaluative, and miscellaneous pain were derived. Scores were calculated by adding the sequence number of each item in each category (eg, "throbbing" would have a value of 4 in category 1, "miserable" would have a value of 3 in category 16, etc), then dividing by the total number possible for each component of pain. This provided a common scale among all qualities of pain, a percent of the maximum possible score.

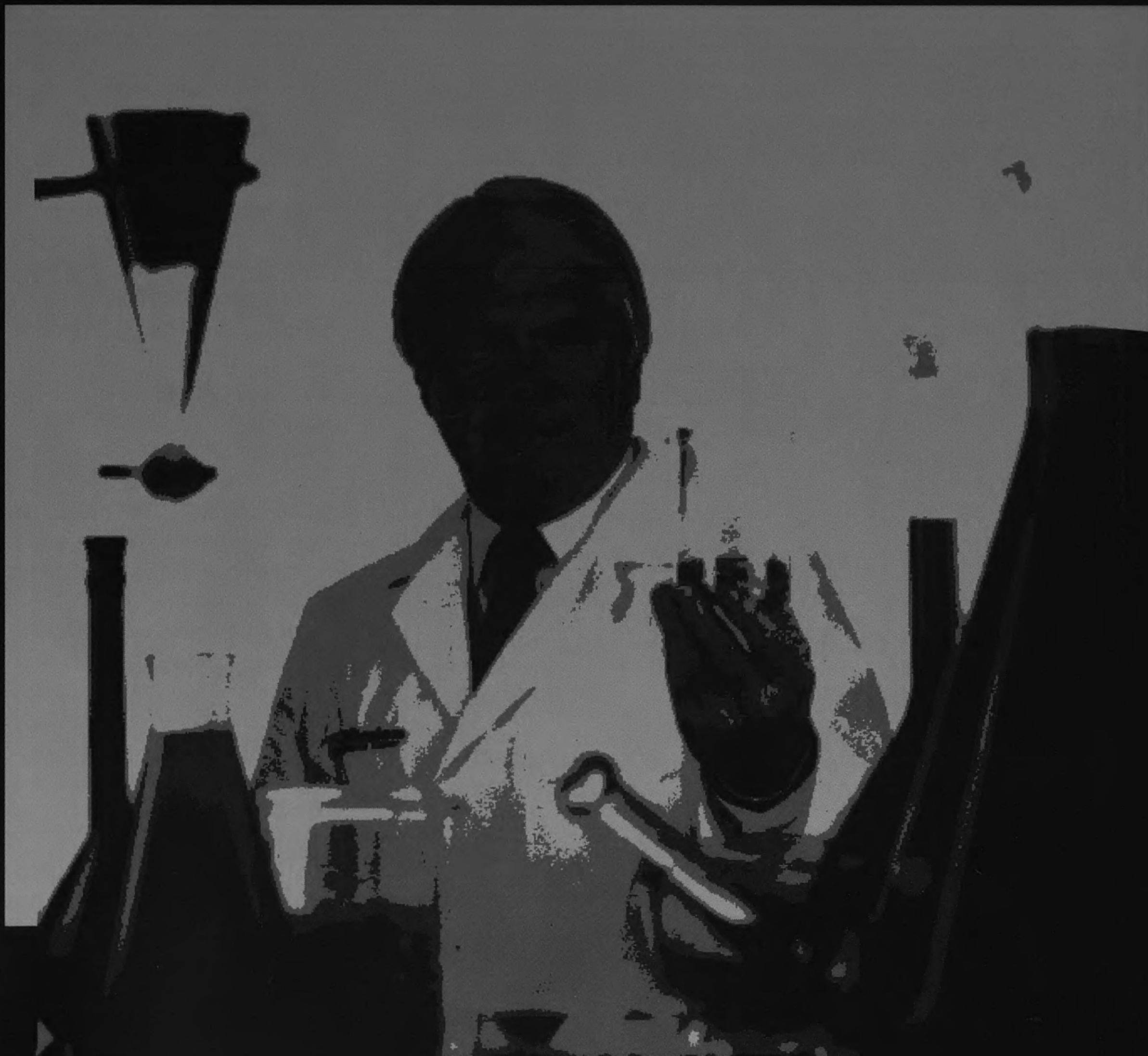
When administering the MPQ, subjects were told to choose one word from each category and to choose a word from that category only if it described their current sensation. Multiple selections from the same category were disallowed.

Prior to testing, subjects read the MPQ in order to become familiar with the descriptors before the actual test. Once the subjects were acquainted with the instrument and could verbally explain the proper procedure for completing the form, testing commenced.

First, we read the instructions to the subjects and answered any questions that they had. Then, subjects were instructed to immerse their right feet and ankles into the ice bath and were told not to remove them during the 21 minutes of immersion. Thirty seconds after immersion, subjects were instructed to fill out their MPQ. The questionnaires were then completed 3 minutes after the initial immersion, 6 minutes after the initial immersion, etc, up to 21 minutes. The feet were then removed from the ice bath. The subjects were allowed to dry their feet and ankles, but were not permitted to leave their seats. In order to examine a recovery period, the sequence of filling out the MPQs was continued every 3 minutes until 42 minutes had elapsed from the initial immersion.

Water temperature at the beginning of the test was 2°C (±1°C). No attempt was made to control water temperature; we wanted 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.

Each subject repeated the protocol on 5 consecutive days at the same time each day.



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

Fig 1.—The McGill Pain Questionnaire - Categories 1 to 10 represent sensory components of pain, categories 11 to 15 represent affective components of pain, category 16 represents pain intensity, and categories 17 to 20 represent combination terms (ie, involving two or more types of pain).

Sensory, affective, evaluative, and miscellaneous pain were analyzed using a repeated-measures one way analysis of variance (ANOVA). Data were tested at the p = .0125 level. A Bonferroni correction of an overall p = .05 with four dependent measures (*á=a/c*).

Results

Twenty-two of the original 28 subjects completed the testing. Five subjects withdrew from the study during the first 9 minutes of immersion on day one. One subject did not complete the testing because he had dental surgery prior to day five.

No significant differences were found for sensory ($F(4,84) = 2.01$, $p = .10$), affective ($F(4,84) = 2.73$, $p = .035$), evaluative ($F(4,84) = 2.13$, $p = .084$), or miscellaneous ($F(4,84) = .41$, $p = .80$) pain during the 5 days of testing (Fig 2).

Discussion

Glaser et al (6) defined habituation as "... a process of ... accustoming" that "... depends on the mind, that is reversible, and that may involve the diminution of normal response or sensation." Habituation is considered a function of the central nervous system (CNS) in which a threshold is altered to an unchanging peripheral input (21). Previous studies of cold-induced pain (1,2,15,16,23,24,26) have indicated that pain is one of the normal sensations that undergoes CNS habituation. These studies have reported habituation to cold-induced pain in terms of physiological variables such as a decreased sympathetic response, enhanced vagal response, increased catecholamine levels, decreased vasospasm, or in terms of improved cognition, neuromuscular changes, or local temperature changes. Some investigators (1,2,7,25) have examined a pain measurement as an indication of habituation to cold-induced pain. The measurement of pain in these instances was the intensity of the pain.

A precise definition of pain has not been determined (19). We do know if pain has a number of associated qualities. Melzack and Torgerson (19) identified three major qualities of pain and developed an instrument, the MPQ, to measure these qualities. The qualities of pain identified were sensory, affective, and evaluative pain. They also described a fourth quality, miscellaneous pain, which includes terms that could be listed in at least two of the three aforementioned categories.

The availability of an objective measurement of pain and recent clinical experiences caused us to question the existence of habituation to the perception of cold-induced pain. This then prompted us to quantify the pain response during cold immersions.

There was not a conclusively documented habituation to the perception of cold-induced pain over a 5-day period. Although a clinical protocol was followed as closely as possible in this study, there was one factor that was absent. This was the instruction given to the athletes prior to immersion. We did not tell our subjects what they could reasonably expect to feel during immersion (ie, we did not give them sensory information). In a clinical protocol, athletes are often informed about the types of sensations that they may feel during the immersion.

Sensory information provides a preview of the sensations that one will experience when exposed to the stressor, ie, cold (17). Numerous authors (9-12,20,22,27) have demonstrated that a reduction in emotional distress occurs when subjects are given sensory information.

This reduction of emotional distress has been accounted for by two hypotheses (17). The first states that sensory information provides the subject with an accurate comparison to use to check his or her own experience. The elements of surprise and uncertainty are eliminated and the subject will feel that he or she has more control over the situation (9). The second hypothesis states that sensory information changes the way the noxious stimulus is processed by the brain. The correctness of the information is not as important as the

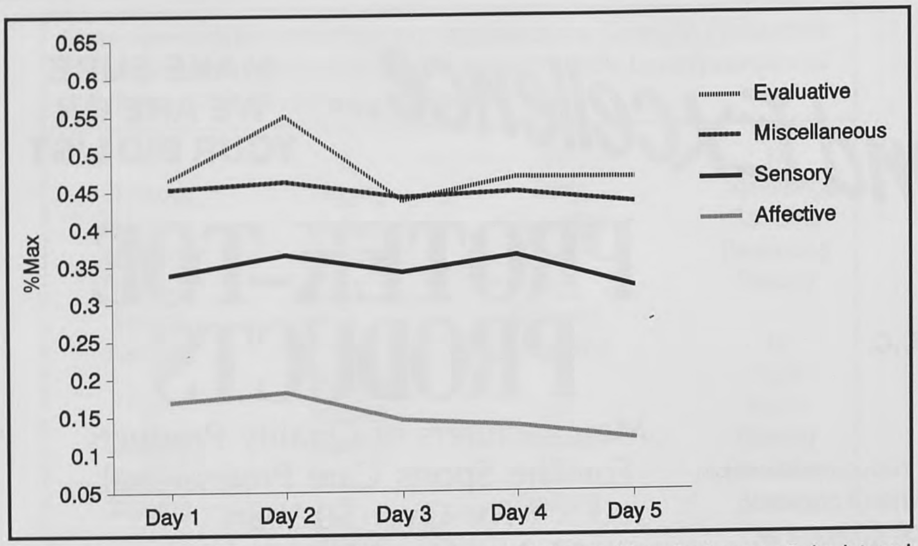


Fig 2.—Percentage of maximum possible score for each of the qualities of pain over a 5-day interval

types of descriptors used (4); although, the persuasiveness of the directives may be a factor (28).

In the clinical setting, habituation to the perception of cold-induced pain may indeed occur. Often, the athlete is presented with the four classical sensations of cold: pain, burning, aching, and analgesia—or a similar combination. Hence, the athlete has been given sensory information about the noxious stimulus that he or she is about to experience. The emotional distress would be reduced regardless of whether the information was accurate.

Our subjects were not given sensory information directly. They did receive a list of words to use to describe their sensations, the MPQ, but were not told which ones applied. The MPQ contains 76 words and it would be nearly impossible for a subject to think about all 76 words simultaneously. Therefore, the feeling of uncertainty was not alleviated and the processing of the stimulus was not altered.

One could argue that after the first immersion the subject would have experienced the stimulus and thus would have developed his or her own sensory information from the experience. This is probably true. However, the sensory information they developed most likely stressed the negative components of the experience. Epstein (5) demonstrated that distress is not diminished if the stimulus is expected to be of great magnitude. Our subjects may have developed sensory information that emphasized pain or used the terms selected during the first immersion as their sensory information.

The increase in evaluative pain from day one to day two is consistent with Epstein's (5) idea. One would expect affective pain to increase as well if the subject was dwelling on the negative aspects of the experience.

Another possible explanation for the absence of habituation is that the subjects did not have a painful condition prior to cold exposure (eg, sprained ankle). Perhaps the presence of pain in an injured body part has an effect on the perception of pain when the part is cooled. In this case, the cold may act as a counterirritant.

It is interesting to note that pain never reached zero, even after 21 minutes of rewarming. This is contrary to what we tell athletes. Typically, we explain that the athlete will achieve analgesia, an inability to feel pain, sometime during the cold immersion. It is clear that this does not occur. In fact, only one subject reported no pain during testing. This report of analgesia occurred during minute 36 of testing, but pain promptly returned during the final 6 minutes of the test. The term hypalgesia has been suggested to describe a decrease, but not absence, of cold-induced pain (8).

The results of this study indicate that habituation to the perception of cold-induced pain does not occur. Further research is needed to determine the effects of sensory information and a current painful condition on reported pain during cold immersions.

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Habituation to Cold-Pain During Repeated Cryokinetic Sessions

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ABSTRACT: Clinicians claim that patients habituate to cold-induced pain during cryokinetic treatments, but this has not heretofore been tested. We treated the right ankle of 38 subjects with a simulated cryokinetic treatment daily for 8 days using either 1° or 5°C water. On days 9 and 10, the right ankle was treated with the opposite temperature and the opposite ankle (left) was treated with the habituation temperature. Cold-induced pain was recorded five times each day (after each ice immersion bout) using Borg's Perceived Pain Scale and the McGill Pain Questionnaire. There was a sharp decrease in pain from days 1 through 5, but no difference between days 5 through 8. Pain during bout one was significantly greater than the following four bouts for all days except day 1. Location of pain changed between days but not between bouts. The instep was the most frequent location of pain for the first 3 days. The choice of "no specific location" increased steadily from day 2 to 8. The number of descriptor terms chosen on the McGill Pain Questionnaire decreased from day 1 to day 8. Exceptions to this were the terms cool, cold, freezing, and numb. Common terms chosen on days 1 through 3 were throbbing, sharp, burning, tingling, hurting, and nagging. On days 9 and 10, pain in the opposite (left) limb was greater than pain at the end of right limb habituation, but similar to day 1 of habituation. Right limb immersion with a lower temperature resulted in greater pain than that perceived on day 8. Daily repeated cryokinetic treatments are sufficient to produce habituation to cold-induced pain. Habituation was specific to the limb treated and temperature of habituation; thus, we conclude it is primarily physiological with some psychological influence. Athletic trainers are justified in telling patients who are undergoing ice water immersion that the cold pain will diminish with repeated applications.

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Cryokinetics is a popular treatment for acute ligament sprains. It involves an initial 20-minute cold application followed by four periods of 3 to 5 minute cold applications interspersed with 2 to 3 minutes of active exercise (7). The cold applications decrease injury pain so that active exercise within a normal range of motion can begin quickly after the initial injury, and rehabilitation is completed more quickly (7). One problem with cryokinetics is that the cold causes substantial pain before it moderates the injury pain (7). Clinicians who use cryokinetics claim that the body quickly adapts to the cold application, and cold-pain is not a problem after one to two treatments (7).

The belief that adaptation occurs during cryokinetics is based on clinical experience and indirect research involving short-term cold applications to the fingers and face (1,9,15) and single daily applications (1,6,15). The only attempt to evaluate adaptation during a therapeutic application of cold reported no decrease in pain during a 20-minute application, but some decrease (habituation) after 5 days (6). The methodology in that study, however, did not involve clinical conditions. For instance, during ice immersion subjects were directed towards thinking about their pain, whereas during cryokinetics clinicians try to redirect patients' attention from the pain. Also, cold application was a single 21-minute cold application rather than a full cryokinetic treatment involving 4 to 6 cold applications during each treatment session.

Previous research of adaptation indicates that cold-induced pain occurs only in water of 18°C or less (15), and is specific to the temperature exposed to or warmer (15) and to the body part treated (1,15). But these conclusions are based on non-therapeutic applications of cold.

The questions addressed by this study were: Does the body habituate to repeated therapeutic cold applications so pain is reduced? If so, is the habituation specific to the body part and temperature used during habituation?

Methodology

Thirty-eight subjects (Age = 19.7±1.5, Males [ht = 71.3±2.9 in, wt = 175.9±37.5 lb] Females [ht = 62.9±3.8 in, wt = 123.7±15.2 lb]) underwent 9 days of cryokinetic treatments to the right ankle and 1 day to the left ankle. Five times during each session they recorded pain sensation using the McGill Pain Questionnaire (10) and Borg's Perceived Pain Scale (2).

Informed consent was obtained from volunteers with no history of injury during the past 12 months.

Twelve subjects were randomly assigned to each of four groups, but only 38 continued past the first day: 11 in one group and 9 in the other three groups. Groups 1OT and 1OA received cryokinetics for 8 days with 1°C water; groups 2OT and 2OA with 5°C water, all to the right ankle. (See Table 1 for explanation of group names.) On day 9, the right ankles of groups 1OT and 2OT were treated with the opposite temperature while the left (opposite) ankles of groups 1OA and 2OA were treated with the group's original temperature. On day 10, groups 1OT and 2OT received the left ankle treatment at the selected temperature and groups 1OA and 2OA received the opposite temperature treatment to the right ankle.

Cryokinetic sessions consisted of five bouts of cold immersion with exercise following each. The first cold immersion

Table 1.—Limb and Temperature Assignments for Subjects

GROUP	N	DAYS 1-8 Temp/Extremity	DAYS 9 Temp/Extremity	DAYS 10 Temp/Extremity
1OT*	9	1°C/Right	5°C/Right	1°C/Left
1OA**	9	1°C/Right	1°C/Left	5°C/Right
2OT*	9	5°C/Right	1°C/Right	5°C/Left
2OA**	11	5°C/Right	5°C/Left	1°C/Right

*Opposite temperature on day 9; opposite ankle on day 10
**Opposite ankle on day 9; opposite temperature on day 10

lasted 20 minutes; the remaining four were 5 minutes each. Subjects wore toe caps (11,14) during cold immersion, which was in one of two 50 gal hog troughs, large enough for 8 subjects to sit around. The troughs were partially filled with water. Ice was then added to cool the water to 1°C or 5°C. The water was stirred every 3 to 5 minutes during immersion bouts.

Each exercise bout lasted 3 minutes. All subjects followed the same prescribed exercise progression (Table 2). Exercises consisted of active range of motion, stretching, walking, jogging, sprinting, hopping, and jumping. The early days included the less strenuous exercises, and, as the days passed, the exercise became more strenuous.

Pain was measured by the McGill Pain Questionnaire (8) and Borg's Perceived Pain Scale (2). The McGill Pain Questionnaire includes three parts: location, description, and duration. Location of pain was determined from two drawings of the lower leg and foot (labeled "inside of foot" and "outside of foot"). Subjects circled on the drawing the area corresponding to their greatest pain.

Description of pain involved subjects choosing words that described what their pain felt like. The questionnaire contained 20 sets of words with two to five words per set (77 words total)[1]. For instance, the

[1] See page 220 of this issue for a copy of this portion of the McGill Pain Questionnaire.

Table 2.—Daily Exercise Progression for Simulated Cryokinetics, using Exercise as Described by Knight (7)
The number in parenthesis indicates time (minutes: seconds).

DAY 1 BOUTS
1st: active ROM (3:00)
2nd: active ROM (1:00), standing on both feet (2:00)
3rd: standing on both feet shifting weight (3:00)
4th: weight bearing (2:00), toe raises (2 x 15 times, apx 1:00)
5th: shifting weight (1:00), weight bearing (1:00), toe raises (2 x 15, apx 1:00)

DAY 2 BOUTS
1st: heel cord stretch (1:00), walk small steps (2:00)
2nd: walk small steps (1:30), walk medium steps (1:30)
3rd: walk medium steps (3:00)
4th: walk medium steps (1:00), walk large steps (2;00)
5th: walk large steps (3:00)

DAY 3 BOUTS
1st: heel cord stretch (1:00), walk large steps (2:00)
2nd: walk large steps (1:00), walk lazy S's (2:00)
3rd: walk lazy S's (1:30), walk lazy Z's (1:30)
4th: walk smaller figure eights (2:00), walk sharper Z's (1:00)
5th: walk figure eights (1:00), walk sharp Z's, cutting (2:00)

DAY 4 BOUTS
1st: heel cord stretch (1:00), walk lazy S's (1:00), walk lazy Z's (1:00)
2nd: walk sharp Z's (1:00), walk small figure eights (2:00)
3rd: walk with faster pace straight (1:00), jogging straight (2:00)
4th: jogging straight (2:00), jogging with lazy S's (1:00)
5th: jogging straight (1:00), jogging with lazy S's (2:00)

DAY 5 BOUTS
1st: heel cord stretch (1:00), jogging straight (2:00)
2nd: jogging lazy S's (1:30), jogging lazy Z's (1:30)
3rd: jogging sharper Z's (2:00), jogging figure eights (1:00)
4th: jogging sharp Z's (1:00), jogging figure eights (2:00)
5th: jogging smaller figure eights (3:00)

DAY 6 BOUTS
1st: heel cord stretch (1:00), jogging lazy S's (1:00), jogging lazy Z's (1:00)
2nd: jogging sharp Z's (1:30), jogging figure eights (1:30)
3rd: jogging figure eights (2:00), sprinting 5-10 yards with slow start and stop (1:00)
4th: sprinting 5-10 yards with slow starts and stops (2:00), jogging small figure eights (1:00)
5th: sprinting 5-10 yards with slow starts and stops (1:30), medium speed lazy S's (1:30)

DAY 7/9 BOUTS
1st: heel cord stretch (1:00), jogging lazy S's (0:30), jogging lazy Z's (0:30), medium speed straight running (1:00)
2nd: sprinting 5-10 yards with slow starts and stops (3:00)
3rd: sprinting 5-10 yards with quicker starts and stops (3:00)
4th: sprinting 5-10 yards with quick starts and stops (3:00)
5th: hopping (0:30), defensive slide (1:00), hopping (0:30), defensive slide (1:00)

DAY 8/10 BOUTS
1st: heel cord stretching (1:00), medium running straight ahead (2:00)
2nd: sprinting 5-10 yards with slow starts and stops (1:00), sprinting 5-10 yards with quick starts and stops (2:00)
3rd: hopping (0:30), defensive slide (1:00), deep bending jumps (2 x 10, apx :45), defensive slide (0:45)
4th: sprinting lazy S's (1:00), sprinting lazy Z's (1:00), sprinting with turns (1:00)
5th: sprinting with cutting (1:00), defensive slide (1:00), sprinting with cutting (1:00)

Table 3.—Perceived Pain Scores by Day and by Bout from both Borg and McGill Scales (Means±Standard Deviations of scores from 38 subjects)

Day	Immersion 1	2	3	4	5
Borg Scale					
1	4.1±2.2	4.2±2.0	4.7±2.1	4.4±2.7	4.6±3.1
2	4.3±2.2	3.9±1.9	3.6±2.1	3.6±2.3	3.7±2.7
3	4.3±2.6	3.5±2.4	3.2±2.4	3.8±2.9	3.3±3.0
4	3.9±2.4	3.2±1.8	2.8±1.8	2.6±2.1	2.1±1.9
5	2.9±1.9	2.4±1.7	2.0±1.7	1.9±1.8	1.7±1.8
6	3.0±2.4	2.1±1.8	2.0±2.1	1.9±1.8	1.5±1.7
7	3.0±2.2	1.9±1.6	1.7±1.7	1.4±1.7	1.3±1.8
8	2.7±2.2	1.9±1.7	1.8±1.9	1.5±1.7	1.3±1.8
LT	4.5±3.0	3.4±2.8	3.2±2.7	2.1±1.9	1.7±1.5
HT	3.3±2.0	2.8±2.0	2.5±2.4	2.4±2.0	1.9±2.1
OF	6.2±2.8	4.7±2.5	4.3±2.6	4.1±2.8	3.9±2.8
McGill Scale					
1	24.3±13.4	23.6±14.6	23.5±15.3	24.4±16.2	24.2±18.9
2	21.7±15.2	9.7±15.6	18.3±16.3	19.6±17.0	18.5±15.9
3	18.6±15.4	15.3±13.7	15.8±15.0	15.7±16.1	13.4±13.7
4	14.8±13.5	12.0±14.2	11.3±13.3	10.6±12.5	8.4±9.7
5	9.4±9.8	7.9±8.3	8.1±9.6	7.6±10.3	7.8±11.7
6	10.0±10.8	8.2±9.7	7.6±8.0	7.7±9.4	6.4±8.8
7	8.8±12.3	7.8±10.1	6.4±9.4	5.4±10.9	5.4±9.9
8	9.4±12.2	6.2±9.1	6.2±8.4	5.7±7.5	5.2±7.6
LT	14.7±16.1	10.2±15.2	10.0±16.7	5.7±17.6	5.0±4.9
HT	13.3±14.1	7.2±9.2	8.6±10.1	6.9±7.2	7.9±10.5
OF	20.5±16.5	14.4±16.5	14.7±16.8	14.8±17.4	15.3±17.7

LT=Water temperature lowered from 5°C to 1°C
HT=Water temperature increased from 1°C to 5°C
OF=Opposite (left) ankle used

words of category 16 were: "annoying, troublesome, miserable, intense, unbearable." The instructions were "Some of the words below may describe your pain. 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 applies best."

Description of pain is scored two ways: The total number of words chosen (NWC) is counted and the numeric value of the chosen words (each word of each category has a numeric value) is summed to give a numeric value to each session.

Duration of pain was measured, similar to description of pain except there were only three categories of words, each with three terms. Borg's scale measures perceived pain intensity and is based on a 10 point scale (0 = no pain, 10 = near maximal pain). Subjects chose a number on the scale that represented their perceived pain intensity.

During an orientation session, prior to testing, subjects became acquainted with both pain scales by reading the scales and asking and answering questions about them.

Five treatments were given during each of 2 consecutive weeks. Most were administered Monday through Friday, but subjects who missed a treatment during the week made it up during the weekend. Subjects chose one of five time slots during the day to receive treatments, but were required to come at the same time of day for all treatments and testing throughout the project. Six to ten subjects were treated simultaneously during each of the time slots.

During treatments, subjects were encouraged to read, study, or converse with others in the lab about anything but the pain they were feeling. With 2 minutes remaining in each cold application subjects were asked to complete the questionnaires.

Means, standard deviations, and Pearson product moment correlations were computed and data were analyzed with two-way and one-way ANOVAs, t-tests, and Duncan post hoc tests using SPSSX on a Vax computer. A Bonferoni correction for multiple univariate tests required that the alpha level be adjusted from .05 to .006.

Results

Perceived pain decreased between days and bouts as measured by both McGill and Borg Pain Scales (Table 3). Although there was only a moderate correlation between the Borg and McGill scores ($r=.66$), the results of the ANOVA and post hoc tests on the two sets of data were almost identical. Therefore, unless otherwise indicated, the statistical analysis results reported hereafter are from the Borg data.

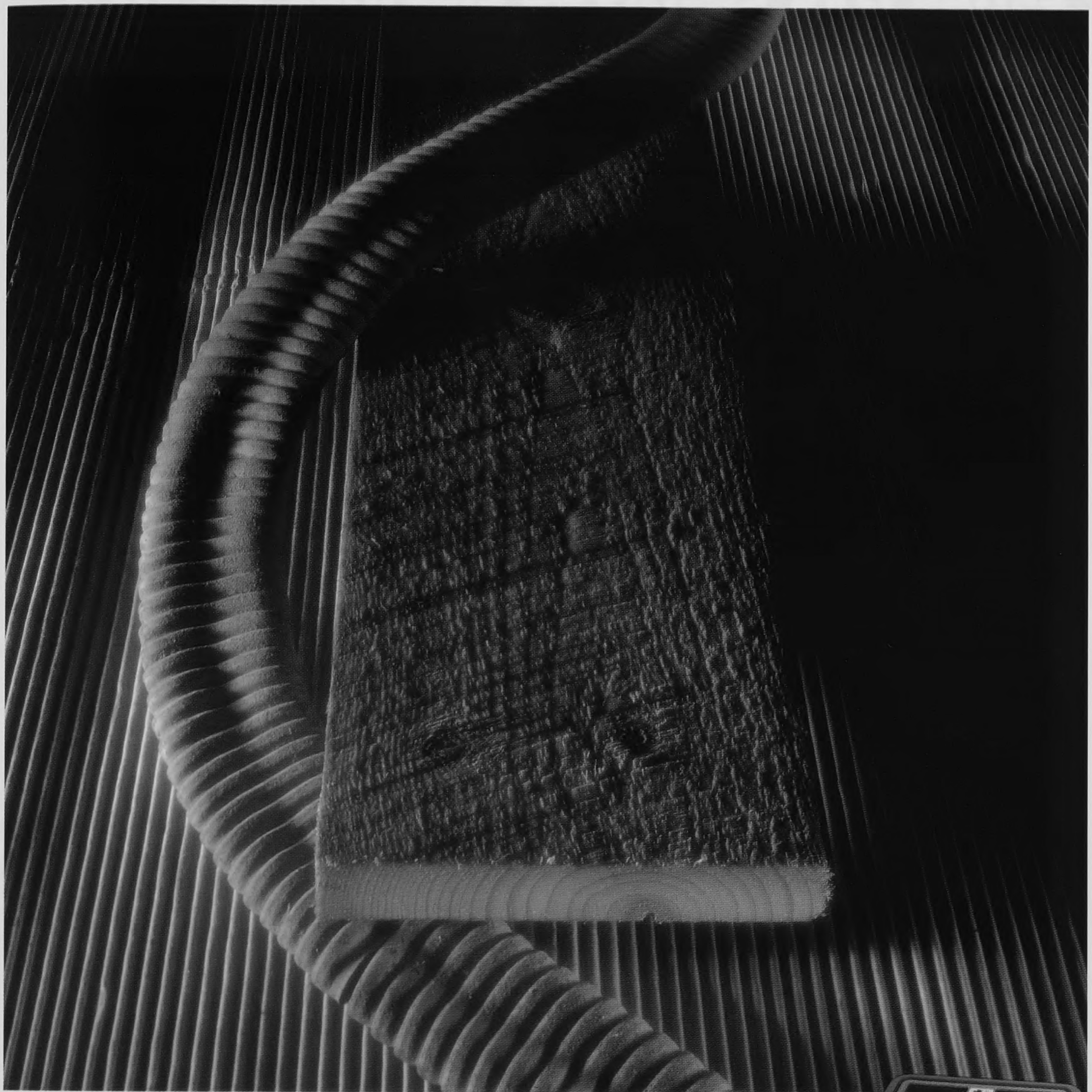
It appears that most of the changes in pain occurred during the first 5 days (Fig 1). Pain was significantly greater on day 1 than days 2 through 8 ($F(7,1512) = 41.6$, $p<.001$, Duncan $< .05$). There were also significant differences between days 3 and 4 and between days 4 and 5 (Duncan $< .05$). The differences between days 2 and 3 and between days 5 through 8 were not significant. A response of "0 or nothing at all" on the Borg scale was very common on days 5 through 8, indicating no further habituation.

There was an overall bout-to-bout decrease in pain ($F(4,1895)=16.3$, $p<.001$). Pain during bout one was significantly greater than all other bouts on days 2 through 8 (Duncan $< .05$). On day 1 the pain during bout one was not greater than other bouts that day. There were pain decreases from bouts one to five on days 2 through 8.

Subjects treated with 1°C water experienced greater pain than subjects treated with 5°C water during habituation ($t(1898) = 10.93$, $p<.001$).

Location and Terms Chosen During Habituation

Location of pain changed between days, but not among bouts. The instep was the most frequent location of pain for the first 3 days. (Of a possible 190 choices—38 subjects x 5 bouts—the instep was chosen 42-50 times/day.) No specific location (21-43 choices/day), heel (31-36 choices/



Rich-Mar HV–II High Volt and Ultrasound Combination Unit

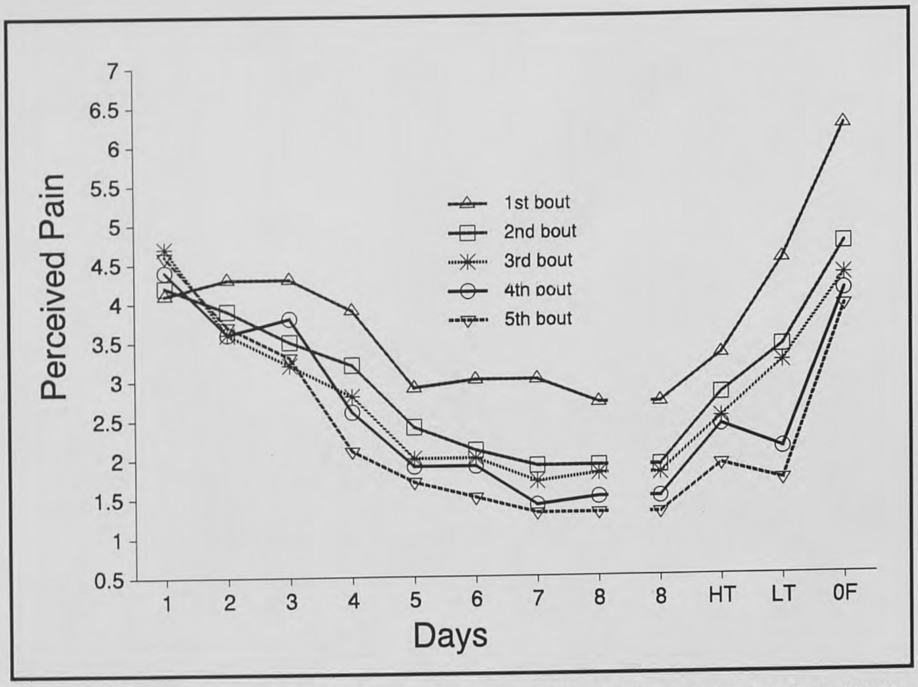


Fig 1.—Perceived pain intensity during the five bouts of the 10 days of simulated cryokinetics Subjects were habituated for the first 8 days at either 1°C or 5°C (data combined). On days 9 & 10 treatments were to the opposite left ankle (OA) or to the right ankle at the opposite temperature (HT=higher temperature, habituated at 1°C then tested at 5°C; LT=lower temperature, habituated at 5°C then tested at 1°C).

day), and arch (24-44 choices/day) were also common choices for the first 3 days. The frequency of no specific location steadily increased from day 2 (21 choices) to day 8 (108 choices). Other than no specific location, choices were evenly distributed between malleolus (7-26 choices), heel (28-35 choices), arch (11-23 choices), and instep (18-34 choices) on days 4 through 7.

The total number of pain descriptor terms chosen (NWC) on the McGill Questionnaire decreased from day 1 to day 8. On day 1 the number of no descriptors chosen for McGill descriptor groups averaged from 60 to 80 choices/day, and by day 8 averaged from 100 to 170 choices/day per group. Groups 18 and 19 of the McGill Pain Questionnaire were exceptions. The term "numb" was included in group 18 and was a frequent choice throughout the testing, averaging 70 choices/day. Group 19 was composed of cool, cold, and freezing, which were also frequently chosen throughout the experiment, averaging between 20 to 60 choices/day. Terms chosen frequently on the first 3 days were throbbing, shooting, sharp, burning, tingling, hurting, annoying, numb, freezing, and nagging. On days 4 through 8, a small number of responses were distributed evenly between descriptors while the majority chose no response.

Post Habituation Testing

During post habituation testing (days 9 and 10) pain elicited during immersion of the opposite (left) limb at the same temperature and in the habituated (right) limb during immersion at the opposite temperature was different than pain on days 1 and 8. Pain in the opposite limb was significantly greater than day 8 pain ($F(2,567) = 80.3$, $p<.001$, Duncan $< .05$). Pain in the two limbs on their respective first day of cold immersion (ie, day 1 for right, day 9 or 10 for left) was similar according to the Borg scale but less in the left ankle according to the McGill Pain Questionnaire ($F(2,567) = 70.5$, $p<.001$).

Pain in the opposite limb during bout one was greater than during bouts two through five (Duncan $< .05$), but there was no difference between bouts two through five (Duncan $< .05$). Pain in the opposite limb during the first bout was also greater than pain in the right limb during the first bout on the first day (Duncan $< .05$).

Following habituation, application in lower temperature water resulted in pain similar to day 1 and greater pain than day 8 ($F(2,467) = 61.6$, $p<.001$, Duncan $< .05$). Pain during bout one was greater than pain during bouts four and five (Duncan $< .05$) and greater than pain during bout one of day 1. Although the initial pain during the temperature decrease was greater, pain during bouts 2 through 5 decreased rapidly, indicating a more rapid habituation.

Following habituation, pain during immersion in increased temperature was significantly less than on day 1 ($F(2,467)=69.9$, $p<.001$, Duncan $< .05$), but not different than day 8. Pain during bouts were not different from one another (Duncan $< .05$).

"No specific location" was the most commonly chosen location of pain during posthabituation tests (28-54 choices/day). Heel, malleolus, and instep were common choices for the treatment of the opposite limb (heel 23 choices/day, malleolus 27 choices/day, instep 58 choices/day). Location was evenly dispersed between instep, heel, and malleolus for treatment at the different temperatures (instep 14-24 choices/day, heel 12-18 choices/day, malleolus 10 choices/day). A slight correlation was noted between location of pain and McGill scores ($r=.28$, $p<.001$) and location of pain and Borg scores ($r=.34$, $p<.001$).

Following habituation, the NWC on the McGill Pain Questionnaire increased for the opposite limb pain and remained constant for temperature changes. Commonly chosen terms for pain in the opposite limb were throbbing, shooting, sharp, burning, tingling, hurting, sore, numb, and freezing.

Discussion

Our data on normal subjects support the clinical impression that pain decreases with repeated cold applications during cryokinetics (7) and adds to our understanding of habituation from previous studies involving short-term cold immersion (6) and in other body parts (15). Clinicians appear to be justified in telling patients that their pain will decrease with repeated cold applications, although we still must find out what effect injury-induced pain has on this process.

Ingersoll and Mangus (6) reported little habituation after 5 days of 21-minute ice immersions. Their approach was more of a basic science approach, while ours was more clinically oriented. Specifically: 1) their subjects received only single daily applications over 5 days while our subjects received five applications each day for 8 days; 2) their subjects were in isolation and could not talk to anyone, while ours were in groups and were encouraged to visit with each other; 3) their subjects completed the

McGill Pain Questionnaire every 3 minutes, which may have drawn their attention to the pain while our subjects completed the questionnaire only once during each application; and 4) our subjects exercised following each cold application, while their subjects were sedentary. Additional research is needed to determine which, if any, of these factors is responsible for the differences between our studies.

Adams and Smith (1) reported "local cold conditioning" occurred after 1 month of daily, 20-minute cold exposure. They noted that during the month pain related to cold exposure began to decrease and finally disappeared, but did not specify when this occurred. This decrease and disappearance of pain may be explained as habituation, similar to the decrease in pain in our subjects.

Strempel (12) reported a decrease in cold-induced pain intensity after 21 successive days of cold immersions. Using an abbreviated McGill Pain Questionnaire, he noted the number of words chosen pertaining to emotion and mental state decreased, while undiscriminating terms remained the same. Strempel (13) also reported subjective cold-pain habituation from one exposure to another during 21 days of repeated cold tests. These results further support the existence of habituation to cold-pain during repeated cold applications.

Our results agree with Kunkle (8), who reported that subjects immersed in 0°C water experienced greater pain than those immersed in 5°C water. Our subjects exposed to the lower temperature recorded more pain during habituation than those exposed to the higher temperature.

Ingersoll and Mangus (6) also stated that pain never disappeared totally during or 21 minutes after cold immersion. Many of our subjects reported that cold-pain disappeared after 4 or 5 days. This difference between these two studies may also be due to the methodological differences.

Absence of a decrease in pain among immersion bouts on the first day was surprising. Many subjects indicated verbally that the first bout was far worse than the remaining four; however, the data do not confirm this observation. Further study is needed to understand the discrepancy between subjects' verbal and written responses.

The specificity of location of pain decreased along with pain from day 1 to 8. As pain decreased, more and more subjects chose no specific site of pain. This adds to the indication of habituation, since specific pain feeling changed over days.

An earlier report from our lab indicated that pain occurred at the malleolus and Achilles' tendon during cold immersion while wearing a toe cap, but mostly in the toes when subjects wore no toe cap (11). Tovell (13) felt that the toe cap was satisfactory in keeping the toes warm and comfortable during ice immersion. These data confirm that impression; our subjects who reported pain at the toes also noted that their toe caps leaked. Though there was some discomfort in the toes, subjects felt the toe cap helped the toes feel more comfortable.

These data confirm the concept that adaptation is primarily physiological (7,15) with some psychological influence (7). Adaptation is specific to body part (15). Authors have reported physiological adaptations of blood flow, vagal response, blood pressure, and skin temperature to repeated cold applications (1,3,9,16).

These data also confirm studies of others (3,15) who reported adaptation to be specific to temperatures greater or equal to the temperature exposed to during habituation. Clinically, an 'ideal' temperature for cold immersion still remains unknown.

The terms commonly reported by many authors as sensations during cold application are pain, warming, tingling, and numbness (4,6). The term "pain" is not a descriptor on the McGill Pain Questionnaire. And although the term "warming" was not a choice there was a thermal group to choose from. From the thermal group, burning was identified as a common term during the first three days of cryokinetics. From these results, we assume that some form of thermal sensation is experienced during cold application. Surprisingly, Ingersoll and Mangus (5) did not report burning as a major term selected.

Tingling was a common term in this study for the first few days of cryokinetics, but mostly during bouts two through five. Ingersoll and Mangus (5) reported tingling as a major term only during the postapplication period. The tingling sensation may be related to the rewarming between successive cold immersions during cryokinetics.

The term "numbness" was as common during bouts two through five as during bout one. This indicates that an initial 20-minute ice application followed by 5-minute reapplications is adequate to produce analgesia or hypalgesia. Apparently these time frames are acceptable for producing numbness during cryokinetics.

The fact that both cold and numb were commonly chosen terms supports the idea that cold and pain are separate sensations (5,8).

Now that habituation to cold-induced pain has been confirmed in normal subjects exposed to simulated cryokinetic treatments, the next step is to repeat the study on injured patients. Whether injury-induced pain will delay, accelerate, or have no effect on the rate of habituation to cold-induced pain awaits investigation.

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Sensory Perception of the Foot and Ankle Following Therapeutic Applications of Heat and Cold

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Mark A. Merrick, BS

ABSTRACT: Many athletes are treated with hot and cold modalities prior to therapeutic exercise, but the effects of these treatments on sensory perception are not clear. The purpose of this study was to examine the effects of hot and cold treatments on sensory perception. We recruited 21 volunteer subjects, who reported for testing on three separate occasions. One of three treatments was applied to the left ankle and foot each day for 20 minutes: cold immersion, hot immersion, or quiet sitting (control). Three variables were measured following treatment: topagnosis, two-point discrimination, and one-legged balance. We assigned treatments and the testing order according to a Greco Latin square. Data were analyzed using a multivariate analysis of variance (MANOVA). No significant differences were detected for the three dependent measures, suggesting that therapeutic applications of heat and cold do not affect sensory perception. These findings indicate that heat and cold applications can be used prior to therapeutic exercise programs without interfering with normal sensory perception as do other analgesic and anesthetic agents. For example, the hypalgesic effect of cold, which is essential to cryokinetics, can be realized without fear of altered sensory perception.

Many athletes are treated with hot and cold modalities prior to therapeutic exercise, but the effects of these treatments on sensory perception are not clear. If sensory perception is altered following therapeutic applications of heat or cold, it is possible that the athlete will reinforce neural pathways that are not sport specific and therefore counterproductive to progress in the rehabilitation program. The purpose of this study was to examine the effects of hot and cold treatments on sensory perception.

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Methods

Subjects

We obtained informed consent from 21 volunteer subjects who had no previous ankle injuries. We recruited them from the student body at Indiana State University in Terre Haute, Ind.

Protocol

Subjects reported to the Sports Injury Research Laboratory on three separate occasions. Each session commenced with application of the treatment: cold immersion, hot immersion, or quiet sitting (control). Hot and cold treatments involved immersing the right foot and ankle above the malleoli for 20 minutes per session. Water temperature upon immersion was 1°C for the cold treatment and 40°C for the hot treatment. We made no attempt to maintain water temperature throughout immersion. Our reasoning was that we wanted to simulate a clinical protocol.

Following treatment, we recorded three dependent measures: topagnosis, two-point discrimination, and postural balance. We made measurements on both the treated foot and the contralateral foot.

We measured topagnosis by blindfolding the subject, touching the sole of his or her foot with a marker, giving the subject a marker, and asking him or her to use the marker to point to the spot where he or she was touched (Fig 1). We used the distance between the marks as the measure for topagnosis.

Fig 1.—Topagnosis measurement

We determined two-point discrimination by using thirteen styrofoam blocks that were covered with athletic tape, with one or two thumbtack points protruding from the surface of the block through the tape. Five blocks had one tack and eight blocks had two tacks. The tacks of the two-point blocks were placed at 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, and 4.0 cm apart. During testing, we pressed the block against the sole of the foot and asked the subject to determine if the block had one or two pins (Fig 2). The pins did not penetrate the skin. We attempted to apply

Fig 2.—Two-point discrimination measurement

uniform pressure throughout testing. A sensitivity score (S) was calculated to determine two-point discrimination: $S = (IC\,(1 - CC)^{1/2})/(CC\,(1 - IC))$; IC = incorrect responses, and CC = correct responses.

Postural balance was assessed using a one-legged balance test (stork stand). We instructed subjects to stand on one foot with their hands on their hips and the opposite foot tucked behind the knee of

Fig 3.—Balance measurement

the supporting leg (Fig 3). The time the subject maintained this posture was used as the measure of balance. The test was considered complete if the subjects: (1) lifted their toes or heel off the ground, (2) moved their arms away from their sides, or (3) moved their unsupporting heel away from the knee of the supporting leg.

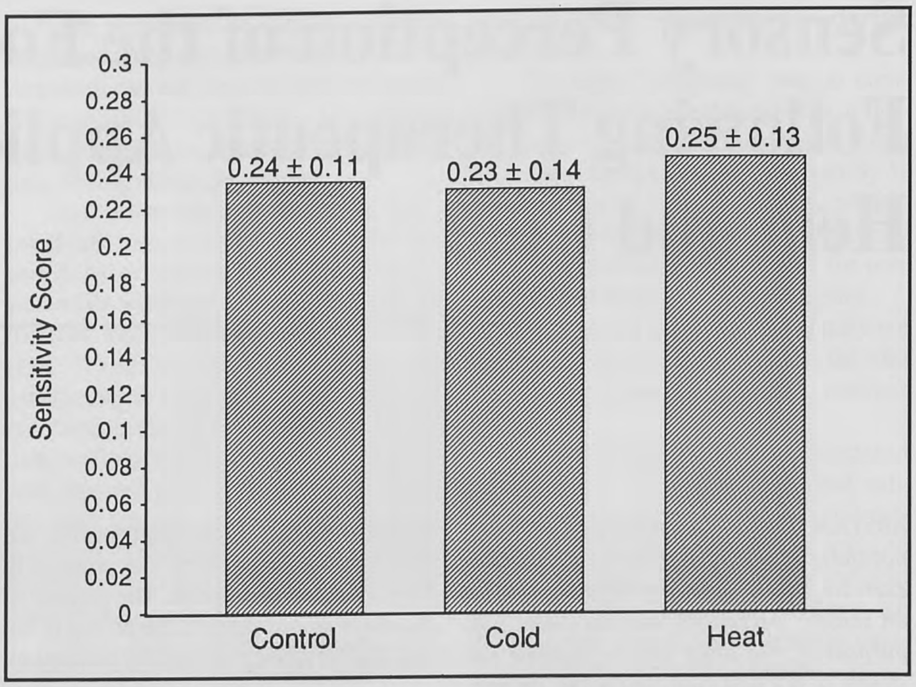

Fig 4.—Two-point discrimination sensitivity scores for cooling, heating, and no treatment

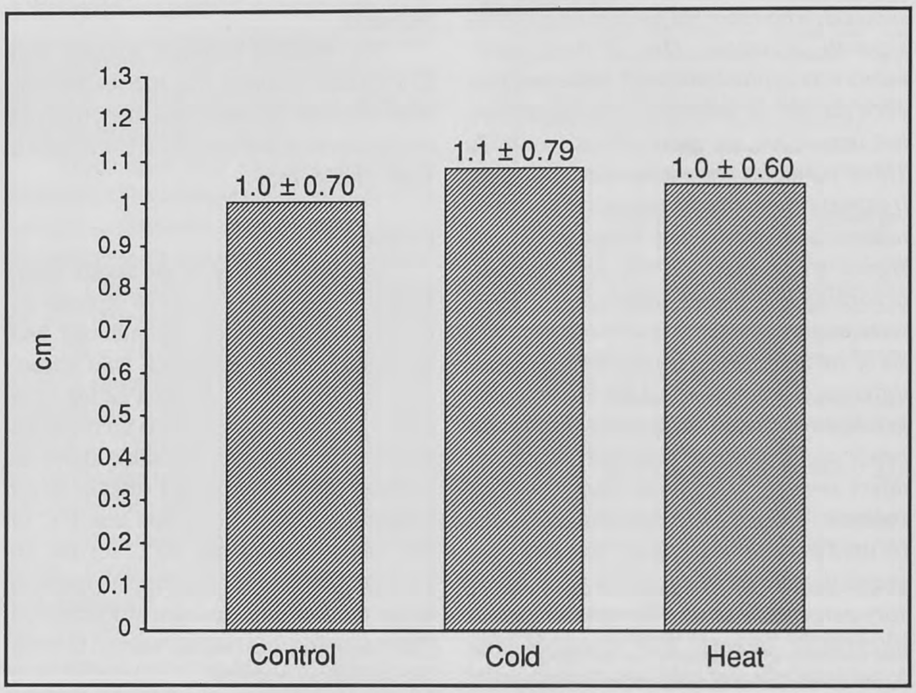

Fig 5.—Topagnosis distance scores for cooling, heating, and no treatment

Research Design and Statistical Analyses

The treatment and test orders were arranged according to a Greco Latin square. A repeated measures MANOVA was used to determine if differences existed between linear combinations of the dependent measures.

Results

There were no significant differences (Wilk's Lambda (6,86) = 0.95, p = .89) between the three therapeutic treatments for two-point discrimination (Fig 4), topagnosis (Fig 5), or balance (Fig 6).

Discussion

Sensation can be divided into three categories: superficial, deep, and combined. Superficial sensation involves touch, pain, temperature, and two-point discrimination. Deep sensation is concerned with muscle and joint position sense (proprioception), deep muscle pain, and vibration sense. Stereognosis (the recognition and naming of familiar objects in the hand) and topagnosis involve both superficial and deep sensory mechanisms (2). We evaluated each sensory mechanism in our study: two-point discrimination, representing superficial sensation; proprioception, representing deep sensation; and topagnosis, representing combined sensory mechanisms.

Because superficial and deep sensations were not affected by cold or hot immersion, use of the term anesthesia as an effect of hot or cold modalities is inappropriate. There is an exception, of course. Pain, which can be a superficial or deep sensation, or both, is

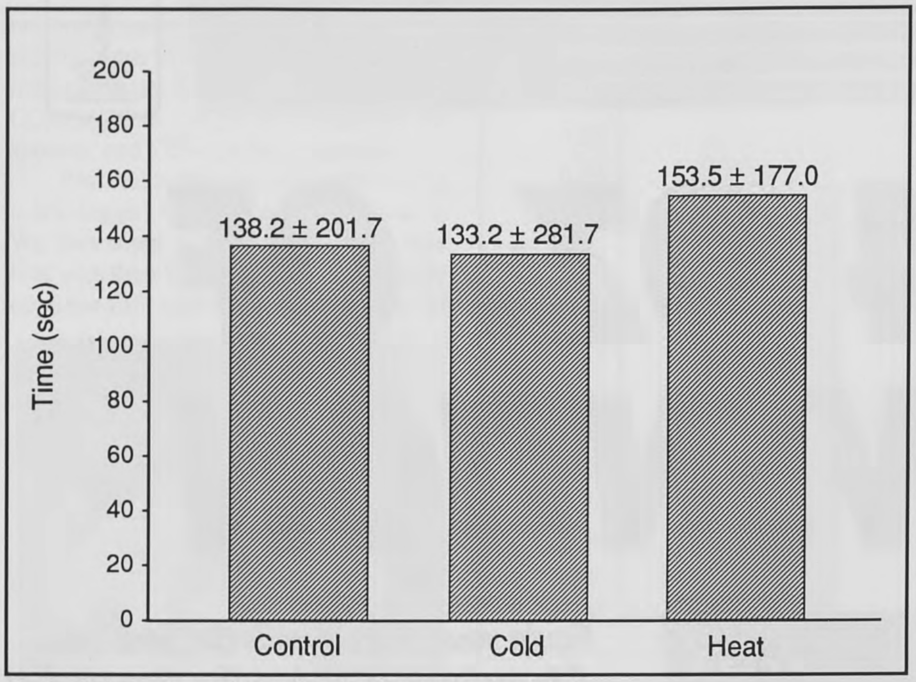

Fig 6.—Balance scores for cooling, heating, and no treatment

influenced by hot and cold modalities. This decrease in pain has been called analgesia, although the term hypalgesia is probably a more appropriate term (5).

Our findings are consistent with those of LaRiviere & Osternig (6), who found no difference in ankle joint position sense with cooling. Their protocol differed from ours in that we used 1°C ice immersion and they used ice immersion at approximately 4°C. Also, their measure of sensory perception was different than ours. They used open kinetic chain joint position sense, while we used closed kinetic chain proprioception (balance).

Cooling may affect proprioception in the same fashion as local anesthetics, which do not alter proprioception (1,3,6). Since the entire leg was not cooled or heated, it is possible that at least a portion of the proprioceptive mechanisms controlling posture were not affected. The source of proprioceptive input for posture maintenance may arise from afferent inputs from mechanoreceptors in the ankles or the soles of the feet, spindles in the leg muscles, or possibly some other source. This question has not been conclusively resolved (4). Certainly, a portion of proprioceptive afferent signals were exposed to cooling or heating.

While cooling or heating the body part does not affect two-point discrimination, heating or cooling the caliper probes does increase two-point discrimination acuity on the forearm and palm which are at normal skin temperatures (7). Altering probe temperatures appears to be unrelated to local cooling of an extremity. Only cold and touch receptors at the point of contact by the two-point discrimination probe are stimulated, while cooling the entire body part stimulates numerous cold receptors over the surface area cooled and the touch receptors are only stimulated under the two-point discrimination probes.

We conclude that the therapeutic applications of heat and cold used in this study do not affect sensory perception. Therefore, heat and cold applications to the foot and ankle can be used prior to therapeutic exercise programs without interfering with normal sensory perception as do other analgesic and anesthetic agents. For example, the hypalgesic effect of cold, which is essential to cryokinetics, can be realized without fear of altered sensory perception.

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Nerve Injury in Athletes Caused by Cryotherapy

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John S. Kirkpatrick, MD
Frank H. Bassett, III, MD

ABSTRACT: Cryotherapy is a therapeutic modality frequently used in the treatment of athletic injuries. In very rare circumstances, inappropriate use in some individuals can lead to nerve injury resulting in temporary or permanent disability of the athlete. Six cases of cold-induced peripheral nerve injury from 1988 to 1991 at the Sports Medicine Center at Duke University are reported. Although disability can be severe and can render an athlete unable to compete for several months, each of these cases resolved spontaneously. Whereas the application of this modality is typically quite safe and beneficial, clinicians must be aware of the location of major peripheral nerves, the thickness of the overlying subcutaneous fat, the method of application (with inherent or additional compression), the duration of tissue cooling, and the possible cryotherapy sensibility of some individuals.

The initial treatment of choice for athletic injuries is almost always some form of cryotherapy. Coaches, athletic trainers, and physicians treat a wide variety of acute injuries with universally good results (10). It appears that the vast majority of individuals can be treated safely with cryotherapy modalities, because thousands of successful applications are performed in athletic training settings each year throughout the world.

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Although cryotherapy was initially used empirically, the physiologic effects of this treatment have been shown to be beneficial (10). The most obvious physiologic effect is that of decreasing tissue temperature. While superficial temperatures decrease extremely rapidly, deep temperatures do not decrease as fast; but, they do continue to decrease after the cold modality is removed (9,16). It appears that the decrease in tissue temperature is intimately related to a circulatory response (2,11). Although the circulatory response is important, of primary importance may be the decrease in metabolic activity seen with tissue cooling (1,9,10,14). Local effects also have been shown to effect inflammation, spasticity, and the excitability of nerve endings, thus producing an increased pain threshold (2,5,7-10). Unfortunately, in very rare circumstances, peripheral nerve injury can result from improperly applied or excessively applied cryotherapy (4,6,12).

In this paper, we present six cases of peripheral nerve insult in athletes (mean age = 22 yr ± 2 yr). The injuries of these athletes were cryotherapy-induced and were referred to the Duke University Sports Medicine Center. It is interesting to note that all were males actively participating in organized sports. Each had a history of previous use of cryotherapy without difficulty. Four of the subjects were collegiate athletes, while the fifth (two nerves) was a professional basketball player. The peripheral nerve injuries included three peroneal nerves, two lateral femoral cutaneous nerves, and one supraclavicular nerve.

Case Reports

Case 1: A 22-year-old college football player injured his right knee during practice. The athletic trainer evaluated this individual and thought that the neurovascular assessment was normal, but that a second-degree sprain of the lateral collateral ligament had occurred. A plastic ice bag (crushed ice in a gallon bag) was applied and held in place on the lateral aspect of the knee by an elastic wrap. The athlete was removed from practice and walked with crutches in a partial weight bearing state. Approximately 30 minutes later, the ice bag was removed, and a follow-up evaluation of this athlete by the athletic trainer demonstrated a right peroneal palsy with decreased sensibility and motor weakness. To evaluate the severity and neuromuscular response, an electromyography (EMG) was performed at 4 weeks, which indicated axonotmesis (ie, nerve injury without severing the nerve). Six months postinjury, this athlete had recovered sensation and motor function completely.

Cases 2 and 3: The day after a very strenuous game in which he had played for 40 minutes, a 24-year-old professional basketball player underwent cryotherapy to the lateral aspect of the left hip and the lateral knee. These treatments involved the application of a "crushed ice/water bag" supported by elastic wraps for approximately 30 to 60 minutes. After the ice bags were removed, numbness was noted over the anterior lateral thigh and the dorsum of the foot. The athlete also noticed his inability to control his foot (complete footdrop). Clinical evaluation by the athletic trainer and the physician using a percussion test demonstrated a complete peroneal nerve palsy at the level of the fibular head, as well as decreased sensation of the anterior lateral thigh and a sensory pattern for the lateral femoral cutaneous nerve.

This athlete was unable to participate in the remainder of the professional season, but did continue to improve. At 6 months, he essentially had complete resolution of symptoms. He played the next season without problems.

Case 4: A 21-year-old collegiate sprinter complained of pain over the anterior superior iliac spine after a track meet. The following week (2 days postinjury) he applied a plastic bag filled with crushed ice to the area for 15 to 20 minutes once daily for 5 days. The bag was "hand held" in place during treatment. On Friday, he began to note numbness over the lateral aspect of the thigh. Evaluation by the team physician revealed decreased sensation over the distribution of the lateral femoral cutaneous nerve and a positive percussion test. We recommended discontinuing cryotherapy. Symptoms completely resolved 4 days later.

Case 5: A 20-year-old defensive back reported an area of decreased sensation and paraesthesia over the anterior aspect of the left shoulder. He had been ice massaging the shoulder for 10 minutes three times daily for the past 3 days, because of generalized soreness; but, he denied any major injury or trauma in the recent past. He noted the decreased sensation following cryotherapy the previous weekend. Examination demonstrated a decreased sensation to pinprick in the area extending from the clavicle outward to the anterior deltoid. He also had a positive Tinel's sign over the base of the neck, which indicated a compromised supraclavicular nerve. The athlete demonstrated complete normal neurologic findings at a follow-up exam approximately 2 to 3 weeks following the cessation of cryotherapy.

Case 6: A 21-year-old college football player injured the lateral aspect of his lower leg/knee and received cryotherapy through the application of an ice pack and an elastic wrap for 30 minutes while in a long sitting position. After that time, the patient noted numbness over the dorsum of his foot. On examination by the team physician, the athlete revealed decreased sensation over the dorsum of the foot and minor decreased function of the great toe extensor and the evertors of the foot (4/5—good rather than normal grade). One hour later, his symptoms were resolved completely.

The application of ice with varying levels of compression led to neurologic compromise in the described subjects. The duration of treatment was from 15 or 20 to 60 minutes. The duration of disability ranged from less than 1 hour to greater than 6 months; yet fortunately, all patients did experience complete recovery.

These patients represent individuals seen in our training room or seen by physicians at our Sports Medicine Clinic on a referral basis from 1988 to 1991. As a referral center, we treat many patients for whom the general use of cryotherapy is extremely safe. These six cases are representative of rare injuries.

Discussion

Several authors have delineated the mechanism of injury to peripheral nerves by cold application (3,13). Sunderland (15) summarized the work of many in his text and concluded the following:

1. Motor functions are affected first and to a greater degree than sensory functions. This may be related to fiber size.
2. Different sensory modalities are not affected equally or simultaneously.
3. If necrosis does not develop, rapid restoration of function is seen as warming occurs. It is interesting to note that, generally, sensory functions are normalized prior to motor functions.
4. There is tremendous variation in the resistance of individuals' peripheral nerves to injury from cryotherapy.
5. It appears that injury does not result unless the peripheral nerve is cooled below 10°C.
6. Cryotherapy can disturb function at temperatures above freezing. Total motor/sensory loss can occur between 0° and 5° C.

It is important to note that some of Sunderland's conclusions were developed as a result of dissected nerves being subjected to direct cold treatment using noncompressive liquid or gas techniques. This allows the collection of direct and nonconfounded data, but also minimizes the true effects of clinical application of cryotherapy. Direct exposure of nerves does not occur in the clinic, as multiple overlying tissues intervene and respond during the application of cryotherapy. Thus, although the aforementioned studies outline indirect effects, we must be aware that additional insulative factors are present in the clinic.

All of the patients in this series were relatively thin with very little subcutaneous fat. The majority of athletes, however, probably have a level of subcutaneous fat that adequately insulates peripheral nerves from cold injury. It is interesting to note that we are aware of only one female cross-country runner reported to have nerve injury, as reported in a conversation with Randy Kegerreis and Laura Kegereis (October 1991). Thus, it is our opinion that the insulating effect of skin and subcutaneous fat, as well as the circulatory response to the application of cold, minimizes the opportunity for damage in the vast majority of athletes.

The experimental data (3,9,13) reported by others outline and explain the clinical findings revealed by the patients in our series. It is interesting to note that although time did not appear to be a primary factor in the experimental studies, it may be a more important factor in clinical use, particularly when it is combined with compression. The longer the cold is applied, the greater the opportunity for cooling the nerve below the critical threshold.

Experimental studies (3,13,15) have described axonotmesis to the damaged nerves. Electromyographic examination in the peroneal nerve injury was consistent with axonotmesis (Case 1) and the clinical presentation of the severe injuries in our series.

Clinical Relevance

The inappropriate, unmonitored application of cryotherapy to acute injuries may cause disabling neuropathies in select individuals. Fortunately, it appears that the majority of patients obtain full recovery, but the disability may be transient (less than 3 days) or prolonged (up to 6 months). We recommend that cryotherapy be restricted to relatively short time frames (approximately 20 minutes) in areas of the body where peripheral nerves may be somewhat superficial, and that extreme care be used in the application of compression with the use of this modality in those patients who might be more susceptible or reactive to cryotherapy (ie, application of ice in an athlete who is thin and where attenuation of the effects of cryotherapy may develop).

Although it is obvious that compression can be applied by an elastic bandage, it also is important to remember that pressure from the cold modality by the weight of the affected body part or a heavy ice bag may produce unwanted compressive forces.

Many questions remain regarding the combination of cryotherapy and compression. Fortunately, patients can be assured that this condition is temporary, but interim care may require the restriction of activities that would place the patient at risk (ie, ankle injury from weak peroneal muscles, abnormal responses, etc). This article is not an attempt to discourage the use of cryotherapy, but rather to encourage the athletic trainer to be more attuned to cases in which the application may require additional care.

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Answers to Spring CEU Credit Quiz
Volume 27, Number 1

1. e	3. e	5. d	7. b	9. a
2. e	4. d	6. e	8. e	10. d

Answers to Summer CEU Credit Quiz
Volume 27, Number 2

1. b	3. a	5. e	7. b	9. e
2. e	4. c	6. d	8. e	10. e

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

Denegar/Perrin: *Effects of transcutaneous electrical nerve stimulation, cold, and a combination treatment on pain, ...*
Isabell, et al: *The effects of ice massage, ice massage with exercise, and exercise on the prevention and treatment ...*
Ingersoll/Mangus: *Habituation to the perception of the qualities of cold-induced pain*
Carman/Knight: *Habituation to cold-pain during repeated cryokinetic sessions*
Ingersoll, et al: *Sensory perception of the foot and ankle following therapeutic applications of heat and cold*
Malone, et al: *Nerve injury in athletes caused by cryotherapy*
Mancuso/Knight: *Effects of prior physical activity on skin surface temperature response to the ankle during and after ...*
Paris: *The effects of the Swede-O, New Cross, and McDavid ankle braces and adhesive ankle taping on ...*
Nitske, et al: *Weight cycling practices and long-term health conditions in a sample of former wrestlers and other ...*
Hackman, at al: *The athletic trainer's role in modifying nutritional behaviors of adolesent athletes: putting theory ...*
Keating/Mason: *A simple splint for wrestler's ear*

Circle the correct answer.

1. In the study on DOMS and the effect of transcutaneous electrical nerve stimulation and cold, elbow extension ROM increased greater in:
   a. subjects receiving the sham treatment.
   b. subjects receiving cold as part of the treatment.
   c. subjects receiving TENS only.
   d. subjects who did not receive stretching.
   e. all of the above

2. The hypothesis that former wrestlers have increased risk of obesity and chronic disease is supported by the study on weight cycling practices.
   a. True
   b. False

3. In the study on ankle skin temperature response:
   a. prevention of the build-up of a thermal gradient on the skin was accomplished by shaking the ice pack every 5 minutes throughout application.
   b. the subjects exercised on a treadmill at randomly calculated speeds.
   c. elevated skin temperature lasted less than 5 minutes following exercise.
   d. atmospheric temperature was given no consideration in the experiment.
   e. none of the above

4. In their treatment of wrestler's ear, Keating and Mason:
   a. aspirated the hematoma with a small needle first.
   b. molded the elastomeric material into the ear.
   c. applied a compression wrap.
   d. instructed the patient that the pad could be removed briefly during bathing and shampooing after the first 24 hours.
   e. all of the above

5. Which of the following is not an indication of peripheral nerve damage due to cryotherapy?
   a. increased sensibility
   b. motor weakness/decreased function
   c. palsy
   d. numbness
   e. all are indications

6. The findings of the study on ankle braces included the following:
   a. The residual support ankle braces provide during and after prolonged activities is conclusively documented.
   b. Some commercial ankle braces may be used as an ankle support alternative to tape in selected activities.
   c. Braced ankles outperformed taped ankles in extended periods in all activities.
   d. all of the above
   e. none of the above

7. Habituation to the perception of the qualities of cold-induced pain:
   a. is considered a function of the CNS in which a threshold is altered to an unchanging peripheral input.
   b. is not dependent on the mind.
   c. is irreversible.
   d. does not involve the diminution of normal response or sensation.
   e. b and d

8. The authors in one of the articles studied the effects of ice massage on the treatment of delayed onset muscle soreness. One of the conclusions that they reached was that the use of ice massage on delayed onset muscle soreness:
   a. may be contraindicated.
   b. does not significantly reduce symptoms by itself, but does so significantly when combined with exercise.
   c. is far more beneficial than exercise alone.
   d. both b and c
   e. none of the above

9. Heat and cold applications used prior to therapeutic exercise programs have been shown to:
   a. interfere with normal sensory perception.
   b. have the same effect on sensory perception as other analgesic and anesthetic agents.
   c. do not affect sensory perception.
   d. alter the hypalgesic effect of cold.
   e. none of the above

10. Which of the following factors influence nutrition in young people?
   a. sports where weight is a disadvantage
   b. psychosocial changes
   c. search for independence and identity
   d. concern for appearance
   e. all of the above

11. Habituation to cold-pain during repeated cryokinetic treatments:
   a. is primarily psychological.
   b. occurs most commonly at day 4.
   c. has been shown to be specific to body part and temperature.
   d. has little physiological basis.
   e. all of the above

12. Peripheral nerve injury due to cryotherapy:
   a. is rare.
   b. can result in permanent disability.
   c. would never resolve itself.
   d. all of the above
   e. a and b only

13. Limitations of the study on weight-cycling practices among wrestlers and other athletes include:
   a. The problem of long-term effects of dehydration associated with rapid weight loss was not addressed.
   b. Long-term health risks associated with more drastic weight loss methods chosen by younger adult wrestlers in the study could not be fully addressed.
   c. The potential for harm in weight cycling practices among adolescents who are growing at a rapid rate needs further study.
   d. all of the above
   e. a and c only

14. Ways the athletic trainer can influence or change dietary behavior might include:
   a. peer modeling.
   b. promoting self-efficacy by enhancing perception of choice and control.
   c. cooperative support networks.
   d. all of the above
   e. a and b only

15. Ways to evaluate nerve damage include:
   a. percussion test
   b. electromyographic exam
   c. pinprick
   d. a positive Tinel's sign
   e. all of the above

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Effects of Prior Physical Activity on Skin Surface Temperature Response of the Ankle During and After a 30-minute Ice Pack Application

David L. Mancuso, MA, ATC
Kenneth L. Knight, PhD, ATC

ABSTRACT: The effects of various durations of treadmill running on ankle skin temperature response during and following ice application were investigated. We measured the ankle skin surface temperature of 12 male subjects with a telethermister (YSI Model 44) during each of three conditions: control and two exercise conditions that involved treadmill running for 15 or 30 minutes, followed by a 30-minute ice pack application and 90 minutes rewarming. The control condition involved no exercise prior to ice pack application. Ankle skin temperature increased significantly during 15 and 30 minutes of exercise, although the temperature difference between the two conditions was not statistically significant. Mean skin cooling temperatures were slightly, though not significantly, higher following exercise than following no exercise. The rate of cooling, however, was unaffected by prior exercise. Mean skin temperatures during rewarming were significantly higher following the exercise conditions, but the rate of rewarming was unchanged by exercise. Mean rewarming temperatures were higher in the 30-minute exercise condition than in the 15-minute exercise condition. Longer ice applications or shorter reapplications may be necessary following exercise of at least 15 minutes, but further investigation is necessary to substantiate this supposition.

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There are many indications for using cryotherapy in sports medicine, including the immediate care and rehabilitation of acute injuries (4,10,12). Cryotherapy has become the established posttrauma modality (3,10). It is believed that ice applied to acute musculoskeletal injury reduces tissue metabolism and resulting secondary hypoxic injury—thus recovery time is reduced (10).

Many opinions exist concerning the most efficient cold application procedures for immediate care of acute injuries (14). Some clarification has resulted from research on the effects of cold application in acute injury care (9,14,16); however, this research has been conducted on sedentary subjects. In athletic competition, most injuries occur during exercise. In a study on the effects of various ice application times on ankle skin surface temperature responses, Mlynarczyk (13) suggested that prior exercise might affect the rate of temperature change during cold application.

The purpose of this study was to determine if prior physical activity affected the skin surface temperature response of the ankle during and following a 30-minute ice pack application.

Methodology

We employed a repeated measures design with 12 volunteer male subjects (age=23.1 $\pm$ 1.4 yr, height=68.9 $\pm$ 3.3 in, weight=157.0 $\pm$ 18.9 lb, predicted VO2 maximum=51.0 $\pm$ 7.9 ml/kg x min). We studied three conditions: control—no exercise, 15 minutes exercise, and 30 minutes exercise. Each subject completed all three conditions 24 to 48 hours apart. We determined the order in which subjects completed the three conditions by two 3x3 balanced Latin Squares to which subjects were randomly assigned. Heart rate and work load during a submaximal stress test using Astrand's (2) bicycle ergometer protocol predicted their fitness levels. We accepted only subjects with average-to-high fitness levels (VO2max 44ml/kg x min).

During the control session, we required subjects to rest supine on a bed for 15 minutes preexercise. Subjects' knees were extended and their feet elevated approximately 6 inches above the bed on treatment pillows, while we positioned temperature probes (Yellow Springs Instrument (YSI) 402) over the anterior talofibular ligament of each ankle. We marked the location of the probe placement with a felt tip marker so that subsequent probe placements were consistent. A crushed ice pack (2.5 lb of crushed ice in a 1.5 gal plastic bag) was secured to the ankle by a 6 ft by 6 in elastic wrap, applied in a figure-of-eight manner. We positioned the ice pack over the lateral aspect of the ankle, covering the area extending from the Achilles' tendon over the lateral malleolus to the anterior tibialis, and, distally, from approximately 6 to 8 inches above the lateral malleolus to the midtarsals (13). To prevent the build-up of a thermal gradient on the skin, we shook the ice pack by hand every 5 minutes throughout the application (16).

We applied the ice pack for 30 minutes and then removed it. We reapplied the elastic bandage to the ankle and repositioned the ankle in the elevated position. Postapplication lasted 90 minutes.

The exercise conditions were identical to the control condition except that 15 or 30 minutes exercise and 5 minutes postexercise periods were interspersed

between rest and ice pack application. For exercise, the subjects ran on a motor-driven treadmill (Quinton 24-72) at an intensity between 60% to 80% of their predicted maximum oxygen uptake. Exercise intensities for both exercise sessions were accomplished by adjusting the speed of the treadmill. We calculated the appropriate treadmill speed using the following formula (1):

$$\text{speed (m/min)} = \frac{\%\ VO2\ max - 3.5}{.2}$$

We measured ankle skin surface temperature every 2.5 minutes with a YSI 12-Channel Telithermister (#44TD), while atmospheric temperatures were recorded at 10-minute intervals throughout the three experimental sessions.

Results

Mean experimental and contralateral ankle skin temperatures for each condition are presented in Tables 1 and 2.

The final preexercise temperature measurement was used for statistical analysis. There was no significant difference in experimental ($F(2,11)=1.0, p=.40$) and contralateral ($F(2,11)=0.5, p=.60$) ankle temperatures between conditions at the beginning of the experimental sessions.

Experimental ankle skin temperature increased 2.0° and 2.3°C during the 15 and 30 minutes of exercise, respectively. Contralateral ankle skin temperature increased 1.7° and 1.9°C during 15 and 30 minutes of exercise, respectively. A comparison of final preexercise and initial postexercise temperatures was made with paired t-tests. These increases were significant ($p=.013$) for all four situations. Skin temperature was not increased significantly more during 30 minutes of exercise than during 15 minutes of exercise ($t(11)=1.3, p=.21$). The effect of exercise in elevating skin temperature remained for 110 minutes (30-minute ice application and 80-minute postapplication) following exercise as evidenced by the contralateral ankle.

Table 1.—Mean Experimental Ankle Skin Temperature (°C, Mean ± S.D.)

Time (Min)	Exercise None	15 min	30 min
Preexercise			
-15	29.8 ± 1.4	30.3 ± 1.5	30.5 ± 1.3
-10	29.6 ± 2.3	30.4 ± 1.3	30.6 ± 1.8
-5	29.8 ± 1.4	30.3 ± 1.2	30.7 ± 1.9
0	29.7 ± 1.4	30.4 ± 1.4	30.6 ± 1.8
Overall	29.7 ± 1.3	30.3 ± 1.3	30.6 ± 1.7
Postexercise			
-5		32.4 ± 1.1	32.9 ± 1.0
0		32.0 ± 1.3	32.8 ± 0.9
Overall		32.3 ± 1.1	32.8 ± 1.0
Ice Application			
1	23.1 ± 3.9	26.0 ± 3.5	26.7 ± 2.7
5	16.4 ± 4.9	17.0 ± 5.1	17.9 ± 3.5
10	12.5 ± 4.7	14.3 ± 4.7	14.3 ± 3.2
15	10.2 ± 4.1	12.7 ± 4.6	13.3 ± 3.1
20	9.3 ± 4.0	11.2 ± 4.4	12.1 ± 2.9
25	8.5 ± 3.7	10.0 ± 4.0	10.8 ± 3.1
30	7.9 ± 3.6	8.5 ± 3.2	10.3 ± 3.6
Overall	12.2 ± 6.1	13.9 ± 6.4	14.7 ± 5.6
Postapplication			
1	14.1 ± 3.0	14.1 ± 3.4	16.2 ± 3.1
5	16.2 ± 2.8	17.1 ± 3.3	19.7 ± 3.3
10	18.1 ± 2.8	19.9 ± 3.1	22.5 ± 3.2
15	19.4 ± 2.7	21.8 ± 3.3	24.4 ± 3.0
20	20.5 ± 2.9	23.2 ± 3.5	25.7 ± 2.8
25	21.4 ± 3.1	24.3 ± 3.5	26.7 ± 2.7
30	22.2 ± 3.2	25.2 ± 3.5	27.5 ± 2.7
35	22.8 ± 3.3	26.1 ± 3.5	28.2 ± 2.5
40	23.4 ± 3.5	26.8 ± 3.4	28.7 ± 2.3
45	23.8 ± 3.5	27.5 ± 3.5	29.0 ± 2.2
50	24.4 ± 3.7	28.0 ± 3.5	29.4 ± 2.0
55	24.9 ± 4.0	28.4 ± 3.5	29.7 ± 1.9
60	25.2 ± 4.1	28.7 ± 3.4	30.0 ± 1.7
65	25.4 ± 4.0	28.9 ± 3.3	30.3 ± 1.6
70	25.7 ± 4.0	29.1 ± 3.3	30.5 ± 1.6
75	25.9 ± 4.1	29.3 ± 3.2	30.7 ± 1.6
80	26.2 ± 4.1	29.5 ± 3.2	30.8 ± 1.5
85	26.4 ± 4.2	29.6 ± 3.3	30.8 ± 1.5
90	26.5 ± 4.0	29.7 ± 3.2	30.9 ± 1.5
Overall	22.8 ± 4.8	25.7 ± 5.3	27.6 ± 4.4

Ice Application Temperatures

Times of 2.5, 5, 10, 20, and 30 minutes during ice application were used for statistical analysis. Mean overall experimental ankle temperatures were slightly higher ($F(2,24)=2.2, p<.14$), although not significantly, in the 15 min exercise and 30 min exercise conditions than in the no exercise condition during ice application. Six rates of change in temperature during ice application were calculated for each condition (Table 2); they were the first minute, the first 10 minutes, the first 20 minutes, the first 30 minutes, the second ten minutes, and the third ten minutes of ice application. No significant difference was found between conditions ($F(2,11)=0.1, p<.91$).

Post Ice Application Temperatures

Times of 1.5, 10, 20, 30, 40, 50, 60, 70, 80, and 90 minutes post ice application were used for statistical analysis. Mean overall experimental ankle skin temperatures were significantly different between conditions during rewarming ($F(2,24)=8.0; p=.003$). Contrasts revealed significant

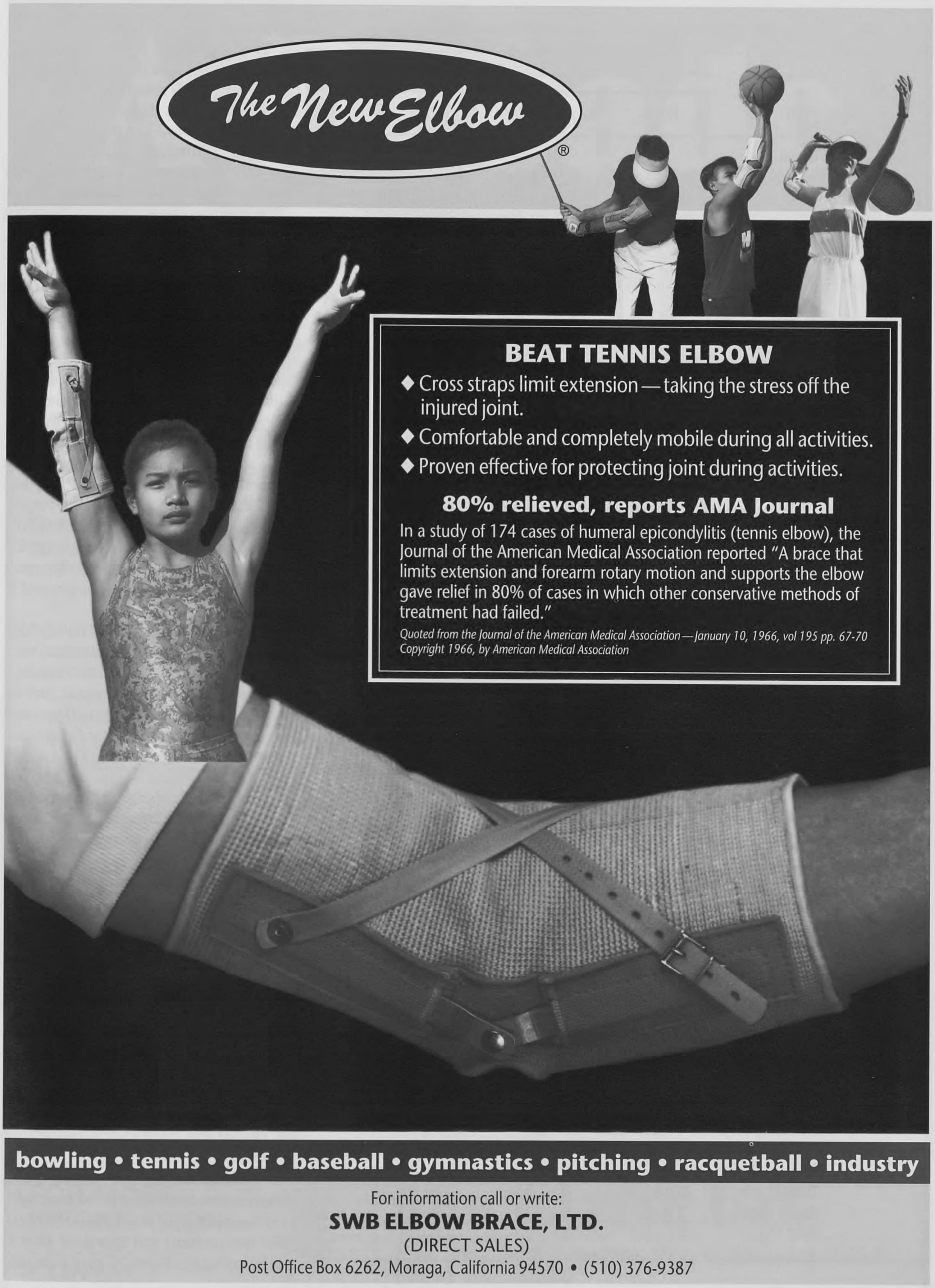
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Table 2.—Mean Contralateral Skin Temperature (°C, Mean ± S.D.)

Time (Min)	Exercise None	Exercise 15 min	Exercise 30 min
Preexercise			
-15	29.7 ± 1.4	30.0 ± 1.3	30.3 ± 2.0
0	29.5 ± 1.7	30.0 ± 1.3	30.3 ± 2.0
Overall	29.6 ± 1.5	30.0 ± 1.3	30.0 ± 2.0
Postexercise			
-5		31.7 ± 1.2	32.2 ± 1.4
0		31.7 ± 1.3	31.9 ± 1.3
Overall		31.7 ± 1.2	32.1 ± 1.3
Period of Ice Application to Opposite (Experimental) Leg			
1	29.2 ± 1.3	31.8 ± 0.9	32.4 ± 1.1
10	29.2 ± 1.5	31.5 ± 1.3	32.1 ± 1.0
20	29.2 ± 1.4	31.4 ± 1.4	31.9 ± 1.1
30	29.3 ± 1.6	31.5 ± 1.4	31.9 ± 1.2
Overall	29.2 ± 1.4	31.6 ± 1.3	32.1 ± 1.1
Period of Postapplication to Opposite (Experimental) Leg			
1	29.3 ± 1.5	31.5 ± 1.2	31.7 ± 1.3
10	29.5 ± 1.9	31.5 ± 1.6	31.7 ± 0.9
20	29.2 ± 1.9	31.4 ± 1.5	31.8 ± 1.0
30	28.9 ± 1.8	31.3 ± 1.6	31.3 ± 1.3
40	28.8 ± 1.8	31.4 ± 1.9	31.1 ± 1.5
50	28.9 ± 1.8	31.4 ± 1.9	30.8 ± 1.5
60	28.9 ± 2.1	31.2 ± 1.8	30.6 ± 1.4
70	28.7 ± 2.2	30.7 ± 2.0	30.4 ± 1.2
80	28.6 ± 2.1	30.1 ± 1.6	30.2 ± 1.2
90	28.6 ± 2.0	29.9 ± 1.7	30.2 ± 1.2
Overall	28.9 ± 1.9	31.1 ± 1.7	31.0 ± 1.3

Table 3.—Rate of Change in Skin Temperature During Ice Application and Postapplication (°C/min ± S.D.)

Time Interval	Exercise None	Exercise 15 min	Exercise 30 min
Ice Application			
First min	6.6 ± 4.5	6.1 ± 3.4	6.2 ± 2.7
First 10 min	1.7 ± 0.6	1.7 ± 0.6	1.9 ± 0.3
First 20 min	1.0 ± 0.2	1.0 ± 0.2	1.0 ± 0.2
Second 10 min	0.3 ± 0.3	0.3 ± 0.2	0.2 ± 0.2
Third 10 min	0.1 ± 0.1	0.3 ± 0.2	0.2 ± 0.2
Postapplication			
First min	4.1 ± 1.3	3.7 ± 0.2	4.0 ± 1.3
First 5 min	1.7 ± 0.5	1.7 ± 0.2	1.9 ± 0.4
First 15 min	0.8 ± 0.2	0.9 ± 0.1	0.9 ± 0.9
Second 15 min	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.1
Third 15 min	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Fourth 15 min	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Final 15 min	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1

differences between the no exercise and the 15 min exercise ($t(11)=2.0$, $p=.039$), the no exercise and the 30 min exercise ($t(11)=4.0$, $p=.001$), and the 15 min exercise and 30 min exercise ($t(11)=2.0$, $p=.056$) conditions. The rate of change of temperature during postapplication was not significantly different between conditions ($F(2,11)=0.2$, $p=.86$) (Table 3).

Atmospheric temperatures averaged 24.9 ±0.6, 24.8 ± 0.5, and 25.0 ± 0.5 during the conditions.

Discussion

The increase in skin temperature during exercise substantiates the results of previous studies (6,15). Edwards et al (6) reported an increase of 1.0°C in average skin temperature during a 30-minute bicycle ride at 40% to 60% VO2 maximum (at an atmospheric temperature of 28°C). In the present study, local skin temperature (experimental ankle) increased 2.1° and 2.3°C during 15 and 30 minutes, respectively, of treadmill running, at 60% to 80% VO2 maximum. The difference in skin temperature response is probably the result of the higher intensity of exercise used in our study.

One author (15) reported average skin temperatures increased slightly for 5 minutes postexercise (30 minutes treadmill running at 70% VO2 maximum) and remained above preexercise for 20 minutes. In our study, skin temperature did not continue to increase once exercise had ended. Also, in the present study, the exercise effect on skin temperature remained for 110 minutes. The difference in the lingering effect of exercise on skin temperature between the two studies may be caused by methodology differences. Saltin et al (15) measured average skin temperature including torso sites, while we measured only one local site (the ankle).

Cooling Temperatures

The results of our study are in agreement with the literature that shows that there is a rapid decrease in skin temperature followed by a slower and steady decline with cold application (5,14,16). Exercise 5 minutes prior to ice application did not change this trend in skin temperature response.

The results of our study appear to be in disagreement, however, with Mlynarczyk's (13) observation of one subject, who violated her protocol and exercised prior to one treatment condition (20-minute ice pack

application). Mlynarczyk (18) observed that the skin temperature of this subject fluctuated and then increased during ice application. At 12.5, 15, and 20 minutes of ice application, the ankle skin temperature was 10°, 14.2°, and 17.0°C, respectively. In the present study, prior exercise did not cause the ankle skin temperature to increase or fluctuate. Ankle skin temperature during the 15 min exercise and 30 min exercise conditions rapidly decreased initially and then steadily declined for the remainder of ice application. At times of 12.5, 15, and 20 minutes of ice application (30-minute ice application), ankle skin temperatures were 13.1°, 12.7°, and 11.2°C, respectively, for the 15 min exercise condition and 14.1°, 13.3°, and 12.1°C, respectively, for the 30 min exercise condition.

The difference in ankle skin temperature response between Mlynarczyk's one subject and the present study may be the result of differences in time between exercise and ice application. In Mlynarczyk's study, there was a 30- to 60-minute delay before the ice pack was applied. To further support this explanation, a similar response to Mlynarczyk's one subject occurred in one subject in our study. During the first 12.5 minutes of ice application, his skin temperature dropped to 16.5°C (from the preapplication temperature of 31.0°C). Temperatures then fluctuated between 17.0° and 18.0°C for the next 10 minutes of ice application and then increased to 20.5°C during the final 5 minutes of ice application. This trend of fluctuation and minimal decrease in skin temperature during ice application was not evident in any other subject or condition. Upon questioning the subject, we found that he had walked 15 minutes (approximately seven-tenths of a mile) 1 hour prior to the nonexercise condition. The abnormality in cooling temperatures may have been caused by activity 1 hour prior to the no exercise condition. This observation, along with the observation of Mlynarczyk's one subject, suggests the possibility of a delayed effect of exercise on skin surface temperature response to ice application. It may be that a delayed effect was more influential on skin temperature response than the immediate effect. This delayed effect needs to be further studied.

Mean skin temperatures during cooling were slightly, though not significantly ($F(2,11)=2.2$, $p<.14$), higher following exercise than following no exercise. Any difference in cooling temperature is most likely attributed to higher initial (pre ice) temperatures caused by prior exercise. This appears to be true considering that the rate of cooling was unchanged with exercise ($F(2,11)=0.1$, $p<.91$).

Exercise effects aside, mean skin temperature in the present study did not decrease as much as previous studies (13,16). These authors reported similar skin temperature reductions of 28.0°C (13) and 28.7°C (16), respectively, during a 30-minute ice pack application to the ankle. Another author (5) reported a decrease of 26.6°C following a 10-minute ice massage to the gastrocnemius muscle. Our study showed only a 21.9° decrease in ankle skin temperature during the 30-minute ice pack application (no exercise condition).

Variance in atmospheric temperatures between studies was not a factor. Mean overall atmospheric temperatures were 24.0° ± 0.9°, 24.3° ± 0.4°, and 24.9° ± 0.5°C, respectively, in the three studies. Varying temperatures of the ice pack among studies also does not seem possible. All three studies were from the same laboratory using the same ice machine.

Rewarming of Skin Temperature Following Cold Application

Research concerning rewarming of skin temperature following ice application has reported a rapid rise followed by a slower, more gradual increase towards pre-ice application temperatures (8,14,17). Our results suggest that prior exercise does not change this trend. One author (13) calculated rates of rewarming following a 30-minute ice pack application to the ankle of .55°, .13°, and .04°C/min during the first, second, and third 30-minute intervals, respectively, of postapplication. Our rewarming rates for the no exercise condition were .47°, .09°, and .04°C/minute, respectively, for the same time intervals; in the 15 min exercise condition, rates were .56, .08, and .03°C/minute, respectively, for the same time intervals; in the 30 min exercise condition rates .57°, .08°, .03°C, respectively, for the same time intervals.

Our rates of rewarming were similar to those reported in the literature (13). However, mean rewarming temperatures were considerably higher in the present study than mean rewarming temperatures reported in the literature (13). Mlynarczyk reported skin temperatures of 19.8°, 23.7°, and 25.5°C at 30, 60, and 90 minutes, respectively, postapplication (following a 30-minute ice pack application). Our skin temperatures were 2.4°, 1.5°, and 1.2°C higher than those reported by Mlynarczyk (13) for the same time periods postapplication (no exercise condition). This can be partly explained by the greater reductions of skin temperature with ice application reported in the literature (13,16) (see cooling temperatures). Consequently, mean skin temperatures began and remained higher during postapplication in the present study. However, the exercise effect on skin temperatures also appears to have played a role in this difference. In the 15 min exercise condition, skin temperatures were 5.4°, 5.0°, and 4.3°C higher than the temperatures reported in the literature (13) for the same postapplication time periods. In the 30 min exercise condition, the temperature differences were 7.7°, 6.3°, and 5.5°C, respectively, for the same time periods. This exercise effect on mean rewarming temperatures may require a change in ice application protocol.

Ice Application Protocol for Acute Injury Care

Mlynarczyk (13) provided an excellent review of the literature concerning cold application intervals for acute injuries. There is a great inconsistency in how long and how frequently ice should be applied in the acute stage of injury. Variations included continual and intermittent ice application. Recommended ice applications ranged from a "time-on" period of 5 to 12 minutes for 24 to 48 hours (7) to a "time-on" period of 15 to 30 minutes (14), to applying ice as often as possible for 24 to 48 hours (11). Besides the discrepancy in suggested ice application durations, most authors failed to provide rationale for the particular time intervals of application. Perhaps duration of acute care procedures should be determined by the severity of the injury; ie, acute care procedures can be terminated earlier for a mild injury than for a severe injury (10).

A study to determine the effects of five different cold application lengths (10, 20, 30, 45, and 60 minutes) on the rate of cooling and the rate of rewarming the ankle revealed that ankle temperatures were significantly warmer ($p<.05$) at 30, 60, and 90 minutes postapplication in the 20-minute ice application than the 30-, 45-, and 60-minute applications (13). The 30-minute application was not significantly different from either the 45- or 60-minute conditions at 30-, 90-, or 180-minute postapplication time. This study led to the suggestion of a "time-on" of 30 minutes and 90 minutes "time off" (10,13).

Optimal tissue temperature for reducing cellular metabolism, thus reducing secondary hypoxic injury, has not been established. Thus, it is difficult to suggest the optimal ice application protocol for acute injury care. Mlynarczyk (13) offered some assistance by recommending a protocol based on Moore's (14) suggestion of 25°C as the critical temperature for maintaining tissue function. Below this temperature, Moore claims tissues can be maintained in the absence of blood. Thus Mlynarczyk (13) used 25°C as the "target" temperature for injured tissues. Based on the results of her study, Mlynarczyk (13) recommended reapplying an ice pack for 30 minutes within 104 minutes for acute injuries. Based on the results of this study and using the same criteria as Mlynarczyk, an ice pack should be reapplied for 30 minutes within 85, 60, and 48 minutes following 0, 15, and 30 minutes of exercise, respectively. The adjustments in ice application durations are needed because of the effects of prior exercise on rewarming temperatures. Skin temperature following ice application reached 25° sooner for the 15 min and 30 min exercise conditions than for the nonexercise (control) condition.

Remember that the suggested protocol is arbitrary. Above all, it appears that longer ice applications may be necessary when acute injury follows exercise than when acute injury does not follow exercise. This distinction cannot be made from the results of this study because the effects of reapplication of ice on skin temperature were not investigated.

Contralateral Ankle Skin Temperature

Although the experimental and contralateral ankles were under the same conditions during preexercise and postexercise, contralateral ankle temperatures were consistently cooler. These differences ranged from 0.1° to 0.4°C during preexercise and from 0.4° to 0.7°C during postexercise. The accuracy and readability of the YSI temperature probe used to measure skin temperature is 0.5° ± 0.2°C, respectively (as reported by the manufacturer) (18). The differences in temperature between the experimental and contralateral ankles are within measurement error.

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Iliotibial Band Friction Syndrome as Exhibited in Athletes

Carrie Ann Lucas, EMT

ABSTRACT: Iliotibial band (ITB) friction syndrome is an overuse injury common in runners, cyclists, weight lifters, skiers, and soccer players. It is characterized by pain over the lateral femoral epicondyle caused by excessive friction between the ITB and the lateral femoral epicondyle.

ITB friction syndrome can be prevented by using correct mechanics and training practices. Avoiding such errors, such as a swift change in playing surfaces or running excessive distances, can prevent this condition. Orthotics to correct mechanical problems also can prevent this injury. Stretching is not only a good treatment, it also is a good prophylaxis. Rest and the application of therapeutic modalities resolve most cases of ITB friction syndrome, but, in persistent cases, surgical intervention may be considered.

Iliotibial band (ITB) friction syndrome often is resolved by conservative treatment, but if symptoms persist in spite of the treatment, surgical intervention should be considered (8-10,12,13). ITB friction syndrome was first described by Renne (17) in 1975, and by Orava (16) in 1978, and it has been the subject of many studies since that time. ITB friction syndrome is commonly found in middle- and long-distance runners and also in those athletes whose sports require repetitive knee flexion.

The commonality of ITB friction syndrome was shown by Clement et al (1), who reported ITB friction syndrome as the sixth most common overuse injury in runners (4.3%). James et al (4) found that ITB friction syndrome comprised 5% of injuries to runners and Orava (16) found it to comprise 6.4%. Although most common in runners, it has been found in skiers, cyclists, weight lifters, and soccer athletes (1,4,5,10,16,17).

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Anatomy

The iliotibial tract originates on the proximal iliac crest. It is a band of fibrous tissue that emerges from the tensor fascia latae and gluteal fascia and inserts in the lateral tubercle of the tibia (tubercle of Gerby) and lateral proximal fibular head (7,15,19). It is connected longitudinally to the linea aspea, the lateral septum, and the gluteus maximus and minimus (7,19). The ITB thickens distally and is connected to the lateral border of the patella (7,19).

The ITB may be described as having four layers: the superficial, middle, deep, and capsulo-osseous layers (19). The superficial layer extends from the termination of the linea aspea to the insertion on the tibia, with the middle layer just below the superficial layer. The deep layer extends from the lateral supercondyle area of the femur in a coronal plane to the tibia in a sagittal plane. The capsulo-osseous layer serves as a retaining wall medially and allows the bony origin to extend down to the lateral capsule and laterally and posteriorly attaches on the head of the fibula with the insertion of the biceps femoris (19).

Biomechanics

In a static standing position, the ITB is held in place by several muscles (5). Proximally, the ITB is in a position posterior to the coronal axis of the hip at the greater trochanter and helps maintain hip extension. The gluteus maximus and tensor fascia latae maintain this position. Distally, the ITB is in a position in front of the coronal axis of the knee and helps maintain knee extension.

While walking or running, the ITB plays a different role. In the swing phase, the proximal ITB and tensor fascia latae are anterior to the greater trochanter, thereby helping maintain hip flexion. Throughout the stance and push-off phases, the proximal ITB is pulled over the greater trochanter as the hip extends. Distally, the ITB is pulled over the lateral femoral epicondyle as the knee is flexed past 30°. This helps maintain knee flexion (5).

Weight bearing increases the compressive/frictional forces over the greater trochanter and lateral femoral epicondyle. When increased forces are combined with genu valgum, excessive foot pronation, or a leg-length discrepancy, increased friction occurs (5).

Clinical Features

ITB friction syndrome is an overuse condition caused by excessive friction between the ITB and the lateral femoral epicondyle (8,13,14,16-18). This results in either bursitis over the lateral femoral epicondyle and/or inflammation of the ITB and periosteum (6,9,11,14,16).

Symptoms and Signs

ITB friction syndrome is characterized by pain and point tenderness over the lateral femoral epicondyle about 2 to 3 cm above the lateral joint line (8,9,14,16-18) Sometimes pain is not localized and is described as radiating or descending to the insertion of the ITB, but is maximal over the lateral femoral epicondyle (6,11-14,16). Generally, discomfort only affects sports activity, but sometimes occurs during walking (16). Pain is aggravated by repetitive flexion of the knee and is relieved by walking stiff-legged (6,7,12-14,17). Running downhill (6,8,9,12,13) and on banked surfaces (8,9,11,14) aggravates the pain, which is most intense at heel strike (9,14,16). Crepitus or pitting edema sometimes are found over the lateral femoral epicondyle during knee flexion (12,16,17). Snapping over this area also may be felt during knee flexion (16).

Predisposing Factors

There are a number of conditions that predispose an athlete to ITB friction syndrome. The most common is maltraining (6,8,12,14,18). Too swift of a change in running surfaces (from pavement to dirt or vice versa), increased distance, or the type of running (more hills) will cause excessive stress on the lateral aspect of the knee. ITB friction syndrome is manifested when the patient's training program is altered; therefore, a careful history will help with the evaluation of this condition (6).

Predisposing factors include structural abnormalities. One factor is a tight ITB (8,9), as evidenced by Ober's test. Other predisposing factors are genu valgum and forefoot pronation (8,9,12,18). Leg-length discrepancies and prominent lateral femoral epicondyles have been noted in athletes with ITB friction syndrome (8,9). All of these conditions place the ITB in closer proximity to the lateral femoral epicondyle, which creates a greater possibility for friction to occur.

Special Tests

There are three special tests for ITB friction syndrome: Ober's, Renne's, and Noble's. Ober's test was created by Frank Ober in 1936 to test ITB tightness in diagnosing low back pain and sciatica (15). To perform the test, have the athlete lie on the unaffected side with the knees flexed sufficiently to eliminate lumbar lordosis. Flex the athlete's affected knee to 90°, hold it tightly with one hand, and stabilize the pelvis with the other hand. Extend the hip until the knee is in line with the body and abduct the leg. After the athlete relaxes and the leg is dropped, the leg will stay in an abducted position if the test is positive, and the leg will drop to the thigh if the test is negative (2,3,14,15).

Renne's test was developed in 1975 to test for ITB friction syndrome. To begin this test, the athlete should stand on the affected leg. Then, have the athlete squat until the knee is in 30° to 40° flexion. As the leg is flexed, pain will be increased over the lateral femoral epicondyle, creating a positive result (6,8,14,17).

Noble's test was developed by Clive Noble to test for ITB friction syndrome. To begin, have the athlete lie supine. Flex the affected knee to 90° and apply direct hand pressure to the lateral femoral epicondyle. Extend the leg and, as the knee is extended, pain will be elicited at about 30° flexion if the test is positive (6,8,11,13,14).

Treatment

James et al (6) stated that total rest is the best treatment for ITS friction syndrome, but unfortunately that is the last treatment many runners choose to accept. Treatment first involves correcting any predisposing factors (6,8,9,11,13,18). If the athlete has training errors, these errors must be corrected. Treatment also may include orthotics to correct pronation, excessive rotation, and leg-length discrepancy. Stretching is needed for tight ITBs using any of the many ITB stretches (8,13,14,18). Rest and the use of oral anti-inflammatories are crucial for relief of symptoms (8,11-13,16,18). The use of ice, heat, ultrasound, and electrical stimulation are used to reduce inflammation and steroid injections are advocated in persistent cases (8,9,11-13,16,18).

Treatment Program

In order to determine a treatment program for the athlete, the severity of the inflammation must be graded. Lindenburg et al (9) outline a grading system for ITB friction syndrome. Grade 1° is when pain starts after the run, but it does not affect performance. Grade 2° is when pain occurs during the workout, but does not affect performance. Grade 3° is when pain occurs during a run and it does affect performance, and Grade 4° is when pain prevents a workout. After grading the severity of inflammation, a treatment program can be initiated.

Lebsack et al (8) describe a comprehensive treatment program for all stages of ITB inflammation. First is the immediate phase when pain and inflammation are to be controlled and any poor training habits or structural abnormalities are corrected. This requires a reduction of activity and the administration of oral anti-inflammatories. Modalities such as ice, heat, ultrasound, and electrical stimulation are applied. Stretching exercises also are used to combat ITB tightness.

There are several stretching techniques that can be adopted. The Ober technique (Fig 1), crossover stretch (Fig 2), standing wall lean (Fig 3), standing lateral fascial stretch with trunk rotation (Fig 4), standing wall lean and crossover stretch (Fig 5), and modified Ober technique (Fig 6) are all used to increase ITB flexibility. These all are static stretches that should be used regularly (2,5,8).

There are two more phases of treatment of ITB friction syndrome: the short-term phase and the long-term phase (8).

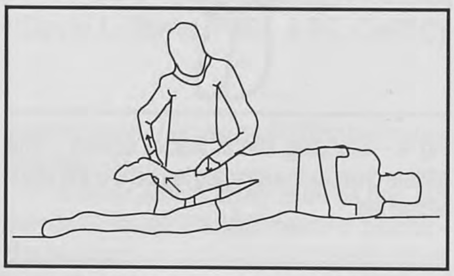

Fig 1.—Ober technique - The athlete lies on the unaffected side and the knee is adducted.

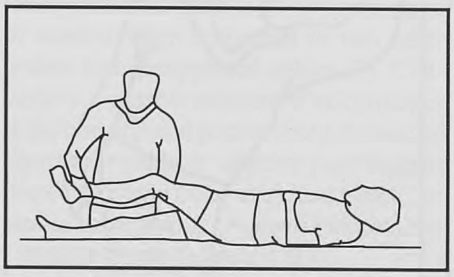

Fig 2.—Crossover stretch - The athlete's affected leg is adducted over the unaffected leg.

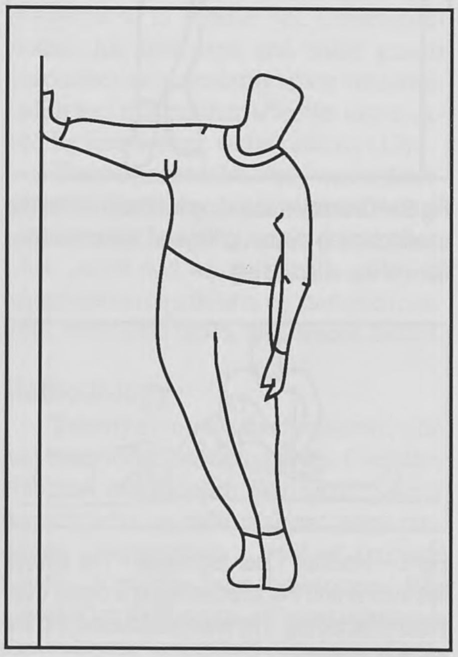

Fig 3.—Standing wall lean - The affected leg is closest to the wall.

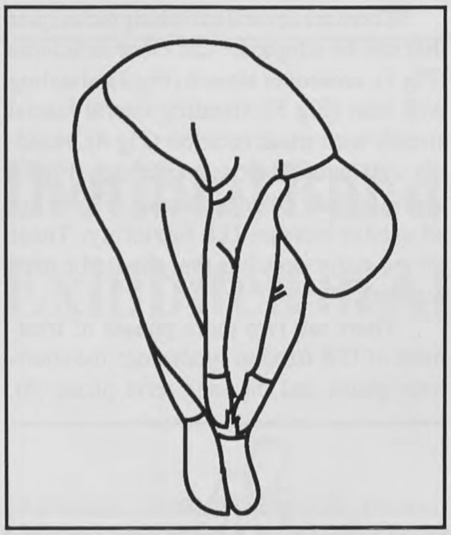

Fig 4.—Standing lateral fascial stretch - The athlete crosses the affected leg behind the unaffected leg.

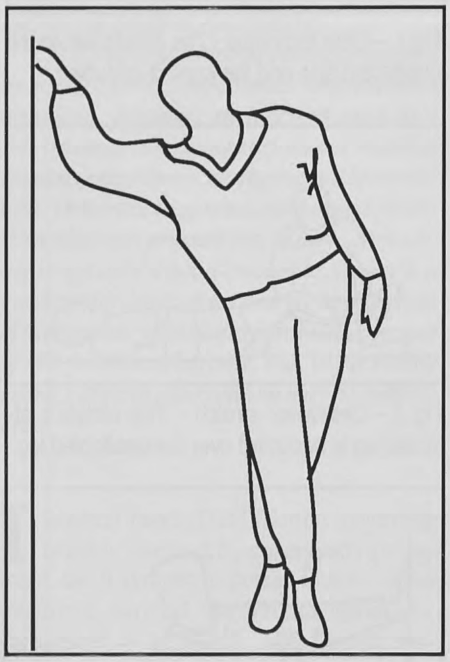

Fig 5.—Crossover standing wall lean - With the unaffected leg closest to the wall, it is crossed in front of the affected leg.

Fig 6.—Modified Ober technique - The athlete lies supine and the affected leg is crossed over the unaffected leg. The knee is adducted and the ankle is abducted.

The short-term phase of treatment begins if symptoms are not resolved within 10 days. Previous treatment should be continued with the possible addition of steroid injections (given at 2-week intervals) and further restriction of activity (6,8,9,12,17). If deconditioning is a concern, the athlete may participate in other activities such as swimming, if it does not continue to aggravate the symptoms (12). In clinical observation, even activities such as swimming and biking exacerbate this condition. If the athlete swims without using the legs, and using a pull-buoy, swimming may be done pain-free. The athlete also may be able to bicycle pain-free by immobilizing the affected leg while on a stationary bicycle.

The long-term phase begins after pain and inflammation are resolved (8), when the athlete returns to activity. During this stage, it is important to prevent reoccurrence of symptoms (8,14). A gradual return to activity with stretching before and after workout is essential to successful return to activity (8). If training errors have not been corrected or inflammation reduced, return to activity will not be successful.

Surgical Intervention

If an athlete does not respond to conservative treatment, surgical intervention must be considered. Martens et al (10) suggests that conservative treatment should be maintained for an average of 9 months before consideration of surgical intervention. Noble (12,13) bases his decision for surgical intervention on the fact that at 30° flexion, the posterior fibers of the ITB are tighter against the lateral femoral epicondyle than are the more anterior fibers. The surgical procedure consists of making a 2 cm incision in the posterior fibers of the lateral femoral epicondyle while the knee is in 30° flexion (6,8,9,12). This is to release the pressure of the posterior fibers on the lateral femoral epicondyle and eliminate the friction associated with the pressure. The leg is then placed in a posterior knee splint for 1 week, after which weight-bearing is allowed (10). After the sutures are removed, the athlete can start activity again (6,8,9,12).

In summary, ITB friction syndrome can be prevented by using correct mechanics and training practices. Avoiding such errors, such as a swift change in playing surfaces or running excessive distances, can prevent this condition and possible surgical intervention. Orthotics to correct mechanical problems also can prevent this injury. Stretching is not only a good treatment, it is also a good prophylaxis. Rest and the application of therapeutic modalities resolve most cases of ITB friction syndrome, but, in persistent cases, surgical intervention may be considered.

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The Effects of the Swede-O, New Cross, and McDavid Ankle Braces and Adhesive Ankle Taping on Speed, Balance, Agility, and Vertical Jump

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ABSTRACT: Scores from motor performance tests were compared using subjects with taped and untaped ankles. Previous studies have shown that taped ankle support may be detrimental in vertical and standing broad jumping performance. Conflicting data have been published on the effects of commercial ankle braces on various motor tasks. The performances of 18 elite soccer players in selected tests of speed, balance, agility, and vertical jumping were compared under conditions of untaped, nonelastic adhesive taped, Swede-O-braced, New Cross-braced, and McDavid-braced ankles. Vertical jump performance was significantly reduced when subjects wore New Cross braces. There were no significant differences in tests of speed, balance, and agility among any of the support conditions. Until now, nonelastic adhesive tape has been the preferred method of prophylactic ankle support. I conclude that certain commercial ankle braces may be used as a support alternative during selected activities.

For many years it has been common practice for athletic trainers to use prophylactic ankle tape. Many studies have evaluated the effectiveness of tape under various experimental conditions, but the results have not produced a concensus of opinion. Several researchers have shown that tape loses much of its supportive quality after exercise (3,6,8,17,21,23,27), while others have demonstrated significant support retention (9,15,16,20,29).

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Numerous studies (1,5,14,19,22,28, 30) have compared the effects of ankle strapping conditions (eg, untaped, nonelastic taped, elastic taped, combination elastic-nonelastic taped, Louisana wrapped) on various motor performance tasks. No significant differences were found in performances of speed (22,28), balance (14,22), agility (19,22,28,30), and vertical and long jumping (22,30) among any of the experimental treatments in these studies. Some researchers have stated that ankle taping did not significantly affect the ankle plantar flexion torque production (1,5,7); however, earlier authors reported that ankle taping significantly decreased vertical (13,18) and standing broad jumping ability (19).

Several comparisons of commercial or experimentally-adapted ankle braces to nonelastic adhesive tape under various experimental conditions have produced confounding results (3,9-11,21,25). One study in which ankle stabilizers of varying stiffnesses were fitted directly into shoes showed decreased performance over an obstacle course (measured by time) as ankle and subtalar movement restriction increased (24). Another study using a laboratory instrument to apply inversion torque to a polyurethane foot form to which the respective supportive devices were attached, found that after 20 minutes of movement, the two most restrictive braces lost 4.5% and 8.5% of ankle support, compared to a 21% loss of support with adhesive-taped ankles (3). Tape provided a 25% greater pretest inversion range of motion restriction than any of the braces, but, after movement, there was no difference in residual support among the two most effective braces and tape (3).

A more recent study showed that the Swede-O brace limited passive plantarflexion range of motion significantly more than any other device when tested after 4 minutes of jogging and walking (7). Also, the Swede-O brace and the tape significantly restricted passive dorsiflexion range of motion when compared to two other braces and unsupported ankles (7). Conversely, a passive measure of ankle ranges of motion pre- and post-activity showed no significant ankle or subtalar joint support from either tape (zinc oxide and elastic) or elastic ankle guards (Ace and Futuro) after 1 hour of playing squash (21).

Significantly slower base running times during softball practice were reported while wearing one particular ankle brace as compared to another (8). Others concluded that both tape and ankle guards were effective in retaining ankle immobilization and that neither affected lower extremity functioning while running (10).

The purpose of this study was to determine if differences exist in selected tests of speed, balance, agility, and vertical jump when performed while using a variety of experimental conditions, eg, untaped (control), nonelastic taped, and braced ankles.

Methodology

Twenty-five male soccer players, who had been identified through the Canadian National and Quebec Provincial Soccer Associations as elite players, were randomly selected from a pool of approximately 75 players from the Montreal Regional High Performance Centre. Although some players' ankles had been injured previously, no residual effects were prevalent at study time as confirmed by the attending athletic trainer. During the study, seven players withdrew because of injuries incurred while training with their club teams or for personal reasons. The remaining 18 players (age = 17.6 ± 1.7 yr, ht = 69.4 ± 4.4 in, wt = 155.2 ± 9.8 lb) served as subjects. All subjects had experienced having their ankles taped, and 2 weeks prior to the study they were given the ankle braces to wear and become accustomed to.

The four selected performance tests as described by Johnson and Nelson (12) were: (1) the 50-yard sprint, (2) the Nelson Test of static and dynamic balance, (3) the SEMO Agility Test, and (4) the Sargent Chalk Jump Test. All tests were administered at an indoor athletic complex on a synthetic surface. Testers remained at the same stations throughout the study in order to control the effects of individual variances in data recording.

Speed over a distance of 50 yards from a standing start was recorded to the nearest .01 second with a hand-held stopwatch. The Nelson Test, used to measure both static and dynamic balance, consisted of a series of stepping blocks, upon which the subject was asked to maintain one-footed balance for 5 seconds, and a 12-foot balance beam, situated 7 inches above the floor and over which the subject had to cross both in a heel-to-toe fashion and by sidestepping.

The SEMO Agility Test, which incorporates lateral, backward, and forward running, was used to measure agility performance to the nearest 0.1 second. The Sargent Chalk Jump Test measured the distance between the subject's highest reach on a wall from a standing position and the wall mark made at the highest point of the jump. Measurement difference to the nearest ¼ inch was calculated as the vertical jump data.

Each subject was tested on speed, balance, agility, and vertical jump in random order. All tests were performed under each of the five ankle support conditions. The order in which the supports were worn was determined by random selection also. The subjects completed the battery of activities under one ankle condition only on the first day. A period of 7 days preceded each subsequent testing session for each of the four remaining experimental conditions. The athletic trainer supervised a 10-minute warm-up of jogging and stretching prior to each day's testing.

Under the control condition, each subject performed the four tests without his ankles being taped or braced. For the taped condition, the subjects shaved their ankles to 6 inches above the malleoli, and a coating of tape adherent then was sprayed on the skin to minimize slippage. Antifriction heel and lace pads with skin lubricant and underwrap then were applied prior to the nonelastic adhesive athletic tape. A modification of the Gibney closed basketweave as shown by Arnheim (2) was used. Proximal and distal anchor strips were attached to the underwrap, but were allowed to overlap directly onto the shaved skin to prevent slippage. Two extra strips of tape (half stirrups) were added to afford the rear foot more support in valgus (calcaneal eversion). All ankles were taped bilaterally by the same athletic trainer to control the effects of individual variations.

Braces used were the McDavid A101 ankle brace (McDavid Knee Guard, Inc, Claredon Hills, Ill), New Cross #120 ankle brace (New Cross International Limited, Scarborough, Ontario, Canada), and Swede-O ankle brace (Swede-O-Universal, North Branch, Minn) (Fig 1). Subjects put on the braces and tightened them according to the instructions of the athletic trainer.

Each motor performance test was analyzed with the SAS statistical package General Linear Model (GLM) one-way analysis of variance with repeated measures (26). Five planned posthoc comparisons (Scheffé tests) were used to identify the location of significant differences among the group means.

Results

There were no significant differences among conditions in the results of speed ($F(1,4)=.71, p=.59$), balance ($F(1,4)=.52, p=.73$), and agility ($F(1,4)=.61, p=.66$). However, there were differences found between vertical jump conditions ($F(1,4)=3.99, p=.01$); New Cross-braced ankles showed less difference than untaped ankles (Scheffé $p=.054$). It is imperative to note a similar, yet insignificant difference in vertical jump performance between untaped ankles and McDavid-braced ankles ($p=.49$) (Table 1).

Discussion

Although slower times with ankle braces have been recorded while base running during softball practice (8), the present data support the findings of other studies that reported no significant differences in speed, balance, and agility when ankles were taped (14,19,22,28,30). As there were no significant differences in performance tests of speed, balance, and agility in this study—with any ankle support devices or with unsupported ankles—it would be wrong to conclude that braces and tape are either helpful or detrimental in these performance settings. Therefore, the amount of support offered by an ankle brace in these activities may be the determining factor of choice.

Over a six-year period, Rovere et al (25) tabulated ankle injuries of athletes with taped and braced ankles while wearing combinations of high-top and low-top

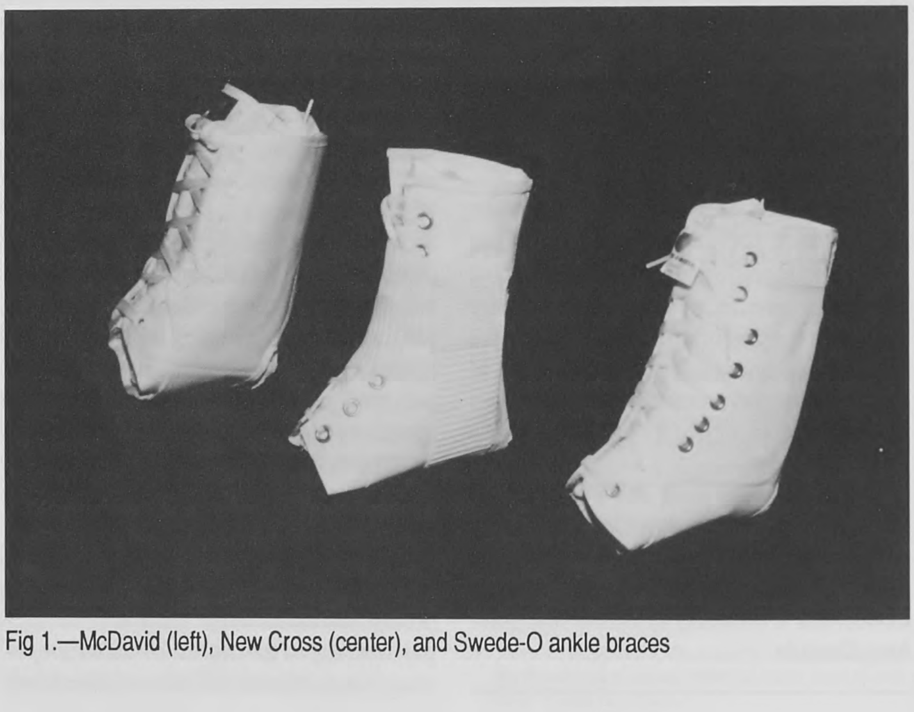

Fig 1.—McDavid (left), New Cross (center), and Swede-O ankle braces

Table 1.—Results of Athletic Performance Tests (N=18; Mean and Standard Deviation)

	Untaped	Taped	Swede-O Brace	New Cross Brace	McDavid Brace
Speed (sec)	6.60 ± 0.31	6.59 ± 0.28	6.62 ± 0.29	6.70 ± 0.30	6.66 ± 0.36
Balance (sec)	74.49 ± 7.45	76.82 ± 8.50	76.39 ± 9.30	74.24 ± 7.73	76.04 ± 9.60
Agility (sec)	11.69 ± 0.84	11.53 ±0.68	11.47 ± 0.53	11.64 ± 0.71	11.61 ± 0.49
Jump (in)	23.50 ± 2.29	22.94 ± 1.84	22.60 ± 2.38	22.22 ± 2.34*	22.36 ± 2.02

* Significantly different (p > .05) from untaped condition (control)

shoes. They reported that, overall, fewer injuries occurred while wearing low-top shoes in combination with lace-up ankle braces.

The present study revealed a significant decrease (5.4%) in vertical jump performance between untaped and New Cross-braced ankles. A decrease in this activity, although insignificant, also was noted among untaped and McDavid-braced (4.9%), Swede-O-braced (3.8%), and taped (2.4%) ankles. Burks et al (4) also reported decreased performances (3.4% to 4.6%) in the vertical jump while wearing tape, or either of two types of ankle braces (Swede-O and Kallassy) when compared to unsupported ankles. Similar percentage decreases in the standing broad jump performances were observed with the Swede-O brace and in the shuttle run with the Kallassy brace (4). Further, two older studies on jump performance yielded decreased vertical (13,18) and standing broad jump (18) scores with taped ankles compared to untaped ankles. It also is interesting to note that Gehlsen et al (7) recorded significantly lower plantarflexion torque at slow and moderate speeds with taped and braced ankles when compared to unsupported ankles.

Is the small percentage decrease in athletic performance when wearing ankle prophylactic devices warranted in order to achieve increased ankle joint protection (4)? Table 1 shows the mean differences in vertical jumping among two of the braces (Swede-O and McDavid) and the untaped ankles as 0.9 and 1.14 inches respectively. These differences were statistically insignificant. However, the argument for the need to maintain maximal performance capabilities may be supported by the examples of the soccer goalie who needs the extra measure to fingertip a shot over the crossbar, or a basketball player faced with a tipoff. However, ankle injuries are the most frequent injuries occurring in sports (2), and, from the athletic trainer's point of view, all preventive measures must be taken.

The findings of this study suggest that some commercial ankle braces may be used as ankle support alternatives to tape in selected activities. However, future research on ankle prophylaxes should focus on their effects on vertical jump performance over extended activity periods. The residual support that braces provide during and after prolonged activities also should be investigated.

Subjects' performances in speed, balance, and agility were not significantly affected by wearing tape or braces when compared to wearing no ankle support. Similarly, no significant differences in vertical jump performance were found between taped and braced ankles. Therefore, budgetary considerations may be the critical factor when selecting certain ankle braces to replace nonelastic adhesive tape.

Many teams have limited budgets for medical supplies. This concern was important as early as the mid-1970s (19). Other researchers (11,25) have noted the cost-effectiveness of using braces instead of tape. Table 2 represents the expenditure when purchasing tape and braces for the 25-week season of a college basketball team. The players would be active 6 out of 7 days per week, including games and practices.

With a top quality 1½-inch zinc oxide athletic tape at an approximate cost of $2.00 (Canadian) per roll, an average of two thirds of a roll would be used to tape one ankle in the modified Gibney closed basketweave. With adjunct supplies such as tape adherent, underwrap, heel and lace pads, and skin lubricant, the total cost of taping one ankle was projected at $1.45 (Canadian). When braces are substituted for tape, a net saving of 63.2% can be made during a basketball season.

Table 2. —Tape and Ankle Brace Cost Comparisons During a 25-week Basketball Season (prices in Canadian Funds)

A.	Tape cost per player Participation: 6 days/week 150 days total participation x 2 ankles = 300 protected ankles/season 300 ankles @ $1.45	=	$435.00
B.	Brace cost per player 4 braces/season (Based on two pairs per season) 4 braces @ $40.00	=	$160.00
C.	Savings (A - B) / per player	=	$275.00 (63.2%)
	12 - player roster savings	=	$3300.00

Savings can also be estimated for a soccer player who plays and practices three times per week (61.6%) for an all year (48 week) indoor-outdoor season, and for a football player active 6 days per week during a 10-week season (54.0%). The latter would purchase one pair of braces for a short season. The soccer player's costs for braces would be liberal as the figures are based on the purchase of two pairs of braces per year. If only one pair was used for a complete season, the savings would increase for both soccer (80.8%) and basketball (81.6%), with the latter team budget savings for a 12-man roster increasing from \$3300 to \$4260.

I conclude that some commercial ankle braces may be used as an alternative to adhesive tape, and that athletic trainers might want to consider them in light of potential savings.

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Weight Cycling Practices and Long-term Health Conditions in a Sample of Former Wrestlers and Other Collegiate Athletes

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ABSTRACT: Weight cycling (repeated episodes of weight loss and regain) has been shown to reduce the resting metabolic rate in some chronic dieters. Concerns have been raised that wrestlers' repeated patterns of weight loss and gain may reduce metabolic rates and increase long-term health risks. We conducted this study to assess previous weight loss practices, current body weight, and incidence of chronic disease in a sample of male athletes who earned athletic letters in intercollegiate sports at the University of Wisconsin-Madison between 1950 and 1988. Survey questionnaires were mailed to 79 ex-wrestlers and 153 nonwrestling athletes, with responses from 60 wrestlers (76%) and 104 nonwrestlers (68%). We found no significant differences in weight gained after graduation (10.2 pounds for wrestlers and 8.6 pounds for nonwrestling athletes), current exercise practices, incidence of chronic disease, prevalence of obesity, and current dieting rates in this sample of former college athletes. Collegiate wrestlers gained an average of 16 pounds during the off-season. Most wrestlers reported that they lost between 3 and 11 pounds per match and that they used a combination of five or more weight loss techniques. Most frequently reported techniques included increasing exercise, restricting food, exercising in a hot environment, using a steam room or sauna, restricting fluids, and exercising in a rubber or plastic suit. Fewer wrestlers than nonwrestlers reported that they smoked tobacco. The health effects of changes in proportions of fat-free body mass after weight cycling were not addressed in this survey. The hypothesis that numerous cycles of weight loss and regain among wrestlers may result in long-term weight gain and/or increased risk of chronic disease was not supported by the results of this survey.

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Repeated episodes of weight loss and regain (weight cycling) have been associated with reduced resting metabolic rate (RMR), altered patterns of body fat distribution, and increased rates of weight gain (3,7,13). These changes may be harmful because they have been associated with increased risk of chronic diseases such as coronary heart disease (11). Previous weight cycling practices of former college wrestlers may lead to increased rates of obesity, high blood pressure, and coronary heart disease that are higher than those of former athletes from other collegiate sports. This descriptive study was conducted to assess the weight loss practices and current prevalence of chronic disease associated with weight cycling and obesity in a sample of former collegiate wrestlers and other collegiate athletes.

Weight cycling has been a common practice among high school and collegiate wrestlers (1,9,10,15,16,19,20,22). While such practices have been associated with reduced RMR in adolescent athletes (17), there has been little, if any, systematic study of the long-term health implications of these practices. Brownell et al (5) reviewed the metabolic and health effects of weight loss practices of athletes, including wrestlers, and predicted that wrestlers may experience enhanced food efficiency and possibly increased susceptibility to obesity in later life. They recommended studies of weight changes in wrestlers to verify those predictions. Gunderson and McIntosh (8) found a greater incidence of self-reported obesity and indicators of chronic disease in a sample of ex-collegiate wrestlers. In contrast, Melby et al (12) compared RMR between 12 weight cycling collegiate wrestlers and 13 weight stable wrestlers before, during, and after a 6-month wrestling season and reported that participation in numerous cycles of weight loss and regain over the course of several months did not lower RMR.

Methods

We mailed questionnaires to 232 former athletes from the University of Wisconsin at Madison. The sample consisted of all of the 79 ex-athletes who: (1) earned letters in wrestling, (2) graduated between 1950 and 1988, and (3) had addresses listed in a current sports alumni directory (listed alphabetically by year of graduation). Our control group consisted of 153 former athletes. Each time a former wrestler was identified for our sample, we selected controls by picking the next two athletes who graduated in the same year and earned the same number of letters in nonwrestling sports.

We sent a follow-up letter to nonresponders to encourage their participation in this study. Sixty wrestlers (76%) and 92 nonwrestlers (60%) returned useable surveys. The nonwrestlers in our sample included athletes who earned letters in football (n=19), basketball (n=10), crew (n=10), baseball (n=9), track (n=8), swimming (n=6), golf (n=6), gymnastics (n=4), hockey (n=3), fencing (n=3), tennis (n=2), cross-country (n=2), soccer (n=2), and combinations of football with track, golf, or crew (n=8).

We compared groups to identify differences in weight, body mass index (BMI), and smoking status via standard t-tests (14). All other comparisons were done with chi-square statistics.

We used each athlete's self-reported height and weight to calculate body mass index (BMI, also known as Quetelet index, measured as kg/m^2) and categorized athletes as underweight, appropriate, overweight, or obese (less than 19.5, 19.5 to 24.4, 24.5 to 29.4, and greater than 29.4 kg/m^2, respectively). Body mass index is commonly used as an indicator of body fatness because the correlation of BMI with body fat, as determined by direct measures of body density, is between 0.7 and 0.8 (4). We also assigned rankings according to the estimated severity of wrestlers' weight loss techniques. A rank of 1 was assigned to weight loss methods that are normally recommended by nutrition experts, a rank of 2 indicates that the technique may contribute to dehydration, and 3 indicates a technique for which the likely consequences are more drastic, such as acute dehydration.

It may be unreasonable to expect detectable changes in chronic health conditions among younger athletes who have had only 3 to 20 years elapse since the end of the collegiate competitions. Therefore, we split our sample into younger (younger than 40 years) and older (40 years or older) groups to analyze the prevalence of chronic disease.

Table 1.—Mean Body Mass Index (BMI) Values and Body Weights of Wrestlers and Nonwrestlers

	Wrestlers' mean weights	Nonwrestlers' mean weights	Probability
BMI at graduation	25.4	25.1	0.204
BMI in 1990	26.9	26.2	0.523
Weight at graduation	78.4 kg	85.8 kg	0.003
Weight in 1990	83.0 kg	89.7 kg	0.007
Mean weight gained since graduation	4.49kg	3.75 kg	0.58

Table 2.—Proportions of Athletes Who Were Rated in Various Weight Categories According to Body Mass Index

	Wrestlers		Nonwrestlers	
	n	percent	n	percent
During wrestling season				
Underweight	5	8.5	*--	--
Appropriate weight	45	76.3	--	--
Overweight	6	10.2	--	--
Obese	3	5.1	--	--
At graduation				
Underweight	1	1.7	5	5.5
Appropriate weight	24	40.0	40	44.0
Overweight	32	53.3	37	40.7
Obese	3	5.0	9	9.9
In 1990				
Underweight	0	0	0	0
Appropriate weight	14	23.3	29	31.9
Overweight	36	60.0	52	57.1
Obese	10	16.7	10	11.0

*Data on weight during sport seasons were not collected for nonwrestlers in this survey.

Results

Body Weights

Wrestlers weighed less than nonwrestlers at the time of graduation from college and at the time of the survey (Table 1). However, body mass index values were similar for wrestlers and nonwrestlers at both times and there was no difference between wrestlers and nonwrestlers in the amount of weight that had been gained since graduation.

There were no differences between sports in the proportions who were underweight, appropriate weight, overweight, or obese at the time of graduation ($X^2(3) = 3.83$, $p = 0.28$) or at the time of the survey ($X^2(2) = 1.86$, $p = 0.40$) (Table 2). Both wrestlers and nonwrestlers had experienced significant upward shifts in the proportions who were in the overweight or obese categories ($X^2(6) = 26.57$, $p = 0.001$ for wrestlers and $X^2(6) = 42.76$, $p = 0.001$ for nonwrestlers). There was no difference in the proportions of wrestlers and nonwrestlers who reported a problem in maintaining their weight at the time of the survey (32% of wrestlers and 28% of nonwrestlers; $X^2(1) = 0.19$, $p = 0.67$). When asked if they had a weight problem in college, 29% of wrestlers vs 8% of nonwrestlers said they had experienced weight problems ($X^2(1) = 11.39$, $p = 0.001$).

Current Weight Control Practices

There was no difference between the proportions of wrestlers and nonwrestlers who were dieting at the time of the survey (10% and 20%, respectively; $X^2(1) = 2.59$, $p = 0.11$). Of those who were dieting, there were no detectable differences in the dieting methods used ($X^2(12) = 10.94$, $p = 0.53$). The type of diet most frequently mentioned by both groups was a low-cholesterol diet (reported by two wrestlers and four nonwrestlers in response to an open-ended question).

Other Lifestyle Practices

Fewer wrestlers than nonwrestlers had ever been cigarette smokers (15% and 29%, respectively; $X^2(1) = 4.29$, $p = 0.04$). However, the number of years of smoking did not differ for wrestlers and nonwrestlers who reported that they had been smokers (14.3 years for wrestlers and 13.1 years for nonwrestlers, ($t(34) = 0.29$, $p = 0.77$)).

Exercising on a regular basis (at least 30 minutes, three times per week) was reported by 77% of wrestlers and 72% of nonwrestlers ($X^2(1) = 0.32$, $p = 0.57$), and there were no significant differences in the number of athletes who listed aerobic forms of exercise in their regular routines (62% and 51%, respectively; $X^2(1) = 2.58$, $p = 0.11$).

Wrestlers' Weight Loss Practices

Over half of the wrestlers in this study indicated they had "almost always" lost weight in order to make weight for wrestling matches. The most frequently reported amount of weight lost per match was 9 to 11 pounds (4.1-5 kg). When asked for their largest weight loss in 1 week to "make weight" for a match, wrestlers reported losing a mean of 13.2 pounds (6.0 kg) with a range of 4 to 30 pounds (1.8 - 13.6 kg). There was a significant difference of 16 pounds (7.3 kg) between the wrestlers' mean weight during the wrestling season and the usual weight during the off-season ($t(1) = 9.04$, $p = 0.0001$). Forty-eight percent of wrestlers indicated that their highest off-season weights had occurred during the summers.

Wrestlers were considered to be yo-yo dieters if they reported losing weight for more than half of their matches. Nonwrestlers who reported losing weight more than six times while in college were considered yo-yo dieters. Yo-yo dieting in college was reported by 68% of the wrestlers and only 2.2% of the nonwrestlers. Furthermore, 81% of the nonwrestlers reported that they never attempted to lose weight while they were in college, but only 5% of wrestlers did not diet in college. The prevalence of yo-yo dieting was the same for those who graduated between 1950 and 1969, as for the younger wrestlers who graduated in the 1970s and 1980s ($X^2(4) = 1.56$, $p = 0.81$).

The most common weight loss technique used by wrestlers during their college years (Table 3) was restricting food intake (37%), followed by increasing exercise (22%). Seventy-three percent reported using a combination of five or more techniques for weight loss.

There appeared to be a trend toward increased severity in the weight loss technique used most often by younger wrestlers ($X^2(2) = 8.23$, $p = 0.016$). Only 4% of the wrestlers who graduated in the 1950s and 1960s ranked as their first use a technique of severity 3, while 23% of the wrestlers who graduated in the 1970s and 1980s did so. Also, of graduates from 1950 to 1969, 26% reported reducing food intake as their #1 ranked technique, while only 12% who graduated between 1970 and 1988 did so.

Table 3.—Wrestlers' Weight Loss Techniques

Technique	Severity Index*	Users		Ranked First	
		1950s & 60s grads	1970s & 80s grads	1950s & 60s grads	1970s & 80s grads
Restricting food intake	1	25	30	15	8
Increasing exercise	1	24	31	5	8
Restricting fluids	2	19	28	3	3
Spitting	2	10	3	0	0
Taking saliva stimulants	2	7	1	0	0
Exercising in hot environment	3	20	31	1	8
Exercising in rubber suit	3	5	28	0	4
Sitting in a steam room	3	21	27	1	1
Taking laxatives	3	2	0	0	0
Vomiting	3	0	1	0	0
Other (unspecified)	1	0	0	0	
None	0	1	1	0	

*Weight loss techniques with higher severity ratings are more likely to cause severe dehydration.

Health Problems

There were no significant differences ($X^2(5) = 9.35$, $p = 0.10$) in the number of health problems reported by wrestlers and nonwrestlers (Table 4). When athletes were divided into categories by age (40 and older vs under 40), more older than younger athletes had developed health problems ($X^2(4) = 12.62$, $p = 0.01$ for wrestlers; $X^2(4) = 33.60$, $p < 0.001$ for nonwrestlers). When looking only at athletes who were 40 and older, more nonwrestlers (68%) than wrestlers (42%) had developed health problems ($X^2(1) = 5.23$, $p = 0.02$). In addition, more of the older nonwrestlers (49%) than the older wrestlers (23%) had developed heart problems (hypertension, angina, heart attack, heart disease, high cholesterol, high triglycerides, and/or stroke; $X^2(3) = 8.02$, $p = 0.05$). There were no significant

Table 4.—Health Problems Reported by Wrestlers and Nonwrestlers, by Age

Condition	Wrestlers (n=60)		Nonwrestlers (n=92)	
	under 40	40 and older	under 40	40 and older
High cholesterol	0	4	3	12
Hypertension	0	4	0	10
Hemorrhoids	0	6	0	7
Arthritis	0	4	0	5
High triglycerides	0	2	1	4
Gout	0	3	0	3
Digestive disorders	0	1	1	3
Kidney disease	0	1	0	3
Heart attack	0	0	0	3
Gall stones	0	0	0	3
Depression	0	1	0	1
Heart disease	0	1	0	1
Angina	0	0	0	1
Cancer	0	0	0	1
Respiratory problems	0	0	0	1
Diabetes	0	0	0	1
Stroke	0	0	0	0
Other	0	1 (joint problems)	0	1 (multiple sclerosis)

differences in chronic disease prevalence between younger wrestlers and younger nonwrestlers.

Discussion

Long-term memory of body weight is a reliable measure of previous weight (6). The magnitude of weight lost during cycling in our study (mode = 4.1 - 5 kg) is consistent with other reports of wrestlers' practices to lose weight. In two studies of college-age wrestlers, mean losses of 4.8 kg from preseason to midseason (12) and 3.4 kg from midseason to postseason (18) were reported. More severe losses were reported among 14 weight cycling high school wrestlers who lost between 5.9 and 6.8 kg in a week.

Wrestlers' practices to lose weight have been a subject of concern for the American College of Sports Medicine (1) and the American Medical Association (2). However, the hypothesis that former wrestlers have increased risk of obesity and chronic disease is not supported by the results of this study. When compared to former athletes from other sports, wrestlers in this sample had no more prevalence of self-reported obesity and weight control problems. Heart disease was less prevalent in wrestlers 40 years and older, than other athletes of the same age. Former wrestlers were less likely, however, than other athletes to have smoked tobacco, and smoking rates may be important in evaluating the practical significance of associations between wrestlers' weight loss practices and chronic disease rates.

Wrestlers who use rapid weight loss techniques may experience severe dehydration leading to a decrease in the volume of fluid being filtered by the kidneys (13). Wrestlers in this study reported no more problems with kidney disease than nonwrestlers, but further research is needed to specifically address the possible long-term consequences of dehydration in wrestlers.

Studies that use more precise indicators of body composition, RMR, renal function, and chronic disease risk factors such as blood cholesterol levels and arterial blockage would more clearly identify the long-term health effects of weight cycling in wrestlers. In our study, athletes from sports other than wrestling were not asked about weight gains or losses during the athletic season. It is likely that athletes from certain sports such as football and rowing would have experienced some deliberate or concomitant changes in body weight during periods of competition. Further research is needed to make comparisons among sports for such variations in body weight among athletes from different sports.

In this sample of former athletes, wrestlers who graduated in 1970 or later were more likely to have used drastic weight reduction methods than the wrestlers who graduated in the 1950s and 1960s. It is possible that the more severe weight cycling practices of former wrestlers in this sample were too recent to produce a detectable pattern of long-term health risks in a sample this size. Similarly, our study did not address the potential for harm in weight cycling practices among adolescent athletes who may be more susceptible because they are growing at a rapid rate. Such determinations are beyond the scope of this study, but may warrant investigation in future research. There is no evidence in this study to suggest that athletic trainers need to discontinue reasonable and prudent weight loss recommendations for young adult wrestlers.

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The Athletic Trainer's Role in Modifying Nutritional Behaviors of Adolescent Athletes: Putting Theory into Practice

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ABSTRACT: Nutritional practices influence athletic performance and recovery from injury. The athletic trainer is ideally positioned to effect dietary changes with adolescent athletes—a group at high-risk for nutritional imbalances. Research shows that young adults generally do not change dietary practices when given factual nutrition and health information. This article provides a variety of behavior change strategies, based on models derived from health education and health psychology, which are likely to influence dietary choices. Promoting self-efficacy by enhancing perception of choice and control, peer modeling, cooperative support networks, goal-setting techniques, and behavioral self-monitoring may provide the motivational framework necessary to enhance dietary compliance. Dietary behavior change techniques are a valuable part of an athletic trainer's resources.

Encouraging high school athletes to eat well is a challenge for athletic trainers, because improvements of dietary behavior really are the only means to enhance nutritional status. Athletic trainers know the value of optimal nutrition in sports performance and rehabilitation, and may wish to add new skills to help athletes change their dietary behaviors. After briefly reviewing the context of nutrition for young athletes, this article provides a theoretical basis and practical suggestions for incorporating nutrition education and dietary behavior change into a comprehensive training program.

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Nutrition Issues for Athletes and Athletic Trainers

Making dietary choices consistent with optimal physical and mental performance is an integral part of an athlete's training program. The impact of nutrition on athletic performance is significant during adolescence, because physiological and biochemical systems have not yet fully matured and the need for exogenous support of growing tissue is greater than in adulthood. Unfortunately, most young athletes regularly make poor nutritional choices. Athletic trainers can provide young athletes with the needed evidence of enhanced performance and recovery from injury that is attainable through a well-chosen nutritional program. They also can motivate them to incorporate good nutrition into their overall training program.

Adolescent athletes may risk their nutrition and health status due to poor dietary practices, inadequate nutrition knowledge, frequent intake of inappropriate dietary supplements, and a propensity to follow dietary fads (12, 24). At the high school level, the typical male athlete eats a great deal of food while many female athletes eat too little. Even when sufficient calories are consumed, diets may be marginally deficient in micronutrients such as iron (27), magnesium (11), and zinc (16), which are essential to perform optimally in sport or to support normal physical development.

In several male-dominated sports, weight manipulation has been associated with nonrecommended dietary practices, such as rapid weight loss used in wrestling, and for substantially increased body mass in football (1). The female athlete whose caloric intake is below her caloric expenditure is typically suffering from the social pressures that promote women to diet and exercise compulsively in an attempt to conform to an unrealistic standard of slenderness (10). Coaches may exacerbate this dieting pressure by urging young women and men to achieve a target body weight inconsistent with normal growth and development, which ignores their genetically endowed body type. An additional factor that may enhance an adolescent's drive toward thinness is the perceived benefit of competing in a sport where weight may be a disadvantage (eg, distance running, gymnastics, swimming, diving, wrestling, cheer-leading). The combination of high physical demands and dietary restrictions places many female and male athletes at great risk of nutritional deficiencies and the possibility of developing an eating disorder (10).

An athlete's beliefs about his or her body can also motivate his or her behavior. A positive body image can build self-esteem and help an athlete achieve goals consistent with optimal sports performance and a healthy lifestyle. On the other hand, body image dissatisfaction or a negative body image can lead to self-destructive behaviors (20). Body image is an intense emotional issue with many high school athletes, especially girls. How they see themselves and how they think others see them profoundly influence their nutritional choices.

Adolescents are at nutritional risk because of both physiological and psychosocial influences (30). Dramatic increases in physical growth and development create a high demand for vitamins, minerals, protein, and energy. Psychosocial changes such as the search for independence and identity, concern for appearance, and active lifestyles can have a strong impact on nutrient intake. Highly nutritious meals and snacks may be secondary considerations, because teenagers tend to base their food choices on convenience, taste, affordability, time, and peer influence (8, 19, 22, 23) rather than on exercise and recovery needs.

Nutritional choices of high school athletes may be affected by a concern for body image (10). Adolescents at this age often feel a need to maintain a particular social image, which could translate nutritionally into the foods they eat in front of their peers (12). Many may believe it is inappropriate or embarrassing to eat carrot sticks or pears in the presence of friends and teammates. Athletes may perceive that eating a bag of chips or cookies could bring much more popularity than eating salads or fresh fruit.

One way athletic trainers can help male athletes find a healthful balance in the foods they eat is to promote the act of sharing snacks. Sharing a submarine sandwich cut into one- or two-inch individual servings, a bunch of grapes or other popular fruit, or a bag of bagels, are all possible health- and performance-enhancing behaviors that athletic trainers can promote. Young male athletes can discover that they are able to eat healthfully, be popular, and maintain a strong image all at the same time.

Many adolescent athletes have been informed about good health and nutrition practices from teachers, nurses, and coaches (2, 30), as well as from numerous articles in reputable popular magazines (29,30). However, knowledge alone is rarely sufficient to promote behavior change, and a discrepancy between teenagers' health knowledge and their behavior has been frequently noted (6,21,26). Although adolescents may be generally well-informed about good health practices, this knowledge often is poorly translated into their daily lives (30). Rather than focusing nutrition education programs solely on food facts and knowledge, educators and athletic trainers must address the additional factors of attitudes and values to help create the desired outcome of motivation and dietary behavior change (7).

People change their health behaviors when they perceive a reason for the change or when they know that the change will make a positive difference in their lives (9, 15). Among the potential benefits resulting from optimal food choices are an increase in the level of athletic performance, a decrease in healing time after injury, a greater assurance of optimal physical development, an increase in the athlete's self-concept, and the establishment of long-term eating patterns that will likely contribute to robust health later in life.

Self-Efficacy

A theoretical rationale for identifying goals, outcomes, or expectations is based on self-efficacy theory (15). Self-efficacy is a situation-specific form of self-confidence, or the belief that one is competent and can do whatever needs to be done in a specific situation (14). This sense of "I can do" refers to a personal judgment of how well one can organize and implement patterns of behavior in situations that may contain certain novel, unpredictable, or stressful elements (3). Bandura (5) has suggested four sources of self-efficacy attainment for behavior change, which form a model, in part, for the ideas presented in this paper. Self-efficacy can be achieved through the following four methods:

1. Guided practice of the desired behavior (enactive attainment through skill mastery)
2. Vicarious experiences of success (modeling of peers, athletic trainers, and significant others, and reflecting on past successes)
3. Social persuasion (bulletin boards, sharing of ideas and menus, rewards, involvement of the family and coaches in the social support network, and testimonials of success), and
4. Ability to monitor physiological changes (increase positive behavioral cues, decrease negative cues, active role-playing of desired behavior in difficult situations, goal-setting, and behavioral self-monitoring)

Social learning theory, used in relation to self-efficacy, suggests that a person's learning and social experiences, coupled with his or her values and expectations, influence behavior (1, 4, 31). Social learning theorists contend that adolescents will model behavior according to three things: (1) the reactions they receive from others, (2) the behavior of those adults with whom they are in close contact, and (3) the behavior they view on TV and in movies (31). Adolescents particularly are more likely to model what they see, rather than what they hear people say. Therefore, seeing other important people, such as parents, coaches, teammates, and athletic trainers eating well and talking about the value of nutrition and sports performance is likely to influence the young athlete (25).

Enhancing Perception of Choice and Control

A perceived sense of control may be one of the most important elements influencing an adolescent's food choices. Perception of control, or the belief that one can exercise personal choice (21), creates a sense of competence, usefulness, and purpose. At their critical stage of psychological development, adolescents begin to experience a sense of freedom and personal selection regarding lifestyle choices (18). By enhancing a perception of control, the athletic trainer assists in the athlete's personal development. Linking perception of control with health-promoting dietary choices is a skill that may be viewed as part of the athletic trainer's equipment. Enhanced perception of choice and control can be achieved through a positive context of nutrition education, peer modeling, advice by role models, the observation of behaviors of significant others, marketing and advertising messages, goal-setting, and the voicing of a commitment.

A Positive Context for Nutrition Education

Nutrition education that employs a positive context to promote healthful eating is likely to be more useful than a program that uses a fear-based warning approach (24). People react to positive messages much better than to negative ones. An athletic trainer has a better chance of influencing an athlete's nutritional behavior by emphasizing the relationship between optimal nutrition and the athlete's performance and recovery, rather than by instilling guilt and fear with warnings about what to avoid (19). Continually promoting "what to do" and diminishing dialogue about "what not to do" will help young athletes learn an optimistic approach to nutrition (28). Emphasizing immediate or short-term benefits also is more likely to be effective than simply linking the nutrition message with some distant view that one will "feel better."

Increasing perception of choice also will help ensure success. An adolescent who is told what nutritional changes to make will not respond as well as an athlete who is given a number of options that would result in positive change. Encouraging young athletes to choose their own dietary goals and practices increases their sense of ownership and responsibility for their dietary choices. The athletic trainer will have greater success if the athlete is presented with a number of nutritional options, all of which would be beneficial, rather than prescribing one specific dietary change. For example, the athletic trainer could identify three options, such as increasing complex carbohydrate intake, consuming more vitamin C-rich fruits and vegetables, or drinking more water. Then, let the athlete choose which of the three goals to concentrate on first.

Peer Modeling

Peer modeling is another effective method of enhancing perception of choice and control. Students are more responsive to the influence of peers who share similar values and interests than to the influence of students with dissimilar values (13). In the high school setting, athletes often eat what their peers eat. If the athletic trainer can influence the "leaders" on the team to eat more nutritionally, other athletes are more likely to follow the example being set.

The advice and behavior of others—such as personal friends and authority figures such as coaches, teachers, parents, older siblings, and accomplished athletes—are significant factors influencing people to make favorable dietary behavior changes (9). The behavioral intention model (1) suggests that people's perceptions of the attitudes of "important others," toward a given behavior or set of behaviors, are important influences of their own behavior. Perceptions can be derived from the observation of actions and the acquisition of knowledge from influential persons. In most cases the athletic trainer is a friend as well as an authority figure, and has a regular influence on athletes. To function as an effective role model, the athletic trainer must be knowledgeable and feel comfortable with presenting nutrition information to athletes. In addition, the athletic trainer must practice the desired behaviors that he or she hopes will be adopted by the athletes (23). In a more figurative manner, athletic trainers and health educators are encouraged to follow the words of Gandhi: "We must be the change we wish to see in the world."

A Cooperative Systems Approach

In addition to modeling health-promoting eating behavior and influencing the nutritional practices of key opinion-leader teammates, the athletic trainer can incorporate the athletes' coaches and parents into nutrition education programs. A cooperative systems approach, as shown in Figure 1, is one way to illustrate the dynamic interactions of people who can influence adolescent athletes' food choices on a daily basis. Coaches, parents, and other family members are important components of the student's support network and can be actively encouraged to participate in a systemic effort.

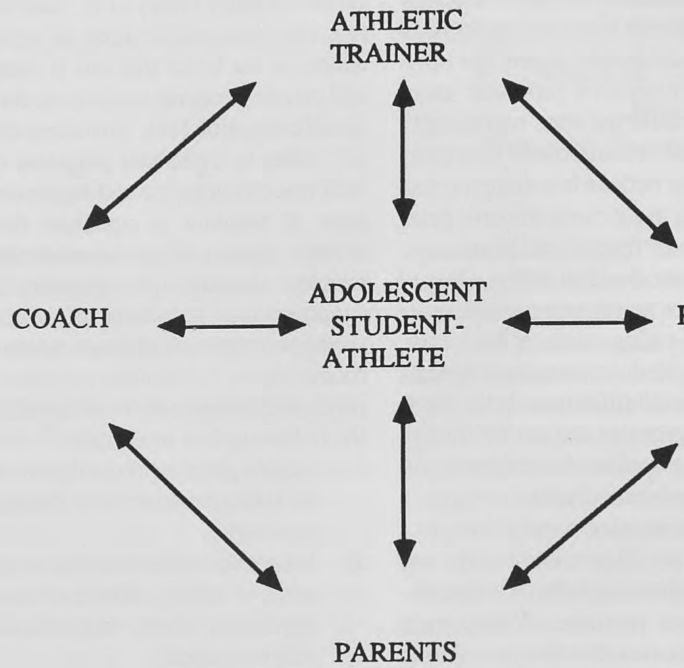

Fig 1.—A cooperative systems approach that can influence dietary choices of adolescent athletes

The systems approach can be consciously encouraged by athletic trainers in a variety of ways. The athletic trainer is in a unique position to invite the parents and coaches to attend sports nutrition workshops with athletes. Coaches, parents, and other family members may be encouraged to participate in joint nutrition goal-setting activities. Discussion among parents, athletes, and coaches concerning how they may support the athlete in attaining his or her nutrition goals can be facilitated at school meetings or potluck dinners that are sponsored by the athletic trainer, coach, or principal.

Awards can be offered by the athletic trainer to family and team members who submit recipes, such as for the "tasty-carbo-quick-meal-of-the-week" competition or for the "low-fat, fruit-based dessert" contest, or even to each team member who meets his or her nutrition goals. Credit can be given to athletes who try a new carbohydrate snack or substitute carbohydrates in place of high-fat foods. Public sharing of ideas and promotion of efforts to try new foods or eating behaviors stimulates social support and self-efficacy in the young athlete.

Marketing Nutrition to Athletes

Marketing and advertising messages appear to have a strong influence on teenagers' nutritional behaviors (8, 9). Adolescents model the behaviors of "star athletes," and advertisers capitalize on this notion by hiring sports heros to sell athletic shoes, breakfast cereals, soft drinks, and a multitude of other products. Athletic trainers can use marketing strategies in similar ways. For example, a bulletin board in the training room that displays motivating nutritional messages, along with pictures of well-known athletes, can provide an excellent educational format. The athletic trainer can provide a "nutrition message of the week," which athletes will see on the bulletin board, along with pictures of star athletes, when they come to the training room.

A factor analysis of messages that students found motivating toward changes in nutritional behaviors has been conducted (24). The findings may be useful when designing bulletin boards. The most powerful messages for students were:

1. Watermelon, peaches, pineapple, apples.... You can add lots of variety to what you eat by choosing REFRESHING FRUIT.

2. Fruit makes such a delicious dessert. It does not leave you with that heavy, stuffed feeling.
3. Fruit makes a refreshing dessert. A bowl of plain sliced peaches and bananas has only about 75 calories and is so enjoyable.
4. You can eat a LOT of fruit before the calories amount to much, because fruit is so low in calories.
5. Choose an apple, an orange, or a banana for your sack lunch dessert. Fruit provides 50-150 calories, compared to 350 calories in two oatmeal cookies.
6. Do you get in a rut when you eat? Add interest by choosing a crisp, refreshing VEGETABLE SALAD often.
7. Drink water with your meals instead of punch, unless you need extra calories.
8. What to drink? Water is an excellent as a no-calorie beverage.
9. Compare a banana (about 130 calories) to a piece of cake (about 300 calories). Choose the dessert that fits YOUR calorie budget.
10. Fruit juice — such a refreshing AND nutritious drink!
11. Fruits and vegetables are important — eat four or more each day.

Goal Setting

Setting goals is one of the most effective methods that athletic trainers can employ to help young athletes eat well. The most important element of goal setting is the focus on desired behaviors rather than on the problem. A simple five-step method of setting goals includes these elements:

1. Establish a positive, quantifiable goal.
2. Identify behaviors to achieve the goal.
3. Identify support person(s).
4. Establish an initial action plan.
5. Identify reward.

Behavioral goals generally are recommended over outcome goals, because a person has control over his or her behavior. For example, an athlete generally has control over eating a daily low-fat diet consisting of six to ten servings of carbohydrates, four servings of vegetables, four servings of fruits, two servings of lean protein, two to three servings of calcium-rich foods, and eight glasses of water. In contrast, the athlete may not have control over whether his or her body loses ten pounds of fat or gains ten pounds of muscle, since the amount and rate of gain in lean body mass is subject to genetic and developmental limits, regardless of diet. Therefore, goals that focus on changes in body composition generally are not recommended. Athletes are outcome-oriented, so athletic trainers can link behavioral goals with outcomes and still encourage the focus on behaviors. To operationalize the goal-setting method, a sample worksheet is provided in Figure 2.

1. My one week nutritional goal is:
2. Five or more ways I will achieve my goal are:
3. Whom will I ask to help me? What will I ask of this person?
4. My first step, in the next two days, will be to:
5. At the end of the week, I will reward myself by:

Fig 2.—A sample goal-setting sheet to help encourage positive dietary behavior change

Goals are most effective when set in a positive, measurable context. The athlete must be able to measure and record targeted behaviors. The use of positive statements helps to create a series of internal images and memories, which assist in achieving the goal. When presented with a negative goal-setting statement, the athlete's mind may create images inconsistent with the desired behavior change. For example, if a teenager is told not to think about eating chocolate cake, his or her mind recalls chocolate cake and has difficulty moving past this image. An alternate approach would have the athlete focus on the energy benefits of eating at least five servings of pasta each week and setting that as a goal. The mind easily forms images of mounds of spaghetti noodles served with low-fat tomato marinara sauce.

Quantifying goals into behavioral terms is essential to provide structure and refinement toward the dietary changes. After appropriately identifying a goal, the athlete is asked to identify specific actions that will be taken to achieve the goal. Strategies might include buying the necessary foods, packing snacks for use before and after a workout, or writing the goal on a card and placing the card in one's locker, notebook, or on the bathroom mirror.

The third step towards successful goal attainment is to identify a support person—thus establishing a social support network. In addition, the athlete must be able to communicate clearly what specific actions he or she would like their support person to take. A teammate, friend, or athletic trainer may be an ideal support person to provide a listening ear, a supportive face, and words of encouragement.

Identifying an action to be taken during the first 3 days of the goal period is the next step. Breaking large behavioral goals into smaller tasks maximizes achievable outcomes. Secondly, the success of a first step, however small, establishes a positive mode and reinforces the athlete to continue toward the larger goal.

The fifth step in the goal-setting process is to identify a reward. Rewards are important because they reinforce the series of actions and attitudes that resulted in reaching the athlete's goals. Rewards are most effective when consistent with the behavioral goal. For example, a chocolate sundae is not the best reward for eating three servings of vegetables each day. Rewards can include the purchase of non-food items such as books, a new piece of clothing or music, bedroom accessories, tickets to sports or entertainment events, or activities such as outings, video- or movie-watching, picnics, social events, or games.

The sample goal-setting sheet in Figure 2 incorporates a 1-week time frame. Longer times, such as 2, 3, or 4 weeks also can be used effectively, particularly after the athlete and athletic trainer have established familiarity with the process. Goals spanning more than 4 weeks are generally less effective than short-term goals, because focus and motivation tend to wane as time passes. Goal attainment is enhanced when goals are both written and verbalized to individuals in the athlete's social support network.

Behavioral Self-Monitoring

A dietary checksheet is a useful tool to promote healthy food choices in a positive, intentional context. A written or graphic

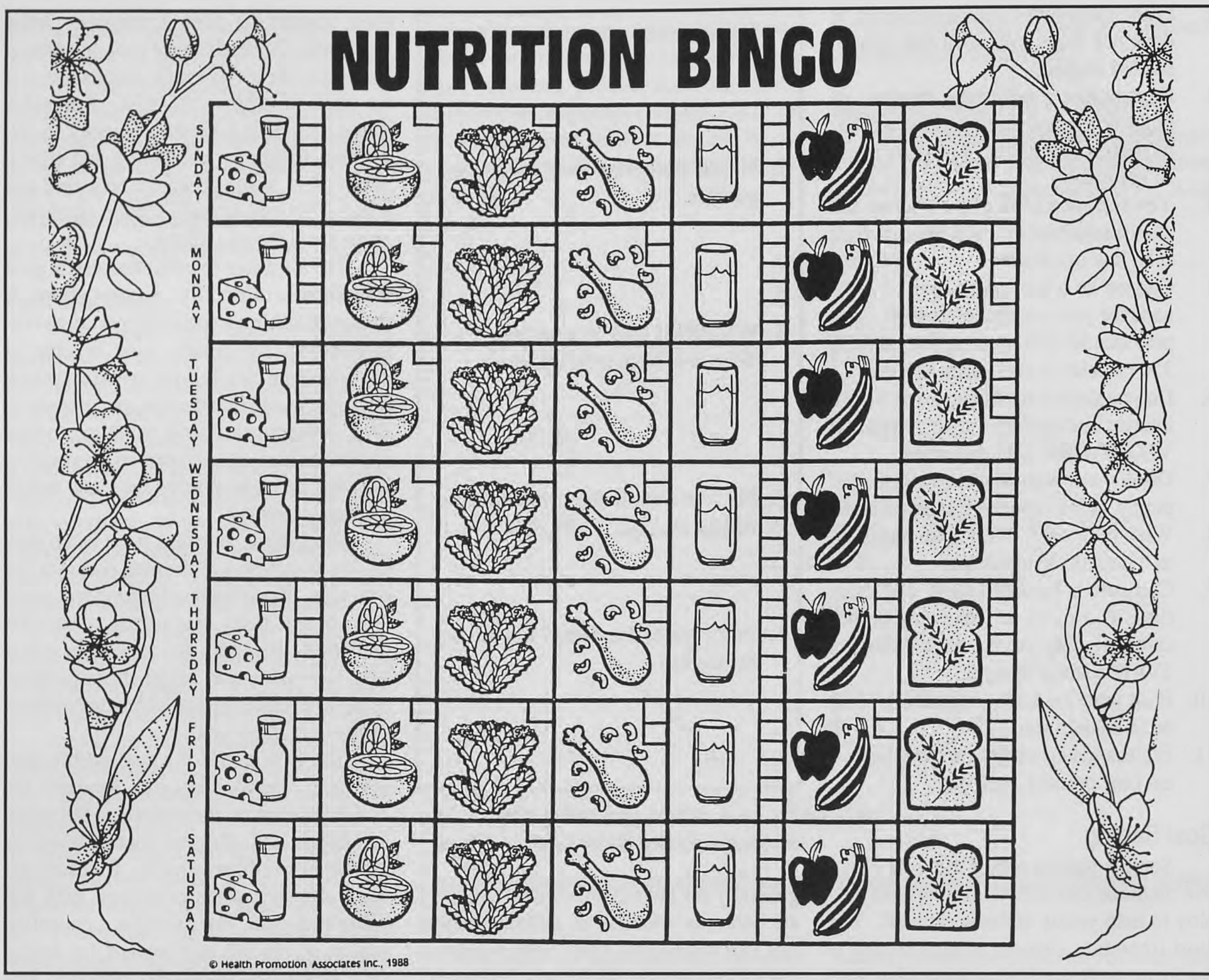

Fig 3.—Sample "Nutrition Bingo" behavioral goal record sheet (above) and weekly checklist (facing page)

list of food categories can be presented for each day, with a targeted number of servings from each category being the athlete's goal. For example, a "Nutrition Bingo" system, shown in Figure 3, has been successfully employed to help direct people toward dietary goals (17). The weekly sheet displays graphic images of foods representing categories such as whole grains, fruits, vegetables, water, dairy products, and lean meats/dried beans with a suggested number of daily servings. An athletic trainer could devise a similar checksheet and distribute copies directly to athletes, or provide the sheets to coaches for use with a team. When the checksheet is carried with the athlete, it serves as a reminder and motivator regarding foods to be eaten. When posted on the refrigerator, the sheet can also serve as a focal point for family discussion, social support, and meal planning for the athlete.

Readiness

Adolescent athletes must be ready before they can take the necessary steps to change their dietary practices. Readiness is "the possession of behaviors, attitudes, skills, and concomitant resources that make it possible for individuals to incorporate a new health behavior into a permanent lifestyle (15)." A readiness model shows a progression from knowledge gathering and understanding to complete adoption of the new behavior as part of a lifestyle.

Athletic trainers can apply nutrition education principles and research to influence adolescent athletes to make healthy dietary choices. Athletic trainers can educate athletes about nutritional training methods that promote a positive self-concept as well as enhance performance, aid in recovery from injuries, and contribute to overall health. A primary goal of athletes is to participate in their sport in the best physical and mental condition possible. By adding dietary behavior change to the many therapy treatments used, athletic trainers will be helping athletes to reach their personal and athletic goals.

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NUTRITION BINGO

DAIRY: One cup lowfat milk or yogurt, 1 1/2 oz. cheese, or one 300 mg calcium supplement. Four servings a day recommended.

VITAMIN C-RICH FOODS: One piece or 1/2 cup juice of grapefruit or tangerine; 1/2 cup melon, strawberries or other berries; or 1 whole green pepper or tomato. One serving a day recommended.

LEAFY GREENS: One cup raw or 1/2 cup cooked or kale, chard, spinach, broccoli, or brussels sprouts; or one cup romaine, or red or green leaf lettuce. One serving a day recommended

DARK MEATS & DRIED BEANS: Three oz. of lean beef, pork, or dark meat from chicken or turkey; or 1 cup cooked beans like pinto beans, black-eyed peas, split peas, or lentils. Two servings a day recommended.

WATER: One cup water or herb tea. Six servings a day recommended.

FRUITS & VEGETABLES: One cup raw or 1/2 cup cooked of any additional fruits or vegetables. Two servings a day recommended.

WHOLE GRAINS: One slice whole-grain bread; 1/2 cup oatmeal, brown rice or other cooked grains; or 3/4 cup ready-to-eat whole-grain cereal. Four servings a day recommended.

TO DO LIST

For my goal this week, I will:

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I can answer yes to all of these questions about my goal:

- ☐ 1. Does it say exactly what I will do?
- ☐ 2. Do I have direct control over it?
- ☐ 3. Could a friend see me doing it?
- ☐ 4. Can I tell when I've accomplished it?
- ☐ 5. Does it say what I will do rather than what I won't do?
- ☐ 6. Is it easy to do?

The steps I will take to reach my goal are:

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Maisonneuve Fracture Dislocation of the Ankle

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Michael M. Wilkinson, MS, ATC
Andy Bryan, MEd, ATC
Gene R. Barrett, MD
Walter R. Shelton, MD
J.O. Manning, MD

ABSTRACT: Ligamentous injuries of the ankle are usually benign and may be managed satisfactorily by nonoperative measures. This is not true, however, of the Maisonneuve variant. In this paper we present a case report of a high school athlete who sustained a Maisonneuve fracture dislocation of the ankle. The diagnosis was missed initially, because of an incomplete examination. The subsequent physical and radiographic examination revealed the proper diagnosis. Guidelines for the evaluation and appropriate treatment are discussed.

One of the most common injuries sustained by athletes involves a partial tear of the ligaments of the ankle, commonly termed an ankle sprain (5). This type of injury usually involves one or two of the lateral ankle ligaments. Such an injury is usually satisfactorily managed by simple taping, adhesive strapping with stronger support materials, or bracing. In more severe cases, a brief period of casting may be required to facilitate healing.

A more severe ankle injury involves a fracture about the ankle and is more easily diagnosed by the associated pain, swelling, and crepitus (5). The same high energy forces that produce a fracture may occasionally result in complete tearing of the ligaments of the ankle and loss of the stabilizing structures of the ankle mortise (3). The absence of local crepitus, usually seen in ankle fractures, makes the diagnosis of these complete ligamentous injuries difficult. If disruption of the ankle mortise occurs, surgical stabilization may be required (1,2,4). It is the responsibility of the evaluating athletic trainer and the team physician to diagnose these injuries and render appropriate care. We would like to present a case report of such an injury.

All of the authors are associated with the Mississippi Sports Medicine and Orthopaedic Center in Jackson, MS. Felix Savoie, Gene Barrett, Walter Shelton, and J.O. Manning are orthopedic surgeons. Michael Wilkinson and Andy Bryan are athletic trainers.

Case Report

An 18-year-old male athlete sustained an ankle injury during a football game. He had no previous history of injuries to this ankle. Following the injury he had to be assisted off the field and could not continue playing. On the bench, the athlete explained that his foot had been planted, and when his body twisted, he felt a pop. He said it seemed as though his foot stayed behind (indicative of a planted foot). He complained of severe pain around the entire ankle. On the sideline, physical examination revealed tenderness around the medial and lateral malleoli. There was minimal swelling and the ligamentous structures were thought to be stable. Because of the severe pain, he was referred to the emergency room for radiographic evaluation. X-rays of the ankle were reviewed and were felt to be consistent with a simple, Grade I, ankle sprain (Fig 1). A prefabricated splint was applied to the ankle. The patient was told to use crutches and apply ice to the ankle. He was given a written note allowing him to return to play the next day and was sent home.

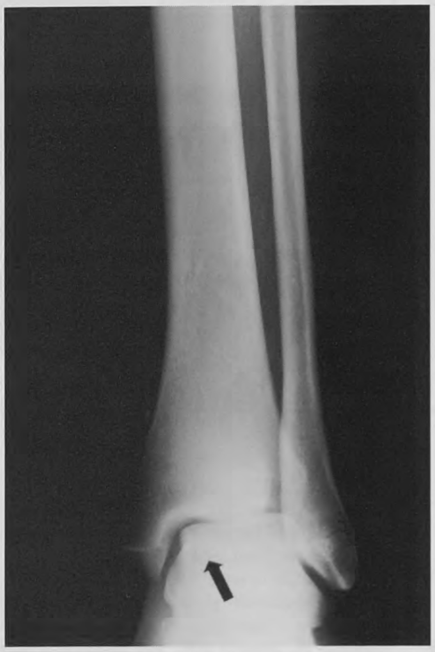

Fig 1.—Initial ankle radiographs demonstrating some widening of the ankle mortise

The patient returned to school 4 days following the injury, complaining of severe pain and swelling. His coach referred him to the team athletic trainer for evaluation and management. After examination, the athletic trainer referred the patient for orthopaedic consultation.

Orthopaedic evaluation revealed a diffusely swollen ankle. There was tenderness over the deltoid ligament medially, all of the lateral ligamentous structures, and proximally along the syndesmosis and interosseous membrane. In addition, there was crepitus to palpation over the proximal fibula. Radiographs of the ankle

Fig 2.—The radiograph obtained 72 hours post injury reveals displacement of the ankle mortise and a distinct lateral shift of the talus.

revealed a distinct shift of the talus and disruption of the ankle mortise (Fig 2). Radiographs of the entire tibia and fibula revealed widening of the ankle mortise and the proximal fracture of the fibula, pathognomonic of a Maisonneuve fracture dislocation of the ankle (Fig 3).

Surgical repair of the ankle ligaments and stabilization of the mortise with a syndesmotic screw restored normal congruency and function of the ankle (Fig 4). Recovery was uneventful and the patient returned to normal athletic activities within 4 months of the injury.

Discussion

Maisonneuve, in 1840, was the first to recognize the role of external rotation in the production of injuries to the ankle (Fig 5) (3). Although he described most of the more common injuries to the ankle as well, it is the dissociation of the ankle mortise, with or without the proximal fibular fracture, that bears his name (5). The internal rotation of the leg on the fixed foot (external foot rotation on a fixed leg) results in tearing of the deltoid

Fig 3.—The radiograph reveals the proximal fibula fracture associated with a Maisonneuve fracture dislocation of the ankle.

Fig 4.—Surgical repair of the ligaments and stabilization of the ankle mortise with a 3.5 mm cancellous screw clearly restores the normal anatomical congruity of the ankle mortise.

ligament, anterior and posterior tibiofibular ligaments, and the syndesmotic ligaments (3,5). The force then continues up the interosseous membrane to exit through the proximal tibiofibular joint or through the shaft of the proximal fibula (3,5).

It is essential that the injury be recognized in the acute phase as the late sequelae of nonoperative management includes

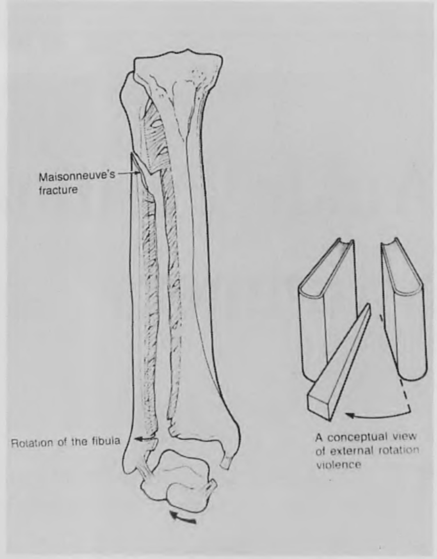

Fig 5.—The injury results from an internal rotation of the leg on a planted foot. This results in sequential tearing of the ligaments and progression of the force along the interosseous membrane to exit proximally in the leg.

degenerative arthritis and pain, leading to a dysfunctional ankle (5). Key findings may include medial ankle tenderness, a ballottable fibula, and proximal fibular tenderness (1,2,4). Each of these should be evaluated in every ankle sprain. Manual stress testing, radiographs of the entire lower leg, and stress radiographs may be helpful in making the diagnosis (5).

Once syndesmotic stabilization is accomplished, an uneventful recovery is typical for this injury (1,2,4,5). Immobilization is employed for 1 to 3 weeks, followed by rehabilitation of the periarticular musculature. Weight bearing is delayed for 6 to 8 weeks, until syndesmotic screw removal.

A Maisonneuve fracture-dislocation of the ankle should be considered in all ankle sprains. Simple manual tests and radiographs aid in diagnosis, allowing for appropriate treatment and satisfactory recovery.

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Ankle Positioning in Ankle Taping of Swimmers

Timothy Carver, MA, ATC/LAT

When taping an ankle, most athletic trainers place the ankle in a 90° neutral position while applying the athletic tape (2,3,5,7-9). This position (Fig 1) is chosen because it is functional in relation to weight-bearing activities. However, an ankle position of 90° is not the functional position in competitive swimming. For proper swimming technique the ankle should be in full plantar flexion (1,4,6), which results in a more effective kick (4).

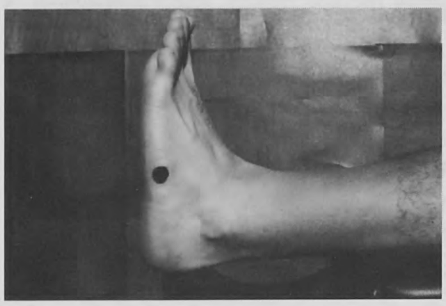

Fig 1.—Lateral view of ankle in the traditional 90° (neutral) taping position

Although swimming is not a weight-bearing activity, stress is applied to the ankle by the water as the swimmer kicks. A competitive swimmer recovering from a sprained ankle may be unable to kick with the same force because of ankle tenderness. The ankle can be taped for support in order to make the athlete feel more comfortable while kicking.

When taping for competitive swimming, it is best to position the ankle in full plantar flexion (Fig 2). The ankle is prepared by removing the hair and liberally applying a tape adherent. Begin taping by placing two anchor strips on the leg (Fig 3) followed by three stirrup-style strips (Fig 4), which are positioned closer to the heel of the ankle than when taping in the neutral position. Then place an anchor strip (Fig 5) over the top edge of the stirrups to secure these strips. Continue with a figure-8 strip (Fig 6) that also is moved slightly posterior to keep the tape off the head of the fifth metatarsal. Next add a lateral (Fig 7) and then a medial heel lock strip (Fig 8); also moved posterior and angled to avoid the head of the fifth metatarsal. Finish with anchor strips that begin at the heel and continue in an overlapping manner until the top of the stirrup strips are covered and place one anchor strip around the midfoot (Fig 9).

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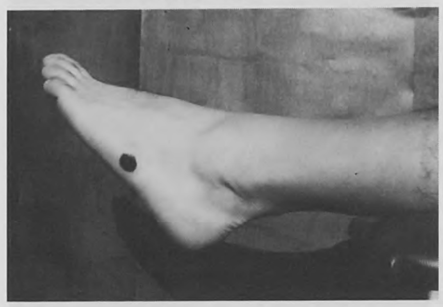

Fig 2.—Lateral view of ankle in the full plantar flexion taping position (Dot on foot is over the head of the fifth metatarsal.)

Tape the swimmer in close proximity to the pool—preferably at water's edge—because normal walking is difficult with the ankle taped in the plantar-flexed position. Because of the water, the tape loosens much quicker than dry ankle taping. Therefore, some swimmers need to have their ankle taped three or four times during the course of a swim meet. To solve this problem I recently began using grey utility (duct) tape on swimmers, as suggested in a conversation with William Prentice of the University of North Carolina (September 1991). This type of tape seems to be truly waterproof and normally will last an entire swim meet with only a slight decrease in effectiveness.

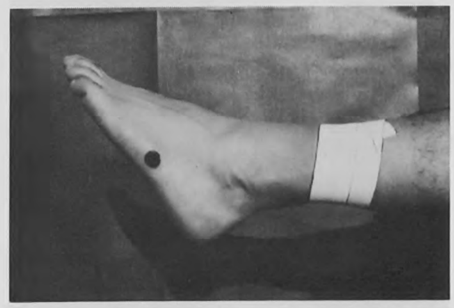

Fig 3.—Lateral view of ankle with two anchor strips

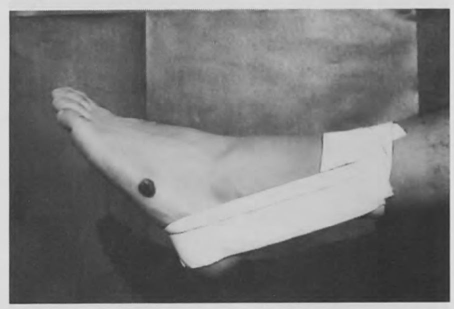

Fig 4.—Lateral view of ankle with three stirrup strips (Edges of the tape are outlined.)

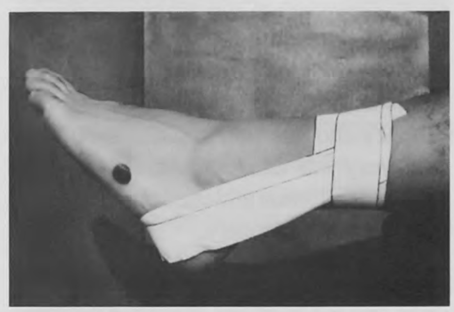

Fig 5.—Lateral view of ankle with anchor strip securing edge of stirrup strips

The four swimmers whom I have taped in the full plantar-flexed position

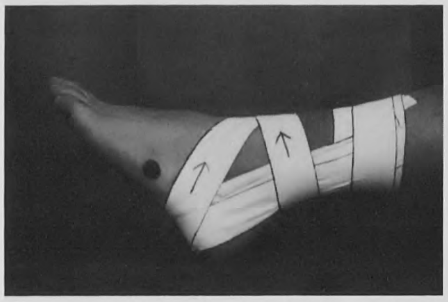

Fig 6.—Lateral view of ankle with a figure-8 strip applied (Arrows indicate the direction of tape.)

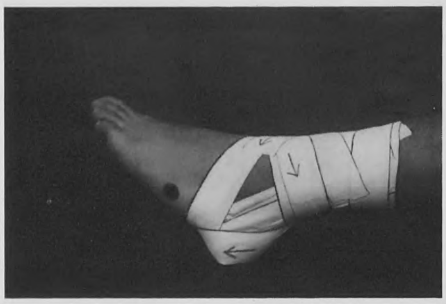

Fig 7.—Lateral view of ankle with a lateral heel lock strip applied

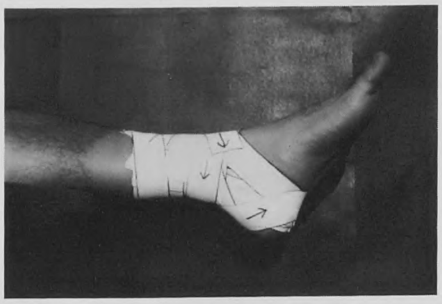

Fig 8.—Medial view of ankle with a medial heel lock strip applied

Fig 9.—Lateral view of completed plantar-flexed position ankle taping

report a greater satisfaction with the procedure, than with the traditional 90° ankle taping position. And, these swimmers did not experience any feeling of loss of stability while swimming with their ankles taped in the plantar-flexed position. I recommend that athletic trainers consider taping their swimmers' ankles in the full plantar-flexion position for added support and comfort.

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A Simple Splint for Wrestler's Ear

Thomas M. Keating, MD
John Mason, ATC

Wrestler's ear, an acute hematoma of the external ear (1,2), is commonly associated with wrestlers and other athletes who engage in contact sports (3). It may occur even when protective ear guards are being used. The syndrome is frequently difficult to treat adequately because of patient noncompliance (1,3). The necessary postaspiration compression dressing is time-consuming to apply, often impossible to replace accurately, and frequently is an embarrassment to the patient. Commonly, its use is discontinued early; therefore, recurrence of the hematoma results.

We, and others (2,4,5,7,8), have experimented with various techniques for making a compression splint of the ear. Casual discussion with Allen Montoye, DDS, in 1987, led us to try a dental elastomeric impression material. The molded impression can be easily removed for bathing and readily and accurately reapplied by the patient, resulting in a high degree of compliance with the treatment program. In many cases, with care, the splint has been used safely by athletes who return to athletics within a few days.

Beginning in March 1987, we treated a consecutive series of 23 patients without complication, with an average return to full activity of 3 days. There was only one recurrence and it responded successfully to repeat treatment.

A dental elastomeric impression material, Coltene President (Feldwiesenstrasse 20; CH-9450 Altstatten/Svizzera) putty, was used because it has a very high viscosity and can be obtained in various degrees of viscosity. The working time is approximately 5 to 6 minutes at normal body temperature. It is relatively inexpensive, keeps well under refrigeration, and is convenient to use. There is no significant exothermic reaction as it sets up.

The product is provided as a yellow base material and a white catalyst (Fig 1), and will keep virtually indefinitely when refrigerated. The materials are mixed in equal parts (Fig 2) and kneaded with the fingertips until the color is uniform (Fig 3).

Fig 1.—Yellow base material and white catalyst material

Fig 2.—Equal parts of each material

Fig 3.—Using the finger tips, the base and catalyst are mixed.

The material is approved for use in the mouth for making impressions of the teeth, and has been safely used in dentistry for many years (6). The time of contact with the mucous membranes is limited for making dental impressions. The time of skin contact for treatment of the wrestler's ear will be greater, but the ease of removal facilitates careful follow-up and inspection. We have noted no skin problems associated with its use, although there may be the possibility of a contact allergy.

Our technique begins with aspirating the hematoma with a small needle under sterile conditions. Then, compression is maintained with a sterile gauze over the area while the material is prepared. The elastomeric material is then molded onto the ear (Fig 4) forming an accurate impression (Fig 5), taking care to keep the external auditory canal open. After the material has set (5 to 6 minutes), it is removed and trimmed as necessary and then replaced in

Fig 4.—The material is molded onto the ear.

Fig 5.—The material forms an accurate impression.

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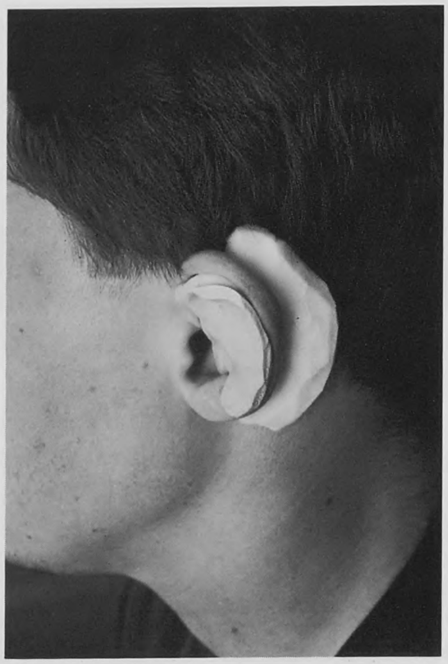

Fig 6.—The mold and padding

Fig 7.—The compression wrap

the ear. We place a pad of foam or cotton balls behind the auricle (Fig 6) and apply a compression wrap (Fig 7).

We instruct the patient to maintain compression for the next 5 days. After 24 hours we allow the patient to remove the pad briefly during bathing and shampooing. Within a few days of injury, the patient can return to wrestling activity with normal ear protection over the mold.

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Low Back

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NATA RESEARCH AND EDUCATION FOUNDATION
CALL FOR ABSTRACTS

1993 National Athletic Trainers' Association Annual Meeting • Kansas City, Missouri • June 1993
[Deadline for submission: January 15, 1993]

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

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

- **Basic Science** - includes controlled laboratory studies in the subdisciplines of exercise physiology, biomechanics, and motor behavior, among others, which relate to athletic training and sports medicine.
- **Clinical Studies** - includes assessment of the validity, reliability, and efficacy of clinical procedures, rehabilitation protocols, injury prevention programs, surgical techniques, and so on.
- **Educational Research** - a broad category ranging from basic surveys to detailed athletic training/sports medicine curricular development. An abstract in this category will generally include assessment of student learning, teaching effectiveness (didactic and clinical), educational materials, and curricular development.
- **Sports Injury Epidemiology** - includes studies of patterns of injury among athletes. These studies will generally encompass large-scale data collection and analysis. Surveys and questionnaires may be classified in this catagory, but are more likely to come under the Observational/Informational Studies category.
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NATA RESEARCH AND EDUCATION FOUNDATION
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Dr. Russell Cagle, ATC
NATA-REF Free Communications
Department of Athletics
Willamette University
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Abstracts

Clint Thompson, MS, ATC

Bednarczyk JH, Hershler C, Cooper DG. Development and clinical evaluation of a computerized limb volume measurement system (CLEMS). ***Arch Phys Med Rehabil.*** **1992;73:60-73.**

Edema of the limbs often is a problem in the rehabilitation of athletes. Edematous tissue is poorly oxygenated, heals slowly, and often becomes the site of infection. Treatments for edema have been poorly supported by research, because of the lack of a valid, reliable, noninvasive, and clinically useful measurement of fluid accumulation. Water displacement, regarded as the "gold standard" in volume measurement, is slow, difficult to use with some patients, and requires that the limb be maintained in a dependent position. The tape measure method relies on a model of the leg as a truncated cone and is difficult to place with tension evenly distributed on the edematous limb. The computerized limb volume measurement system (CLEMS) is a recently developed method to evaluate edema. Data streams, generated from a hand-held stylus and fed to the computer, are processed by the software (digitized and encoded). The graphics portion of the software generates a simulated image of the leg. The tracing process is rapid (less than 10 minutes) and can be done with the patient in any comfortable position. The volumes generated by CLEMS were compared to volumes determined by water displacement and by tape measurement. Measurements of five subjects with no known vascular disease were taken proximal to the fibular head. From these measurements, CLEMS appeared to be as accurate and reliable as the water displacement method. There was a low correlation between the tape measure method and both water displacement and CLEMS. This tool allows study of lower limb volume and can easily be used in the clinical setting.

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Hawes MR, Nachbauer W, Sovak D, Nigg BM. Footprint parameters as a measure of arch height. ***Foot & Ankle.*** **January 1992;13:22-26.**

The authors challenged the use of footprint measures to estimate arch height of the foot by measuring the arch height of 115 male subjects using a modified Mitutoyo digital caliper. The results were correlated with measurements of Clark's arch angle, the footprint index of Irwin, the arch index of Cavanagh and Rogers, the arch length index, and the truncated arch index. It was found that footprint parameters are invalid as a basis for prediction of categorization of arch height.

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Amendola A. Controversies in diagnosis and management of syndesmosis injuries of the ankle. ***Foot & Ankle.*** **January 1992;13:44-50.**

While the most common presentation of syndesmosis disruption occurs in conjunction with ankle fractures, the etiology and treatment of syndesmotic sprain, with and without diastasis, is addressed in this article. Biomechanical analysis of ankle stability as influenced by the deltoid ligament, the interosseous membrane, and the fibula is discussed. Fixation of syndesmosis injuries is considered, along with the necessity of removing the fixation prior to resuming normal activities. Radiographic examination involving mortise positioning concluded that the width of the clear space, on anterior-posterior (AP) and mortise views, was the most reliable parameter for detecting syndesmotic widening. Operative considerations, including type of fixation and a time frame for removing the fixation, also are discussed.

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Hall GL, Hetzler RK, Perrin D, Weltman A. Relationship of timed sit-up tests to isokinetic abdominal strength. ***Res Q Exerc Sport.*** **1992;63:80-84.**

One method commonly used in determining an individual's fitness level is the timed sit-up test. Sit-up tests are used because of the relationship between abdominal strength and the incidence of low back pain. Most of these tests use time as a factor to determine abdominal strength and endurance. However, the research in this area lacks the validation of timed sit-up tests and abdominal muscular strength. The purpose of this study was to test the validity of three timed sit-up tests to measures of isokinetic abdominal strength. The three sit-up tests used were the Krause-Weber (straight leg), the Robertson curl-up (crunch), and the AAHPERD (knees bent). The results showed that a poor relationship exists between isokinetic measures of abdominal strength and timed sit-up scores. Their data suggests that timed sit-up tests are not a valid measure for estimating abdominal strength. However, a major delimitation of this study is that the researchers compared isokinetic abdominal muscular strength to isotonic abdominal muscular endurance in the timed sit-up tests. Further investigation is needed in order to understand the relationship between timed sit-up tests and abdominal muscular strength and endurance.

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Staab JS, Agnew JW, Siconolfi SF. Metabolic and performance responses to uphill and downhill running in distance runners. ***Med Sci Sports Exerc.*** **1992;24:124-127.**

Distance runners often participate in races with courses that include hills. A common observation is that a runner's performance is slower on hilly courses than flat courses even when the start and finish lines are the same elevation (meaning the amount of uphill and downhill running is equal). Research has proven that the metabolic demands are higher for running uphill than for running downhill. However, the physiological mechanism that limits performance on hilly courses in unknown. The purpose of this study was to examine some of the physiological reasons for slower performances on hilly courses and how pace varies on uphills and downhills with energy expenditure. Eleven male distance runners ran three simulated races on a treadmill. The results of this study showed that running pace had an inverse relationship with hill grade percent, which is a physiological attempt to maintain a constant energy expenditure. On uphills, the runner's pace would slow, but their VO_2, HR, and blood lactate would increase. The average race pace was 2.6% slower on the hilly courses. Also, the large amounts of lactate accumulation on the uphills remained relatively high throughout the rest of the race, thus limiting the performance even though the uphill portion was completed. The authors concluded that slower performances on hilly courses was a result of the high energy expenditure on the uphills, which was not compensated for on the downhills.

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Graves JE, Pollock ML, Leggett SH, Carpenter DM, Fix CK, Fulton MN. Limited range of motion lumbar extension strength training. *Med Sci Sports Exerc.* 1992;24:128-133.

One of the most common complaints of the general population is low back pain (LBP). A causative factor of LBP is weakness of the trunk musculature. In addition, range of motion (ROM) often is limited by pain and joint stiffness. As a result, LBP patients often are prescribed progressive resistance exercises (PRE) even if ROM is limited. Previous research has indicated that strength gains are only made within the ROM that is worked. The purpose of this study was to determine if a limited ROM PRE lumbar extension program is beneficial to the development of strength through a full ROM. Thirty-three asymptomatic males with no history of LBP were established on various PRE programs for a 12-week training period. The results of this study led to the conclusion that lumbar extension strength increased throughout the entire ROM, even through training was limited to only part of the ROM. Strength increases were measured in the untrained ROM, indicating a carryover effect. These findings are significant because LBP patients who only are able to train through a limited ROM may still receive a full ROM training benefit.

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■

VanDuser BL, Raven PB. The effects of oral smokeless tobacco on the cardiorespiratory response to exercise. *Med Sci Sports Exerc.* 1992;24:389-395.

The use of oral smokeless tobacco (OST) has drastically increased in the past decade, and young male athletes have been the main target of the advertisers of these products. The largest active ingredient in OST is nicotine. Previous research has shown that nicotine increases heart rate (HR) and blood pressure in humans. The purpose of this study was to determine the effects that nicotine has on HR, oxygen uptake (VO_2), stroke volume (SV), and plasma lactate concentration (LC) at rest and during exercise. Fifteen males with a history of OST use took part. Results showed that VO_2 was not affected by OST use during rest or submaximal exercise. However, HR at rest and during exercise was significantly increased by OST usage when compared to the placebo. SV was reduced by OST usage at rest and during submaximal exercise, and LC was significantly increased during submaximal exercise. The LC increase indicates a greater demand for glycolytic energy production as a result of decreased muscle blood flow. This data means OST users begin an earlier onset of LC accumulation resulting in quicker fatigue and thus decreased performance. Also, because of the effect of nicotine on the heart, users of OST are at increased risk of a coronary insufficiency if they suffer from cardiovascular disease.

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■

Haynes SC, Perrin DH. Effect of a counterirritant on pain and restricted range of motion. *J Sport Rehab.* 1992;1:13-18.

A variety of therapeutic agents are used to relieve the pain and stiffness associated with injury to the musculoskeletal system. Counterirritants, often called sports balms or analgesic creams, are one popular form of treatment that have been used for decades. The U.S. Food and Drug Administration has classified counterirritants as Category 1 drugs. The purpose of this investigation was to examine the effects of a counterirritant on the pain and loss of motion associated with delayed onset muscle soreness (DOMS). Fourteen female subjects were recruited to participate in the study. Elbow extension was measured by one researcher using a standard goniometer. The intensity of perceived pain that was associated with DOMS was measured using a graphic pain rating scale. The subjects were asked to rate the pain they experienced while attempting to extend their arm. Repeated eccentric muscle contractions were used to induce DOMS. The subjects were randomly divided into two groups for application of 8 ml of ointment, either a counterirritant or placebo. The major finding was that a counterirritant treatment decreased the perceived pain and decreased the restriction in elbow extension range of motion associated with DOMS. These data suggest that counterirritants may have an important clinical role in the treatment of minor athletic injuries.

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■

Li JTC, Yunginger JW. Management of insect sting hypersensitivity. *Mayo Clinic Proc.* 1992; 67: 188-194

Virtually all physicians and most lay persons are aware that stings from bees, yellow jackets, hornets, and wasps can cause severe allergic reactions. Although most clinicians know that allergy tests and immunotherapy are available, some are unsure about who should be referred for assessment. The Hymenoptera order of insects consists of two superfamilies: (1) aphids—honeybees and bumble bees, and (2) vespids—yellow jackets, hornets, and wasps. The cross reaction between yellow jacket and hornet venoms is strong; the cross reaction between these species and bees or wasps is limited. Approximately 1.2% to 3% of the general adult population have reported a history of a systemic reaction. A detailed history is crucial for proper management of insect hypersensitivity. Urticarial reactions can be considered mild and systemic and are almost always accompanied by pruritus. Severe systemic reactions can include bronchoconstrictions, hypotension, and typical symptoms and signs of anaphylaxis. Clinical assessment of the severity of anaphylaxis, as well as the response to therapy, is important because patients who have experienced severe reactions also are likely to have severe reactions after stings. Skin tests to determine Hymenoptera venoms are safe and can be helpful in classifying the sting reaction. The purpose of using allergy testing for insect stings is to assess a patient for possible immunotherapy.

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■

Anderson MA, Rutt RA. Effects of counterforce bracing on forearm and wrist muscle function. *J Orthop Sports Phys Ther.* 1992;15:87-91.

Tennis elbow is believed to be an overuse injury of the extensor carpi radialis brevis, resulting in microscopic rupture and subsequent tendinous nonrepair with immature collagenous scar tissue. The purpose of this study was to evaluate the effects of two types of counterforce elbow braces on wrist and forearm muscle force. Seventeen subjects were recruited from local tennis clubs. The subjects had no current or recent history of lateral epicondylitis or other elbow, forearm, or wrist pathology on the dominant extremity. They were randomly tested three times wearing no brace, brace 1 (Pro Tennis Elbow Brace), or brace 2 (Aircast Tennis Elbow Brace). Wrist flexion/extension and forearm pronation/supination for maximum peak concentric and eccentric muscle force at 60°/second and 120°/second was performed on a KinCom isokinetic dynamometer. The authors concluded that neither type of counterforce elbow brace had any effect in the normal population on the ability of the wrist flexors/extensors or the forearm pronators/supinators to generate muscle force.

Gina Lorence
Pike Creek Sports Medicine Clinic
Wilmington, DE

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Mascaro T, Seaver BL, Swanson L. Prediction of skating speed with off-ice testing in professional hockey players. *J Orthop Sports Phys Ther.* 1992;15:92-98.

Ice hockey is considered an anaerobic sport that requires muscle strength, power, and anaerobic endurance. The authors' purpose for this study was to determine the best off-ice predictors of sprint skating speed in professional hockey players. Nine subjects participated—five forwards, three defensemen, and one goalie. All subjects were free of any acute lower extremity injury and were not involved in any concurrent athletic activity. Off-ice functional tests included the 40-yard dash, standing long jump, vertical jump, and isokinetic testing of the quadriceps and hamstrings at 60°/second and 180°/second. Skating speed was determined by a 54.9 meter sprint skate test. The authors noted a significant correlation with vertical jump, anaerobic power, and with several isokinetic tests. They concluded that, if available, the best predictor of skating speed is the isokinetic average power of the left quadriceps at 180°/second and average power of the right hamstrings at 60°/second.

Gina Lorence
Pike Creek Sports Medicine Center
Wilmington, DE

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Wilk KE, Arrigo CA, Andrews JR. Isokinetic testing of the shoulder abductors and adductors: windowed vs. nonwindowed data collection. *J Orthop Sports Phys Ther.* 1992;15:107-112.

Isokinetic testing is common in sports physical therapy clinics. As a subject moves the apparatus through range of motion, they reach an end stop of the preset range of motion, and a spike in the torque curve can be observed. The authors state that misinterpretations of the rebound torque spikes produced may result in torque data twice that of the actual torque generated, and thus gross misinterpretation of the test results. Fifty healthy professional baseball pitchers participated in isokinetic testing, for throwing and nonthrowing shoulders, on the Biodex at 180°/second and 300°/second. The authors found a significant difference between windowed and non-windowed mean peak torque data for both shoulders at both speeds. This article suggests utilization of windowing the isokinetic tests to eliminate end range torque spikes during shoulder abduction/adduction tests.

Gina Lorence
Pike Creek Sports Medicine Center
Wilmington, DE

New Products

Barrie Steele, MS, ATC

Total Gym Attachment—the Closed Chain Platform—is Introduced

Engineering Fitness International, makers of the closed kinetic chain exercise system, Total Gym, announces its newest attachment—the Closed Chain Platform. It is designed to allow the Biomechanical Ankle Platform System (BAPS) to be mounted to the Total Gym.

Therapists cite the advantages of combining the Total Gym and the BAPS:

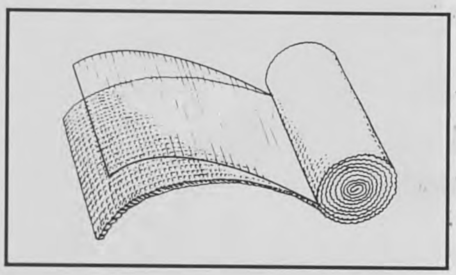
- Patients can train on the BAPS in an unloaded state allowing a weakened foot or ankle to perform normal motion without the stress of full body weight.
- Clinicians can objectively assess and progressively increase a patient's tolerance to weight-bearing activities using Total Gym's calibration scale based on percentages of body weight.
- Total Gym positioning allows varying degrees of knee flexion while performing the BAPS training. This simulates normal function and facilitates muscle stability at the knee.

Many foot, ankle, and knee conditions can be treated using the BAPS and Total Gym. The Total Gym closed kinetic chain exercise benefits the patient by facilitating muscle strength, coordination, and proprioception in a functional movement pattern. The BAPS trains a foot or ankle injury in the appropriate proportions of dorsiflexion, plantarflexion, inversion, and eversion. Specific conditions that can be treated by using the combination are ankle sprains, ankle/foot fractures post immobilization, status post foot surgery, gastrocnemius strain, Achilles' tendinitis, Achilles' rupture post repair, and knee conditions needing muscle stability and proprioception training.

The Total Gym Closed Chain Platform can be used without the BAPS and comes with a Toe Stand Bar attachment that allows gastrocnemius strengthening and stretching. The bar is adjustable, thereby controlling the degree of plantarflexion. The soleus muscle and talocrural joint capsule can be stretched by using the Toe Stand Bar with the knees flexed. The Closed Chain Platform can be used to perform lower extremity plyometric exercise.

It can be purchased by phone order through Engineering Fitness International at (800) 541-4900 or by writing 9225 Dowdy Drive, Suite 221, San Diego, CA 92126.

Gel-E-Rol Elastic Bandage is Designed for Heat Retention and Compression



Silipos® of Niagara Falls, NY, has introduced Gel-E-Rol. This elastic bandage with a patented gel impreganted into the elastic fibers, is formulated with United States Pharmaceutical Medical Grade Mineral Oil, which will diffuse onto the skin. This diffusion has several therapeutic effects, and the bandage can be used in conjunction with antibiotic ointments or an analgesic. It also will conform around bony prominences with a high degree of compression.

These wraps are designed for heat retention and compression. They are ideally suited for minor contusions and muscle strains.

A complimentary sample is available upon request from Silipos at 2045 Niagara Falls Boulevard, LPO Box 320, Niagara Falls, NY 14304, or call (800) 626-2612 in the United States, or (800) 345-5103 in Canada.

New Portable HV II SP Ultrasound and High Volt Simulator is User-Friendly

Rich-Mar has announced the new and improved HV II SP ultrasound and high volt stimulator. The established and proven HV II SP still has the reliable Rich-Mar electronics and quality that has made it a standard in the athletic training market. The improved HV II SP features a new control panel that is much easier to understand. It features user-friendly schematics for quicker setup.

The HV II SP stimulator features a smooth, comfortable high volt current with adjustable pulsed pair intervals from 5 to 255 microseconds for motor fibers and sensory fibers. It also has a pad balance that can regulate the pad intensity in continuous and/or alternate mode, plus a ramp feature in the alternate mode.

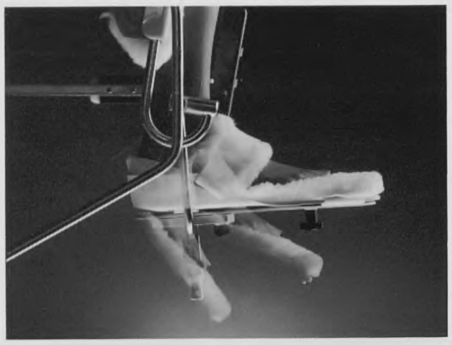
The HV II SP ultrasound has a 10cm^2 soundhead that is sealed for underwater treatment. Its lightweight ergonomic design fits the operator's hand for greater comfort. The ultrasound features six duty cycles for superficial tissue and bony prominence, plus a 100% setting for deep tissue.

The HV II SP is completely portable in its rugged, self-contained carrying case and weighs only 25 pounds. There also is an optional cabinet for office use.

The new styling and easier to use panel coupled with the proven reliability of the HV II SP make it the affordable, portable combination therapy modality.

For more information about the HV II SP, contact Rich-Mar Corporation at Box 879, Inola, OK 74036-0879, or call (800) 762-4665.

The JACE Ankle CPM System is Introduced



The JACE Continuous Passive Motion (CPM) System for the ankle has been designed to enhance patient therapy compliance while promoting maximum joint mobility—factors critical to preventing the negative effects of prolonged immobilization.

The device is lightweight and simple to operate and easily adjusts to a sitting or reclining position for maximum patient comfort.

Anatomical alignment is maintained because of its axis to axis orientation, and range of motion parameters are adjustable from 0-20° dorsiflexion and 0-40° plantar flexion.

For more information, contact Thera Kinetics, Inc at 1300 Route 73, Mount Laurel, NJ 08054, or call (609) 778-1166, or (800) 234-0900.

Rich-Mar Announces New Dual-Head Ultrasound

Rich-Mar announces the new, user-friendly 510 dual head ultrasound. The 510 has the unique options needed in ultrasound treatment. The 510 offers two different transducer sizes—5cm^2 and 10cm^2—for easier treatment of all patient areas.

The 510 features comfortable, ergonomically designed transducer heads that are smaller in size and weight for greater operator comfort. The Model 510 also features state-of-the-art internal digital electronics and six duty cycles that allow for the most flexible treatment of patients.

The new 510 also uses an Ultrasonic Active Diagnostic Indicator to assure proper ultrasound delivery to the patient. Its cradle select mechanism automatically determines which transducer is being used, saving valuable set-up time. The transducers are completely sealed for underwater treatments and have a two-year limited warranty, including crystals and cables. The 510 is another reliable quality product at an affordable price from Rich-Mar.

For information, contact Rich-Mar Corporation, Box 879, Inola, OK 74036-0879, or call (800) 762-4665.

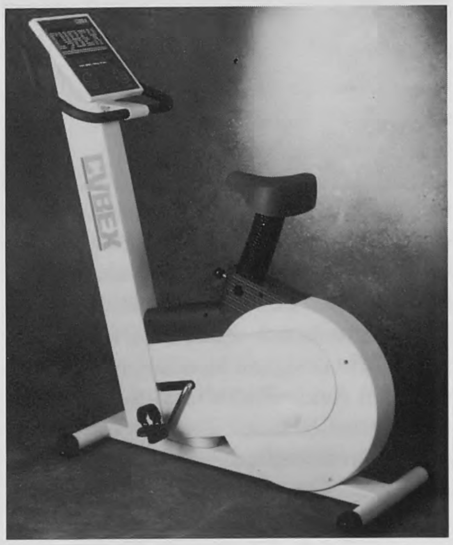
Durable Shoulder Pulley Introduced for Increasing Shoulder ROM

Pre Pak Products has introduced a new shoulder pulley. It features a stainless steel door mounting bracket that can be placed on the top or along the side of a door. Grip assistance is provided with a sliding loop handle, and rope length can be easily adjusted. Ranger 92 is an ideal device for increasing or maintaining shoulder range of motion.

This patented, self-lubricating pulley is extremely durable and provides a quiet, smooth, gliding action. An illustrated instruction booklet is included with each unit, and the company offers a money-back guarantee.

For more information, contact Pre Pak Products at 2227 Faraday Avenue, #D, Department NAT, Carlsbad, CA 92008, or call (800) 544-7257.

Cybex Introduces the Bike—a New Cycle Ergometer



Cybex, a division of Lumex, Inc, announces the release of a new cycle ergometer to complement its line of cardiovascular fitness products. The Bike is extremely user-friendly. You simply get on, select your exercise mode, and go. There are no complicated instructions to follow or adjustments to make that take away from valuable workout time.

The Bike is equipped with many useful features to make riding more enjoyable, yet tough enough to take the punishment of the most demanding user.

For more information, contact Cybex at 2100 Smithtown Avenue, P.O. Box 9003, Ronkonkoma, NY 11779-0903, or call (800) 645-5392.

▪ Video Review ▪

Tom Gocke, MS, ATC

Athletic Injuries of the Cervical Spine
Masters of Sports Medicine
Glaxo Video Library
Five Moore Drive
Research Triangle Park, NC 27709
Color, 1½" VHS
Playing Time: (Part I - 13½ minutes)
(Part II - 9½ minutes)
Price: Not available

Athletic Injuries of the Cervical Spine is a video program that concentrates on the initial evaluation and management of the athlete who has a cervical spine injury. Part I focuses on a mini-neurologic assessment, proper techniques for immobilization and transportation to a medical facility, and airway management and access via facemask removal. It provides an effective sequence for removal of football equipment at the hospital. In addition, the authors (Dr. Maroon, Dr. Bailes, and Fran Feld, ATC, EMTP) stress the importance of preplanning and teamwork in the approach and successful management of a football player with a cervical spine injury.

Part II addresses common cervical spine pathology, mechanisms of injury, prevention of cervical spine injuries, Brachial Plexus Stretch Syndrome, common X-ray findings associated with cervical spine injury, the value of magnetic resonance imaging (MRI) in the evaluation of individuals with cervical spine injuries who present with positive neurologic findings, and criteria for returning to competition following a cervical spine injury.

Athletic Injuries of the Cervical Spine provides valuable, accurate, and up-to-date information on managing an athlete with a cervical spine injury. While the sport of football is emphasized, it would be appropriate to apply these techniques to all sports. The ATC's involvement and the development of a team approach (ATC, EMT, and physician) in managing such an injured athlete is emphasized. The video is informative and would be a valuable tool for use in athletic training education programs.

Book Review

Phil Callicutt, EdD, ATC

The Comprehensive Manual of Taping and Wrapping Techniques
Kenneth E. Wright, DA, ATC, and
William R. Whitehill, MA, ATC
Cramer Products, Inc., Gardner, KS 66030
1991
120 pages, Illustrated
Price: $21.95

This manual was authored by Dr. Kenneth Wright and William Whitehall, of the University of Alabama, with the assistance of NATA Hall of Famers, "Doc" Dodson, Lindsy McLean, Buddy Taylor, and Chris Patrick; and other contributors Ken Murray, Tim Garl, Don Lowe, Bill McDonald, "Sang" Lyda, Alice McLaine, Lorraine Michel, Russ Miller, Hunter Smith, Ed Ryan, and Skip Vosler. These contributors bring their vast experiences into play and present taping and wrapping procedures that have been proven effective for many years. It was published by Cramer Products and Johnson & Johnson.

Sports medicine is an ever-changing body of knowledge with advances being developed and implemented on a daily basis. However, in the majority of cases concerning injuries to the musculoskeletal system, the athletic trainer will tape the injury. Taping has been a topic of discussion since the early publications of the profession, such as *Adhesive Plaster Bandaging in Athletics*, authored by O. Hichens Glimstead (the former athletic trainer at the University of Notre Dame) and published by Johnson & Johnson in 1924.

The authors of ***The Comprehensive Manual of Taping and Wrapping Techniques*** state that the manual was written in order to present a current comprehensive guide to taping and wrapping techniques that are traditionally used in the various professions of sports medicine. They recommend that you first read the entire procedure, and then return to the beginning of the explanation of the technique and apply the tape and/or wrap. This comprehensive manual has 300 quality photographs and illustrations to enhance the reader's understanding of the principles and concepts of taping and wrapping. The manual is divided into four comprehensive, easy-to-read chapters, each with an appendix. Chapter one addresses the preparation of the athlete for protective taping and wrapping; chapter two details the taping and wrapping techniques for the lower extremity; chapter three is a comprehensive explanation of taping and wrapping techniques for the torso; and chapter four highlights taping and wrapping techniques for the upper extremity.

This work should serve as an ideal self-study manual for athletic trainers and coaches, or as a supplementary text for a class that addresses the prevention and care of sports injuries at the secondary or collegiate level. It is complete, well-written, well-illustrated and is a superior product. ***The Comprehensive Manual of Taping and Wrapping Techniques*** will become a welcome addition to your collection of texts in the field of sports medicine.

A Color Atlas of Low Back Pain
Kenneth Mills, MD, Graham Page, MD, and
Richard Siwek, FRPS, AIMBI
F.A. Davis Company, Philadelphia, PA
1990
92 pages, Illustrated

One of the most controversial subjects in the field of medicine in general, and sports medicine in particular, is the cause and treatment of low back pain. Sports medicine professionals have gathered a potpourri of causes and treatment protocols. A wise physician once made this astute observation, "you can't cure low back pain, you just learn to manage it and live with the condition!" Volumes have been published on the subject, numerous seminars and symposiums have been conducted worldwide on the subject, and there still are a wide range of opinions on the subject.

A Color Atlas of Low Back Pain covers all aspects of this continuing medical "mystery." The text is divided into sections that cover different subjects. The first section details the causes of low back pain: spina bifida, scoliosis, spondylolisthesis, fractures, prolapsed intervertebral disc, aortic aneurysm, rectal carcinoma, spinal bone tumors, lumbar stenosis, and psychological aspects of back pain. The second section addresses history taking and provides the reader with a Disability Index Questionnaire. The third section is an extensive review and discussion about physical examination of the low back. This section is very interesting and includes familiar, as well as unfamiliar tests. The fourth section is entitled Investigations, and is a complete study of blood tests, radiographic investigations, discography, computerized axial tomography, nuclear magnetic resonance imaging, lumber puncture/lumber myelography, and lumbar puncture. This section becomes extremely technical in nature, but it is understandable and thought-provoking. The fourth section is devoted to the concepts of conservative treatment: home remedies, physiotherapy, extra splintage for low back pain, leg traction, and manipulations. The fifth and final section is a brief overview of surgery and includes discussion of chemonucleolysis, structural causes, neurological causes, and visceral causes.

This text is comprehensive in addressing the topic of low back pain, and the photographs are detailed and of good quality. This text may not give you all the answers to this condition or injury area, but it will provide a great deal of useful information.

Authors' Guide

(Revised February 1992)

The *Journal of Athletic Training* welcomes the submission of manuscripts that are of interest to persons engaged in or concerned with the progress of the athletic training profession (athletic injury prevention, evaluation, management, and rehabilitation; administration of athletic training facilities and programs; and counseling and educating athletes concerning health care). Manuscripts should conform to the following:

SUBMISSION POLICIES

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 with all statements. Manuscripts that are not accompanied by such a letter will not be reviewed. "This manuscript contains original unpublished material that has been submitted solely to the *Journal of Athletic Training*, is not under simultaneous review by any other publication, and will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the *Journal of Athletic Training*. In consideration of the NATA's taking action in reviewing and editing my (our) submission, the author(s) undersigned hereby transfers, assigns, or otherwise conveys all copyright ownership to the NATA, in the event that such work is published by the NATA."
3. Materials taken from other sources, including text, illustrations, or tables, must be accompanied by a written statement giving the *Journal of Athletic Training* permission to reproduce the material. Photographs of individuals must be accompanied by a signed photograph release form. Accepted manuscripts become the property of the National Athletic Trainers' Association, Inc.
4. The *Journal of Athletic Training* uses a double blind review process. Authors should not be 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 aid the author in presenting work that is compatible with the style policies found in the *AMA Manual of Style*, 8th ed. (Williams & Wilkins) 1989. 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. The active voice is 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.
8. Each page must be typewritten on one side of 8 ½ x 11 inch plain paper, double spaced, with one-inch margins. **Do not right justify pages.**
9. 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
10. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.
11. 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.
12. 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.
13. 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.
14. List three to six key words or phrases that can be used in a subject index to refer to your paper. These should be on the same page as, and following, your abstract. For **tips from the field**, the key words should follow immediately after the title on the first numbered page.
15. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the 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.
16. 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 that 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 the *Journal of Athletic Training* receive, with the 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.
17. 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.
18. Citations in the text of the manuscript take the form of a number in parentheses, 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.
19. The Reference page(s) accompanying a manuscript should list authors numerically and in alphabetical order, and should be in the following form: a) articles: author(s) (list all) with the family names then initials, title of article, journal title with abbreviations as per *Index Medicus* (underlined), month (if journal is not consecutively paged throughout the volume), year, volume, inclusive pages; b) books: author(s), title of book (underlined), city and state of publication, publisher, year, inclusive pages of citation. Examples of references to a journal, book, and presentation at a meeting are shown below. See the *AMA Manual of Style* for others.
   a. Knight K. Tips for scientific/medical writers. *Athletic Training, JNATA*. 1990; 25:47-50.
   b. Day RA. *How to Write and Publish a Scientific Paper*. 3rd ed. Phoenix, Ariz: Oryx Press; 1988: 54-55.
   c. Albohm M. Common injuries in women's volleyball. In: Scriber K, Burke EJ, eds. *Relevant Topics in Athletic Training*. Ithaca, NY: Mouvement Publications; 1978: 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; June 15, 1978; Las Vegas, Nev.
20. Tables must be typed. See references cited in #5 or #19a for table formatting. Type legends to illustrations on a separate page.
21. Photographs should be glossy black and white prints. Do not: use paper clips, write on photos, or attach photos to sheets of paper. Carefully attach a write-on label to the back of each photograph so that the photograph is not damaged.
22. 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. All artwork to be reproduced should be submitted as camera-ready black and white line art. If it is to be reproduced in black plus a second (or more) color, submit it as black and white line art. Clearly mark each area of color, shading, or screening (a percent or tint of black or a color), on a separate photocopy. The author will pay all costs for color reproduction.

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This brochure provides an introduction to athletic training and the NATA. A brief overview of the NATA is given, as well as an explanation of the job responsibilities of an athletic trainer and the way to become an ATC.

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Targeted toward secondary school settings, this brochure explains the job responsibilities of athletic trainers and the important role that they play in high school athletics. It also explains to employers how to hire an ATC.

NATA Job Referral Service (Brochure)
This brochure explains how to use the NATA Job Hotline, Bulletin Board, and Job Referral List. It also explains to employers how to list a job opening.

Athletic Trainers: Treating Athletes Better (Video)
Eleven minutes in length, this video (VHS format only) gives an in-depth explanation of the role that an athletic trainer plays in the health care system. The six domains are explained, as well as the educational requirements needed to become an ATC.

HOW TO ORDER
To order any of the NATA brochures or the video, please complete the Request Form, include the appropriate payment, if any, and mail to the address indicated.

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Any order of less than 50 brochures is free of charge. Orders for more than 50 brochures will be charged $5.00 for shipping and handling for each set of 50 brochures. (See the Request Form for examples.)

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VIDEO

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NATA

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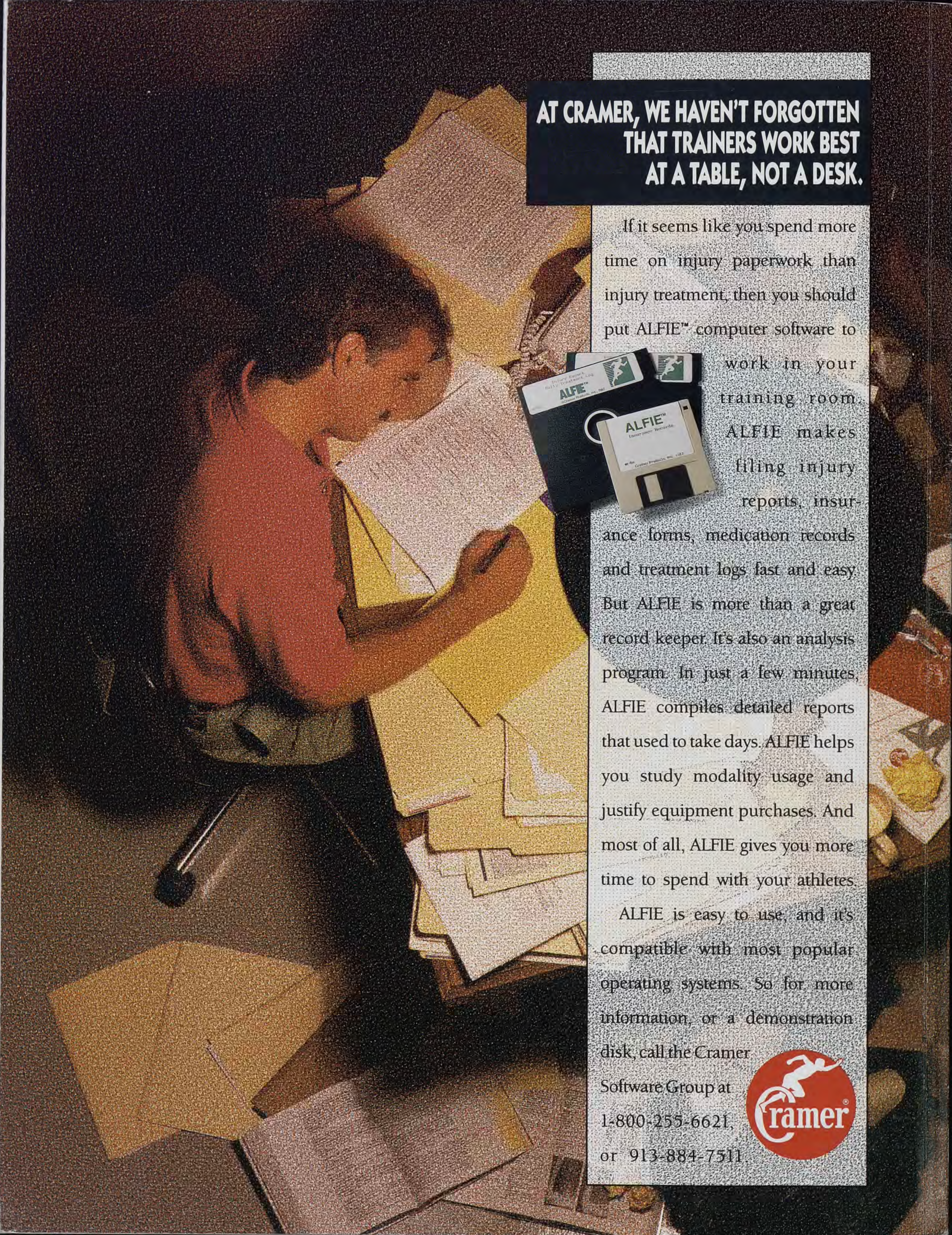
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