JOURNAL OF ATHLETIC TRAINING

Official Publication of The National Athletic Trainers' Association

NATA

VOLUME 28

NUMBER 3

FALL 1993

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JOURNAL OF ATHLETIC TRAINING

Official Publication of
The National Athletic Trainers' Association

Volume 28, Number 3, Fall

The *Journal of Athletic Training* (ISSN 1062-6050) is published quarterly ($32 for one-year subscription, $40 foreign) by the National Athletic Trainers' Association, Inc., 2952 Stemmons Freeway, Dallas, TX 75247. Second-class postage paid at Dallas, TX, and at additional mailing offices. POSTMASTER: Send address changes to: *Journal of Athletic Training* c/o NATA, 2952 Stemmons Freeway, Dallas, TX 75247. CHANGE OF ADDRESS: Request for address change must be received 30 days prior to date of issue with which it is to take effect. Duplicate copies cannot be sent to replce those undelivered as a result of failure to send advance notice. ADVERTISING: Although advertising is screened, acceptance of the advertisement does not imply NATA endorsement of the product of the views expressed. Rates available upon request. The views and opinions in the *Journal of Athletic Training* are those of the authors and are not necessarily of the National Athletic Trainers' Association, Inc. Printed by United Litho 2818 Fallfax, Falls Church, VA 22042. Produced by Graphic Concepts, 1801 Rockville Pike #330, Rockville, MD 20852. Printed in U.S.A.

door neighbor was robbed. In an effort to catch the guilty party, the police search every house in your neighborhood, including yours, for the stolen property. You protest because they have no reason to suspect you or search your home. But the police cite research showing 65% of burglaries are committed by a person who lives within a 2-mile radius of the burglarized home. They also tell you, "If you didn't do it, then you should have nothing to hide." Should you let them in? They do, after all, have the right intentions. Fortunately, our society is not supposed to work this way.

The point is that villains come in all forms. Anyone can recognize the villain dressed in black, with the cape, who twirls his handlebar mustache. It's the villain who is disguised that is the most difficult to recognize and therefore most dangerous. And drug testing is a villain with the best disguise of all...good intentions.

At some point, athletes have to be responsible for making their own choices and decisions. Athletics seems to have the habit of making the choices for the athlete. Drug testing will do nothing for athletes when their eligibility is up. Without the NCAA to force feed them a decision, what choice will they make? I don't have a better solution. But the most correct solution (although far from perfect) is to educate athletes. Provide them with information and allow them the opportunity of an informed decision. Perhaps the efforts of Dr. Kay Stoll in "ethical decision-making" would aid the problem. The ultimate goal is ethical decision-making for life, which is what athletics traditionally has NOT taught its participants.

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TEAM PHYSICIANS

I would like to compliment Brent S.E. Rich, MD, ATC, for his article "All Physicians Are Not Created Equal" (*JAT*, 1993;28:177-179). I was delighted to find out that there is another "MD/ATC."

It has long been a pet peeve of mine that it seemed like every physician turned out, particularly in my field of orthopaedics, is marketing him/herself as a "sports medicine specialist." The sad fact is that during this explosion of sports medicine specialists, the availability of medical care for the high school athlete has remained unchanged. It makes me concerned that all too many of these practitioners may be using the title merely as a marketing device to attract the young, healthy, weekend athlete who most often has excellent insurance coverage or maybe is more well off than the run-of-the-mill patient panel that this practitioner would otherwise see, ie, "skimming the cream" while unburdening themselves of the run-of-the-mill medical problems of the common man that his colleagues have to deal with regularly. The other "abuse" which perturbs me is the use of this title by a physician or other health care practitioner to ally himself with a local high school or small college team to be associated with their glory and notoriety, again to display himself before the community. However, the most distressing part of this charade relates to the very heart of Dr. Rich's article. This is the fact that anyone can label himself as a "sports specialist" without any more than the basic education, and this education need not even be a medical education as evidenced by the number of "therapists" who advertise themselves as sports specialists and who may not have had any more than a couple weeks' course in massage therapy. For the athletic trainer, who is taking care of the "unimportant" high school athlete or small college athlete on a day-to-day basis and has to rely on his medical background to provide complete and proper care for his athletes while making a fraction of what these "specialists" make, it is vital that he/she align him/herself with competent and qualified medical professionals. As such, I feel it is vital that athletic trainers have an extensive understanding of what does and does not make a qualified and competent "sports medicine specialist."

Dr. Rich goes on to quite appropriately point out, that to many people, orthopaedic surgery and sports medicine were often interchangeable, and that there was no other sports medicine specialties besides orthopaedics. He makes a very strong point for the primary care or family practice sports medicine specialist. I am afraid that people reading Dr. Rich's article could potentially view it as a "sour grapes" ranting and raving against the more highly paid and more "glamorous" specialists. Speaking as a board-certified orthopaedic surgeon, I would like to express my unequivocal and wholehearted support of Dr. Rich's stand. I personally believe that at the high school and small college level and indeed at the recreational athletic level, the majority of the medical questions, complaints, problems, and injuries are probably best handled by a sports medicine specialist who has more of a comprehensive general medical family practice type of background than a subspecialty trained orthopaedic surgeon who would not know exercise-induced asthma from a run-of-the-mill pneumonia. I feel this is particularly true when one looks at the training that is usually involved in the sports medicine fellowships for orthopaedists.

As a Certified Athletic Trainer, with coaching experience in football, basketball, and track at various high school and collegiate levels, it seemed natural for me to pursue a sports medicine fellowship after the completion of my residency in orthopaedic surgery. At that time, in 1989, as I am sure it still is at this time, the fellowship program was to a great extent learning different ways to spell ACL or doing extensive bench work looking at the strength and functional effect of an obscure strand of collagen in some incomprehensible Xenograft as a possible replacement for the anterior cruciate ligament in humans as it was being tested in a rabbit model. While education and experience in these areas are absolutely vital to advance the knowledge of the orthopaedic management of sports injuries, it is totally useless to the practitioner who is looking at providing orthopaedic care at the community level. It has long been my opinion that a fellowship in sports medicine for the orthopaedic surgeon looking to become involved in a nonacademic practice (especially for a primary care physician) should include not only the diagnosis and management of

musculoskeletal injuries, but also a good understanding of nutrition and diet, a good basic understanding of exercise physiology pertaining to conditioning and training of the healthy athlete, as well as reconditioning of the injured athlete, a good basic understanding of physical therapy modalities, and a good understanding of the general medical, ie, cardiopulmonary, dermatology, etc aspects of sports medicine.

I would like to wholeheartedly recommend this reading to all athletic trainers, particularly those involved in the high school and small college levels. I would like to lend my personal support to the ideas and recommendations Dr. Rich has brought forth in his article and wish him well in his entry into the field of sports medicine as a primary care physician. I am elated to welcome another ATC into the ranks of the MDs (and DOs).

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MD/ATC

I read with interest a recent letter (*JAT* 1993:28:5-6) that Harold J. Einsig, MD, ATC, had not heard of many physicians who were also Certified Athletic Trainers.

I have been certified by the NATA since 1983 and pursued a graduate degree in exercise physiology before receiving my Doctor of Osteopathy degree from the Chicago College of Osteopathic Medicine in 1988. I am still a certified member of the NATA, a licensed Registered Athletic Trainer in Illinois, and a member of the California Athletic Trainers' Association. I am also on the California Athletic Trainers' Association Clinical and Industrial Medicine Committee. I have maintained my registration status and membership because I am involved in the ongoing teaching process of athletic trainers, in my office and in the high schools and colleges where I am an attending team physician.

Dr. Einsig brings up a very good point, in that the path to certification as an athletic trainer is a natural path to primary care sports medicine, which I presently practice. It also blends the relationship of physician and athletic trainer, and, because of my background, I am more comfortable with the athletic trainers with whom I work because I know of their training background and level of expertise. As such, I still participate as a proctor in the national certifying examination process.

In summary, as more physicians are exposed to the training and background of Certified Athletic Trainers, they will feel more comfortable with, rely more upon, and realize the importance of their skills and expertise in the clinic and training room and on the sidelines.

I would welcome any comments or questions from NATA members who are interested in blending an osteopathic physician's musculoskeletal expertise with an athletic training background.

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THE CERTIFIED ATHLETIC TRAINER AS CLINICAL INSTRUCTOR

The responsibilities of the certified athletic trainer as clinical instructor are increasing dramatically. Certainly, the Committee on Health Education Accreditation guidelines for athletic training education programs require a great deal of accountability in this area. Unfortunately, time spent in the training room does not ensure that students acquire clinical skills. More often than not, these experiences are somewhat random; two students may not share similar experiences. Moreover, merely passing the oral/practical portion of the national certification exam in athletic training is not sufficient evidence that student athletic trainers have learned the comprehensive skills of the profession. Continuing education demands of clinical instructors, particularly in the areas of new technologies and therapeutic techniques, add to the burden of effective and up-to-date clinical instruction for students. To further complicate the matter, learning these new skills requires an increased time commitment from clinical instructors. Conventional didactic presentations do not lend themselves to learning the practical application of new skills. Rather, more intensive, hands-on, time-consuming short-courses or workshops are necessary.

The upgraded responsibility demands a close scrutiny of clinical instruction. Quality instruction does not just happen; it requires discipline, attention, and evaluation. One common approach to regular assessment of clinical instructors is through student athletic trainer evaluation. A brief questionnaire can be developed for this purpose. However, as is frequently done during evaluation of didactic instruction in the classroom, a peer evaluation should also be considered. In an ideal situation, another certified athletic trainer could observe the clinical instruction of a student trainer, perhaps seeing strengths and weaknesses and suggestions for improvement not identified by students. To give this evaluation more punch, perhaps job descriptions under which athletic trainers are hired can include their role as clinical instructor. In addition, performance evaluations completed by administrators would include clinical instructor effectiveness. With increased emphasis in this area, clinical instructors will have both the incentive and recognition to excel. Ideally, outstanding performance as a clinical instructor could be rewarded with a merit salary raise. A professional preparation program which does not formally recognize the vital contribution of clinical instruction may be risking complacency in this area. Perhaps all certified athletic trainers who provide clinical instruction should be recognized as adjunct professors in the athletic training major or professional preparation program.

No body of information exists regarding quality clinical instruction in athletic training. Hence, clinical instructors are concernedabout how to best instruct and evaluate students' clinical skills. Research is critical in this area in order to shape our understanding of how to proceed. Perhaps a thoughtfully considered philosophy directing the clinical instruction process would be helpful in the meantime.

Clinical instruction of athletic trainers must be emphasized, and formal recognition of the certified athletic trainer's role in this process is critical. However, the clinical instructor's methods and teaching effectiveness require significantly more attention in the future.

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POSITION STAND ON LIGHTNING AND THUNDER

A brief article, "Death in 15 Seconds," by JA Moyer appeared in the *NATA News* in March of 1993. I feel that this article has misleading information in it. My response to it will appear in the *NATA News*.

Our research of this topic revealed a lack of any other information about lightning in the athletic training literature. As a result, our school district has developed a position statement on thunder and lightning, which I would like to share with journal readers, who may want to adopt a similar position. Should the NATA adopt a position on this issue?

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Position Statement on Thunder & Lightning

Research indicates that lightning is the number two cause of death by weather phenomena, accounting for 110 deaths per year. The Athletic Health Care Services of the District of Columbia Public Schools maintains the following position on thunder and lightning:

- If thunder and/or lightning can be heard and/or seen, stop activity and seek protective shelter immediately.
- In situations where thunder and/or lightning may or may not be present yet you feel your hair stand on

end and skin tingle, immediately assume the following crouched position: drop to your knees, place your hands/arms on your legs, and lower your head. Do not lie flat.
- In the event that either situation should occur, allow 30 minutes to pass after the last sound of thunder and/or lightning strike prior to resuming play.

The National Weather service has stated that lightning can strike up to a distance of 10 miles, with storms traveling at a speed exceeding 50 miles per hour. However, thunder can be heard only within a distance of 8 miles. Therefore, if you hear thunder and/or see lightning, you are in immediate danger and should seek protective shelter in an indoor facility at once! An indoor facility is recommended as the safest protective shelter. However, if an indoor facility is not available, an automobile is a relatively safe alternative. If neither of these are available, the following guidelines are recommended. Avoid standing under large trees and telephone poles. If the only alternative is a tree, choose a small tree in a wooded area that is not on a hill. As a last alternative, find a ravine or valley. In all instances outdoors, assume the aforementioned crouched position. Avoid standing water and metal objects at all times (ie, steering wheel, metal bleachers, metal cleats, umbrellas, etc.).

The most dangerous storms give little or no warning; thunder and lightning are not heard or seen. Up to 40% of all lightning is not accompanied by thunder, and 20-40% of thunder cannot be heard because of atmospheric disturbances, thus the term "silent killer." At times, the only natural forewarning that might precede a strike is feeling your hair stand on end and skin tingle. At this point, you are in imminent danger of being struck by lightning and should drop to the ground and assume the aforementioned crouched position immediately. Do not lie flat. Should a ground strike occur near you, lying flat increases the body's surface area that is exposed to the current traveling through the ground.

The National Weather Service recommends that 30 minutes should pass after the last sound of thunder is heard and/or lightning strike is seen before resuming play. This is sufficient time to allow the storm to pass and move out of lightning strike range.

A perilous misconception that it is possible to see lightning coming and have time to act before it strikes could prove to be fatal. In reality, the lightning that we see flashing is actually the return stroke flashing upward from the ground to the cloud, not downward. When you see the lightning strike, it already has hit. It is a fact that you will never see the bolt that hits you. If used immediately, the information provided can be used to minimize the risk of injury or death from lightning.

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Management Of The Critically Injured Football Player

Francis Feld, MEd, ATC, NREMT-P

Abstract: *Evaluation and treatment of a football player who has sustained life-threatening injuries is a rare but significant challenge for the sports medicine team. Early recognition and intervention in these injuries is crucial. Helmets and shoulder pads complicate management of these patients. In this article, I present a rapid and simple assessment method used by paramedics for trauma patients. Treatment focuses on when football equipment should be removed and how the equipment complicates Advanced Life Support measures. A strong, working relationship with Emergency Medical Services is encouraged.*

During my career as an athletic trainer and paramedic, I have found myself on both sides of the debate over removing football equipment. Athletic trainers traditionally have been taught to never remove the equipment, while Emergency Medical Services (EMS) personnel have been taught to always remove equipment. I do not believe that either argument is correct; nor do I believe that either argument is wrong. A recent article in the *Journal of Athletic Training* questioned the proper method of gaining access to a player's airway.[17] These comments are appropriate and allow athletic trainers to examine their procedures and preparedness for dealing with these types of injuries. However, this recent examination of emergency treatment procedures was limited to face-mask removal. In this article, I examine the total picture of managing a critically injured player, with emphasis on a means of rapidly assessing the player and how football equipment complicates management.

I shall define critically injured as "experiencing respiratory distress, loss of consciousness, or sudden cardiac arrest." Cervical spine injury is assumed in all cases. The issue before us is: when to remove the equipment. We must assess the player in order to determine the extent of his injuries, and we must treat those injuries. The helmet and shoulder pads must be removed at some point.

It is my belief that the helmet and shoulder pads should be removed on the field if and only if the player presents with critical injuries as defined. An examination of the pathophysiology of these injuries is necessary before we can examine a method of assessment.

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Pathophysiology

The mechanism which causes an athlete to present as a critically injured patient is varied. Respiratory distress may be caused by foreign-body obstruction, closed-head injury, high cervical-spine injury, pneumothorax, or underlying medical problems, such as asthma or anaphylaxis. Loss of consciousness is usually related to head injuries, but could be caused by hypoglycemia, drug overdose, hyperthermia, or stroke. Sudden cardiac arrest is usually secondary to an ischemic event, but may be caused by anoxia, neurologic insult, metabolic disturbances, or a combination.[18] While this list is not all-inclusive, it does include most of the major possibilities. Many of these causes do not apply to a young, healthy athlete. Regardless of the cause, the possibility of any critically injured athlete's condition degenerating into cardiac arrest is the worst possible scenario. The exact mechanism is varied, but is usually related to anoxia.[18] Anoxia alters the cardiac conduction system and allows ventricular escape beats to occur; decreased stroke volume and hypotension result. Perfusion of the myocardium is reduced, and ischemia occurs. Catecholamine release further lowers the threshold for ventricular ectopy, and ventricular fibrillation or asystole are the usual end result. The vast majority of cases will present with ventricular fibrillation.[18] Successful resuscitation is directly related to the time from onset of ventricular fibrillation to defibrillation.[1,5]

Neurologic causes of cardiac arrest can be of two types: 1) The cervical spine injury occurring above the C-4 level will affect the phrenic nerve and result in decreased respiratory effort from loss of diaphragm function[8]; or 2) Cardiac arrest may be immediate in the case of a C-1 fracture-dislocation, or may occur much later with lesions in the region of C-4.[10] Expanding intracranial lesions will result in hypertension and bradycardia.[4] Assume that all patients with severe head injuries have cervical spine injuries until proven otherwise.[3,4,6,7,9,15]

The constant theme throughout is to quickly identify anoxia and intervene in order to properly ventilate the patient. Preventing an unstable condition from degenerating into cardiac arrest is the goal.

Assessment

Assessment of all injured athletes begins with ABCs. This assessment has been expanded and can be considered as ABCDEs.[14]

Airway and Cervical Spine. Assess the athlete to determine airway patency.

Stabilize the cervical spine simultaneously. Keeping the cervical spine in an in-line neutral position is required throughout evaluation and management. Removal of the mouthpiece is a high priority. If the airway is not patent, immediate steps to ensure patency, such as a jaw-thrust maneuver, must be performed. Consider inserting an oral airway if a gag reflex is absent.

Breathing. Breathing should be spontaneous and of adequate depth and rate to maintain proper ventilation. A rate of less than 10 or greater than 30 breaths per minute calls for assisted ventilation. Lung sounds should be auscultated (evaluated with a stethoscope) by a qualified person as soon as possible.

Circulation. Determine pulse rate and quality. An initial rapid pulse rate is most likely a normal variant in athletes. Repeated assessments of the rate are indicated to determine how quickly it returns to normal. Absence of a radial pulse indicates that the patient has decompensated and is in serious difficulty. Assess capillary refill and skin temperature, also, to provide an indication of tissue perfusion. Bleeding should be identified and controlled if it is extensive. Blood pressure can be estimated by pulse measurement. If there is a carotid pulse, the systolic pressure is above 60. If the femoral pulse is present, the systolic pressure is between 70 and 80. If the radial pulse is present, the systolic pressure is above 90.[4] At some point, blood pressure should be auscultated. This may occur during transport to the hospital.

Disability. Measure the level of consciousness in terms of the athlete's response to verbal or painful stimuli. Examine pupils for size, equality, reaction, and accommodation to light. Also, determine movement and strength in the extremities.

Expose and Examine. Examination of the chest and abdomen necessitates the removal of some clothing and equipment. Complete removal of the shoulder pads may not be necessary, based upon clinical findings. However, any athlete complaining of chest pain or dyspnea needs to have his chest exposed in order to assess lung sounds, as previously mentioned, and needs to be placed on cardiac monitoring as described later in this article. Cold weather must be considered when exposing large portions of the body, and measures to protect against hypothermia should be taken. Modesty may be considered, but, under no circumstances should it limit the examination.

This assessment can be accomplished in less than 30 seconds by trained personnel. Indeed, many of these steps can be conducted simultaneously, and an experienced team approach will allow completion of the assessment within seconds. Any positive findings detected during this examination should be corrected immediately. Results of this assessment determine how the player is managed.

Trauma triage guidelines vary by locality. The guideline for the 11-county region surrounding Pittsburgh considers spine injuries alone as meeting the criteria for transport to a Level I Trauma Center (Emergency Medical Services Institute, unpublished document, 1988). The Champion Trauma Score is a more universal scoring system and does not consider spine injuries in the absence of decreased level of consciousness, hypotension, or dyspnea to indicate transport to a trauma center.[14] In either case, the decision of how to remove the athlete from the field must be made quickly by the sports medicine staff.

Management

The management of critically injured football players must be a team approach, involving the athletic trainer, the team physician, and EMS. Treatment consists of airway management, oxygen administration, cervical spine immobilization, intravenous access, and cardiac monitoring with defibrillation and drug therapy in the event of cardiac arrest. Of these treatments, football equipment complicates airway management, cardiac monitoring, and defibrillation. Let us examine these in more detail.

The face mask does not hinder evaluation of the airway, but it does hinder treatment. Assisting respiration with a bag-valve mask and an oral or nasal airway is the initial treatment of choice, if ventilation is inadequate. Endotracheal intubation is the definitive measure for airway control.[4,14] This can be accomplished via the nasal or oral route. Both procedures have limitations and are not without controversy[9,15]; however, these topics are beyond the scope of this article. Removing the face mask is necessary to conduct any of these measures efficiently. Putman[17] suggested different ways of face-mask removal and raised concern about speed and efficiency in performing this procedure. Letters to the editor in subsequent editions of the *Journal of Athletic Training* added to this concern and offered other alternatives.[12]

Cardiac monitoring of these patients is necessary and requires access to the chest. Electrodes are applied to the right and left clavicular regions and to the left side of the chest in the midaxillary line below the nipple. Cutting the jersey, shoulder pad strings and straps, and any shirt worn under the pads will be necessary. The skin should be dry.

Defibrillation of a football player is more complicated. The chest must be completely exposed and dry in order to ensure operator safety. Place paddles below the right clavicle and over the apex of the heart (Fig 1). This cannot be done safely with the shoulder pads in place. Sweat-soaked pads could conduct current and result in arcing of the charge, resulting in ineffective delivery of countershock, burns to the patient, or accidental defibrillation of the operator. Personnel could now be faced with two patients instead of one. Shoulder pads must be removed before defibrillation.

This leaves the athletic trainer with a dilemma. Equipment must be removed in order to treat the athlete in cardiac arrest or the unstable athlete who may arrest at any moment. This is done in the face of a cervical spine injury. All tasks must be accomplished quickly; however, I have found no literature dealing with this situation. Helmet removal has been treated on an "as needed" basis, but only O'Donoghue mentions defibrillation. Further, only Arnheim notes to remove the shoulder pads to perform CPR.[2,3,6,7,11,16,19]

In the case of a football player in cardiac arrest or a player with injuries that increase the chances of cardiac arrest, I propose that the helmet and shoul-


DUE TO CIRCUMSTANCES DEFINITELY WITHIN OUR
CONTROL, THIS PERFORMANCE HAS BEEN CANCELLED.

der pads be removed, while keeping the cervical spine in an in-line neutral position. This procedure is not as difficult as it may sound and can be conducted quickly, if practiced. I must emphasize that this does not apply to players with cervical spine injuries without respiratory or cardiac involvement. Those athletes may be immobilized effectively with all equipment in place, and face mask removal is not always necessary.

If the helmet is removed without removing the shoulder pads, the cervical spine will be placed in an extended position because the shoulder pads lift the thorax. This position defeats the purpose of in-line neutral stabilization, which is essential. Removing equipment is an all-or-none proposition.[7]

We suggest the following procedure for removing the equipment. The person at the head holds the athlete's head in an in-line neutral position. The second person removes the mouthpiece. The jersey, shoulder pad strings and straps, and chin strap are cut. The jaw pads are removed by a gentle twisting motion which unsnaps them. The second person slides one hand up the cervical spine until as much of the hand as possible is on the occiput and places the other hand beneath the mandible. This person now controls cervical spine stabilization. The person at the head spreads the helmet at the ear holes and removes the helmet. A slight forward rotation of the helmet may be necessary in order to clear the occiput. Excess forward rotation may cause the face mask to become caught on the nose.

Two additional people slide their hands between the scapula and posterior shoulder pad plate from each side. At the command of the person holding the head, all three people lift the thorax and head as a unit. The person who was originally holding the helmet removes the shoulder pads. The athlete is now lowered to the ground as a unit, and cervical spine stabilization can be resumed by the person who removed the shoulder pads. It is important to emphasize that the athlete's head and thorax need to be lifted less than an inch in order for the pads to be removed. Practice is necessary in order to perform this procedure easily and quickly (Figs 2 & 3).

Fig 1.—Proper defibrillator paddle placement.

EMS Interaction

Efficient interaction between EMS and athletic trainers is essential if athletes with critical injuries are to be managed properly. While EMS personnel may be on hand for games, they most likely are not immediately available during practices. Athletic trainers must have a means of activating EMS immediately. The trainer must have the necessary equipment and training to initiate emergency treatment. A close, working relationship between the athletic trainer and EMS will ensure that the athlete is treated properly.

All athletic trainers must learn the capabilities of their local EMS agency. Not all EMS agencies are capable of delivering advanced life support measures, such as defibrillation, intravenous access, and intubation. Indeed, 911 service is not available everywhere in the United States.

Fig 2.—With the head stabilized, prepare to lift the torso maintaining cervical spine alignment.

Fig 3.—Lift the player as a unit and remove the shoulder pads.

A close, working relationship with EMS has been mentioned several times. The athletic trainer can conduct educational sessions for EMS on sports injuries. If the EMS agency is a volunteer organization, the athletic trainer may choose to join the agency and gain emergency medical technician or paramedic certification. Inviting the members of EMS to observe summer football camp will allow them to understand the nature of athletic training. The athletic trainer might consider observing emergency calls with the EMS agency to understand the nature of EMS. Any or all of these methods can be used to promote a strong and positive relationship. Athletic trainers should explore these methods and see which would be best for them. Other ways of promoting this relationship might be found.

If your local EMS agency does not provide advanced life support, you may want to consider obtaining an automatic external defibrillator. These devices have gained wide popularity recently, with the evidence of increased success of rapid defibrillation.[5] Lay persons have been trained to use these devices safely.[13] You must consider the cost of the device and state laws, but the value of early defibrillation cannot be minimized.

Planning

Fortunately, critical injuries do not occur commonly in football. Nevertheless, athletic trainers must be prepared for just such an event. This preparation includes:

1. An effective and practiced emergency plan with a good working relationship with the local EMS agency;
2. Good evaluation skills so that critical injuries may be recognized early;
3. Readily available equipment to manage the patient until EMS arrives;
4. Regular practice using the equipment by all members of the athletic training staff;
5. Legal certification to use any equipment that might be outside the scope of practice of athletic training;
6. Practice in removing all equipment (not the face mask alone) in the event of a critical injury. Practice in removing equipment is vital.

Proper preparation for the unlikely will increase the success of resuscitating a critically injured football player. I believe that we, as a profession, are fooling ourselves if we think that face-mask removal is our only concern. Other equipment must be removed sooner or later. Who is better qualified to do this than the athletic trainer? I urge athletic trainers to examine their own situations and ensure that they have an effective plan and the proper training and practice to deal with these unlikely, but all too inevitable, events.

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The Fluoroscope in a Traditional Sports Medicine Setting

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Thomas V. Gocke III, MS, ATC

Abstract: *Using a fluoroscope in a sports medicine setting is a new innovation. By using a hand-held portable fluoroscope, radiographic imaging can be done in the athletic training room or at an on-site athletic location. The fluoroscope produces a high-quality, real-time image. This is accomplished immediately, without the delay time and expense involved when the injured athlete is referred to an emergency facility. Through the use of the fluoroscope, a definite diagnosis can be made, and treatment can begin immediately. The fluoroscope has proven to be cost-effective, not only by decreasing radiographic expenses, but also by decreasing the time commitment of both the athlete and the athletic trainer.*

The phenomenal growth and interest in sports medicine over the last decade have produced many innovations that have improved the quality of health care available to athletes. The use of a hand-held portable fluoroscope in a traditional athletic training setting is one such innovation. It allows quick and accurate radiographic imaging of long bone and joint injuries by a team physician (Fig 1).

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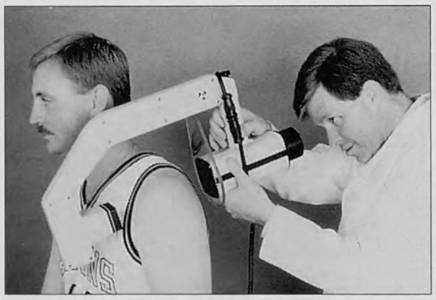

Fig 1.—Athlete being examined by team physician.

Description

The fluoroscope provides a high-quality, real-time image by using low-power radiation, emitting a tightly focused beam with little overflow or scatter of a conventional x-ray (Fig 2). The radiation output is 95% less than a conventional x-ray machine.[3] Lead aprons are recommended, however, for added protection for both the patient and the operator.[6] The unit is powered by a 110-V outlet or a rechargeable battery pack, which, when fully charged, will allow continuous use for 2 hours. A monitor and printer can be added to the system to produce a photograph (at a cost of 10 cents per photo), or a radiographic cassette can be added to provide a radiographic image. The hard copy then can become part of the student athlete's permanent record.

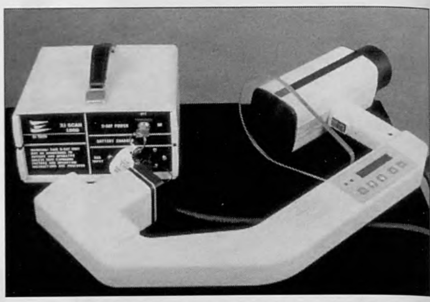

Fig 2.—Basic fluoroscope.

The portability of the fluoroscope is one of its most important assets. The fluoroscope weighs 8 lbs, while the complete unit weighs only 30 lbs and may be packed in a carrying case[5] (Fig 3). The fluoroscope can be moved easily from the athletic training room to the competition site.

Applications

Fluoroscopy is not a new concept; fluoroscopes were used by commercial shoe salesmen to check the fit of the shoe during the 1950s. In medicine, fluoroscopy has many varied applications, including diagnosis, fracture reduction, and prosthesis positioning.[2] Such applications can take place in an office, clinic, or surgical setting. Fluoroscopy also can be used to locate foreign bodies or for proper catheter insertion and placement.[2,4]

Using fluoroscopy in an athletic setting is a relatively new concept. When an athlete sustains an injury requiring radiographic evaluation, significant time and manpower often are required to transport the athlete. Additionally,

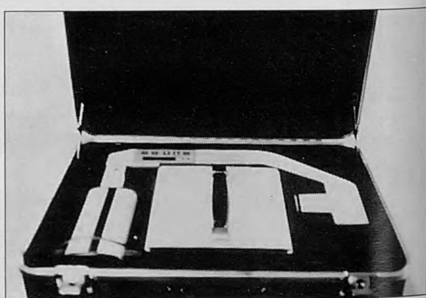

Fig 3.—Fluoroscope in carrying case.

conventional x-rays require a financial commitment from the athlete and/or the athletic department. By using the fluoroscope in the athletic training room or at the competition site, most injuries can be evaluated easily. Within minutes, a definitive diagnosis can be made and treatment initiated. The fluoroscope should be used as a diagnostic tool by a physician. Traditional radiographic images still may be required for the hips, pelvis, knee, and spine, as the image quality may decrease for large density areas.

Case Reports

Case 1

A 20-year-old female field hockey player complained of pain at the 5th metacarpal phalangeal joint of her left hand. She had no obvious signs of fracture. She was treated conservatively by immobilizing the injured area and was scheduled to see the team physician later the same day in the training room clinic. During the examination, the physician used the fluoroscope to rule out a fracture and make the diagnosis of a sprain. The athlete was able to return to competition without loss of time from class or practice to obtain formal x-rays.

Case 2

An 18-year-old running back sustained a second degree sprain of his ankle during the first period of a football game. The team physician requested that an x-ray be taken to rule out a fracture. Using the fluoroscope, the team physician found a fracture of the distal aspect of the fibula. The student-athlete was immobilized and removed from further participation.

Case 3

A 21-year-old basketball player dislocated the proximal interphalangeal joint of his third finger. The physician used the fluoroscope to rule out a fracture. No fracture was identified, the physician reduced the dislocation and evaluated the joint. The student-athlete was allowed to return to the game immediately with proper immobilization.

Discussion

The fluoroscope offers several advantages in a sports medicine setting, such as increased quality of health care, saving valuable time of the student-athlete and the athletic trainer, portability, and, perhaps, financial savings. The most important aspect is improved quality of health care for the student-athlete by allowing an immediate definitive diagnosis. Fractures can be identified and distinguished from minor sprains without placing the athlete at risk. With the immediate evaluation of an injury using the fluoroscope, treatment can begin at once.

Fluoroscopy can also save valuable time for both the student-athlete and the athletic trainer. In most cases, when a physician requests that a student-athlete obtain a radiographic evaluation, a trip off-campus to a medical facility is required. For the student-athlete, whose time is already in demand, this requires additional time spent away from classes, studying, or practice. For the athletic trainer, time spent transporting an injured player for x-rays is time taken away from other deserving athletes. Although some radiographic evaluations (such as head, neck, back, and knee) must be done at a medical facility, the fluoroscope helps eliminate many trips for bone injuries.

Financially, the fluoroscope can be quite cost-effective.[1] Although initial outlay is approximately $28,000, significant savings may be realized in the long run. Savings on conventional x-rays may cover the cost of the fluoroscope in 1 to 2 years, depending upon the number of x-rays required. Once the initial investment is made, there is no additional expense, except for the hard- copy photographs or maintenance. In some cases, use of the fluoroscope may results in decreased insurance premiums, due to the decreased number of hard-copy x-rays charged to the athlete's insurance carrier. These hypotheses have been corroborated recently (Gocke et al, unpublished data, 1991).

Conclusion

Sports medicine professionals must provide student-athletes with the best medical care available. The mobility and safety of the easy-to-use fluoroscopic unit make it ideal for use in a traditional sports medicine setting.

Acknowledgment

We wish to thank Elizabeth Coyle for her assistance on this project.

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Laryngeal Fracture in a High School Football Player

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Abstract: *Laryngeal injuries are rare in the athletic setting, but such sports as football, baskétball, and hockey often place the athlete in a position to receive blunt trauma to the throat area. Such an injury has the potential of developing into a life-threatening situation. A high school athlete sustained a fractured larynx during a football game. The injury required surgical repair. Unfortunately, because this type of injury is uncommon in sports, many athletic training books do not extensively address soft tissue and cartilaginous injuries to the structures of the anterior neck. Athletic trainers must be able to recognize the signs and symptoms of a laryngeal injury and refer the athlete for immediate medical attention.*

Airway disruption resulting from laryngotracheal injuries ranks second to intracranial injuries as the most common cause of death following head and neck trauma.[3] Laryngeal trauma usually results from sustaining blunt trauma to the neck. The most common cause of laryngeal trauma is motor vehicle accidents, but, although the incidence is rare, it can be sustained in sports.[2,3] The symptoms of laryngeal trauma can be somewhat deceptive, and, while airway obstruction might not be present immediately, slow progressive airway compromise might develop.[2] For this reason, it is important for athletic trainers to recognize the signs and symptoms of laryngeal trauma, because what might appear initially to be an anterior neck contusion might actually be a serious laryngeal injury requiring immediate medical attention.

Case Report

A 17-year-old high school football player sustained a fractured larynx from a direct blow to the anterior neck region by an opponent's forearm. He did not realize an injury had occurred until he attempted to speak, and discovered his voice was impaired severely. He removed himself from the game. There was no obvious deformity upon visual inspection, but the area to the right of the larynx was slightly red and inflamed. There was tenderness in this area and slight pain when he swallowed. At no time did the athlete experience any airway compromise. After examination by the team physician, ice was applied to the anterior neck region, and the athlete did not return to participation. The athlete's parents were informed of the situation and were instructed to observe him for any respiratory distress. He was taken to the emergency room the following morning for a thorough examination.

After being admitted to the emergency room, he was x-rayed and examined by an otolaryngologist. A CT scan revealed a fracture of the cricoid cartilage, which needed surgical repair. A tracheotomy tube was inserted and a curved linear collar incision was made superior to the tracheotomy site. The cricoid body fragments were anatomically reduced and two sutures were used to maintain their position. A curved dental arch bar was sewn externally through the cricoid to provide external fixation of the cricoid ring. The patient tolerated the procedure well and there were no complications.

Approximately 4 days after the surgery, the tracheotomy tube was removed, and the athlete was discharged from the hospital. He then was examined by the otolaryngologist several times in the following weeks in order to monitor the healing process and, more importantly, to determine the extent of damage to the recurrent laryngeal nerve of the right vocal cord.

Prognosis

Approximately 2 weeks after surgery, the otolaryngologist reported that he had seen slight movement in the patient's right vocal cord. While he believed that some nerve damage had occurred, he was unable to determine the extent of that damage. At that time, a decision was made to continue to observe the patient's natural recovery process for up to 1 year before any additional surgical intervention would be considered.

Following the patient's last visit, approximately 4 months after the surgery, the otolaryngologist reported that he was doing quite well. The doctor had seen a significant increase in the movement of the right vocal cord, and, while a small nodule was present on the anterior aspect of the cord, he expected it to resolve spontaneously. The patient would be examined again in approximately 3 months, but, at this time, the otolaryngologist expected the patient to fully recover at least 85% of his voice and did not foresee any further complications.

Discussion

The larynx is located at the midline of the neck anterior to C4-C6 and serves as a passageway connecting the pharynx and the trachea. The rigid framework of the larynx is composed of the hyoid bone and a system of cartilages consisting of the thyroid, cricoid, and arytenoid cartilages (Fig 1). The cricoid cartilage is the most rigid and the only piece that forms a complete ring.[2,3,5]

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Table 1.—Signs and Symptoms of Laryngeal Injury

SIGNS	SYMPTOMS
- mild bruising	- voice changes
- redness	- pain when swallowing or coughing
- edema	- respiratory changes
- absence of Adam's apple	- stridor
- point tenderness	- shortness of breath
	- inability to breathe
	- spasmodic coughing
	- hemoptysis
	- subcutaneous cretation

The two groups of muscles associated with the larynx are the extrinsic and intrinsic laryngeal muscles. The extrinsic muscles, consisting of the suprahyoid and infrahyoid groups, move the larynx as a unit. The intrinsic laryngeal muscles are involved with vocal cord mobility and are innervated primarily by the recurrent laryngeal branch of the vagus nerve. While the primary action of the larynx is to prevent food from entering the airway, phonation is also an important physiological function of the larynx.[2] This occurs through the movement of the vocal cords during the act of expiration. Because of the close proximity of the recurrent laryngeal nerve to the cricoid cartilage, any pathology involving the larynx that might damage the nerve and, thus, affect the ability of the vocal cords to close, ultimately will affect the quality of the voice.[2,3,5]

Although the incidence of laryngeal injury is rare in the sport setting, athletic trainers must be aware of various signs and symptoms indicating that trauma has occurred within this structure (Table 1). Signs of injury can include mild bruising, redness, edema, and the absence of the usually protruding thyroid prominence, or Adam's apple.[1-4] Unfortunately, the physical appearance of the neck might not indicate the severity of the injury to the underlying structures. Therefore, it is essential to pay special attention to the symptoms of laryngeal injury, no matter how unalarming they might initially appear. These symptoms include changes in the quality of the voice, pain, especially when swallowing or coughing, and respiratory distress or changes, for example, stridor, shortness of breath or, in severe cases, the inability to breathe.[1-4] Additional symptoms are spasmodic coughing, expectoration of frothy blood or frank hemoptysis, and subcutaneous crepitation, which occurs when air has escaped into the soft tissue of the neck.[1,2] An athlete who has suffered a laryngeal fracture typically will complain of extreme point tenderness over the fracture site during light palpation. It is critical for the athletic trainer to use extreme care when palpating the larynx in order to avoid any further disruption of the laryngeal cartilage, which might increase the degree of airway obstruction.[2]

Any trauma to the laryngeal region of the neck might develop quickly into a life-threatening situation, regardless of how mild the symptoms appear initially. Therefore, it is important for athletic trainers to refer an athlete displaying any signs and symptoms of a laryngeal injury to a medical facility as soon as possible. Immediate medical attention not only serves to identify quickly the nature and severity of the injury, but facilitates successful treatment and decreases the possibility of long-term consequences or future complications. Most importantly, though, because laryngeal injuries potentially could develop into life-threatening situations, an athletic trainer who can identify quickly the signs and symptoms of the injury and provide immediate medical attention not only will contribute to the success of the athlete's recovery, but might, in fact, help save the athlete's life.

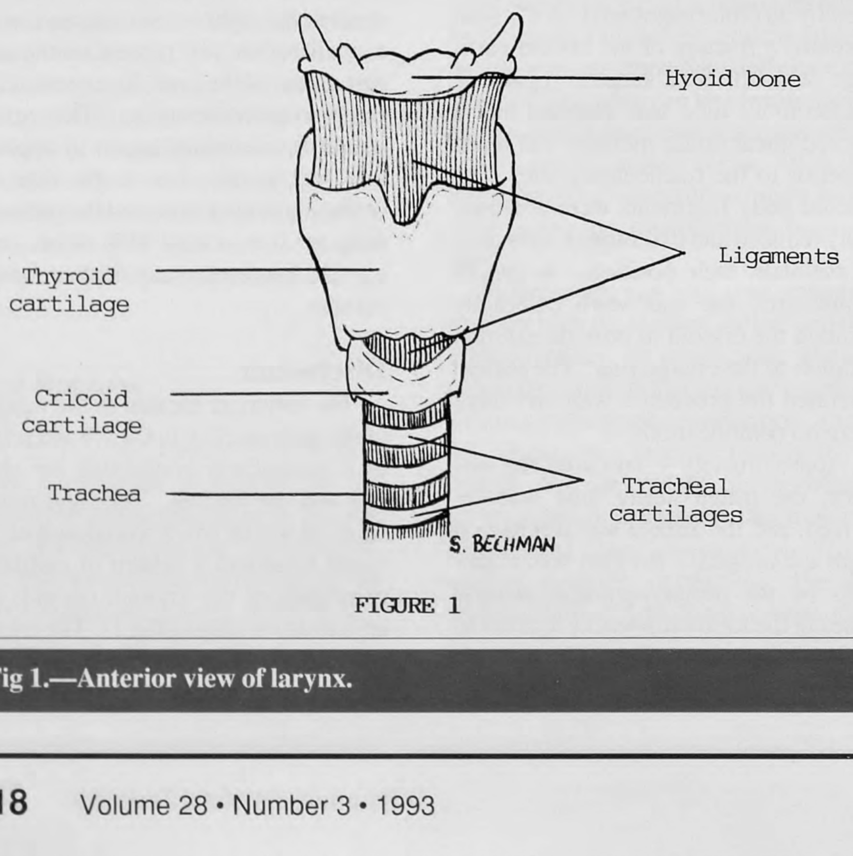

FIGURE 1

Fig 1.—Anterior view of larynx.

Acknowledgement

Special thanks to Michael A. Gottlieb, MD, for his time and assistance in providing information for this case report. Dr. Gottlieb is a member of Pittsburgh Ear, Nose and Throat Associates and is an Assistant Professor of

Laryngology at the University of Pittsburgh.

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The Effect of Stabilization on Isokinetic Knee Extension and Flexion Torque Production

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Abstract: *The purpose of this study was to examine the effect of four methods of stabilization on maximal reciprocal isokinetic knee extension and flexion. Left knee extension/flexion was tested at 60°/s in 20 subjects. Warm-up consisted of five submaximal and one maximal effort followed by three maximal efforts in each of four randomized stabilization conditions: 1) Hands and back stabilization; the trunk was strapped to the back rest and the hands grasped the seat. 2) Back stabilization; the trunk was strapped to the back rest and the hands were folded across the chest. 3) Hand stabilization; the hands grasped the seat and the back rest was removed. 4) No stabilization; the hands were folded across the chest and the back rest was removed. One-way repeated measures ANOVA showed a significant effect of stabilization for knee extension ($F(3,57)=17.44$, $p=.0001$) and knee flexion ($F(3,57)= 5.37$, $p=.002$). Paired, two-tailed student's t-tests with Bonferroni correction showed that, in knee extension, no stabilization was significantly less than all others, $p<.001$. In addition, back stabilization was less than hands and back stabilization, $p<.005$. In knee flexion, no stabilization was significantly less than all others, $p<.01$. In conclusion, the method of trunk stabilization significantly affected maximal reciprocal isokinetic knee extension/flexion strength measurements. Maximal knee extension/flexion torque production was achieved when the trunk was strapped to the back support and when the hands grasped the seat.*

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Clinical strength testing is used to examine the integrity and function of the musculoskeletal system. Muscular strength is a person's ability to generate maximal voluntary tension in a muscle or muscle group. To make a clinically reproducible strength measurement, it is necessary to standardize the testing method.[20] Isokinetic testing equipment is used often to obtain strength measurements. Several variables can significantly affect the isokinetic test result, and a lack of attention to seemingly minor factors can diminish the reproducibility.

The subject's familiarity with the testing equipment can significantly affect the strength measurement.[22] The verbal instructions and encouragement need to be standardized in a consistent fashion.[3] It has been demonstrated that the time of day can significantly affect strength measurements, and surrounding noise also may play a role.[7,13] The position of the subject can influence the muscle's mechanical advantage and length-tension relationship, and, ultimately, its ability to maximally generate force.[1,2,4,6] The location of the resistance pad on the limb needs to be standardized because it can significantly affect the test result.[17] Damping and calibration of isokinetic equipment are important factors that need to be controlled.[16,21,23]

Adequate stabilization is required to allow for maximal torque production. It previously hasbeen demonstrated that different methods of stabilization affect maximal isometric and isokinetic knee extensor torque.[5,14] Mendler[14] tested maximal isometric knee extensor force with different methods of stabilization and found that the greatest force production was possible when back support was provided and the hands grasped the seat. Hart et al[5] found that additional trunk straps significantly increased isometric and isokinetic knee extension torque. The effect of various types of stabilization on reciprocal isokinetic knee extension and flexion torque production is not known yet. The purpose of this study was to examine the effect of four methods of stabilization on reciprocal maximal isokinetic knee extension and flexion torque production.

Materials and Methods

We used a Cybex II dynamometer (Lumex Inc, Ronkonkoma, NY) to test maximal isokinetic knee extension/flexion strength. Data collection took place over a 6-week period. Weekly calibration of the dynamometer per manufacturer's guidelines remained stable.[9] Damping was set at two, per manufacturer's guidelines, and to minimize initial torque spikes, which do not represent true strength.[9,21]

Twelve male and eight female recreational athletes (age=28.9±3.8 yr, ht=1.68±.13 cm, wt=68.1±12.9 kg) consented to participate in the study. Subjects were free of any lower extremity pathology and resisted maximal left knee extension/flexion was pain-free. Initial maximal strength efforts may increase in a single session as subjects "learn" the performance task.[8] To avoid the effect of learning, we used subjects who were familiar with the isokinetic knee extension/flexion from previous participation in research studies and/or rehabilitation. We tested the left leg for reciprocal maximal knee extension/flexion torque production at 60°/s. We chose 60°/s because of its increased reliability over faster velocities.[15] The mechanical axis and resistance pad were aligned according to the manufacturer's guidelines.[9] We tested four different methods of trunk stabilization: 1) Hands and back stabilization; the trunk was strapped across the chest to the back support and the hands grasped the seat (Fig 1a). 2) Back stabilization; the trunk was strapped across the chest to the back support and the hands were folded across the chest (Fig 1b). 3) Hand stabilization; no back support was provided and the hands grasped the seat (Fig 1c). 4) No stabilization; no back support was provided and the hands were folded across the chest (Fig 1d). All four conditions included a thigh and pelvic strap.

Warm-up consisted of five submaximal and 1 maximal effort.[11,12] Three maximal efforts were performed in all four stabilization conditions with a 1-minute rest period between efforts.[11,12,19] We instructed subjects to give a maximal effort each time and gave them no verbal encouragement during the test session. Test order was randomized. The number of possible test combinations with this research design is four-factorial; ie, 24 possible test combinations existed. We tested 20 subjects; therefore, 20 of 24 possible test combinations were used.

Data was taken from the chart recording. The mean of the three efforts for each condition was used for data analysis.[10] Two separate one-way repeated measures ANOVA were used to examine the effect of stabilization in knee extension and flexion. Contrasts were made using student's t-tests with Bonferroni corrections for multiple comparisons.[18] The results are reported in Newton-meters (Nm) and group means with standard error of the mean (SE).

Results

There was a significant effect of stabilization method in knee extension ($F(3,57)=17.44$, $p<.0001$) and knee flexion ($F(3,57)=5.37$, $p<.002$) torque. Knee extension torque was less in no stabilization than the other three stabilization methods, $p<.001$. Knee extension torque was also less in back stabilization than hand and back stabilization, $p<.005$. Additionally, there was a trend for hand stabilization to be significantly less than hand and back stabilization, $p=.12$. Knee flexion torque was significantly less in no stabilization than other stabilization methods, $p<.01$.

Discussion

The method of trunk stabilization can significantly affect maximal reciprocal isokinetic knee extension and flexion torque production. Maximal isokinetic knee extension and flexion torque production was possible with hands and back stabilization (Figs 2 & 3).

Mendler[14] demonstrated that maximal isometric knee extensor force at 60° were possible when stabilization was provided by means of a thigh strap and a backboard, in addition to the hands grasping the seat. When no support was available and when the hands alone were used for support, 70% and 91%, respectively, of maximal force production was possible. Mendler did not use straps to stabilize the pelvis and trunk. However, the importance of using the hands to stabilize the proximal body segments to counteract the knee extensor force distally was hereby dem-

Fig 1a.—Hands and back stabilization.

Fig 1b.—Back stabilization.

Fig 1c.—Hand stabilization.

Fig 1d.—No stabilization.

Table—Torque Production (Nm, mean±SE)

Stabilization	Knee extension	Knee flexion
Hands & back	165.0±13.1[a]	116.5±10.0[b]
Hands	159.2±12.4[a]	115.1±9.4[b]
Back	154.5±12.7[a,c]	113.5±8.8[b]
No	142.0±11.1	103.4±9.0

Significantly different from No stabilization [a] $p<.001$, [b] $p<.01$.
Significantly different from Hands and back stabilization [c] $p<.005$.

onstrated. The ability to counteract the knee extensor force was further enhanced with the back support. Our observations extend those of Mendler to isokinetic knee extension torque results. Additionally, we have demonstrated that the greatest isokinetic knee flexion torque production is possible with the use of the hands and a back support as stabilization.

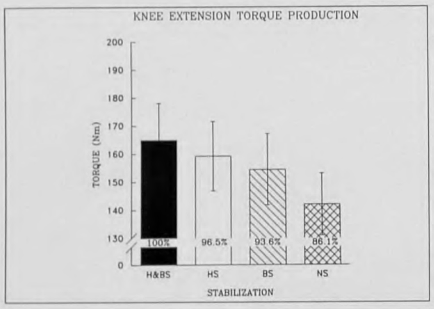

Fig 2.—Knee extension torque production expressed as a percentage of the stabilization condition which yielded the highest value, ie, hands and back stabilization.

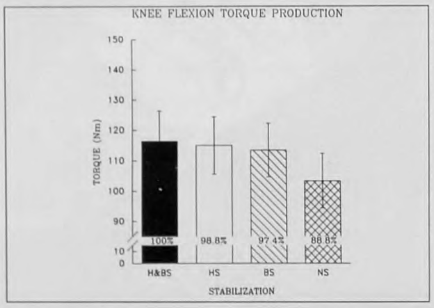

Fig 3.—Knee flexion torque production expressed as a percentage of the stabilization which yielded the highest value, ie, hands and back stabilization.

Hart et al[5] examined the effect of additional trunk stabilization on knee extensor torque at 0°, 30°, and 105°/s. By adding a waist belt and a trunk belt, there was a significant increase in the torque production at all speeds. This effect was amplified with increasing velocities. An increase in maximal isokinetic and isometric force production with the addition of trunk belts is in agreement with knee extension torque results in our study. It is unclear if Hart et al[5] allowed the subjects to grasp the seat. We have shown that the trunk strapped to the back support with the addition of the hands grasping the seat will yield significantly greater torque production, compared to the trunk strapped to the back support alone (hands and back versus back stabilization). Furthermore, we have demonstrated that increased stabilization will enhance the maximal isokinetic knee flexion torque production.

Knee extension and flexion torque production require that the proximal segments be stabilized adequately stabilized to provide an opposite reaction force. Theoretically, torque production in knee extension and flexion will not be maximal if proximal stabilization is inadequate. Stabilization is accomplished best when testing knee extension and flexion by using the upper extremities for support in conjunction with strapping the trunk to the back support.

It has been demonstrated that the angle of the hip may influence the subject's ability to maximally generate tension.[1,2,4,6] When the back support was used, the subject's hip angle was fixed at 70° of flexion. However, the hip angle was not controlled when the back support was not available. This may have influenced the results in the hand stabilization and no stabilization conditions.

In conclusion, different methods of trunk stabilization can significantly affect maximal reciprocal knee extension and flexion torque production. Maximal knee extension and flexion torque production was possible when the trunk was strapped to the back support and the hands grasped the seat.

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The Reliability Of Three Isokinetic Knee-extension Angle-specific Torques

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Evan V. Hellwig, PhD, ATC, PT

Abstract *: To determine the reliability of concentric quadriceps muscle torque at 30°, 60°, and 75° of knee extension, 25 female university students were studied. Each subject was tested on the Kin-Com isokinetic dynamometer on 2 separate days, 7 days apart. The dynamometer's speed was set at 60°/s. Intraclass correlation coefficients for 30°, 60°, and 75° were 0.84 ($p<.01$), 0.87 ($p<.01$), and 0.83 ($p<.01$), respectively. The standard errors of the measure were 5.92 N•m, 7.65 N•m, and 7.35 N•m, respectively. Based on the instrumentation and protocol used in this study, we believe angle-specific torques have good reliability. Because of the error size, clinicians using similar methodology to determine angle-specific torques should be cautious when comparing differences between angle-specific torques of less than 12 to 16 N•m.*

Several studies have reported the reliability of the Kinetic Communicator II (Kin-Com) isokinetic dynamometer (Chattecx Corp, Hixson, Tenn). Farrell et al[3] established the mechanical reliability of the Kin-Com in both static and dynamic modes. Other studies have established the reliability of concentric and eccentric peak torque (PT) values of the quadriceps muscle group.[6,8,9] However, the reliability of torque values at a specific point in the range of motion (angle-specific torques) has not been clearly established.

Angle-specific torques are of value to the clinician because they allow assessment of muscle function at a specific point in the range of motion. This is useful when the clinician suspects or is aware of a strength deficit at a specific point in the range of motion. Several studies have examined the issue of angle-specific torques.[1,4-6] Two of these studies used the Cybex II (Lumex Inc, Ronkonkoma, NY) and used coefficients of variation to suggest that angle-specific torques are of less value than peak torques in the assessment of muscle function.[4,5] However, neither of these studies examined whether angle-specific torques had any value in assessing muscle function at a specific point in the range of motion. Furthermore, neither study examined the test to retest reliability of angle-specific torques. Bohannon and Smith[1] also examined the reliability of angle-specific torques on the Cybex II and concluded that this isokinetic measurement was reliable; however, they used intrasession reliability, not intersession reliability. Therefore, these three studies have not established angle-specific torque intersession reliability.

More recently, Kues et al,[6] reported that angle-specific torque intersession reliability was very high at a variety of velocities and joint angles using the Kin-Com. However, they did not use the manufacturer's recording hardware and software to establish these reliabilities. Therefore, it is unclear whether clinicians can expect reliable angle-specific torques using the Kin-Com's standard instrumentation. This study determined concentric knee intersession test/retest reliability at knee joint angles of 30°, 60°, and 75°, using standard Kin-Com instrumentation.

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Methodology

Twenty-five healthy university graduate and undergraduate female students participated in the study (age=21.0±1.5 yr, ht=166.6±5.7 cm, wt=59.8±5.0 kg). None of the subjects had a prior history of injury to the tested knee, nor experience on the dynamometer within 6 months prior to the study. We obtained informed consent from all subjects.

The measuring instrument was the Kinetic Communicator II, with version 2.4 software. We used the manufacturer's standard lever arm and pad attachments for knee joint testing. Data were collected on the right quadriceps with subjects in the seated position on two occasions, 7 days apart. We averaged three maximal repetitions for each subject on each day. Using a goniometer, we set knee extension at 0°. This was then entered as the zero joint angle. Each repetition started at 90° of knee flexion and stopped at 0° of knee flexion. The speed of the dynamometer was set at 60°/s. The minimal force needed to initiate dynamometer motion (preload) was set at 25 N and the minimal force needed to maintain dynamometer motion was set at 20 N. Gravity correction was performed with the knee at 0° of extension.

We stabilized subjects with straps at the hip, thigh, and tibia. We aligned the dynamometer's axis of rotation with the lateral epicondyle of the femur and placed the tibial pad just above the malleolus.

Before data collection on day 1, we asked subjects to perform three submaximal warm-up contractions followed by one maximal warm-up contraction. During the assessment process, subjects placed their arms across their chests and were instructed to kick out with maximal effort before each repetition.

We extracted data using the average torque curve by moving the value marker to the 30°, 60°, and 75° joint angles and recording the torque values at each of these points along the torque curve (Fig 1). We analyzed the data using a one-way repeated measures analysis of variance (ANOVA) and calculated intraclass correlation coefficients (ICCs) using the Shrout and Fleiss[7] ICC formula (2,k). We calculated standard errors of the measure by multiplying the standard deviation of the angle-specific torque scores of each angle by the square root of 1-R.

Results

The mean scores and the standard error of the means for all three positions are presented in Table 1. The test/retest ICC for 30° was R=0.84 ($p<.01$). For 60° and 75°, the ICC was R=0.87 ($p<.01$) and R=0.83 ($p<.01$), respectively. The standard errors of the measure were 5.92 N•m, 7.65 N•m, and 7.35 N•m at 30°, 60°, and 75°, respectively.

Table 1.—Test/Retest Mean and Standard Error of the Mean (SE)

	Test		Retest	
Angle	Mean	SE	Mean	SE
30°	77.96	3.15	81.72	2.97
60°	125.48	4.42	128.72	4.40
75°	116.04	3.82	117.56	3.59

Discussion

The major finding of our study was that the angle-specific torques at all three joint positions had good reliability. This is supported by ICC values ranging from 0.83 to 0.87 and by relatively small standard errors of measurement. Standard errors of measurement are useful in determining whether the difference between a test and a retest is due to true change or error. For example, if an angle-specific torque at 60° on day 1 is 110 N•m and on day 2 is 120 N•m, a clinician can be reasonably certain that the difference is due to error and not true change because the 120 N•m is not greater than two standard errors from 110 N•m, ie, 110±15.3 N•m. It has been suggested that "a relatively high ICC may not reflect an acceptable measurement if the SEM suggests that the precision of the measurement is not acceptable for the intended purpose."[2] These results differ from the conclusions of Kannus and Kaplan[4] and Kannus and Yasuda,[5] whose studies only reported coefficients of variation and not test-retest reliability. One possible explanation is that both of the above studies used single best values for angle-specific torques instead of the mean of three repetitions.

The ICC values for our study are considerably lower than those of Kues et al,[6] possibly due to differences in test protocol, data acquisition, and data analysis. The two main differences between protocol are: first, their subjects had 2 complete days of practice before beginning testing. Additionally, during each of the practice sessions, each subject performed six repetitions under eight different isokinetic conditions. This total of 96 repetitions on the dynamometer prior to testing compares to four practice repetitions in our study. Thus, their subjects had substantially more experience with the dynamometer than ours did. Second, there was a difference in the number of days between the test and retest sessions. Kues et al had a maximum of 4 days between tests, whereas we provided a minimum of 7 days between test sessions. This may have resulted in our subjects having a greater decrease in familiarity with the dynamometer on the second day than theirs did, thus producing lower correlation coefficients in our investigation.

The high coefficients reported by Kues et al may also be related to modifications in the external equipment used for data collection. They cited a personal communication that suggested the Kin-Com's sampling rate of 100 Hz is too low and thus does not produce an accurate representation of the torque curve. To address this concern, they

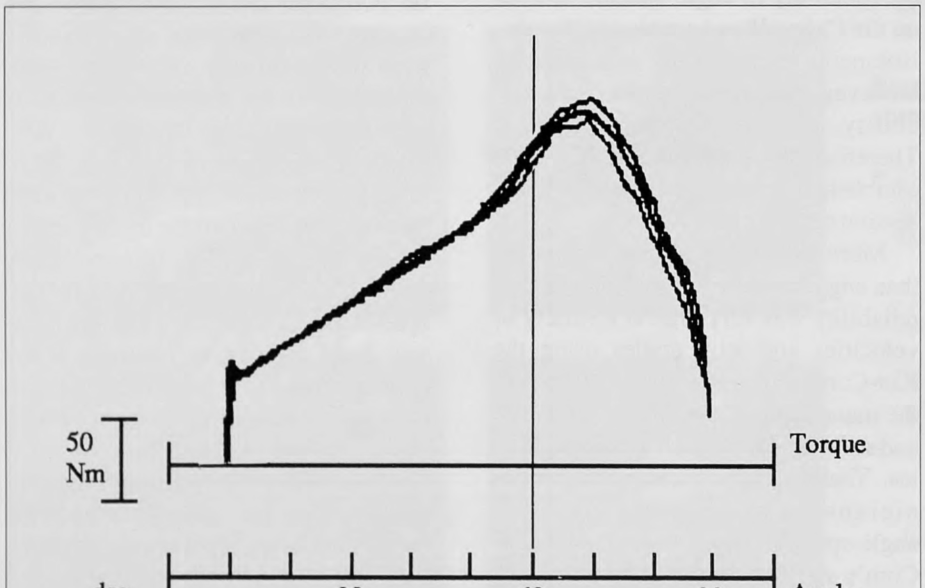

Fig 1.—Angle-specific torque derived from a knee extension torque curve at 60° of knee flexion by one of our subjects.

used external instrumentation to sample at 500 Hz. The current Kin-Com sampling rate may indeed be too low; however, this seems irrelevant since clinicians do not have the benefit of the higher sampling rate. Therefore, with respect to standard instrumentation, our study may more accurately represent the reliability of a clinician's measurements than theirs.

Another possible explanation for the lower correlations in our study was the method of deriving the angle-specific-torque values. Kues et al examined four curves from each test condition and then selected the highest angle-specific torque value of the four. We used the average value of three curves. The averaging process in our study should have stabilized the scores and thus produced a more reliable measure. It is possible that their scores were more reliable, because they more accurately represented the true scores. Additionally, insufficient practice in our study might have obscured the effects of averaging.

A final concern related to the protocol employed by Kues et al is the time required to test the subjects. It is likely that their protocol contributed to higher reliability of measurement. However, their protocol may not be realistic for the busy clinician involved in a variety of activities, in addition to the isokinetic assessment of any number of patients.

In summary, these results indicate that our protocol combined with the standard Kin-Com hardware and software produced angle-specific torques with good reliability and relatively small standard errors of measurement. Nevertheless, the standard errors are large enough that clinicians should be cautious in interpreting changes that are within two standard errors of the measure of each other.

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Use of Orthoplast® for Winter Sports

Susan L. Snouse, BS, ATC, EMT
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Abstract: *Orthoplast® has been found to be successful in padding the joints of athletes who compete in such high-velocity, high-impact winter sports as bobsled, luge, and skeleton. Traditional padding with foam or felt was not as effective against contusions, lacerations, and ice burns. Orthoplast is preferable because of its rigid, nonyielding and lightweight qualities, as well as its ability to be formfitted, thus aerodynamic. Two different techniques of using Orthoplast have been proven effective by the authors in protecting joints and body parts through a necessary range of motion. Bobsled, luge, and skeleton athletes, like other athletes, require full range of motion for effective sports participation. Shingled, jointed padding has been effective in protecting upper extremity joints, while the one-piece technique is used best for the lower extremity and nonjointed areas. These techniques can be used for many other sports where freedom of movement and protection are equally important.*

Orthoplast® (Johnson & Johnson) is often used for bracing or splinting of joint injuries in Sports Medicine.[1-8,11,13] We also have found it to be an effective protective padding for contusions, lacerations, and ice burns incurred by our winter sport athletes. Several winter sports, for example, bobsled, luge, and skeleton, involve high velocities of 40 to 80 mph. Impact injuries from colliding with ice walls are common.

Traditional padding methods were not as successful with our high-impact winter sports. Pads made from foam or felt alone did not give the protection needed for the hard impacts, and it was difficult to maintain proper positioning with these types of pads.

Orthoplast has been used to create pads that can move with the joints and body parts through the necessary range of motion and still protect the area when in static positions. Its advantages are that it is lightweight, provides rigid protection, and is formfitted easily to the athlete. Lightweight materials are valuable for such sports as bobsled and luge because they follow strict weight guidelines. For example, a two-man bobsled team must weigh 859 pounds or less. That total weight includes the sled, athletes, and any padding. Rigid, nonyielding pads are important protection against the high-velocity collisions. Formfitting pads are essential for improved aerodynamics in any sport that is measured in hundredths of seconds. Other types of thermoplastics[10] could be used to give similar protection; however, our experiences are based on the use of Orthoplast. These techniques can be used for other sports where freedom of movement and protection are equally important.

Many authors have discussed using Orthoplast as a postinjury protectant.[1-8,11,13] McCarthy[9] described the use of Orthoplast as a prophylactic or preventive padding. Peppard and O'Donnell[10] reviewed the different types of thermoplastics available. Sims and Markey[12] presented an alternative padding method for contusions (bubble packing), which we considered for winter sport activities. This we deemed unacceptable for bobsled, luge, and skeleton because of the raised, nonaerodynamic position of the padding. We could find only one unpublished paper (Del Negro and Rockwood, USOC 1987) in which a high-velocity and high-impact winter sport was studied. These authors examined the injury rates and types during a full luge season. This paper briefly discusses Orthoplast as a valuable protective padding.

Description of Sports

The sport of bobsled involves two- or four-man teams. The athletes push the sled approximately 50 meters before they jump in and slide down a mile-long iced track. The track consists of up to 18 various curves. Bobsledders are afforded some protection from the walls of the track by the sled itself. However, the athletes also need to be protected from the steel and fiberglass encasing of the bobsled. Common injuries include contusions of the shoulders and hips.

Luge involves one or two athletes sliding feet-first and supine on a small sled. The sled is steered with the legs and with shoulder motion. The start consists primarily of a ballistic double-arm pull from start handles, followed by three to five strong paddling motions with their spike-adorned hands on the iced track. The lateral shins and elbows of a luge athlete are particularly at risk for contusions and lacerations. These areas have an increased chance of contact with the walls and sleds because of positioning.

Skeleton athletes slide alone, prone and headfirst, steering with shoulder motions and dragging their feet. These athletes start by sprinting while crouched alongside their sled for approximately 30 meters before jumping onto the sled. Shoulders take the brunt of most impacts with the walls, and contusions are common.

Athletes involved in these sports encounter speeds of up to 80 mph. Although the goal is to avoid impact with the walls of the track, it is an inevitable experience for all athletes involved. We use Orthoplast for preventive

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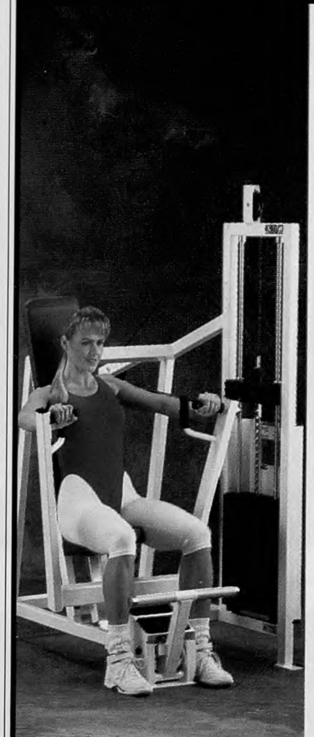

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Fig 1.—See text.

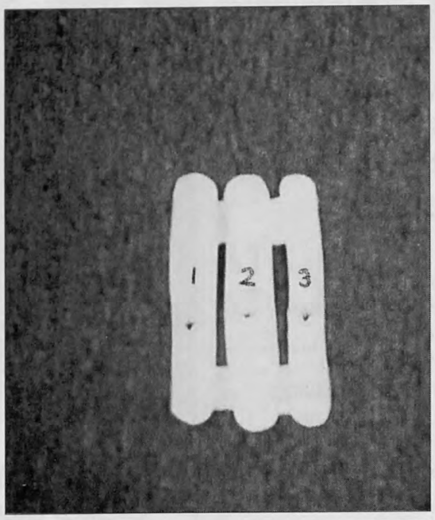

Fig 2.—See text.

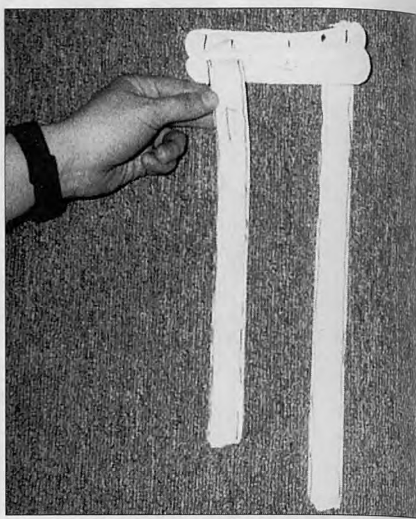

Fig 3.—See text.

protection, as well as for protecting injured areas. The majority of our athletes have preventive pads for the most common impact areas, ie, hips for the bobsledders and lateral shins for the lugers. The athletes are able to use these pads for more than one season. Because of the expense of thermoplastics, we strongly encourage our athletes not to lose the pads.

Techniques

There are two different styles of padding that we use on various body parts. Style one is a shingled padding that has proven effective for protecting upper extremity joints. Style two is a one-piece technique. We have been successful using this technique when padding lower extremity joints and such nonjoint areas as the thigh or forearm.

Style One: Shingled Padding

We will use the shoulder as an example joint to be padded:

1. Cut seven to eight strips of Orthoplast — 1"x6". The number of strips and dimensions will vary with the size of the shoulder. Round off the corners.
2. Heat the strips to the temperature suggested by the manufacturer until the Orthoplast is pliable. A hydrocollator, heat gun, or convection oven could be used.
3. Place four strips over the shoulder. Strips run anterior to posterior in a horizontal fashion with the strip that is most superior overlapping the next by 1/8" to 1/4", and so on (Fig 1).
4. Place the remaining strips longitudinally along the upper arm about 1/4" apart. Superior edges of strips should extend under the last strip of overlapping shoulder cuff (Fig 1).
5. Wrap in place until the Orthoplast forms a semirigid shield.
6. While in place, number/label all strips as to position. Then place the strips in cold water to set the Orthoplast completely.
7. Using 1" white tape, tape upper arm strips together, leaving appropriate spacing between the strips to form a ribbed effect (Fig 2).
8. To tape the strips of the shoulder cuff, use two 12" strips of 1" white tape:
   -Starting with the topmost strip of Orthoplast, place tape on the outside of this strip and tape around the Orthoplast strip, ending on the inside of the strip.
   -Do not tear the tape, but double back, so that the adhesive side of the tape is up.
   -Repeat this step on the other end of the Orthoplast strip with the second piece of tape.
   -Take second strip of Orthoplast, place it halfway over the first strip onto the adhesive tape. The second piece will be attached to the tape adhesive (Fig 3).
   -Wrap the pieces of tape around the second strip and again double back

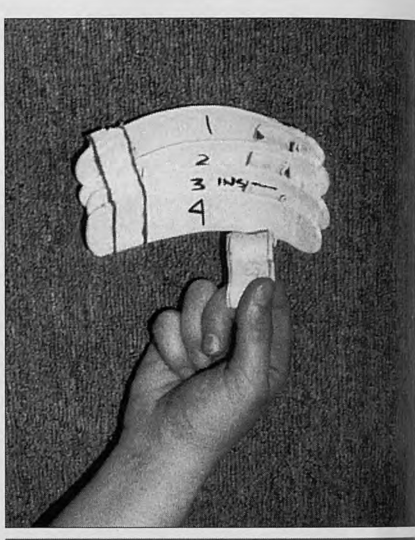

Fig 4.—See text.

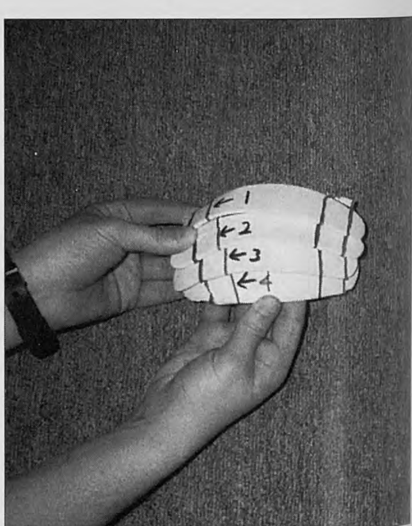

Fig 5.—See text.

Fig 6.—See text.

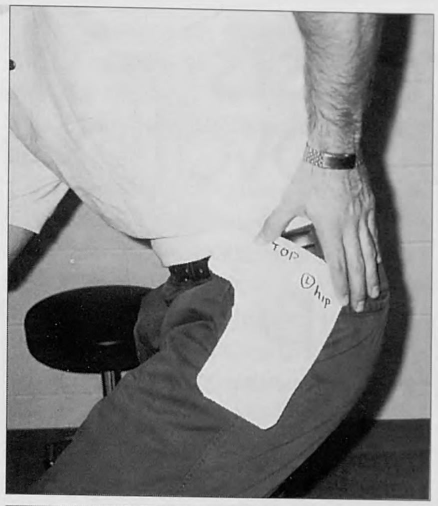

Fig 7.—See text.

on the inside.

-Place the third strip down and tape it in place. Continue until all four strips are secured together in a shingled fashion. Tape over any exposed adhesive (Figs 4 and 5).

9. Place pads between skin and clothing (rubberized/latex racing suits) (Fig 6). If racing suits are not used, use an elastic bandage to secure the pads in place.

Style Two: One-Piece Padding

This is a more traditional approach to padding. In this example, the method of how we pad a hip is as follows:

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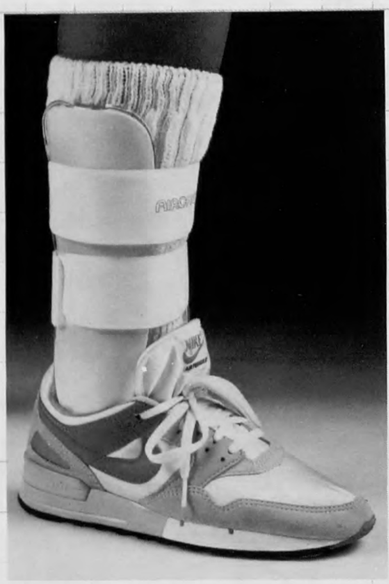

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3. **1980.** Self-Sealing Valve. Makes adjustable aircell convenient. Patent 4,287,920
4. **1985.** Pre-inflated Aircell. Makes adjustment unnecessary—but possible. Patent 4,628,945
5. **1985.** Duplex Aircell. Graduated compression, enhanced pulsation, edema control. Patent 5,125,400
6. **1992.** Long-Life Heel Pad. Virtually eliminates wear and fraying. Patent Pending
7. **1992.** Molded-in-Place Hook Fastener. Stronger Velcro attachments. Patent Pending
8. **1992.** Swivel-Strap. Anatomic Alignment. Snag free. Patent Pending

***The scope and validity of this patent was affirmed in a U.S. District Court in January, 1992.*

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1. Cut out an upside down "L" shape to match the athlete's hip. Leave the anterior space open to allow for hip flexion for sprinting. Round the corners at this time.
2. Heat the Orthoplast as suggested by the manufacturer until it is soft and pliable.
3. Mold the Orthoplast around the area. Have the athlete place his/her leg in hip flexion. Wrap or hold the pad in place until it becomes semirigid (Fig 7).
4. Place the pad in cold water to set completely.
5. Mark pad with name, side, and direction (ie, up or down).
6. Pad entire inside of pad with 1/4" adhesive foam. You can also rim the inside of the pad with foam if a doughnut effect is desired.

The preceding examples and combinations of these techniques have allowed us to deal with the uniqueness of these three winter sports. These techniques also can be used in such other impact sports as field hockey, ice hockey, lacrosse, skiing, and soccer, where a rigid and lightweight protectant is helpful.

Protective padding over joints in motion is always a challenge for the athletic trainer working with athletes. The challenge arises because these athletes must be able to perform their sport unrestricted by any protective padding. Clinically, the techniques discussed here have been repeatedly successful for our immediate needs and are useful across a wide range of sports.

Acknowledgments

We thank Kevin Moody, ATC; Vinny Comiskey, ATC; and Jeanna Schepman, ATC, for their assistance with this article.

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The Effects Of Ice And Compression Wraps On Intramuscular Temperatures At Various Depths

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Abstract: *While ice and compression wraps are commonly used to treat musculoskeletal injuries, the literature describing intramuscular temperatures has not addressed the combination of ice and compression wraps. The purpose of this study was to evaluate intramuscular temperatures at three sites on the anterior thigh (skin surface, 1 cm below the fat layer, and 2 cm below the fat layer) using both ice and compression wraps. Temperatures were recorded in 11 subjects with an isothermex, using implantable and surface thermocouples. Each subject was tested under four conditions: control, compression only, ice only, and ice + compression according to a balanced Latin square. Surface and intramuscular temperatures were recorded at 30 second intervals during 5 minutes of preapplication, 30 minutes application, and 20 minutes postapplication. A repeated measures ANOVA and Duncan post hoc tests were used to evaluate peak temperature differences between the treatment conditions and the depths of measurement. Both ice alone and ice + compression produced significant cooling at all three depths ($F(6,60) = 168.5$, $p<.0005$). Likewise, during the 20-minute postapplication period, these temperatures did not return to their preapplication levels. The compression-only condition produced significant warming at the skin surface, but did not have any effect on intramuscular temperature. At all depths, the ice + compression condition produced significantly cooler temperatures than ice alone. We suggest that compression increases the effectiveness of ice in reducing tissue temperatures. Therefore, ice combined with compression should be more effective than ice alone in reducing the metabolism of injured tissue. This provides an additional rationale for combining ice with compression in treating acute musculoskeletal injuries.*

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Cryotherapy, the use of ice or cold in a therapeutic setting, has become one of the most common treatments in sports medicine. The mechanisms responsible for the physiological response and factors which influence treatment responses, however, are poorly understood or not understood at all.[21] Understanding cold physiology is vital for proper use of this modality.

The primary reason for using cryotherapy in acute injury management is to lower the temperature of the injured tissue which reduces the tissue's metabolic rate[12,19,21,27] and helps the tissue to survive the period of hypoxia following the injury.[14,21] It is well documented that metabolic rate decreases as tissue becomes hypothermic.[5,12,21,27] Most studies on metabolic reduction through cold application have been performed on amputated, stored limbs[19,27,35] or organs.[5,9,12] In these studies, tissue temperatures for the stored limbs and organs were in the range of 1°C to 15°C, with 5°C to 10°C being optimal.[9,12,21,27] In typical clinical cryotherapy, however, the tissues have not been removed from the body, and tissue temperatures range from 15°C to 35°C, depending upon the measurement site and depth and the duration and type of cold used.[10,11,16,26,31,32] These tissue temperatures are greater than those normally measured in tissue preservation protocols.[2,3,10,16,20,31]

Compression is often used in conjunction with cryotherapy for the care of acute injuries.[13,14,17,23] To date, the primary reason for using compression is to increase external pressure on the tissue to prevent edema formation.[13-15,23,34] This occurs by hindering fluid loss from the vessels in the injured area, making it more difficult for fluids to accumulate.[7,15,34]

Little is known about the effects of compression on intramuscular temperature or metabolic suppression. There is some evidence that elastic wraps provide an insulating effect when applied between the skin and a cold application.[29,34] This insulating effect results in a lesser degree of cooling at the skin surface than does ice alone. However, there are no data describing the effects of compression in conjunction with cryotherapy on intratissue temperatures. Therefore, we do not know whether compression affects tissue cooling. This study examined tissue cooling at several depths with both cryotherapy and compression.

Methodology

The effects of four treatment conditions were examined: ice alone, compression alone, ice + compression, and control (no treatment). Subjects underwent all four of the conditions with a minimum of 1 day between treatments. The specific order of treatments for each subject was determined using a 4 X 4 Latin square.

The subjects for this study were 11 volunteers from the student body at Indiana State University (age = 23.5±2.1 yr, ht = 175.3±10.3 cm, wt= 40.4±14.0 kg, anterior thigh skinfold = 15.8±3.7 mm). Prior to participating, subjects completed health status questionnaires and informed consent statements. Approval for this study was obtained from the University Institutional Review Board.

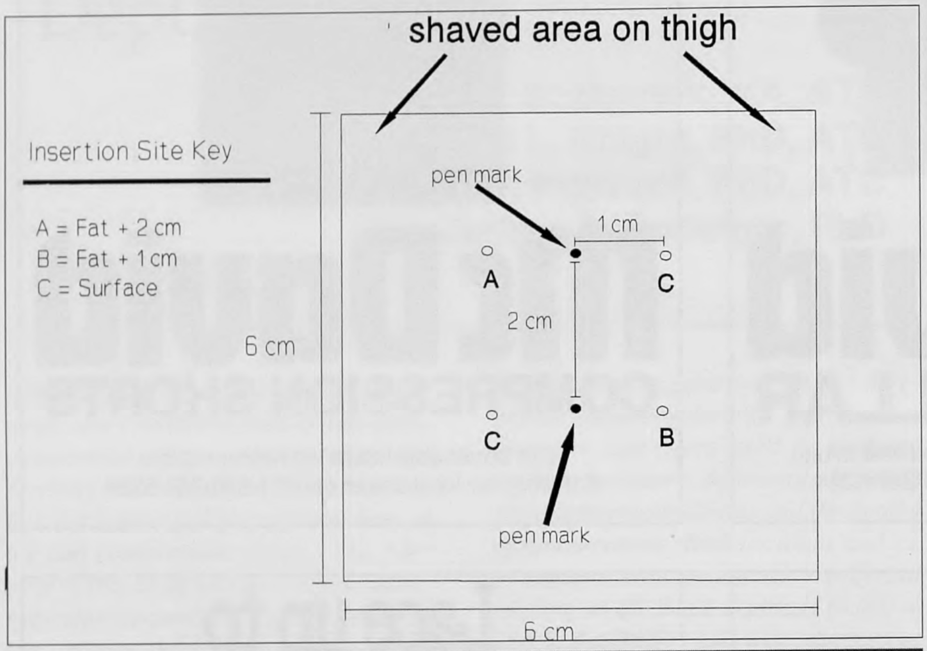

Fig 1.—Thermocouple placement.

Fig 2.—Inserting needle electrode into thigh of a subject.

Skin, tissue, and air temperature measurements were made, using thermocouples interfaced with an electronic thermometer (Columbus Instruments, Iso-Thermex 16-channel). Two models of type T thermocouples were used, one for skin and air temperature measurement (Model TX-31, Columbus Instruments, Columbus, Ohio) and one for intratissue temperature measurement (diameter = 0.41 mm) (Columbus Instruments, Model TX-23-21).

Subjects assumed a supine position on a standard treatment table. The hair was clipped from a 6-cm X 6-cm area located on the anterior thigh halfway between the patella and the anterior superior iliac spine. This area was cleaned with a povidone-iodine surgical scrub solution for 30 seconds and was marked at 2-cm intervals with a felt-tip pen.(Fig. 1) Thermocouples were placed 1 cm medial and lateral to the pen marks, with an implantable or a surface thermocouple at each site (Fig 2).

Two tissue implantable thermocouples and two surface thermocouples were used. The implantable thermocouples were inserted perpendicular to the skin using sterile 21-gauge hypodermic needles. The needles were then removed. Because the subjects had differing amounts of subcutaneous fat, insertion depth was based upon skinfold measurements for each subject. This allowed the thermocouples to be placed at uniform depths into the muscle tissue. Skinfold measurements were made using skinfold calipers (Lafayette Instruments Co, Lafayette, Ind) as described by Michael and Katch.[22] The two depths of measurement (one implanted thermocouple each) were calculated as follows:

$$\text{shallow} = \frac{\text{skinfold}}{2} + 1\text{cm}$$

$$\text{deep} = \frac{\text{skinfold}}{2} + 2\text{cm}$$

Insertion depths were controlled by means of marks made 6 cm from the tips on the leads of the implantable thermocouples. By measuring the distance from the skin surface to these marks, probe depths could be accurately controlled. Dermiclear tape (2.54 cm X 3.75 cm) was placed over the ball tips of the surface electrodes to secure them to

the subjects' legs. Dermiclear tape was also used over the thermocouple insertion sites to secure them.

Once the thermocouples were in place, temperature was measured every 30 seconds. Testing sessions were divided into three subsections: a 5-minute preapplication, a 30-minute application, and a 20-minute post- application. In order to allow their temperatures to stabilize, subjects rested supine on the table for 15 minutes prior to the preapplication period. They received no treatment at this time. No treatments were applied during the 5-minute preapplication period. During the application period, subjects received one of four treatments for 30 minutes. During the 20-minute postapplication period, subjects received no treatments. The total time for each session was 55 minutes.

The four treatment conditions were: control, ice only, compression only, and ice + compression. No treatments were applied during control. The ice treatment consisted of a crushed ice pack (1 kg of ice in a 10 L plastic bag with the air evacuated) placed directly on the treatment area for 30 minutes. The compression treatment consisted of a 1.34-m X 15-cm elastic wrap (Depuy, Warsaw, Ind) placed around the treated limb for 30 minutes. The ice + compression treatment consisted of wrapping a 1 kg ice pack to the treatment area with a 15-cm-wide elastic wrap.

To ensure consistency between the two treatment conditions involving compression, a manometer (AirCast Inc, Summit, NJ) was used to quantify the compression. The bladder of the manometer was placed at the center of the distal margin of the clipped area. The compression wraps were adjusted until typical compression, established at a pressure between 42 and 48 mm Hg,[31] was applied.

At the conclusion of the postapplication period, the thermocouples were removed, and the insertion wounds were cleaned with a povidone-iodine solution and bandaged with adhesive bandage spots. After removal, the thermocouples were disinfected using Cidex (Surgikos Inc, Arlington, Tex) 2% glutaraldehyde solution.[8] The hypodermic needles were disposed of in a sharps biomedical waste container.

Treatment effect was defined as the greatest difference between mean treatment temperature and mean preapplication temperature for each measurement depth and condition. Then, the greatest treatment effects were used for analysis. A 3 X 4 X 4 repeated measures ANOVA was performed to determine differences between measurement depths, treatments, and ordinal position. Duncan post-hoc analyses were used to identify the sources of the differences observed in the ANOVA.

Results

Greatest treatment effect temperatures and times are found in Tables 1 and 2. There was no significant treatment effect for the control condition. For the compression-only condition, the only significant treatment effect was an increase in skin temperature of 1.88°C ($F(6,60)=168.5$, $p<.0005$; Duncan post-hoc analysis $p<.05$). For both the ice alone and the ice with compression conditions, significant treatment effects were decreases in temperature at all measurement depths. The ordinal position of treatment condition did not have a significant effect ($F(9,7)=0.59$, $p=.78$) on temperature.

At the skin surface, temperature decreased immediately and rapidly with the application of either ice or ice with compression (Fig 3). Skin temperature increased quickly and immediately when the source of cold was removed.

Both ice and ice + compression were significantly colder than control or compression alone ($F(6,60)=168.5$, $p<.0005$; Duncan post-hoc analysis $p<.05$). Likewise, ice with compression was significantly colder than ice alone. The compression-only treatment led to a significant increase in skin temperature which returned to normal roughly 10 minutes after the compression was removed. No change in skin temperature occurred with the control treatment.

At 1 cm into the muscle, temperature changes were less pronounced than at the skin surface (Fig 4). Both ice alone and ice with compression resulted in significant temperature decreases ($F(6,60)=168.5$, $p=.0005$; Duncan post-hoc analysis $p<.05$). Temperatures at this depth continued to decrease for approximately 5 minutes after the ice was removed (Table 2). As was true for the

Table 1.— Average Temperatures at the Time of the Greatest Treatment Effect (°C±SD)

	Depth of Measurement		
Treatment	Skin Surface	Fat + 1 cm	Fat + 2 cm
Preapplication	32.50±1.15	36.28±0.74	36.59±0.71
Control	32.79±0.87	36.13±0.62	36.38±0.52
Compression Only	34.38±0.66	36.25±0.51	36.47±0.47
Ice Only	7.24±1.19	26.58±3.66	28.21±2.34
Ice + Compression	4.94±0.68	23.54±3.33	26.46±3.04

Table 2.— Time at Which Greatest Treatment Effect Occurred (min from the beginning of application phase ±SD)

	Depth of Measurement		
Treatment	Surface	Fat + 1 cm	Fat + 2 cm
Control	30.41±2.2	30.32±1.95	30.32±1.95
Compression Only	29.32±1.49	30.73±6.40	31.41±6.38
Ice only	29.73±1.34	35.95±3.75	39.23±5.09
Ice + Compression	30.82±1.25	32.86±1.93	35.32±4.72

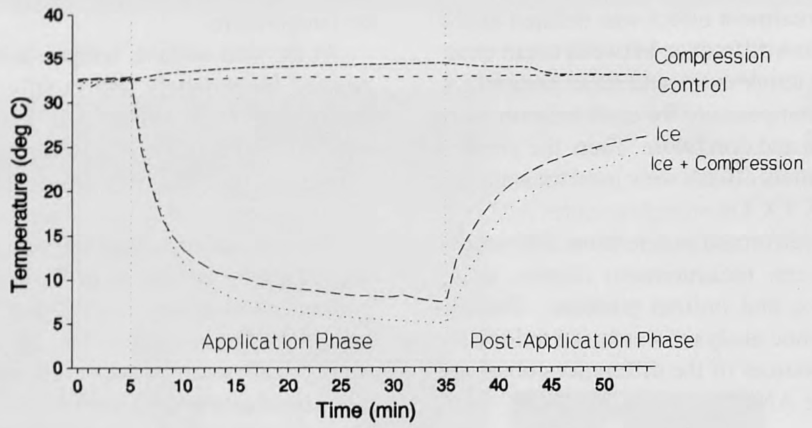

Fig 3.—Skin surface temperatures vs time.

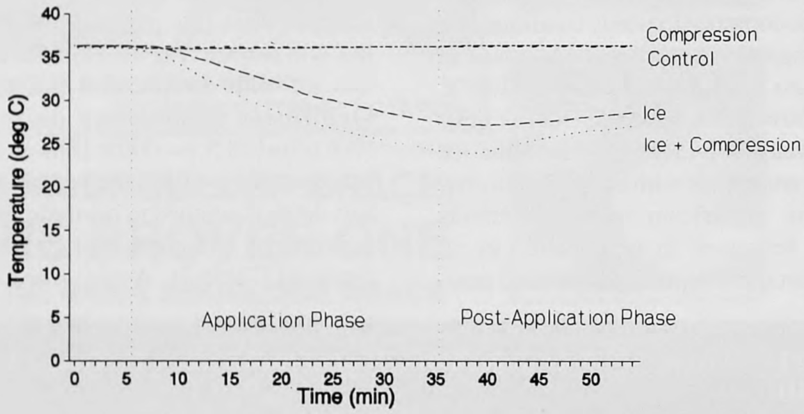

Fig 4.—Intramuscular temperatures (fat + 1 cm) vs time.

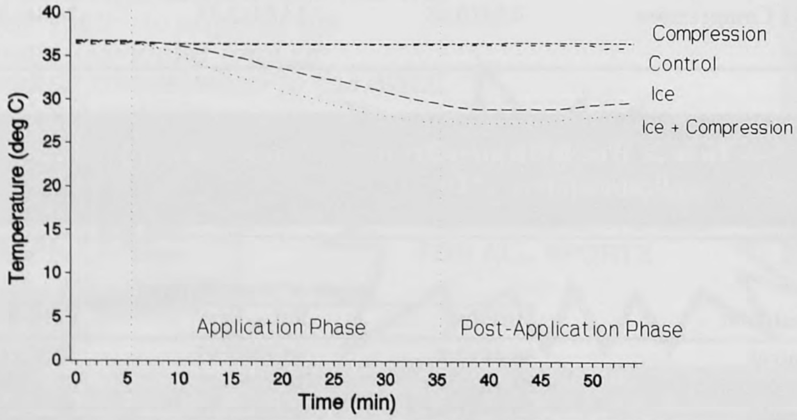

Fig 5.—Intramuscular temperatures (fat + 2 cm) vs time.

skin surface, ice with compression was significantly colder than ice alone. No changes occurred at the 1-cm depth during either the compression only or the control treatments(Table1).

At 2 cm into the muscle, temperature changes were even less pronounced than at 1 cm (Fig 5). Again, both ice and ice with compression resulted in significantly decreased temperatures ($F(6,60)=168.5$, $p=.0005$; Duncan post-hoc analysis $p<.05$). Temperatures continued to fall for roughly 7 minutes after the cold was removed, slightly longer than at 1 cm (Table 2). Ice with compression was again colder than ice alone. Neither compression nor control resulted in any temperature changes at 2 cm into the muscle.

During all of the treatment conditions, skin temperature was significantly cooler than either of the deep temperatures ($F(6,60)=168.5$, $p=.0005$; Duncan post-hoc analysis $p<.05$). During both the ice and the ice with compression treatments, the temperature at 1 cm into the muscle was significantly colder than the temperature at 2 cm into the muscle. These two depths were not different during control or compression alone.

Discussion

One of the primary purposes of this study was to examine the differences between ice alone and ice with compression. Ice with compression was significantly colder than ice alone at all three measurement depths. This can likely be explained by examining the effects that compression has upon the tissue.

First, compression may cause an improved contact between the skin and the ice bag. Normally, when an ice bag is placed on the skin, the interface temperature can be varied, depending on whether the temperature sensor is against an ice cube or against an air pocket in the bag.[14,18,24] Compression may cause more of the ice to be in closer contact with the skin, resulting in improved cooling.

Second, compression greater than 30- to 40-mm Hg reduces blood flow.[1,28] By reducing blood flow, the inflow of heat from other parts of the body is also reduced. Although blood flow is decreased, no deep temperature changes occurred with compression alone. Therefore, reduced blood flow alone does not cool tissue significantly. However, combining reduced blood flow with an external source of cold reduces the body's ability to warm the area being cooled. This would produce significantly colder tissue temperatures than ice alone.

Third, elastic wraps used for compression have been shown to provide an insulating effect.[30] Placing wraps around the ice pack reduces heat gain from the environment, leading to colder tissue temperatures.

Fourth, by compressing tissue, we may decrease the area occupied by that tissue. We are not, however, changing the tissue's mass. Therefore, we may actually increase the density of the compressed tissue. This increased tissue density may lead to greater conductive cooling. Further study is required to substantiate this.

Not only was the ice + compression treatment colder than the ice-only treatment, it also reached its lowest temperature faster (Table 2). This suggests that compression wraps also increase the rate of cooling. Such an increase would be valuable in the treatment of acute injuries where immediate cooling is desired. The temperature decreases recorded with both ice alone and ice + compression treatments are in agreement with others.[4,18,24,26,30] At the skin surface, both ice alone and ice + compression produced a rapid immediate temperature decline followed by a more gradual decline, as others have reported.[4,18,24,26,30]

Skin temperatures for the human thigh during cold applications have not been reported adequately in the literature. The data from this study indicate that lowest skin temperatures for human thighs and for sheep thighs are very similar during ice treatments (5°C).[33] The skin temperature data we recorded suggest that cold applications produce thigh skin temperatures similar to those reported at the ankle during ice treatments.[18,24,30] The skin temperature decreases following 30 minutes of ice application to the thigh (decrease of 25.3°C, ice only; 27.6°C, ice + compression) are greater than those reported at the ankle by Mancuso[18] (20.4°C) or Post[26] (23.1°C and 23.7°C), but are less than those reported by Mylnarczyk[24] (28.0°C) or Urban[30] (28.7°C).

With compression alone, skin temperature increased slightly (increase of 1.9°C), then returned to normal roughly 10 minutes after the compression was removed. It is likely that this temperature increase is related to the insulating effect of the elastic wrap. Urban[30] reported that elastic compression wraps provide an insulating effect between the skin and cold packs, even when the wraps are wet or frozen. Apparently the wraps are capable of preventing some degree of heat loss by the skin.

There is a variety of literature reporting deep temperature changes. Lowden and Moore[16] suggested that intramuscular temperature change is dependent upon depth of measurement, duration of treatment, mode of cryotherapy, and thickness of adipose tissue. In the studies reporting intramuscular temperature change, many do not report measurement depth.[6,17,20,32] In the majority of studies reporting measurement depth, it is measured from the skin surface.[2,3,11,16,33,35] Because adipose thickness varies from subject to subject, measuring from the skin surface does not ensure that the probes are located at similar depths into muscle tissue. Therefore, a temperature reported at 3 cm, may actually represent a temperature at 1.5 cm into the muscle in one subject and at 2 cm into the muscle in another. In order to avoid this inconsistency, we used temperature measurements at uniform depths beyond the adipose layer as determined by a skinfold. This makes direct comparisons with other authors difficult.

At 1 cm into the muscle tissue, temperature decline with both ice and ice + compression was delayed by several minutes, as has been reported by most authors.[10,11,25,32,35] There have also been a few reports of initial temperature increases with cold application.[3,6]

The gradual nature and delayed onset of cooling is most likely explained by conductive cooling. The rate of thermal conduction is dependent upon several factors, including the temperature difference between the two surfaces, the surface area of the contact region, and the temperature of the material being cooled. The rate of thermal conduction in living tissue is such that it takes a few minutes for conductive cooling to reach muscle tissue. Likewise, the temperature difference between muscle tissue and adipose tissue is significantly less than the difference between the skin and an ice pack. This leads to a smaller decline in temperature within the muscle.

Temperature decreases at 1 cm into the muscle tissue (decrease of 9.7°C, ice; 12.7°C, ice + compression) were less than those reported by Lowden and Moore[16] (decrease of 17.9°C). These comparisons are somewhat crude because Lowden and Moore reported measurements 2 cm from the skin surface in the biceps. In studies using the thigh, McGowen[17] reported temperature decreases of 7°C at an unknown depth, and Hobbs[11] reported decreases of 2.3°C at 4 cm and 6 cm, and 2.8°C at 7 cm. The greater depth of Hobbs' measurement does not allow direct comparison.

At 2 cm, compression alone did not affect deep tissue temperature. The temperature decreases with cold applications (decrease of 8.4°C, ice; 10.1°C, ice + compression) are significantly less than the temperature decreases at 1 cm (decrease of 9.7°C, ice; 12.7°C, ice + compression). They are also less than that reported by Bing et al[3] (decrease of 12°C) at 3 cm from the skin surface. The decreases are greater than reported by Hartviksen[10] (decrease of 7°C), whose measurements (2.5 to 3.5 cm into the gastrocnemius) are slightly deeper. Again, no real comparison can be made to Hobbs,[11] who measured at greater depths than we did. In addition, Hobbs' protocol was different. Rather than using small thermocouples, "... a thermometer was inserted into the thigh of a living person at depths of 4 cm, 6 cm, and 7 cm from the skin surface." This would be likely to cause localized inflammation, skewing his results.

When the ice pack was removed, deep temperature continued to fall for 5 minutes at 1 cm and 7 minutes at 2 cm. Such decreases have been reported by others.[10,32,33] It is likely that these can be attributed to conductive cooling. As was the case when applying the ice, the rate of thermal conduction of the tissue is such that it takes several minutes for deep tissue to be significantly rewarmed. Neither deep temperature nor skin temperature returned to normal for either the ice alone or the ice + compression condition at the end of the 20-minute postapplication period. This agrees with the findings of others.[10,25,32,33] In fact, there is literature to suggest that, at rest, deep temperature will not return to normal for at least 6 hours.[25]

The thickness of the adipose tissue is a major point in determining the rate of temperature decrease, as well as the absolute temperature decrease.[16] The subjects in this study were not athletes. An athletic population would very likely have less adipose tissue, and therefore would experience greater cooling with either of the ice treatments.

Skin surface temperatures cooled and rewarmed at a much greater rate than intramuscular temperatures did. These differences bring into question the validity of using skin temperature as a dependent measure for evaluating the effectiveness of cryotherapy. This is an area requiring further study.

During the postapplication phase, no compression was applied. Based upon compression's effect when combined with ice, postapplication compression may result in slowed rewarming. This too is an area deserving further study.

We commonly combine ice and compression when treating acute injuries because it lowers the tissue temperature, reducing local metabolism, which in turn reduces the amount of secondary hypoxic injury in the area. We use compression to reduce the accumulation of fluids in the injured tissue, thereby reducing the length of time needed for reabsorption of that fluid. Previously, ice was combined with compression in order to get the combination of these effects. We now know that combining ice with compression not only provides the combination of these effects, but also increases the effectiveness of the ice in reducing tissue temperatures. We are then providing a greater reduction in local metabolism and therefore a potentially greater reduction in secondary hypoxic injury, possibly allowing the athlete to recover sooner.

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Examination Of The Law Of Grotthus-Draper: Does Ultrasound Penetrate Subcutaneous Fat In Humans?

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Abstract: *One benefit of ultrasound over infrared modalities is its ability to penetrate subcutaneous fat. The purpose of this study was to compare tissue temperature rise during ultrasound treatments in humans with various thicknesses of subcutaneous fat in the medial gastrocnemius. Twenty males served as subjects. A 23-gauge hypodermic needle microprobe was inserted 3-cm deep into the medial portion of the anesthetized gastrocnemius, and connected to a thermocouple temperature gauge. We applied 15 ml of ultrasound gel, preheated to body temperature (37°C), to a 10-cm-diameter target area. Continuous ultrasound was delivered topically at 1.5 W/cm² for 10 minutes. During this time, the soundhead was moved at a speed of 4 cm per second, and the temperature was recorded every 30 seconds. The mean baseline temperature for all subjects was 35.4°C. The mean temperature increase was 4.9°C. We performed a regression analysis to test for correlation between fat thickness and tissue temperature rise of subjects. There was a small positive but insignificant correlation (r=.128). This supports the claim of Grotthus and Draper. Since subcutaneous fat does not serve as a barrier to therapeutic ultrasound, athletic trainers and physical therapists can expect comparable increases in muscle temperature when using this modality on people with varying thicknesses of adipose tissue.*

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Therapeutic ultrasound has been used for healing wounds,[2,5-8,10,18] relieving pain,[15,20] eliminating calcium deposits,[4] increasing tendon extensibility,[2,16] treating plantar warts,[3,11,16,17,19] decreasing joint stiffness, reducing muscle spasms, and increasing blood flow.[16] Ultrasound is often preferred over other thermal modalities, due to its greater depth of penetration. Most heating modalities, such as whirlpool, paraffin, and hot packs, heat the tissues to about 1-cm deep.[1,15,16] Ultrasound and diathermy have a depth of penetration up to 5 cm.[16] This depth of penetration is extremely beneficial when dealing with a multitude of sport and recreational injuries.

The Law of Grotthus-Draper describes tissue effects on ultrasound energy.[9,14,16] In accordance with the law, ultrasound: 1) penetrates through tissues high in water content, 2) is absorbed in tissues high in protein, 3) reflects off bone, and 4) refracts through joints. Due to the properties of fat, ultrasound will penetrate it easily and focus energy on muscle, where the sound is absorbed. We have not found any *in vivo* studies performed on humans in which ultrasound's ability to heat tissues through various thicknesses of fat was investigated. The purpose of our study was to measure tissue temperature at 3-cm depth during ultrasound treatments on humans of various skinfold thicknesses in the lower leg.

Methods

Procedures for this study were approved by the university's Human Subject Research Board. In all, 20 males (age=23±2.2 yr) participated in the study. The subjects' mean calf skinfold was 12.6±6.1 mm, with a range of 4 to 30 mm.

In order to determine how much fat existed between the skin surface and our target tissue (3-cm depth), we measured skinfold thicknesses of the belly of the calf with a caliper (Slimguide, Creative Health Products, Plymouth, Mich). Since the skinfold consisted of two thicknesses of fat, we divided each subject's skinfold by two. This gave us the thickness of the layer of fat and skin between the ultrasound head and the muscle. We subtracted this figure from 3 cm to determine how deep in the muscle the thermistor was. For example, if a subject had a skinfold thickness of 1 cm, 0.5 cm of this was one layer of fat. The needle was 3-cm deep into the tissue, so 3 cm - 0.5 cm = 2.5 cm of muscle thickness.

Since the experiment included inserting a heat-sensitive thermistor, we put subjects on an antibiotic therapy program to reduce the risk of infection. One 500-mg dose of cephalexin hydrochloride (Keftab) was taken 6 hours before the experiment and three more doses were administered afterwards at 6-hour intervals.

A 10-cm-diameter area on the center of the belly of the right medial gastrocnemius of each subject served as the treatment target. We shaved this area and cleansed it with Betadine scrub and 70% isopropyl alcohol. A physician anesthetized the skin with a subcutaneous

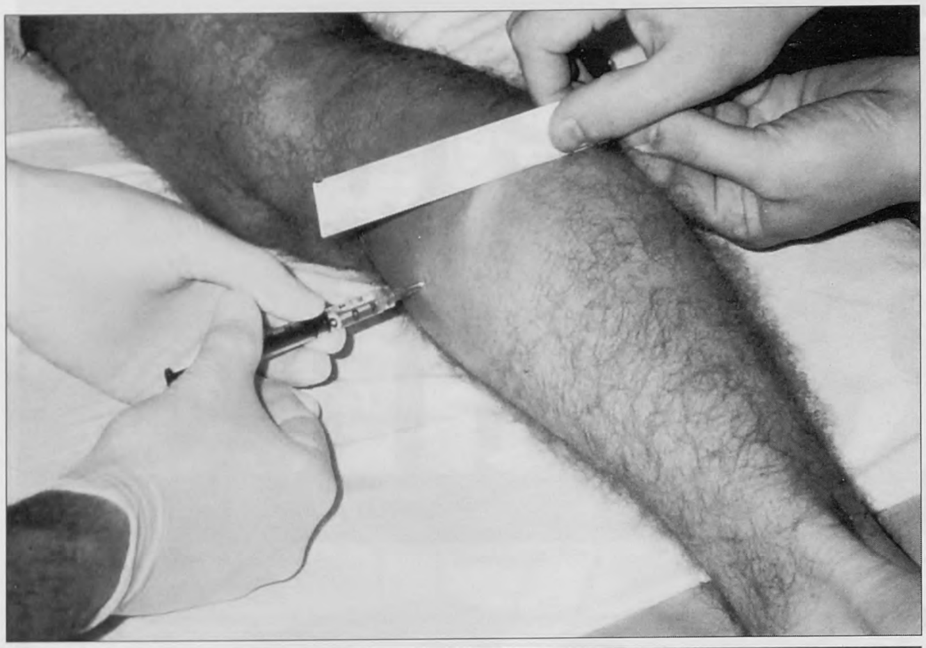

Fig 1.—Prior to the insertion of the needle microprobe, a physician anesthetized the area with an injection of 0.5 cc of lidocaine (Xylocaine). It was through this hole that the thermistor was inserted.

injection of 0.5 cc of 1% lidocaine (Xylocaine) (Fig 1).

A physician inserted a 23-gauge hypodermic needle microprobe into the belly of the right medial gastrocnemius muscle while the subject lay prone. Since we wanted to measure muscle temperature, the probe was inserted 3-cm deep, well below the depth of subcutaneous fat. The distance from the soundhead to the thermistor tip was 3 cm. This needle thermistor was connected to a digital monitor, which displayed the temperature in °C.

We applied 15 ml of 37°C ultrasound gel to the treatment area. After the intertissue temperature reached a baseline, we began the ultrasound treatment. We used the Sonicator 706 (Mettler Electronics, Anaheim, Calif) for ultrasound treatments. The generator operates at a frequency of 1.0 MHz. The 5-cm-diameter transducer houses a barium titanate crystal. We used continuous ultrasound at an intensity of 1.5 W/cm^2. We moved the sound head along the skin in a longitudinal overlapping manner at a speed of 4 cm/s (Fig 2). These strokes were three to four times the size of the soundhead in an area 10 cm in diameter. We recorded the temperature to the nearest 0.1°C every 30 seconds for 10 minutes, or until there was no temperature increase on three consecutive readings. After we completed the 10-minute ultrasound treatment, a nurse removed the thermistor. No complications or infections occurred to the subjects from this study.

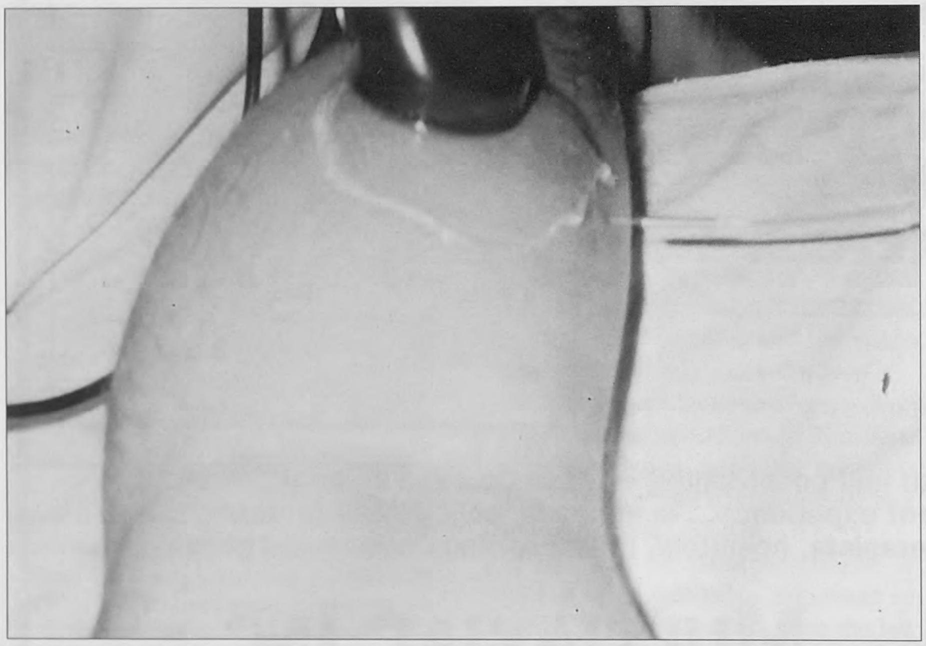

Fig 2.—Application of ultrasound showing the needle microprobe inserted in the medial gastrocnemius at 3-cm depth.

Results

The average baseline temperature was 35.4±1.2°C and the mean temperature plateau was 40.3±1.63°C, which was a muscle temperature increase of 4.9±1.43°C.

Because of the nature of this study, we used two statistical procedures to assess the data. First, we performed an analysis of variance to see if there was a temperature difference between two groups; those with <10 mm of subcutaneous fat and those with >10 mm of subcutaneous fat in the calf (n=10 for each group). Subjects with <10mm had an average temperature increase of 4.9±1.0°C, while those with skinfolds >10 mm recorded mean temperatures of 4.8±1.7°C, a nonsignificant difference ($F(1,18)=.96$, $p=.34$).

Since the range in skinfolds was fairly large (4 mm to 30 mm; $\bar{X}=12.6\pm 6.1$ mm), we also performed a regression analysis to determine if there was a relationship between the amount of subcutaneous fat and tissue temperature rise in the leg. There was a small, positive correlation ($r=.128$) which was not significant ($F(1,19)=.32$, $p=.58$).

Discussion

Many thermal agents are available for treating athletic injuries. Generally these fall into two groups: superficial or infrared agents, and deep-heating agents. Infrared agents frequently used in athletic training are: Hydrocollator packs, paraffin baths, and whirlpools. It is generally believed that no form of infrared energy can penetrate greater than 1 cm into tissue.[1] One possible explanation for this is that superficial fat serves as a barrier to this energy.[12,13] When selective heating of deep tissue is desired, the modality of choice is ultrasound.

The ability for ultrasound to penetrate through fat has been tested using laboratory animals. Lehmann and colleagues[13] used a thermistor system much like ours to measure temperatures in various structures of the knee joints of pigs. They reported that the highest temperatures occurred in the superficial bone and in the meniscus. The next highest temperatures were in the joint capsule, while the lowest temperatures were recorded in the overlying soft tissues, especially the fat.

Lehmann and coworkers[12] also measured the effects of ultrasound on temperature elevation in humans, using a thermistor system. Each subject received two treatments, one at 1.0 W/cm^2 and the other at 1.5 W/cm^2. Treatments lasted 15 minutes, or until the subject complained of pain. In subjects with 8 cm of soft tissue thickness from the skin to the bone, the temperature increased as the intensity of the ultrasound unit was increased. We have shown, like Lehmann and associates,[12,13] that ultrasound can penetrate through subcutaneous tissues, including fat. Yet, we have extended their work by comparing the tissue temperature increases in subjects with varying thicknesses of fat. Based upon the results of our study, we believe that 1 MHz ultrasound is absorbed little in superficial tissues and will penetrate equally through various thicknesses of subcutaneous fat.

The results of this study support the postulation of Grotthus and Draper[9,14,16] and have merit for anyone involved in using therapeutic ultrasound for increasing the temperature of muscle tissue up to 3-cm deep. Since fat serves as a barrier to superficial heating agents, whirlpool, paraffin, and hot packs are not effective in causing deep tissue temperature increases, especially in subjects with much adipose tissue.[1,15,16] We conclude that athletic trainers and physical therapists can use ultrasound to treat deep injuries in athletes or patients with varying thicknesses of adipose tissue.

Acknowledgments

We would like to thank Dennis W. Cappitelli, MD, Charles A. Limp, MD, and Glenn Weiss, MD, for their assistance with this study.

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An Overview Of The Physiology And Pharmacology Of Aspirin And Nonsteroidal Anti-inflammatory Drugs

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Abstract: *In this article, I present an overview of the actions and effects of aspirin and nonsteroidal anti-inflammatory drugs (NSAIDs). Although athletic trainers cannot prescribe or dispense prescription medications, they should be as aware of their effects as they are of other methods of injury treatment. To set the discussion in proper perspective, the inflammatory process and its mediators are reviewed briefly. The eicosanoids are a family of very active chemicals, which include: the prostaglandins, thromboxane, and the leukotrienes. They affect inflammation as well as numerous other body processes. Ingesting aspirin and NSAIDs blocks the production of prostaglandins and thromboxane, resulting in desired and undesired effects. The NSAIDs were developed to have the same action as aspirin, but with fewer adverse side effects. Many NSAIDs are currently available, and the decision as to which agent to use depends upon various factors. Surprisingly, recent studies suggest that some NSAIDs may hinder the healing process. Although not a NSAID, acetaminophen has many important clinical uses. Armed with an understanding of how these drugs act, and their potentially harmful aspects, the athletic trainer can assist the team physician in designing an aspirin- or NSAID-therapy regimen.*

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Every day, athletic trainers administer therapeutic modalities, such as electrical stimulation and ultrasound, as per the advice and guidance of the team physician. The purpose of such therapy is to bring about a rapid and complete resolution of the injury. The treatment plan is devised and agreed upon by the athletic trainer and the team physician, each drawing upon his/her education and past experiences to develop the most beneficial program. In recent years, that treatment plan has come to include prescription and over-the-counter (OTC) nonsteroidal anti-inflammatory drugs (NSAIDs) on a regular basis.

The use of NSAIDs and aspirin in the treatment of sports-related injuries has increased in conjunction with the growing popularity of sports and exercise.[18] In fact, there were 70.3 million NSAID prescriptions filled in the United States in 1991.[3] Past studies have shown that NSAIDs and aspirin, when included with traditional acute injury therapy, decrease pain and swelling and hasten an athlete's return to competition.[18] Chronic injury research has been less extensive, but results indicate that certain NSAIDs have positive analgesic and significant anti-inflammatory properties.[6] Recent research suggests, however, that some NSAIDs may actually slow the mechanism of tissue repair.[4,8,10,15] As a note of clarification, aspirin is technically a NSAID, but is not included in the generic term which describes the newer agents.

Obviously, athletic trainers cannot prescribe medications to injured athletes. Why, then, is this a relevant area of discussion? If the athletic trainer understands the actions, indications, and side effects of these agents, he/she can then play as large a role in NSAID-therapy decisions as in any other rehabilitation plan. An understanding of drug actions and effects also enables the athletic trainer to educate athletes about the treatment plan and the symptoms that may result from aspirin or NSAID therapy.

Legal Aspects

Laws regulating an athletic trainer's administration of various electronic modalities differ from state to state. The laws regarding our role in dispensing and administering prescription medication, though, are quite clear. Under current law, physicians cannot delegate the authority of prescribing, administering, or dispensing prescription medications to athletic trainers.[24] Laws governing dispensing OTC medications also vary by state.[38] I recommend that athletic trainers currently involved in the dispensing of either prescription or OTC medications immediately become familiar with, and conform to, state laws and/or the guidelines of their governing body (NCAA, NAIA, National High School Federation, etc) or school district (See Whitehill, etal[38]).

The Inflammatory Response

To set our discussion in proper perspective, a brief review of the inflammatory response is necessary. Inflammation is the response of vascular tissue to physiological damage. The response prevents the extensive spread of injury-causing agents to nearby tissues, disposes of cellular debris, and sets the stage for the repair process.[21] The process begins with the initial tissue trauma. Following a short period of vasoconstriction, the cellular injury signals the release of chemical mediators, such as histamine, bradykinin, thromboxane, leukotrienes, and prostaglandins.[34] These chemical mediators increase cellular and capillary permeability and stimulate capillary vasodilation. The changes in vascular permeability directly result in edema, due to the flow of fluid into the interstitial space.[32] The increased blood flow and permeability allow for white blood cells to migrate toward the injury site, infiltrate the site, and initiate the healing process.[5] Within 48 hours of the initial insult, fibroblasts begin the process of wound repair and collagen synthesis.[32]

The inflammatory response is essential to the resolution of the injury. However, excessive edema, coupled with vascular damage, can disrupt the flow of oxygen to the healthy tissue surrounding the injury site. The resultant hypoxia can lead to further tissue damage, appropriately referred to as secondary hypoxic injury.[17]

The use of cryotherapy and other modalities in an effort to decrease pain and inflammation have been understood by sports medicine professionals for several years.[17] The following discussion will shed light upon the specific roles played by various chemical mediators in the inflammatory response and how physician-prescribed and -administered pharmaceuticals affect that process.

The Eicosanoid Family

As noted earlier, the prostaglandins, thromboxane, and the leukotrienes all play a role in the inflammatory response. They are all members of the eicosanoid family, derivatives of the 20-carbon fatty acid molecule arachidonic acid (Fig 1). Arachidonic acid is a component of cell membranes and must be released from the membrane prior to its being synthesized to an eicosanoid. Once free, arachidonic acid can be converted to either an initial leukotriene or to a common prostaglandin and thromboxane precursor via two separate pathways. Aspirin and NSAIDs exert their effects by blocking the production of prostaglandins and thromboxanes. Most of these agents have little or no effect upon leukotriene synthesis.

Leukotrienes

Leukotrienes are synthesized from arachidonic acid by the action of the enzyme lipoxygenase. The leukotrienes consist of a family of chemicals which function to mediate chemotaxis, increase vascular permeability, and activate leukocytes.[12] Most pharmacologic agents which block leukotriene production have been too unspecific or toxic so far to use therapeutically.[12]

Prostaglandins and Thromboxane

The prostaglandins represent a variety of very important chemicals that are produced by almost every tissue of the body. Different prostaglandins play various roles in many physiological processes. Those roles are examined in the following discussion and outlined in Table 1.

Mediation of Inflammatory Process. The term mediation is important in describing the activities of prostaglandins. On their own, prostaglandins do not appear to be capable of inducing either pain or edema.[13] They are capable, however, of directly causing vasodilation, but are dependent upon histamine and bradykinin to increase the permeability of the blood vessels. In addition, prostaglandins act synergistically with other chemicals to sensitize pain receptors to mechanical and chemical stimulation.[23]

Fever Mediation. Prostaglandins have been implicated in the role of fever mediation through their release into the hypothalamus. The hypothalamus acts

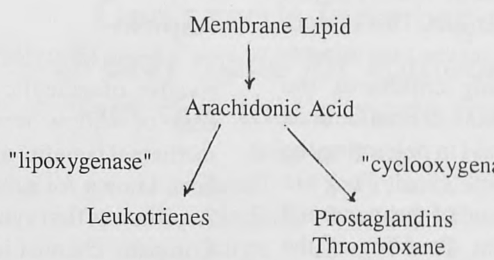

Fig 1.—The stepwise synthesis of the eicosanoid family. Quotation marks denote the enzymes involved in the pathway.

Table 1.— A Summary of the Major Effects of the Eicosanoids

Eicosanoids	Major Effects
Leukotrienes	Chemotaxis
	Leukocyte activation
	Increase in vascular permeability
Thromboxane	Platelet aggregation
Prostaglandins	Mediation of inflammation
	Increase in vascular permeability*
	Sensitization of pain receptors*
	Mediation of fever
	Induction of uterine contractions
	Inhibition of gastric secretion
	"Cytoprotection" of gastric mucosa
	Systemic and renal vasodilation
	Inhibition of platelet aggregation

Note: asterisk denotes synergistic actions.

as the thermoregulatory control center of the body. Although the exact mechanism remains unknown, injection of specific prostaglandins into the cerebral ventricles of animals causes an increase in body temperature.[33]

Gastric Protection. Prostaglandins interact in a number of ways to protect the delicate lining of the gastrointestinal system. They appear to inhibit gastric acid secretion and may have an anti-ulcer effect.[31] Prostaglandins also appear to have the property of "cytoprotection," the ability to protect the gastric mucosa from exposure to harmful substances. Though the mechanism is unknown, cytoprotection may result from a specific prostaglandin which stimulates mucous formation.[31]

Reproductive System. In the uterus, prostaglandins act to stimulate the contraction of the smooth muscle layer, known as the myometrium. This smooth muscle contraction serves two important purposes. During childbirth, the prostaglandin-stimulated contractions of the myometrium aid in delivering the baby through the birth canal. They are also released at the end of the menstrual cycle to facilitate the shedding of the uterine lining by stimulating muscular contractions.[14] These continuous contractions can result in ischemic pain, referred to as "cramping" or primary dysmenorrhea.

Renal Blood Flow. During exercise, the autonomic nervous system releases into the bloodstream chemicals which act as potent vasoconstrictors in many peripheral tissues, including the kidneys. Prostaglandins can serve to dilate renal blood vessels, counteracting those chemicals, thus maintaining a constant flow of blood to the kidneys.[26] This action of the prostaglandins appears to be more significant if the kidneys are functioning abnormally.[16]

Other Effects. A specific prostaglandin, prostacyclin, is released by the internal lining of the blood vessels. This substance appears to inhibit the aggregation of blood platelets on blood vessel walls. Also highlighting the importance of prostaglandins, a recent study suggests that they may promote the repair of cartilage by inhibiting the action of interleukin-1.[9] This discovery could be of major importance for people suffering from rheumatoid arthritis.

Thromboxane

Thromboxane, produced in blood platelets, functions as a powerful inducer of blood platelet aggregation to aide in the clotting mechanism.[12] Therefore, thromboxane and prostacyclin have an antagonistic relationship. This stands as a good example of how prostaglandins are used naturally to attenuate the actions of other chemicals in a variety of tissues.

This basic discussion of the inflammatory response and the properties of the arachidonic acid derivatives sets the stage for discussing how aspirin and the different NSAIDs can affect these processes.

Aspirin

Aspirin (acetylsalicylic acid) is a derivative of salicylic acid. Found in the bark of willow trees, salicylic acid's medicinal benefits and side effects have been known for more than 2000 years. Aspirin was first synthesized by a Bayer Company chemist in the late 19th century. It proved to be far less of a gastric irritant than salicylic acid and was introduced to the marketplace in the spring of 1899. Heralded as a wonder drug, it quickly became one of the most widely used pharmaceutical products in the world. Annual aspirin consumption in the United States now ranges between 26 and 74 million pounds.[23]

Surprisingly, aspirin's mechanism of action has been known only since 1971. John Vane discovered that the aspirin molecule transfers a functional group onto the cyclooxygenase enzyme.[35] As a result, the enzyme is irreversibly inhibited and unable to bind arachidonic acid; therefore, the enzyme can no longer convert arachidonic acid to prostaglandins and thromboxane.

Effects of Aspirin

Following the ingestion of aspirin (3000 to 6000 mg per day for anti-inflammatory action), a series of chemical events results from the blockage of cyclooxygenase. The decrease in prostaglandin production leads to a corresponding reduction in inflammation and edema.[16] The inhibition of prostaglandin and thromboxane synthesis may not be the only effect that aspirin exerts upon the tissues. In some systems, aspirin might impinge upon the formation of 12-HETE, a leukotriene derivative that acts as a chemotactic agent.[16] Aspirin might also reduce inflammation and pain by influencing the migration of chemical potentiators, such as neutrophils and monocytes, and activate neutrophils as well.[16]

Negative consequences might also result from aspirin use. In the gastrointestinal tract, aspirin can cause gastric upset, bleeding, and even ulcers. Various studies have shown an incidence of anywhere from 2% to 40%, depending upon the parameters of the investigation.[16] It does not appear that the gastrointestinal side effects are due to inhibiting prostaglandin synthesis alone, although this area is controversial.[16,28]

The mechanism of gastric irritation does, however, appear to be related to the direct effect of aspirin upon the lining of the stomach.[19] Unbuffered aspirin lowers the electrical potential of the gastric membrane, which then affects the flow of hydrogen ions. Davenport's theory contends that this disruption of hydrogen ions triggers a series of events which lead to gastric erosion and bleeding.[16] Studies have shown that enteric-coated aspirin does not cause as many abnormalities in the stomach lining, due to its buffering action.[16] Mild gastrointestinal upset often can be avoided if aspirin is taken with a meal, due to the "buffering" action of the food.

Aspirin use can also result in complications such as prolonged bleeding time and tinnitus. Prolonged bleeding time results from the inhibition of thromboxane. Since aspirin irreversibly binds to cyclooxygenase, the decreased platelet function lasts from 4 to 6 days (the platelet lifespan) following aspirin intake.[28] In addition, many people taking high doses of aspirin develop a ringing in their ears (tinnitus). It probably is due to an effect upon the inner ear, rather than the central nervous system, and often results from a dosage that is too high.

Reye's Syndrome

First described in 1963, Reye's syndrome is a rare and potentially devastating acute illness that usually strikes children following a viral infection. For several years, epidemiological data suggested a relationship between Reye's syndrome and aspirin use by children infected with either the influenza or chicken pox virus. Those early reports were criticized highly. More recently, a study conducted by the Centers for Disease Control linked aspirin and other salicylates to the occurrence of Reye's syndrome when administered in the management of viral illnesses.[7] Based upon current knowledge, it would appear prudent to not allow anyone under the age of 18, who may have a viral infection, to use aspirin and other salicylates.

Although the cause of Reye's syndrome is unknown, it is known that the illness impairs mitochondrial function, resulting in liver and neurological damage.[37] In 1974, Lovejoy et al[20] proposed a five-stage system on which to chart the symptoms of Reye's syndrome (Table 2).

Reye's syndrome is a potentially fatal condition, and the symptoms must be treated as a medical emergency. However, a diagnosis can be made only through various laboratory tests.

The NSAIDS

In the latter half of this century, chemists have used aspirin as a prototype to develop the group of drugs known as NSAIDs. The main goal of this research is to produce agents that do not present aspirin's sometimes severe side effects. Although there are differences in potency, specificity, and specific mechanisms of action, all NSAIDs inhibit the activity of cyclooxygenase in some manner.[13] The inhibition is not an irreversible reaction like aspirin, but instead, dependent upon concentration.[28]

Along with blocking cyclo-oxygenase, NSAIDs are thought to have additional properties. Possible activities include modulation of T-cell function, inhibition of inflammatory cell chemotaxis, lysosomal membrane stabilization, and free radical scavenging.[2,28] The beneficial activities of the different NSAIDs seem to be quite similar, although there are some differences in action and side effects.

Many different chemical classes and brands of NSAIDs are currently available. New NSAIDs are introduced to the market monthly. The following discussion represents a clinical overview of frequently used chemical classes of NSAIDs (Table 3), as well as those agents with special clinical significance and their standard prescription dosages. The doses listed are for anti-inflammatory action unless otherwise noted. Analgesic doses tend to be 50% to 75% of inflammation-fighting doses.

Ibuprofen (Advil, Motrin, Nuprin)

A propionic acid derivative, ibuprofen is the most frequently prescribed NSAID.[3] It boasts aspirin's potency for analgesic and anti-inflammatory action, but has a lower incidence of side effects. This reduced incidence may be linked to ibuprofen's decreased inhibition of platelet aggregation, lessening possible gastric bleeding.[33] In addition, it appears that ibuprofen may be the most beneficial NSAID for easing the pain of primary dysmenorrhea. A prescription regimen consists of 2200 to 2400 mg per day, taken in three separate doses.[7,22,25] Such a schedule enables it to be taken at meal times, lessening the likelihood of gastric irritation, as mentioned above, and may improve compliance. Daily dosage should not exceed 3200 mg.[2]

Naproxen (Naprosyn)

The second most-prescribed NSAID, naproxen is chemically similar to ibuprofen.[3] Naproxen is 20% more potent than aspirin, with side effects much like ibuprofen.[33] In comparison to ibuprofen, naproxen was marginally superior in decreasing joint inflammation.[25] Due to naproxen's long half-life, the daily recommended dosage of 750 to 1000 mg can be taken on a twice daily schedule, reducing gastric upset due to only two daily exposures.[2,7] Naproxen is eliminated from the body mainly by way of the kidneys; therefore, it should be used with caution in persons with renal complications.[2]

Fenoprofen (Nalfon)

This agent deserves special mention because it appears to be more damaging to the kidneys than other NSAIDs of the propionic class.[28] The reason for this apparent relationship is unknown. However, in a study of people suffering from rheumatoid arthritis, fenoprofen was

Table 2.— Stages of Reye's Syndrome

Stage	Signs and Symptoms
1	Vomiting, Lethargy, Indifference
2	Delirium, Hyperventilation, Combativeness
3	Light coma, Hypoventilation, Intact pupillary response, Decorticate posturing
4	Deep coma, Loss of spontaneous ventilation, Decerebrate posturing, Fixed and dilated pupils
5	Flacidity, Seizures

Adapted from Lovejoy, et al.[20]

Table 3.— Chemical Classes of NSAIDs

Carboxylic Acids			Enolic Acids		
Propionic	Acetic	Salicylic	Oxicams	Pyrazolones	Pyrrolopyrrole
Naproxen Ibuprofen Fenoprofen	Indomethacin Tolmetin Diclofenac	Aspirin	Piroxicam	Phenylbutazone	Ketorolac

Table 4.— Cost of NSAID Therapy

Drug	Usual Dosage	Cost
Diclofenac sodium-*Voltaren* (Geigy)	50mg tid or 75mg qid	$36.07
Fenoprofen-*Nalfon* (Dista)	300-600mg tid or qid	$31.45
Ibuprofen-*Motrin* (Upjohn)	600-800mg tid or qid	$15.50
Indomethacin-*Indocin* (MSD)	25mg tid or qid	$20.36
Indocin-RS (MSD)	75mg once or bid	$18.90
Naproxen-*Naprosyn* (Syntex)	375-500mg bid	$25.75
Piroxicam-*Feldene* (Pfizer)	20mg once per day	$37.41
Tolmetin-*Tolectin* (McNeil)	200-400mg tid or qid	$32.72

Cost of treatment is the pharmacist's wholesale cost for a 14-day treatment at the lowest usual dosage for anti-inflammatory effect. Prices from 1993 *Redbook*.[30]

Table 5.— Drugs Which May Interact With NSAIDs and Their Common Clinical Uses

Drug	Common Use
Angiotensin-converting enzyme (ACE) inhibitor (Capoten, others)	Treatment of hypertension
Anticoagulants (Coumadin, Panwarfin)	Prophylaxis and treatment of pulmonary embolism and venous thrombosis
Beta Blockers (Inderal, others)	Decrease cardiac output and peripheral vascular resistance
Diuretics (Lasix, others)	Promote the excretion of urine
Lithium	Treatment of manic depression
Methotrexate	Treatment of cancer
Metoclopramide (Reglan)	Anti-emetic
Phenytoin Sodium (Dilantin)	Treatment of seizure disorders
Probenecid (Benemid)	Treatment of gout, maintenance of serum levels of cephalosporins or penicillins
Sulfonylureas (Glucotrol, others)	Treatment of noninsulin-dependent diabetes

found to have fewer gastrointestinal side effects than the other NSAIDs to which it was compared.[28] Usual dosage consists of 300 to 600 mg, three or four times daily, with total dosage not exceeding 3200 mg.[2] Due to the increased incidence of renal damage, fenoprofen should be used cautiously.

Piroxicam (Feldene)

Although derived from a different chemical group, piroxicam has properties similar to ibuprofen, naproxen, and fenoprofen. Piroxicam's most important asset lies in its once-a-day dosage schedule of 20 mg.[2,7] The single daily dose greatly benefits compliance, and gastrointestinal irritation can be decreased even more if the drug is taken with the largest meal of the day.[6] Piroxicam has been found to increase the percentage of suppressor T cells in peripheral blood and to inhibit neutrophil migration.[2,28] Such research suggests that a person with a cold or other infection should avoid the drug. Piroxicam is cleared from the plasma mainly by the liver; hence, it can be administered to people with renal deficiency.[28]

Tolmetin (Tolectin)

Tolectin is chemically different than the previously discussed NSAIDs, but has similar effects. The most frequently reported side effect is gastrointestinal disturbance.[2] When given in conjunction with acetaminophen, the analgesic properties of tolmetin are enhanced.[2] Tolmetin is administered in three or four doses of 200 to 400 mg. A daily dose of 1200 to 1500 mg roughly approximates 2400 mg of ibuprofen.[28]

Diclofenac Sodium (Voltaren)

As with other NSAIDs, diclofenac inhibits the synthesis of prostaglandins and thromboxane. However, it also reduces the amount of arachidonic acid made available from the cell membrane, thereby decreasing the amount of leukotrienes produced as well.[2] Standard dosage is 50 mg three times per day or 75 mg twice a day.[2] In addition, renal damage may be associated with diclofenac less frequently, but this is yet to be verified.[2]

Indomethacin (Indocin)

Indomethacin, introduced in 1963, was one of the first NSAIDs developed and continues to be among the most powerful inhibitors of cyclo-oxygenase.[18] Although particularly effective in maladies such as rheumatoid arthritis, ankylosing spondylitis, and gout arthritis, indomethacin is not recommended for use as a simple analgesic or antipyretic due to potentially severe side effects such as gastrointestinal disturbances and headaches.[2] Daily dosage ranges from 75 to 100 mg taken in three or four doses.[2] Prolonged release formulas are available (75 mg one to two times per day); however, gastrointesinal and other adverse effects appear to be similar to those associated with the regular formula.[2]

Ketorolac Tromethamine (Toradol)

Recently introduced, ketorolac is the first NSAID to be available for intramuscular injection, as well as oral administration. Although it also has anti-inflammatory and antipyretic properties, it currently is being marketed only as an analgesic, particularly for postoperative patients.[2] Studies have shown ketorolac to be equal to, or more effective than, morphine.[27,39] Although administered intramuscularly, damage to the gastrointestinal mucosa still occurs. However, doses of 10 to 30 mg given 4 to 5 times per day produced less mucosal injury than 650 mg of aspirin using the same dosage schedule.[2] The maximum recommended daily dose is 150 mg for the first day, followed by no more than 120 mg per day for the remainder of the regimen.[2] Ketorolac represents an exciting step in NSAID development, an agent with the analgesic efficacy of morphine, easily delivered, and nonaddictive.

Phenylbutazone (Butazolidin)

Introduced in 1949, phenylbutazone has decreased in popularity with the development of less toxic NSAIDs. Its use is recommended only after other NSAID therapies have failed, and then only if the physician and patient decide that the benefits outweigh the risks of therapy.[2] The long-term use of phenylbutazone can result in various blood dyscrasias, including aplastic anemia (destruction of red bone marrow) and severe hepatic reactions.[28] At the present time, phenylbutazone's significance is more historical than clinical.

Choosing an NSAID

The main considerations in the design of an NSAID- or aspirin-therapy regimen are efficacy of the agent, patient compliance, adverse side effects, and cost of treatment. Incidence and severity of side effects weigh heavily upon compliance and treatment cost. Compliance is attained more easily if the drug causes minimal discomfort and the dosage requirements easily fit into the patient's schedule. The cost of treatment can be a difficult figure to attain because there are other factors besides the cost of the drugs which are listed in Table 4. An inexpensive option, such as aspirin, can become quite expensive if an ulcer or other gastrointestinal pathology develops and requires more medication or even hospitalization.[6]

An additional factor to consider in designing an NSAID program has recently been discovered. Several studies have shown that NSAIDs may have the ability to slow the healing process. In a study conducted by culturing rabbit articular cartilage chondrocytes in the presence of certain NSAIDs, diclofenac and indomethacin (and piroxicam to a lesser degree) inhibited the secretion of proteoglycans.[8] Proteoglycans are extracellular molecules involved in the formation of cartilage, tendons, and ligaments. They are vital to the process of tissue repair. Other studies have shown that indomethacin and aspirin can interfere with the synthesis or transport of such connective tissue components.[4,10,15]

In contrast to the findings above, a recent study indicated that indomethacin, diclofenac, and piroxicam are capable of suppressing enzymes responsible for the degradation of collagen and cartilage.[36] Such results indicate that NSAIDs may diminish the process of osteoarthritis. These areas of NSAID activity are certain to be the focus of intensive investigation and controversy for the next several years.

Controversy also exists over when an NSAID regimen should begin following an acute injury. Some feel drug therapy should be initiated immediately along with rest, ice, compression, and elevation (RICE) in an attempt to arrest the inflammatory process. Others believe that NSAID therapy should begin no sooner than 24 hours following the injury and implementation of RICE, the idea being that the NSAIDs blockage of thromboxane synthesis will promote additional bleeding. Evidence on either side of the argument is largely anecdotal, most coming from the clinical setting. Very little research exists in this area.

Drug Interactions

NSAIDs bind strongly to plasma proteins, thus competing for binding sites with other agents. Usually, such interactions are of little clinical significance, except when NSAIDs are used in conjunction with other highly bound drugs (Table 5). Therefore, caution should be taken before combining NSAID therapy with drugs such as methotrexate, phenytoin sodium (Dilantin), warfarin sodium (Coumadin, Panwarfin), captopril (Capoten), and ionically bound oral hypoglycemics.[1] Concomitant use of NSAIDs and lithium has resulted in lithium toxicity due to a decrease in the renal clearance of lithium.[1] Owing to the variability of possible reactions and the large number of potential reactive agents, I recommend that the athletic trainer keep a list of ALL medications each athlete is taking so that the information can be readily available to the physician and athletic trainer when designing a NSAID-therapy regimen.

Acetaminophen

Although not an anti-inflammatory agent, acetaminophen (Tylenol, Anacin 3) is an important drug and deserves our attention, due to its clinical uses. Acetaminophen, discovered in 1877, has analgesic and antipyretic properties through its actions upon the central nervous system. Acetaminophen has no anti-inflammatory properties because it cannot inhibit cyclooxygenase in the peripheral tissues.[29] So, it does not present complications such as gastrointestinal disturbance and prolonged bleeding time. Therefore, acetaminophen is indicated for mild pain and fever in those who are either contraindicated for aspirin use due to Reye's syndrome risk (see above) or those who cannot tolerate aspirin or NSAIDs. Usual dosage of acetaminophen is 325 to 650 mg at 4-hour intervals.[2]

Acetaminophen, like all drugs, can be a toxic substance if abused. The minimum toxic dose in adults is 5 to 15 g.[11] Overdoses or prolonged overuse (5 to 8g per day for several days) might result in severe hepatic damage or death.[2] The liver damage appears to be produced by a metabolite of acetaminophen. In therapeutic doses, the toxic metabolite is detoxified by glutathione; however, with extreme intake, if the glutathione drops below 30% of normal values, tissue necrosis occurs.[11]

Conclusion

Aspirin and NSAIDs currently play an important role in the treatment of musculoskeletal injuries and other disease processes. In many instances, they can be as important in the rehabilitation program as the traditional modalities which all athletic trainers apply and understand. The fact that we cannot prescribe or dispense these medications should not discourage interest in the subject.

The field of NSAID pharmacology is constantly changing, making it difficult to follow every new development and study. The knowledgeable and informed athletic trainer can be a valuable ally to the team physician by following NSAID developments. Additionally, the athletic trainer is in the best position to monitor compliance and the occurrence of side effects. This type of working relationship with a physician can only serve to improve the level of care given to athletes and patients.

Acknowledgments

I would like to thank Brent Mangus, EdD, ATC, Bernie Chavies, ATC, Marsha Chavies, ATC, Grace Golden, ATC, and Gerald Higgins, MD, for their direct and indirect contributions to this paper.

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16th Annual NATA Student Wrting Contest

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

1. This contest is open to all undergraduate members of the NATA.
2. Papers must be on a topic germane to the profession of athletic training and can be case reports, literature reviews, experimental reports, analysis of training room techniques, etc.
3. Entries must not have been published, nor been under consideration for publication in any journal.
4. The winning entrant will receive a cash reward and the paper will be published in the *Journal of Athletic Training* with recognition as the winning entry in the Annual NATA Student Writing Contest. One or more other entries may be given honorable mention status.
5. Entries must be written in journal manuscript form and adhere to all regulations set forth in the "Authors Guide" section of this issue of the *Journal of Athletic Training*. It is suggested that before starting, students read: Knight KL: Tips for scientific/medical writers, *Athletic Training , JNATA*,25:47-50. NOTE: A reprint of this article, along with other helpful hints, can be obtained by writing to the Writing Contest Committee Chairman at the address below.
6. Entries must be received by March 1, 1994. Announcement of the winner will be made at the Annual Meeting and Clinical Symposium in June, 1994.
7. The Writing Contest Committee reserves the right to make no awards if in their opinion none of the entries is of sufficient quality to merit recognition.
8. An original and two copies of the paper must be received at the following address by March 1, 1994:

NATA Student Writing Contest
Deloss Brubaker, EdD, ATC
Life College
1269 Barclay Circle
Marietta, GA 30060

Abstract: *Surgical observation can be a useful learning experience for student athletic trainers, due to the nature of the injuries they are learning to deal with. Anesthesiology, examination under anesthesia, sterile draping techniques, instrument identification, surgical procedures, and anatomy are among the topics that could be addressed during the observation period. A basic set of guidelines and possible points of interest for the student athletic trainer are suggested in this article.*

Surgical Observation: An Enhancement To The Student Athletic Trainer's Education

Jim Bazluki, MA Ed, ATC

Acquisition of knowledge by student athletic trainers is multi-dimensional. Learning can and should take many forms. We know that learning takes place through reading, observing, participating, and demonstrating. One educational tool that could enhance the student athletic trainer's education is surgical observation. This opportunity may not be available to everyone, but certainly is one that is worth pursuing, if the avenues present themselves. The surgical observation experience could allow advanced student athletic trainers to gain an appreciation of many surgical procedures, such as: anesthesiology, examination under anesthesia, sterile draping techniques, instrument identification, surgical procedures, and anatomy.

In order to benefit most from the opportunity and to help ensure a successful experience, a set of guidelines would be helpful. Some guidelines that I found helpful include: ways to prepare for the observation, what to expect during the surgery, and possible points of interest for the student athletic trainer. An explanation of these points follows. Hopefully, it will help someone to benefit more fully from the surgical observation experience.

The Opportunity

In most established sports medicine programs, good relationships exist between athletic trainers, team physicians, and consultants. Within these relationships is the potential for many educational opportunities that are not always noticed or used advantageously by student athletic trainers. In some cases, the student athletic trainer has little involvement in the process of injury recognition, evaluation, treatment, and rehabilitation of an athlete. While it is understood that the student trainer lacks the experience of the certified athletic trainer, the student still should be involved in the entire process in order to gain as much experience as possible. Some of the best and most meaningful learning takes place through informal instruction.[1]

Orthopaedic consultants play an enormous role in the health care of athletes, due to the nature of many sports injuries. They have a vast knowledge that can be a primary source of information to the student athletic trainer. The majority of the orthopaedic consultant's cases are not life- or limb-threatening, but it is likely that several athletes under his/her care will undergo some type of surgical procedure. This could provide an excellent opportunity for student trainers to observe the orthopaedic surgeon on his/her home turf—the operating room. One can be told and/or read about what happens during a surgical procedure, but the dimension of personal experience adds meaning to the words and pictures. There is no substitute for "being there."

The surgical observation experience is not necessarily an easy avenue to explore. However, considering what one might gain, it makes the attempt worthwhile. The student athletic trainer should request permission to observe the surgery from his/her supervising athletic trainer before approaching the surgeon. Hospital policies and procedures may make the task seem formidable. Most hospitals have an Office of Risk Management, which deals with potentially high-risk situations that need to be addressed in order to avoid possible lawsuits against the hospital or its staff. It is this office that should be contacted to arrange an observation. Some hospitals require that the involved parties sign a consent form, due to the confidentiality of medical procedures. Having the surgeon assist in the arrangements could help cut the red tape.

Preparation

Once the opportunity presents itself and arrangements have been made, it is up to the observer to properly prepare him/herself for the experience. Ways to do this might include: 1) knowing about the injury and the mechanism of injury, 2) previewing videotapes of similar surgeries, 3) being familiar with physical diagnostic exam techniques for the involved injury, 4) reviewing the anatomy of the area involved, 5) becoming familiar with the surgical procedure (technique, goals, and alternatives), and 6) sitting in on the patient's evaluation and consultation with the surgeon, if possible.

Much of this presurgical preparation is related to "book work" or research. Some of the preparatory material may seem complicated and unclear at the

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time, but it is a necessary part of the procedure and should become clearer as the surgical procedure progresses.

The Observation

The observer should arrive at the hospital approximately 30 minutes prior to the scheduled starting time. Dress should be casual, but professional, with comfortable footwear for standing. Jewelry should be minimal or should be left at home. If you have contact lens and glasses, it is advisable to wear the glasses during the observation. Glasses provide better eye protection.

Upon arrival at the hospital, check in at the operating room main nurses' station. Inform them of who you are and why you are there. Be prepared to tell them the surgeon's name, the patient's name, and the scheduled starting time of the operation. The nurses usually will check with the surgeon and the schedule before proceeding. With confirmation of the surgical observation, they will show you where to go. They will give you a set of surgical scrubs (pants and shirt), surgical cap, shoe covers, and a mask to wear. When the time for the operation comes, a nurse or an orderly will show you to the operating room. Before you enter the operating room hallway, you should have your mask on.

When you enter the actual operating room, you will probably see nurses or staff preparing the room and supplies for the next surgery. One of the nurses, called a scrub technician, is usually already wearing a sterile gown and gloves and preparing the surgical instruments and supplies, while another nurse is gathering supplies for the scrub technician to use. After all instruments and supplies are ready for the operation, a nurse will call for the patient to be brought in and for the anesthesiologist to report to the room. The patient will still be conscious in most cases.

When the patient is settled on the operating room table, the anesthesiologist will begin to administer the anesthesia. Areas of interest at this point might include: how the medications are administered, how the airway is secured, and the several techniques used to monitor the patient during the operation. While the anesthesiologist is administering the anesthesia, several alarms that monitor vital signs will sound. This is normal, and there is no need to become alarmed.

After the patient is fully anesthetized, the surgeon will do a final physical exam on the patient. This examination under anesthesia (EUA) is done to help confirm the preliminary diagnosis. It is done because the patient is fully relaxed, and the tests will be more accurate because pain and muscle guarding are absent.

While the surgeon leaves the room to scrub for the operation, the surgical staff positions and drapes the patient. This may include the use of a tourniquet, which may be of added interest. It is best to stand away from the patient during this process, so that you do not contaminate any sterile fields.

Sterile fields and equipment can usually be identified by the difference in color from the rest of the supplies. Most sterile equipment and supplies are placed on specific tables covered with a blue or green covering. If an unsterile object or person comes into contact with any sterile item, it must be resterilized before it can be used, an inconvenience for the surgical team. It would be wise for you to stay away from anything that might be sterile to help ensure that you are not the cause of contamination. If you are in doubt, it is best to ask before getting too close or touching anything.

After everything is set for the operation, the surgeon and surgical staff will position themselves around the patient. Next, the surgical technician will place the instruments for easy access during the operation. After everything is in place, you can move to a more advantageous spot for the actual observation, usually the side of the patient opposite the surgeon. If the operation is done with the assistance of an arthroscope, you should also be able to view the screen.

To help you understand what the surgeon is doing, a breakdown of the different steps of the operation might be helpful. The operation can be viewed as four basic stages: 1) the opening or entering into the body, 2) identification and confirmation of the injury, 3) repair or reconstruction, and 4) closure. Generally, everything done during the procedure has a purpose, from the angle of the incision to the spacing of the sutures.

Asking questions during the observation depends upon the atmosphere of the operating room. Variables determining the atmosphere might include: the degree of difficulty and complexity of the operation, the personalities and moods of the surgeon and staff, the tone of the room, whether music is being played (such as cassettes of the Grateful Dead or Madonna), or whether there is absolute silence or there are profanities flying out every so often. Whether or not to ask questions is something you must decide at the time, given the circumstances.

Conclusion

Surgical observation by student athletic trainers can be a positive and valuable educational experience. The lessons that can be learned in the operating room have no equal in the field setting. The experience will add new dimensions to the student's experience. The difficulty in setting up an observation is small in comparison to the knowledge and experience that could be gained. Students should be given every opportunity to further their education and experiences.

Acknowledgments

Thanks to the people who arranged the summer internship during which this paper was written, especially Edwin C. Bartlett, MD, and the staff of Eastern Orthopaedic Group of Greenville, NC for their willingness to share their knowledge and kindness.

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Systematic Evaluation Of Brachial Plexus Injuries

Scott Haynes, MEd, ATC

Abstract: *Brachial plexus injuries offer a unique challenge to the athletic trainer because of their relatively high frequency rate in contact sports and because of the complexity of the neuroanatomy in the cervical area. During a game, athletic trainers must make a fast, accurate decision regarding a player's return to competition. It is imperative that the athletic trainer be able to quickly differentiate between minor injuries and more serious injuries warranting removal from the game and/or physician referral. A systematic approach to the evaluation of a brachial plexus injury is essential to ensure proper treatment. This paper will present a structured approach to an on-the-field assessment of brachial plexus injuries.*

Brachial plexus injuries are the most common injury to the nervous system encountered in football; yet, they are the most poorly understood cervical injury.[2] It is reported that 33 of 67 college football athletes sustained at least one significant episode of a brachial plexus injury during their playing careers.[2] Approximately 50% of the players on the University of Wisconsin football team reportedly suffered suspected injury to the brachial plexus during their collegiate careers.[10] Similarly, comparable numbers are noted at the professional level.[6] The high incidence of brachial plexus injuries makes the recognition and management of these injuries a necessity for all athletic trainers. The goal of this paper is to review the approach to the evaluation of a player who presents with brachial plexus injuries.

Anatomy

The functional anatomy of the brachial plexus must be understood before an evaluation can be made. The brachial plexus is the major nerve network of the upper extremity. It is a complex structure that results from the dividing, reuniting, and intertwining of the dorsal (sensory) and ventral (motor) roots of five spinal nerve roots: cervical roots 5 through 8 and thoracic root 1 (Fig 1). This plexus is situated deep in the lower part of the neck and extends between the first rib and the clavicle into the axilla.

The athletic trainer should be familiar with the nerves branching off the plexus, the muscles that they innervate, and the chief actions of those muscles in order to thoroughly evaluate an injury (Table 1).

Typical Scenario: A "Burner"

Brachial plexus injuries result most frequently from tension placed on the nerves.[2,6,7,9,11,12] When an athlete's neck is forced into lateral flexion or rotation, especially while the opposite shoulder is depressed, a substantial amount of traction is placed on the nervous tissues of the brachial plexus.[12] Occasionally, part of the brachial plexus may be compressed between the first rib and the clavicle. This tension or compression may disrupt neural function, resulting in one or more of the following signs or symptoms:

1. numbness and burning of the entire arm, hand, and fingers;
2. sensation loss over dermatomes;
3. complete transient paralysis of the affected nerves involved; and
4. tenderness over the brachial plexus.

Transient signs and symptoms that last for less than 2 weeks are typically classified as mild or Grade 1. Grade 2 or moderate injuries consist of significant sensory and/or motor deficits that

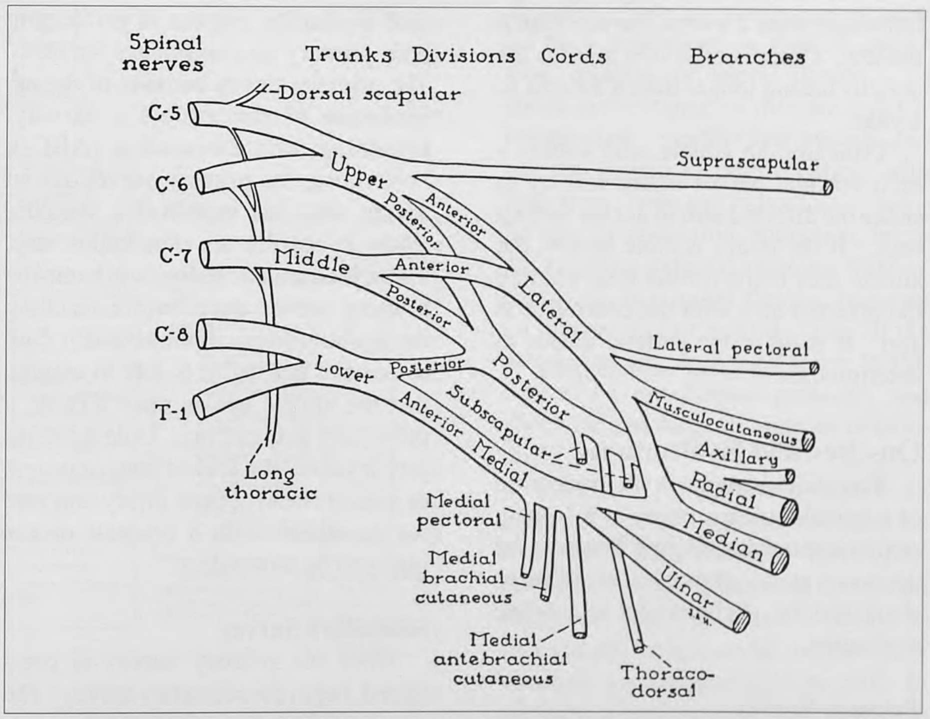

Fig 1.—Diagram of brachial plexus (from Hollinshead & Jenkins[4]).

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Table 1.—Nerves of the Brachial Plexus

Name	Origin	Major Muscle(s)	Chief Action(s)
dorsal scapular	C5	both rhomboidei	retraction of the scapula
axillary	C5,6	teres minor	external rotation of arm
		deltoid	abduction of arm
upper subscapular	C5,6	subscapularis	internal rotation of arm
lower subscapular	C5,6	subscapularis	internal rotation of arm
		teres major	extension and internal rotation of arm
suprascapular	C5,6	supraspinatus	abduction of arm
		infraspinatus	external rotation of arm
long thoracic	C5,6,7	serratus anterior	upward rotation of scapula
lateral pectoral	C5,6,7	upper pectoralis major	adduction-flexion of arm
medial pectoral	C8,T1	lower pectoralis major	adduction-extension of arm
		pectoralis minor	depression of shoulder
thoracodorsal	C6,7,8	latissimus dorsi	extension-adduction of arm
musculocutaneous	C5,6,7	biceps brachii	flexion-supination of forearm
		coracobrachialis	adduction-flexion of arm
		brachialis	flexion of forearm
radial	C5,6,7,8	triceps	extension of forearm
		anconeus	extension of forearm
median	C5,6,7,8,T1	abductor pollicis brevis	abduction of thumb
		opponens pollicis	opposition of thumb
		lumbricals I and II	extension of IP joints, flexion of MP joints, of digits II and III
ulnar	C8,T1	adductor pollicis	adduction of metacarpal, flexion of MCP joint of thumb
		abductor digiti minimi	abduction of digit V
		lumbricals III and IV	extension at IP joints, flexion at MCP
		interossei	adduction and abduction of digit

Adapted from Hollinshead & Jenkins.[4]

last longer than 2 weeks, but less than 6 months. Grade 3 or severe injuries are deficits lasting longer than 6 months to 1 year.[1,7,11]

Typically, an athlete who suffers a mild brachial plexus injury will try to shake the affected arm to get the feeling back. If the injury is more severe, the athlete may come off the field holding the affected arm with the contralateral arm. It is up to the athletic trainer to determine the severity of the injury.

On-the-field Evaluation

You should approach the evaluation of a brachial plexus injury in a logical, stepwise sequence. Figure 2 depicts the necessary steps, although some of these steps can be excluded for a sideline evaluation.

Primary Survey

The evaluation of any injury during an athletic event should follow the standard evaluation process of performing both primary and secondary surveys.[1] The primary survey consists of the assessment of the athlete's Airway, Breathing, and Circulation (ABCs). Performing the primary survey on an athlete who has sustained a shoulder injury is usually an expeditious step. The skilled athletic trainer will begin the primary survey even before reaching the injured athlete. If the athlete is conscious and talking, it is safe to assume that the athlete has an open airway, a pulse, and is breathing. Unless the injury involves the loss of consciousness or a severe head or neck injury, it is rare for an athlete with a brachial plexus injury to lie motionless.

Secondary Survey

Once the primary survey is completed, begin the secondary survey. The standard four-step evaluation process should be followed.

1. Take a history.
2. Observe the athlete.
3. Palpate the involved anatomical structures.
4. Perform special tests.

Realistically, due to the time constraints of a game and the large amount of protective equipment that football players wear, these steps will deviate somewhat from the ideal situation of evaluating an athlete in the controlled environment of a training room.

History and Observation. The first two steps of the evaluation can be combined to expedite the assessment of the injury. Observation should begin as you approach the injured athlete.

1. Note the overall position or posture of the athlete with respect to the alignment of the upper extremities.
2. Check to see if the athlete is moving or using the injured extremity.
3. Notice if the athlete is favoring or supporting one arm.
4. Check to see if the shoulder appears to be in an abnormal position, which may be indicative of a fracture or dislocation.
5. Try to observe with the protective equipment on. If the injury is serious (ie, fracture or dislocation), cut off the equipment.
6. Observe the athlete's facial expression to determine the amount of pain he is experiencing.

Begin taking the history once you are within talking distance of the athlete. If you have been working with the team for the entire season and are familiar with the athlete's previous problems, you will be better able to focus your questions on the present problem. However, if you are unfamiliar with the athlete, you will have to take a more thorough history. **Whether you are familiar with the athlete or not, the history is still the most important part of the evaluation process.** Following are questions you should ask, and statements that will elicit the proper information.

1. What is your problem?
2. Describe the painful symptoms associated with the injury, including the location (remember the shoulder is a common area for

referred pain), character, and intensity of the pain (on a scale of 1 to 10). What makes it better or worse? Grading the intensity of the pain gives the athletic trainer an objective measurement for future evaluations.

3. Describe the mechanism of the injury regarding the position of the head, neck, and arms.
4. Describe the neurological symptoms of numbness, burning, weakness, or tingling. Exactly where and when do symptoms occur?
5. Did you experience any unusual symptoms such as snapping, popping, locking, tightness, or crepitation?
6. When did the symptoms first occur?
7. Was the onset of symptoms sudden or gradual?
8. Describe the past history of similar episodes, if any, including: assessment, treatment, rehabilitation, and other diagnostic testing.

Palpation. Use palpation to further investigate the findings from the history and observation steps. With thorough knowledge of the anatomical structures, palpation techniques can greatly add to the overall assessment of brachial plexus injuries. In general, palpation is used to detect any tenderness, swelling, deformity, crepitation, warmth, pulses, muscle spasms, and the integrity of neurological pathways. Remember to compare the involved structure to the contralateral structure. Avoid causing unnecessary pain by starting palpation away from the injury. This also will encourage cooperation and confidence.

Include the following structures in your palpation of a suspected brachial plexus injury:

1. the cervical spine, clavicle, humerus, scapula, sternum, and ribs;
2. the sternoclavicular, acromio-clavicular, and glenohumeral joints; and
3. the musculature around the shoulder and neck.

During a brachial plexus evaluation, palpate the cervical spine first to rule out a neck injury. Typically, brachial plexus injuries do not have any palpable signs, such as pain or deformity along the posterior aspect of the neck.[11] Pain, swelling, and deformity along the vertebral column can be indicative of a more serious neck injury, such as a fracture or a dislocation. The clavicle and shoulder should also be palpated to rule out a fracture or dislocation. To palpate the remaining structures, the athletic trainer can slip his or her hand under the shoulder pads through the arm and neck openings.

The most common site of pain with a brachial plexus injury is tenderness in the upper trapezius.[11] The musculature around the neck and shoulder may either contain trigger points caused by repeated trauma to the area, or it may be in severe spasm after an acute episode.

Special Tests Several tests must be performed to accurately assess the severity of a brachial plexus injury. These tests should determine if the athlete has full active and passive range of motion (ROM), strength, and sensation of the upper extremities.[1,3,7,11]

Active and Passive Range of Motion. The active and passive movements should incorporate all of the motions that occur at the neck and shoulder. Note any motor loss or painful neck movements of flexion, extension, rotation, or lateral flexion. To check active range of motion, quickly demonstrate shoulder movements and ask the athlete to perform them with both arms. Note any motor loss or painful arcs in: abduction, adduction, internal rotation, external rotation, flexion, extension, horizontal flexion, horizontal extension, or circumduction. If the athlete has any decreased active ROM, repeat the movements passively and check the end range of motions in those directions.

Finally, apply passive overpressure to the neck in all directions to assess the integrity of the structures. This is performed by moving the neck to its end range and applying a gentle stretch to increase the tension on the tissues. Only minimal stretching should be felt. In addition, a compression test should also be performed to assess nerve root irrita-

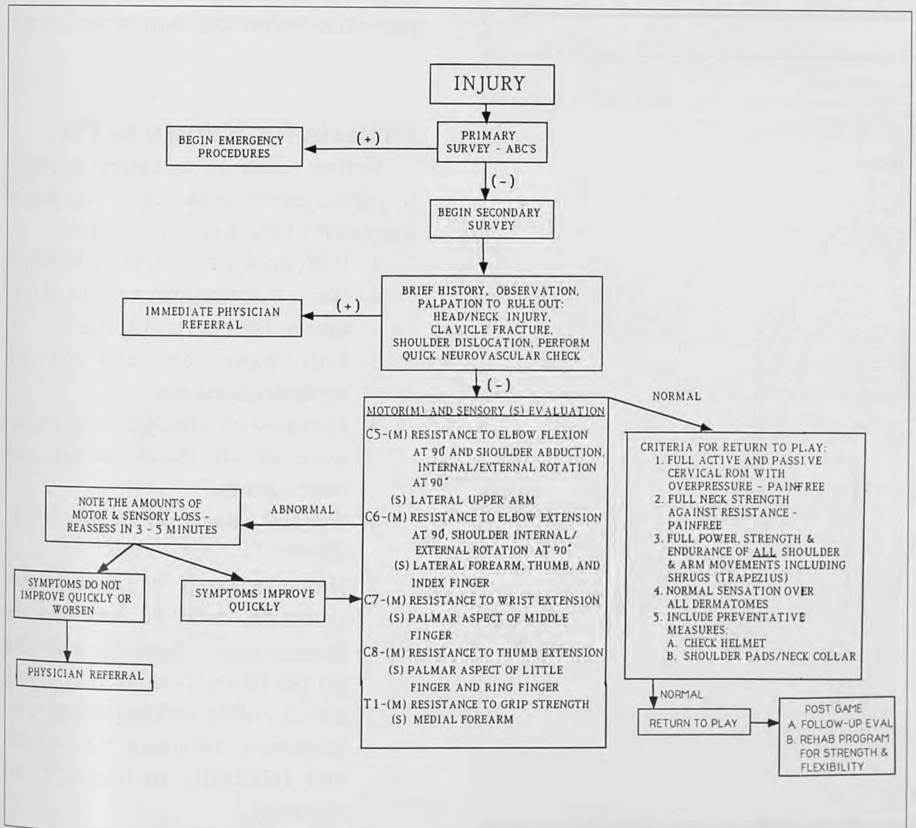

Fig 2.—Algorithm for brachial plexus injury management.

tion.[5] Perform this test by pressing down on the top of the athlete's head while he/she is lying down. If there are any neurological signs with either of these two tests, note the exact level of distribution.

Strength. Complete strength of the shoulder musculature is essential for any athlete to safely participate in sports. The major muscle groups around the shoulder should be tested manually to detect any strength loss. This may be done by performing a bilateral "break" test, which involves having the athlete systematically hold both extremities at the midpoints of each motion. The various joints are then tested by the athletic trainer by attempting to forcefully produce movement in that specific joint. The movements may be remembered by their respective myotomes (Table 2). Muscles most commonly affected include the shoulder external rotators, deltoid, and biceps brachii.[9]

Sensation. Sensation can be quickly checked by gently rubbing your fingers bilaterally over the dermatomes.[5] Question the athlete to see if one side feels "different" than the other. Typically, an athlete with a brachial plexus injury will complain of parathesia over two to four dermatomes.[11] Persistent sensory deficit is very unusual with the typical "burner" and may be indicative of a more serious neurological injury. Figure 3 illustrates the dermatome patterns of the upper extremity.

Upon completion of the special tests, you must decide the status of the athlete. If any loss of motor or sensory function is detected, the athlete must be excluded from participation until normal function returns. Note the amount of insufficiency and reassess the athlete's condition in 3 to 5 minutes. If the symptoms do not improve quickly, or worsen, physician referral is recommended. If the symptoms improve quickly, the athlete should be tested to determine if he/she meets the criteria for return to activity.

Some athletic trainers feel that an athlete with a first-time burner should not be allowed to return to play until his cervical spine has been cleared with X-rays. This documents that he/she does not have any predisposing conditions, such as congenital fusions, spinal stenosis, fractures, etc. This controversial issue should be discussed with the team physician before the start of the season.

Table 2.—Myotomes of the Brachial Plexus

NEUROLOGICAL LEVEL	MOVEMENT
C5	shoulder abduction, internal/external rotation, elbow flexion
C6	shoulder internal/external rotation, elbow flexion, wrist extension
C7	elbow extension, wrist flexion, finger extension
C8	finger flexion
T1	finger abduction/adduction

Adapted from Hollinshead & Jenkins.[4]

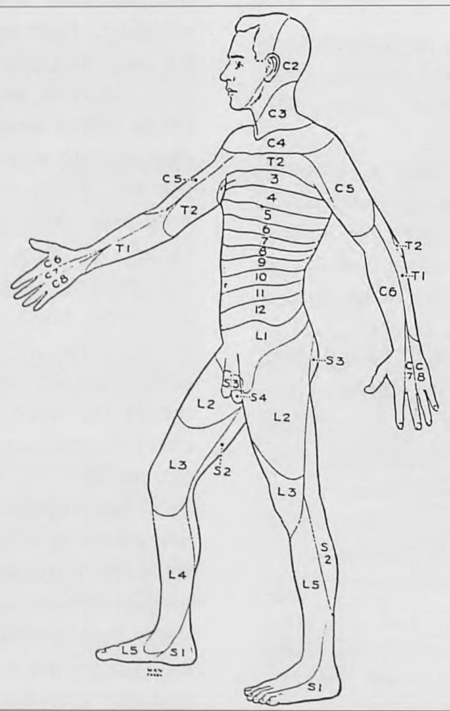

Fig 3.—Anteriolateral view of the dermatomes (from Hollinshead & Jenkins[4]).

Criteria for Return to Play

Before allowing an athlete to return to participation, make sure that he/she meets **all** of the following criteria:

1. Full, pain-free active and passive (with overpressure) range of motion in the cervical spine.
2. Full, pain-free neck strength against resistance.
3. Full power, strength, and endurance of all shoulder and arm movements.
4. Normal sensation in all dermatomes.
5. Has taken steps to prevent reoccurrence, such as checking the helmet and shoulder pads for proper fit and condition, applying a neck collar, and beginning rehabilitation, focusing on strength and flexibility in the neck and shoulder.[13]

The athlete should be reevaluated immediately after participation, as well as once each week for several weeks following the injury.[3,6,8] A much more thorough follow-up evaluation with the clothing and protective padding removed should be performed involving both soft (ie, brush) and sharp (ie, pinprick) sensations, as well as reflex testing. Muscle weakness and atrophy can last for some time following an injury. Delayed symptoms warrant physician referral for other tests which may include: roentgenograms, CT scans, MRIs, myelography, or electromyography.[8]

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"Spencer Splint" For Metacarpalphalangeal Joint Sprains

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The second through fifth metacarpalphalangeal joints are commonly injured in athletics, with the most common mechanism of injury being hyperextension and/or hyperabduction forces (ie, ball hitting hand, faulty catch, fingers caught in jersey, head-first slide, etc). The collateral and transverse ligaments, as well as the numerous muscles that cross the MCP joint offering stability to the joint, are often damaged. An injury to this joint can cause chronic disability and can pose a serious dilemma to the athletic trainer while he/she is carefully trying to splint this area without compromising a player's gripping, catching, and ball-handling abilities or finger dexterity (ie, basketball players, football centers and backs, soccer goalies, baseball players, etc).

Athletic trainers often have found that buddy taping of the fingers, placing check reins within the interdigital spaces, and taping the fingers to prevent painful ranges of motion are effective means of preventing abduction, flexion, and/or extension of the fingers. These traditional techniques, however, sometimes limit the athlete's performance because of the tape on the palmar aspect of the hand and distal aspects of the fingers (Figs 1a, 1b, & 2).

W e developed an alternative, a 4-1/2- X 1/2-inch strip of Orthoplast® or other thermoplastic splinting material, arranged in such way as to limit painful abduction of the fingers, as well as extension and flexion at the MCP joint (Figs 3, 4, & 5). We have found the Spencer Splint to be especially effective for athletes who use the distal portion of their fingers for gripping equipment (ie, hockey/lacrosse sticks, bats, balls, etc) or for executing sport-specific skills (shooting, throwing, snapping a football, catching, etc). It

Fig 1a.—Check reins within the interdigital spaces that result in tape on the palmer aspect of the PIP-DIP segment of the fingers.

Fig 1b.—Buddy taping of the fingers that results in tape on the palmar aspect of the fingers.

Fig 2.—MCP joint hyperextension/hyperflexion-stop strapping that leaves the athlete with cumbersome amounts of tape on the palmar aspect of the hand and fingers.

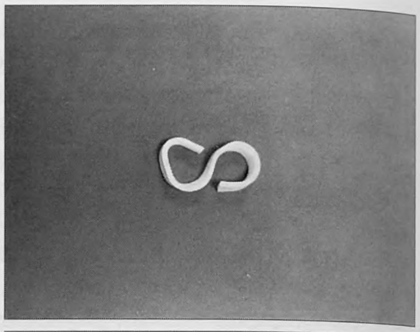

Fig 3.—Spencer Splint.

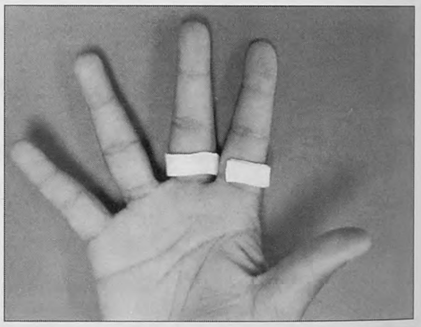

Fig 4.—Palmar view of the Spencer Splint.

Fig 5.—View of the splint from between the fingers.

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eliminates the need for tape on the palmar aspect of the fingers, distal to the proximal interphalangeal (PIP) joint, that might compromise an athlete's fingertip control of an object. In addition, the splint does not require tape anchors on the thenar and/or hypothenar eminences of the hand, which might impair an athlete's performance.

We feel that the Spencer Splint is an appropriate alternative to more traditional taping methods because:

- unlike check reins, the splint allows controlled or restricted independent movement of the fingers, due to the unique "S" shape of the splint.
- the splint prevents the extreme ranges of motion (ie, MCP hyperextension, hyperflexion, and/or hyperabduction) which would be stressful to the injured structures and possibly painful to the athlete, while eliminating excessive amounts of tape or other foreign materials on the wrist, palm, and fingers of the athlete.
- it is reusable so that tape is not wasted.
- it can be applied easily by the athlete so that the athletic trainer does not have to spend his/her valuable time attending to the athlete.
- the splint is constructed out of scrap pieces of Orthoplast that would otherwise be thrown away.
- although the splint results in a small strip of Orthoplast on the palmar surface of the finger proximal to the PIP joint, the splint can be more comfortable to the athlete since it will not roll up, unravel, loosen, etc, as tape might, due to sweat and moisture; and it does not require materials on the palmar aspect of the hand or distal portions of the fingers that can interfere with an athlete's performance.

Materials

- paper/cloth tape measure
- 1/2-inch-wide strip of Orthoplast or other thermoplastic splinting material
- scissors
- hydrocollator or other suitable device for melting Orthoplast
- bucket of cold water

Fig 6.—Construction of the Spencer Splint on the athlete's finger.

Procedure

1. Use a paper/cloth tape measure to estimate the length of thermoplastic material needed. Wrap the tape measure around the fingers in an "S-shaped" pattern starting on the palmar surface of the index finger. Proceed from the palmar surface around the finger to the dorsal surface of the index finger and then through the web space to the palmar surface of the middle digit. Proceed from the palmar surface of the middle finger around to the dorsal surface of the same finger to produce the "S-shaped" pattern. Measure the amount of tape measure used and cut a piece of thermoplastic material corresponding to the length of the tape measure. The width of the splint should not compromise flexion at the MCP or PIP joints.
2. Abduct the fingers to a point just before the onset of pain to allow for ample gripping ability and finger dexterity. Heat the splinting material until soft, and wrap the pliable material around the desired fingers in a manner identical to the manner used to measure the piece of splinting material (Fig 6).
3. After molding the splint to the player's fingers, have the athlete hold his/her hand in cold water, with the splint in place until it hardens.
4. After it is hardened, the trainer may customize the splint by cutting off sharp edges and placing padding or moleskin, etc, where desired.
5. Once the splint is comfortably in place, the trainer may tape the splint in a circular or figure-eight pattern using 1/2-inch tape for added comfort and stability.

The splint has been used successfully by four basketball players, one of whom used it for an entire basketball season (October to March). Psychologically, our athletes have reported the splint to be less cumbersome, thus eliminating concern which might hinder an athlete's level of concentration. Keep in mind that because the splint requires only a minimal amount of foreign material on a very small region of the palmar aspect of the entire wrist and hand, the performance of skill-position athletes, or those who are finicky about foreign materials on the palmar aspect of the hand or distal portions of their fingers, is not hindered. Our athletes have also alluded to the effectiveness of the splint while confirming the comfort of having independent, although controlled or restricted, movement of their index and middle fingers. In addition, the splint has also been used successfully on the dominant and nondominant shooting hands of athletes.

The splint may be altered to meet the needs of the injured athlete, depending upon the nature of the specific injury. The splint may be constructed to immobilize two or three MCP joints, depending upon the injury, or it may be reinforced, using two pieces of Orthoplast, if necessary.

Acknowledgment

The Spencer Splint is named for Spencer Dunkley, former starting center on the University of Delaware Men's Basketball Team (1990-1993), for whom the splint was made originally.

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Call For Abstracts

NATA RESEARCH AND EDUCATION FOUNDATION
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Please read all instructions before preparing the abstract. Individuals may submit more than one abstract, but no individual may present more than one paper. All abstracts will undergo blind review.

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2. Type the title of the paper or project in all CAPITAL letters on the left margin on the abstract form provided.
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4. Indicate the institution where the research or case report was conducted on the same line following the author(s) names, city, state, and zip.
5. Double space and begin typing the text of the abstract flush left in a single paragraph with no indentations. Do not justify the right margin.
6. Mail the original, two photocopies of the original, and 10 blind copies showing no information about the authors, institution, or grant information to: Dr. Russell Cagle, NATA-REF Free Communications, Department of Athletics, Willamette University, Salem, Oregon 97301. A diskette copy would be appreciated also, preferably in WordPerfect or ASCII format.
7. Abstracts postmarked after January 15, 1994 will not be accepted.
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SPECIFIC CONTENT REQUIREMENTS:

CASE REPORTS. Case Reports are presentations of unique individual athletic injury cases of general interest to our membership. These abstracts must be coauthored by an athletic trainer and a team or attending physician. More than one athletic trainer and physician may be included as authors. Abstracts in this category must include the following information:

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

FREE COMMUNICATION ABSTRACTS. Abstracts in this category must include: the purpose of the study or hypothesis, a description of the subjects, the experimental methods and materials, the type(s) of data analysis, results of the study, and conclusion(s). Authors are asked to indicate a preference for oral or poster presentation of their abstract. Authors of free communications are required to categorize their abstract 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 category, 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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Abstracts

Clint Thompson, MS, ATC

Tung-Ping S, Pagliaro M, Schmidt PJ, Wolkowitz O, Rugineau DR. Neuropsychiatric effects of anabolic steroids in male normal volunteers. *JAMA*. **1993;269:2760-2764.**

Anabolic steroids are synthetic androgens that, compared with testosterone, have greater anabolic (growth-promoting) activity relative to androgenic (masculinizing) activity. However, in contrast to their medical indications, over the past 30 years anabolic steroids have been used by members of the athletic community because of the belief that they increase lean body mass, physical strength, and aggressiveness and reduce recovery time between workouts. In association with the increased non-medical use of anabolic steroids, reports appeared describing steroid-precipitating mood and behavioral disturbances. This study systematically evaluated the effects of anabolic steroids on mood, behavior, and cognition in a prospective, double blind, placebo controlled design in healthy normal volunteers who were screened for the absence of any past psychiatric history or concurrent psychotropic drug use. Additionally this study attempted to identify changes in central nervous system biochemistry and neuroendocrine function that are associated with the administration of anabolic steroids in an attempt to further our understanding of possible mechanisms by which anabolic steroids may alter central nervous system function. Volunteers received in a double blind fashion methyltestosterone or placebo under four 3 day drug conditions: placebo (baseline), followed by methyltestosterone at a dose of 40 mg per day (low dose condition), then at a dose of 240 mg per day (high dose condition), followed by placebo (withdrawal). Twenty male volunteers ranged in age from 18 to 42 years. None of the subjects were conditioned athletes or had been previously exposed to anabolic steroids. This is the first study to examine the behavioral effects of anabolic steroid in a placebo controlled, prospective fashion. The study found significant increases during the high dose condition of mean daily highest VAS ratings of distractibility, irritability, and energy level, with trends for an increase in anger, violent feelings, insomnia, and fatigue. Additionally, significant increases were seen during high-dose methyltestosterone administration at one of the three daily rating times for mood swings, violent feelings, forgetfulness, confusion, and euphoria. Their VAS data were paralleled by increases during the high dose condition of the mean daily BDI, HAM-D, and BPRS scores as well as the hostility, anxiety, and somatization scales of the SCL-90. The increased symptoms observed during anabolic steroid administration, while significant, were subtle, reflecting several factors. Symptomatic differences did not, however, reflect differences in plasma anabolic steroid levels. Compared with self-administration in the naturalistic setting, subjects received only a low dose of a single anabolic steroid for a very short period of time. In conclusion, although the results of this prospective, placebo controlled study in a hospital may not generalize well to unregulated use in a naturalistic setting, the study has demonstrated that anabolic steroids have significant impact on mood behavior in normal male volunteers even during short term, relatively low dose administration. This study confirms earlier studies suggesting both the activating and averse mood and behavioral effects of anabolic steroids and further suggests that identification of the possible mechanisms of these effects may significantly advance our understanding of behavioral regulation in humans.

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Steil IG, Greenberg GH, McKnight D, Nair RC, McDowell I, Reardon M, Steward JP, Maloney J. Decision rules for the use of radiography in acute ankle injuries. *JAMA*. **1993;269:1127-1132.**

There are no widely accepted guidelines for the use of radiography in ankle injuries equivalent to those successfully introduced for skull radiography. Two decision rules were derived from a previous study. The first rule stated that an ankle radiographic series was only necessary if the patient had pain near the malleoli and one or more of these findings: (1) age 55 years or greater, (2) inability to bear weight immediately after the injury and for four steps in the emergency department, or (3) bone tenderness at the posterior edge or tip of the malleolus. The second rule stated that a foot radiographic series was only necessary if the patient had pain in the midfoot and bone tenderness at the navicular bone, the cuboid, or the base of the fifth metatarsal. The objective of the current study was to prospectively validate and, if possible, refine these original decision rules. Our goal was to demonstrate that the decision rules had a sensitivity of 1.0 for identifying significant fractures of the malleoli and midfoot, with the highest possible specificity. We included adult patients who present to the emergency departments with pain or tenderness secondary to blunt ankle trauma due to any mechanism of injury. The criterion standard that the decision rules were designed to identify were clinically significant fractures seen in the ankle or foot radiographic series. We defined clinically significant fractures as bone fragments greater than 3 mm in breadth. Patients were young, on average, but the age range extended to 90 years: men and women were equally represented, and the majority had suffered a twisting mechanism of injury. Chi-square recursive partitioning yielded a model similar to the original decision rule, but without the age 55 years or greater variable. The refined decision rule retained a sensitivity of 1.0 for ankle series fracture, but achieved a slightly higher specificity. The corresponding refined decision rule for the foot series differs from the original by not including cuboid tenderness and adding the same weight bearing criterion used in the ankle series decision rule. The Ottawa ankle rules offer physicians the opportunity to use clinical judgement to screen patients with acute ankle injuries for the need for radiography. The rules may be considered sensible for clinical use: they possess a clear and relevant purpose, are concise, and are easy to use in a busy emergency department. The major limitation of the Ottawa ankle rules is that they have not yet been demonstrated to have an impact on actual clinical practice. Physicians should be cautious in patients with multiple painful injuries, altered sensorium, intoxication, paraplegia, or bone disease. The Ottawa ankle rules have not been developed or tested in patients under the age of 18 years. These rules have been shown to be highly sensitive for identifying fractures and have the potential to reduce the use of radiography by 30%. Implementation studies will assess the actual impact of the Ottawa ankle rules on clinical practice.

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Mooresville, IN

Gardner P, Schaffer W. Immunization of adults. *N Engl J Med.* **1993;328:1252-1258.**

In the United States, the immunization of adults does not receive the same priority as the immunization of children, although deaths from vaccine preventable diseases occur predominately in adults. Reasons for the poor record of immunization of adults include lingering doubts on the part of both the public and health care providers about the efficacy and safety of vaccines; uncertainty about specific recommendations; concern about liability; inadequate reimbursement; and poorly developed systems for immunizing adults. Authoritative and convenient guidelines for the immunization of adults have been developed for each of the currently available vaccines. The increasing number of older Americans, recognition of pneumococcal bacteremia as a major health problem in patients with the acquired immunodeficiency syndrome, and the emergence of antibiotic resistant strains of streptococcus pneumonia all indicate that deaths due to invasive pneumococcal disease will increase at about the current estimates of 40,000 per year. The currently available 23 valent polysaccharide vaccine is inexpensive, and a decade of experience has established its safety. Despite the availability of influenza vaccines since the 1950's, 19 of the annual influenza epidemics in the United States since 1957 have been associated with more than 100,000 excess deaths. Despite the fact that a safe and effective vaccine against the virus has been available since 1982, the annual incidence of hepatitis B rose by 37% during the decade from 1979 to 1989, making it the only vaccine preventable disease whose incidence has increased after an effective vaccine became available. Thanks to effective immunization programs in children, diphtheria and tetanus have become rare diseases in the United States. Almost all of these cases of tetanus and diphtheria occur in adults who never completed a primary immunization series. Among the many vaccines used in the United States, the three that have potential for substantial public health benefit are the pneumococcal vaccine, the influenza vaccine, and the hepatitis B vaccine.

Mike Sullivan, MS, ATC
The Center for Hip and Knee Surgery
Mooresville, IN

DuRant RH, Rickert VI, Ashworth CS, Newman C, Slavens G. Use of multiple drugs among adolescents who use anabolic steroids. *N Engl J Med.* **1993;28:922-926.**

The relationship between anabolic steroid use and other drug use remains unclear. Use of steroids may be unique among substance users because they often have an attitude that the body is a temple and do not use alcohol and marijuana because they believe that these substances will affect their health. Alternatively, if the mechanisms of anabolic steroid use are similar to those of other substance use, users of anabolic steroids would also be expected to report use of multiple drugs. This study examined the relation of anabolic steroid use to the use of other drugs, including cocaine, marijuana, alcohol, cigarettes, and smokeless tobacco. Additionally, it sought to determine the degree to which young adolescents reported the use of injection drugs and the percentage of adolescents that reported sharing needles. Finally, it attempted to evaluate the relationship between previous education about HIV and the use of anabolic steroids. In November 1990, an anonymous standardized questionnaire, based on the questionnaire used by the Centers for Disease Control and Prevention for the 1989 Secondary School Health Risk Survey, was administered to all students (n=1881) in the compulsory 9th grade health science classes in Richmond County, Georgia. The survey was designed for the school based epidemiologic surveillance of adolescents' knowledge, attitudes, and behaviors related to health risks and has not been tested for test-retest reliability. Ten questions assessing the frequency of substance use from the CDC's 1990 Youth Risk Behavior Survey were added to the questionnaire. Students in the 9th grade reported less use of anabolic steroids than students in the 10th through 12th grades. The data suggests that a substantial number of young adolescents have used injection drugs, probably anabolic steroids, and one quarter of anabolic steroid users have shared needles to inject drugs during the past 30 days. Anabolic steroid users who reported that they had previously received education about AIDS in school reported sharing needles less frequently that those who had not received such education about AIDS and HIV. Significant associations were found between the use of anabolic steroids and the use of marijuana, cocaine, cigarettes, smokeless tobacco and alcohol. Behavioral changes and interventions designed to track risk reduction and risk avoidance skills that are specifically targeted to these users must be employed, since many of them are likely to engage in more than one type of high risk behavior.

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The Center for Hip and Knee Surgery
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Nyland JA, Currier DP, Ray JM, Duby MJ. A case study of an accelerated rehabilitation program on knee function following anterior cruciate ligament reconstruction. *J Sport Rehab*. **1993;2:53-62.**

This paper discusses function changes during an accelerated rehabilitation program at 6, 10, and 52 weeks postsurgery for a college athlete following ACL reconstruction/meniscectomy of the left knee. The effects of combined pulsed electromagnetic field (PEMF) and neuromuscular electrical stimulation (NMES) on knee extensor torque, thigh girth, and pain level are presented. PEMF-NMES decreased stimulation pain by 76%. Knee extensor isometric torque increased by 23%, and thigh girth decreased less than 5% at 6 weeks. Knee extensor isokinetic torque was 13% and 3% deficient at 90°/s and 240°/s, and standing single leg broad jump distance was 19% deficient at 10 weeks. Knee anterior laxity was 2 mm at 10 weeks and 3 mm at 52 weeks. PEMF-NMES appears to comfortably enhance knee extensor torque gains and diminish thigh girth loss. Despite early return to practice, functional deficit remained and anterior laxity was increased at 52 weeks.

Reprinted with the permission of the *Journal of Sport Rehabilitation.*

Holcomb KR, Skaggs CA, Worrell TW, DeCarlo M, Shelbourne KD. *J Sport Rehab*. **1993;2:97-103.**

A paucity of information exists concerning reliability of the KT-1000 knee arthrometer when used by different clinicians to assess the same anterior cruciate ligament-deficient patient. The purpose of this study was to determine the reliability and standard error of measurement of four clinicians who routinely report KT-1000 arthrometer values to referring orthopedic surgeons. Two physical therapists and two athletic trainers performed anterior laxity tests using the KT-1000 on 19 subjects. Intraclass correlation coefficients (ICC) and standard error of measurement (SEM) were used to determine reliability. Intratester ICC ranged from .98 to 1.0 and intratester SEM ranged from 0.0 to .28 mm. Intertester ICC and SEM for all four testers were .53 and 1.2 mm, respectively. A 95% confidence interval (M 1.96 x SEM) of the intertester variability ranged from -0.18 to 4.52 mm. Therefore, large intertester variation existed in KT-1000 values. Each facility should standardize testing procedures and establish intratester and intertester for all clinicians reporting KT-1000 values.

Reprinted with the permission of the *Journal of Sport Rehabilitation.*

Smith DD. Role of body and joint position on isokinetic exercise and testing. *J Sport Rehab*. **1993;2;141-149.**

This paper reviews the role of body and joint position during isokinetic exercise and testing. Due to the frequent implementation of isokinetic devices, it is important to examine the methodology of their use. Positioning of the subject and the target joint is a critical component of the methodology. The literature reveals significant relationships between the position of the subject and outcome measures such as torque, agonist-antagonist ratios, peak torque to body weight ratios, and reliability. These relationships are evidenced at the larger joints of the lower extremity, such as the hip, knee and ankle, in addition to the shoulder joint of the upper extremity. Therefore, it behooves clinicians to review research regarding the effect of varied body and joint positions on outcome measures and regarding the relevance of specific positions to the predetermined goals.

Reprinted with the permission of the *Journal of Sport Rehabilitation.*

Cibulka MT, Delitto A. A comparison of two different methods of treating hip pain in runners. *J Orthop Sports Phys Ther*. **1993;17:172-176.**

Little or no research has been performed on the physical therapy treatment of hip pain. The purpose of this study was to compare two different treatments for hip pain. Twenty runners who had primary hip pain and sacroiliac joint dysfunction, without evidence of arthritic changes, were randomly assigned to two groups. One group received a mobilization technique to the involved hip, while the other was treated with a manipulative technique known to affect sacroiliac joint dysfunction. The subjects were evaluated by using a pain questionnaire and the Faber test to determine the response of the hip joint to treatment. Data were analyzed with the Mann-Whitney U statistic for perceived pain response and with the Chi-square statistic with Yates correction for the Faber test. Results showed a significant difference in perceived pain response, as well as reproduction of pain with the Faber test, between the two groups. The results suggest that a manipulative technique designed to reduce sacroiliac joint dysfunction is an effective method to reduce hip pain. Physical therapists should evaluate the sacroiliac joint in patients with hip pain.

Reprinted with the permission of *The Journal of Orthopaedic & Sports Physical Therapy*

Satterfield MJ, Yasumura K, Abreu SH. Retro runner with ischial tuberosity enthesopathy. *J Orthop Sports Phys Ther*. **1993;17:191-194.**

In reviewing the literature, no studies were found reporting the use of retro running on flat and hilly terrain, which elicited enthesopathy (stress reaction) at the ischial tuberosity. Therefore, this case study of an atypical enthesopathy condition warrants careful scrutiny in order to generate future research. This case study describes the clinical management of a female runner with bilateral patellofemoral pain who self-initiated a program of backward running and stationary bicycling after reading an article about retro running in a runners' magazine. She subsequently developed ischial tuberosity enthesopathy verified by scintigraphy (bone scan). Her symptoms gradually resolved with physical therapy intervention. Eventually, she was able to forward jog 2 miles on flat surfaces without complaint of pain but did not resume retro running. This case not only suggests the need for further research in retro running kinetics and kinematics but highlights the proactive role health professionals must assume in injury prevention.

Reprinted with the permission of *The Journal of Orthopaedic & Sports Physical Therapy*

Kamkar A, Irrgang JJ, Whitney SL. Nonoperative management of secondary shoulder impingement syndrome. *J Orthop Sports Phys Ther.* **1993;17:212-224.**

Shoulder pain secondary to impingement of the rotator cuff tendons underneath the coracoacromial arch is a common problem seen in athletes who perform repetitive overhead activities. Shoulder impingement has been classified into primary and secondary types. Several factors contribute to impingement, including rotator cuff weakness, posterior capsule tightness, and subacromial crowding. Recently, it has been proposed that scapulothoracic muscle weakness could be a factor that contributes to impingement. Traditional rehabilitation protocols for shoulder impingement syndrome stress individualized rotator cuff strengthening. The authors propose that individualized scapulothoracic muscle strengthening should be a part of any protocol for nonoperative treatment of secondary shoulder impingement syndrome.

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Wilkerson GB, Horn-Kingery HM. Treatment of the inversion ankle sprain: comparison of different modes of compression and cryotherapy. *J Orthop Sports Phys Ther.* **1993;17:240-246.**

Relatively few studies have been performed to examine the effectiveness of different methods of treatment for the inversion ankle sprain. In this study, restoration of function following a grade II inversion sprain was compared among 34 subjects who received one of three methods of treatment, ,each of which incorporated an Air-Stirrup brace. The methods included uniform compression provided by elastic tape, focal compression provided by a U-shaped device, and focal compression with simultaneous cryotherapy. Although the results failed to demonstrate statistical significance at the .05 level ($p=.055$), the two groups that received focal compression attained each of nine levels of function in fewer days than the group that received uniform compression. The results of this study indicate that focal compression appears beneficial, but increased frequency and duration of cryotherapy do not appear to enhance the rate of recovery following an inversion ankle sprain.

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Draper DO, Sunderland S, Kirkendall DT, Ricard M. A comparison of temperature rise in human calf muscles following applications of underwater and topical gel ultrasound. *J Orthop Sports Phys Ther.* **1993;17:247-251.**

For ultrasound to be effective, a conducting medium must be placed between the soundhead and the skin. Little research has been performed to test whether or not these mediums actually work. The propose of this study was to compare the effect of tap water immersion and ultrasound gel conducting mediums on tissue temperature rise in the human leg. A 23-gauge hypodermic needle microprobe was inserted 3 cm deep into the medial portion of the gastrocnemius muscle of 20 subjects. Each subject participated in two random order treatments using tap water immersion and topical gel conduction mediums. Each treatment consisted of continuous ultrasound delivered topically at 1.5 W/cm for 10 minutes. During both treatments, the soundhead was moved at a speed of 4 cm per second, and the temperature was recorded every 30 seconds A significant difference was found between the two treatment methods [$t(19)=9.18, p<.001$]. The topical gel increased tissue temperature 4.8°C, whereas the underwater treatment increased tissue temperature only 2.1°C. Therefore, at a tissue depth of 3 cm, ultrasound gel is a better conducting medium than water. Also, the authors discovered that it took nearly 8 minutes for the temperature to reach therapeutic level during the gel technique. These findings should be of clinical significance to clinicians who regularly use ultrasound.

Reprinted with the permission of *The Journal of Orthopaedic & Sports Physical Therapy*

Cameron DM, Bohannon RW. Relationship between active knee extension and active straight leg raise test measurement. *J Orthop Sports Phys Ther.* **1993;17:257-262.**

This study was conducted to determine the relationship between two alternative tests for indicating hamstring musculotendinous length, active knee extension (AKE) and active straight leg raise (ASLR). Before alternatives to a commonly practiced clinical test such as AKE can be recommended for application, their convergent validity should be established. Twenty-three healthy subjects (avg age=29.4 years) were tested. A 35 mm camera was used to record the position of the right side of the pelvis and lower limb during the performance of the ASLR test on the right. The camera setup was also used to record the position of the right knee and pelvis during the performance of AKE with the right hip flexed to 90°. For ASLR, the angle of the straight leg to the horizontal was measured. The intraclass correlation coefficients for the AKE (.861) and ASLR (.935) tests were good and high, respectively. There was a significant relationship (r=-.718; r=.515; p<.001) between AKE and ASLR. The significant correlation between the measurements obtained using these two tests suggests that both are providing an indication of the same basic phenomenon, presumably hamstring musculotendinous length. For this reason, the AKE test may be a useful alternative to the straight leg raise test for providing an indication of hamstring muscle length.

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Rooney JG, Currier DP, Nitz AJ. Effect of variation in the burst and carrier frequency modes of neuromuscular electrical stimulation on pain perception of healthy subjects. *Phys Ther*. **1992;72:800-809.**

The purpose of this study was to explore the effect of various combinations of burst and carrier frequencies of neuromuscular electrical stimulation (NMES) on subjects' perception of pain intensity associated with induction of high intensity muscle contractions. Twenty-seven healthy volunteers completed the study. After the initial test session, all subjects were treated in three additional sessions with nine combinations of burst frequencies (50, 70, and 90 bursts per second [bps]) and carrier frequencies (2500, 5000, and 10000 Hz) at an NMES amplitude that produced torque equivalent to 50% of maximal voluntary contraction of their quadriceps femoris muscle. Subjects rated each frequency combination for perceived pain intensity with a visual analog scale. The combinations of burst frequencies (50, 70, and 90 bps) and carrier frequencies (2500, 5000 Hz) do not differ from each other in perceived pain intensity but do differ significantly in perceived pain from the combinations of burst frequencies at the carrier frequency of 10,000 Hz. Thus, the clinician may have to try different stimulus combinations on patients at different current training levels to obtain the least individually perceived pain.

Reprinted from *Physical Therapy* with the permission of the American Physical Therapy Association.

Twomey LT. A rationale for the treatment of back pain and joint pain by manual therapy. *Phys Ther*. **1992;72:885-892.**

Manual therapy, with its emphasis on joints movement and exercise, has become increasingly important for the treatment of pain and dysfunction of the musculoskeletal system. The rationale used to explain the success of manual therapy has changed radically in recent years. Early explanations, which included concepts such as adjusting joint subluxations, restoring body alignment, and reducing nuclear protrusion, have been shown to have no basis in fact. Current biological research shows the value of movement in maintaining the health and strength of collagenous, muscular and bony tissues and emphasizes the need for joint movement and for relatively high levels of activity throughout the life cycle. The musculoskeletal system thrives on stress and movement and reacts adversely to prolonged rest or immobilization. The problems associated with working or recreational postures involving prolonged loading at or near the limit of joint range of motion are considered together with a rationale for appropriate therapeutic management. Explanations are provided to enable an understanding of the success of intensive physical therapy for chronic back pain and for manipulation in the treatment of the acute painful locked back.

Reprinted from *Physical Therapy* with the permission of the American Physical Therapy Association.

Threlkeld AJ. The effects of manual therapy on connective tissue. *Phys Ther*. **1992;72:893-902.**

The purpose of this manuscript is to examine the known and theoretical mechanical effects of therapeutic manual techniques on the connective tissue (CT) of joints and fasciae. Typical CT structures that could be influenced by manual techniques will be discussed. The behavior of CT under loading and the influence of immobilization on CT will be examined. The forces developed during manual techniques will be described, and their potential effects on the physical properties of CT will be discussed. Research priorities regarding the effects of manual therapy on CT will be outlined.

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McClure PW, Flowers KR. Treatment of limited shoulder motion: a case study based on biomechanical considerations. *Phys Ther*. **1992; 72:929-936.**

This article describes the management of a 57 year old female patient following a fracture and dislocation of the right humeral head. The treatment of the patient involved the use of thermal agents, manual therapy, continuous passive motion, and splinting of the arm in an elevated position. We describe an approach to treatment of limited shoulder motion that is focused on identifying and applying tension to restricting structures rather than restoration of translatory gliding movements on the humeral head. Our treatment approach is based on recent data from biomechanical studies that challenge the concave-convex theory of arthrokinematic motion first described by MacConaill. We believe that tension in capsular tissue, rather than joint surface geometry, may control the translatory movements of the humeral head. The rationale for treatment involving low load prolonged stress to tissues in the form of continuous passive motion and splinting is discussed as well as potential limitations for more brief forms of stress such as joint mobilization and manual stretching.

Reprinted from *Physical Therapy* with the permission of the American Physical Therapy Association.

Eng JJ, Pierrynowski MR. Evaluation of soft foot orthotics in the treatment of patellofemoral pain syndrome. *Phys Ther*. **1993;73:62-70.**

Background and Purpose. The effectiveness of soft foot orthotics in the treatment of patients who have patellofemoral pain syndrome was investigated. **Subjects.** Subjects were 20 adolescent female patients, aged 3 to 17 years (avg=14.8,SD=1.2), who were diagnosed with patellofemoral pain syndrome and who exhibited excessive forefoot varus or calcaneal valgus. **Methods.** Subjects were randomly assigned to one of two groups: a control group (n=10), which took part in an exercise program, or a treatment group (n=10), which used soft foot orthotics in addition to participating in the exercise program. The exercise program consisted of quadriceps femoris and hamstring muscle strengthening and stretching exercises. A visual analogue scale was used to assess the level of pain of the subjects over an 8-week period. **Results.** Both the treatment and control groups demonstrated a significant decrease in the level of pain, but the improvement of the treatment group was significantly greater than that of the control group. **Conclusion and Discussion.** The results suggest that, in addition to an exercise program, the use of soft foot orthotics is an effective means of treatment for the patient with patellofemoral pain syndrome.

Reprinted from *Physical Therapy* with the permission of the American Physical Therapy Association.

Karst GM, Jewett PD. Electromyographic analysis of exercises proposed for differential activation of medial and lateral quadriceps femoris muscle components. *Phys Ther*. **1993;73:286-299.**

Background and Purpose. The purpose of this study was to determine whether active exercises combining hip adduction with knee extension activate medial components of the quadriceps femoris muscle (QF) more than does knee extension alone. **Subjects.** Twelve healthy adults (6 men, 6 women), aged 20 to 36 years (avg=24.8, SD=5.8), participated in the study. **Methods.** The subjects performed quadriceps femoris setting (QS), straight leg raising (SLR), straight leg raising with the hip laterally rotated (SLR/LR), and straight leg raising combined with isometric hip adduction (SLR/ADD). Electromyographic (EMG) activity was recorded from the oblique (VMO) and longitudinal (VML) portions of the vastus medialis, vastus lateralis (VL), and rectus femoris muscles. **Results.** Comparison of normalized mean EMG magnitudes revealed that the single joint QF components (VMO, VML and VL) demonstrated significantly greater activity during QS that during any of the three SLR variations and that SLR/LR and SLR/ADD did not elicit greater relative activity of medial QF components that did QS or SLR. **Conclusion and Discussion.** These findings do not support the notion that concurrent use of the hip adductors during knee extensor exercises results in preferential strengthening of the VMO.

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CEU Quiz

The NATA Board of Certification accepts this continuing education offering for .5 hours of prescribed CEU credit in the program of the National Athletic Trainers' Association, Inc., provided that the test is used and completed as designed.

To participate in this program, read the material carefully, photocopy the test, and answer the test questions. Mark your answer by circling the correct letter. Then fill in your name, address, and other information and mail with $15 for processing to the address below. **FOR CREDIT, the form must be postmarked by December 15, 1993.**

A passing score is 70%. We will notify the NATA Board of Certification of all persons who score 70% or better, and the NATA will enter .5 CEU credit on those persons' records. Participation is confidential.

Answers to Summer '93 CEU Quiz.

1. c	5. d	9. e	13. b
2. a	6. e	10. c	14. a
3. e	7. c	11. d	15. e
4. a	8. e	12. b	

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

Arnold,etal. *The reliability of three isokinetic knee-extension angle-specific torques.*
Bechman. *Laryngeal fracture in a high school football player.*
Conway/Decker. *"Spencer Splint" for metacarpalphalangeal joint sprains.*
Draper/Sunderland. *Examination of the law of Grotthus-Draper: does ultrasound penetrate subcutaneous fat in humans?*
Feld. *Management of the critically injured football player.*
Haynes. *Systematic evaluation of brachial plexus injuries.*
Koester. *An overview of the physiology and pharmacology of aspirin and nonsteroidal anti-inflammatory drugs.*
Magnusson,etal. *The effect of stabilization on isokinetic knee extension and flexion torque production.*
Snouse/Lundgren. *Use of Orthoplast for winter sports.*
Street,etal. *The fluoroscope in a traditional sports medicine setting.*

CEU CREDIT QUIZ

Name (Dr., Mr., Mrs., or Ms.) ____________________

Institution or Team ____________________

Mailing Address ____________________

City ________________ State ______ Zip ________

Social Security Number ____________________

NATA Membership Number ____________________

Please note: If you are not an NATA member, you may substitute your NATA BOC Certification Number.

Please indicate below the setting in which you work:

❏ High School ❏ Junior College ❏ College

❏ University ❏ Sports Medicine Center

❏ Other (please specify) ____________________

Instructions

1. Photocopy these pages and write on the copy.
2. Read the articles listed above.
3. Answer the questions.
4. Mail with $15 fee (checks made payable to Indiana State University) postmarked by December 15, 1993, to:

JAT - CEU Quiz
Physical Education Department
Indiana State University
Terre Haute, IN 47809

1. The Spencer Splint is an appropriate alternative to more traditional taping methods because:
   a. it does not prevent MCP hyperextension, hyperflexion, or hyperabduction.
   b. it allows controlled or restricted independent movement of the fingers, due to its unique "S" shape.
   c. it can be applied easily by the athlete.
   d. no Orthoplast is placed on the palmar surface of the finger proximal to the PIP joint.
   e. b and c only
2. Use of a fluoroscope in a sport medicine setting:
   a. can provide an on-site diagnosis.
   b. is not a new innovation.
   c. is a good idea, but probably not cost-effective.
   d. both b and c
   e. both a and b
3. In assessments of muscle strength with isokinetic testing equipment, which of the following statements are true?
   a. The subject's familiarity with the testing equipment makes little difference on strength measurement.
   b. Verbal instructions and encouragement need to be standardized and consistent.
   c. Surrounding noise has no effect on measurement.
   d. a and b
   e. b and c
4. Signs and symptoms of laryngeal injury might include:
   a. change in voice quality
   b. pain when coughing
   c. subcutaneous crepitation
   d. All of the above.
   e. a and b only
5. Angle-specific torques:
   a. are of value to the clinician because they assess peak torque, the only useful measure of muscle function.
   b. are relatively unreliable measures of muscle function.
   c. allow the clinician to assess muscle function at a specific point in the range of motion.
   d. None of the above.
   e. a and c
6. Criteria for return to play after a brachial plexus injury include all of the following, except:
   a. 90% of full power, strength, and endurance of all shoulder and arm movements.
   b. checking the helmet and shoulder pads for proper fit and condition.
   c. applying a neck collar.
   d. beginning rehabilitation.
   e. pain-free neck strength against resistance.
7. The NSAIDs:
   a. were originally found in the bark of willow trees.
   b. work by irreversibly inhibiting the activity of cyclooxygenase.
   c. were developed and promoted primarily because they do not have aspirin's sometimes severe side effects.
   d. have recently become suspect of slowing the healing process.
   e. both c and d
8. The hand-held portable fluoroscope:
   a. works as well on large density areas (ie, hips, pelvis, spine) as traditional radiographic images.
   b. does not require lead aprons.
   c. is easily used by an athletic trainer.
   d. b and c only
   e. None of the above.
9. Some advantages of Orthoplast over traditional padding are:
   a. it is less rigid.
   b. it can be form fitted.
   c. it is lightweight and nonyielding.
   d. it is nonaerodynamic.
   e. b and c only
10. Brachial plexus injuries:
   a. are one of the least common injuries to the CNS encountered in football.
   b. are one of the best understood cervical injuries.
   c. are usually quite severe.
   d. most frequently result from tension placed on the nerves.
   e. a and d only
11. Since subcutaneous fat acts as a barrier to therapeutic ultrasound, athletic trainers and physical therapists cannot expect similar increases in muscle temperature when using this modality on people with varying thicknesses of adipose tissue.
   a. True
   b. False
12. One benefit of ultrasound over infrared modalities is its ability to penetrate subcutaneous fat.
   a. True
   b. False
13. Aspirin:
   a. can cause prolonged bleeding time and tinnitus.
   b. works by enhancing prostaglanding and thromboxane synthesis.
   c. raises the electrical potential of the gastric membrane.
   d. has falsely been associated with Reye's syndrome.
   e. both a and b
14. Ways that athletic trainers can be better prepared to manage critically injured football players include:
   a. Establish an effective and practiced emergency plan with the local EMS agency.
   b. Practice removing all equipment in the event of a critical injury.
   c. Expect the local EMS to provide advanced life support when needed.
   d. Develop good evaluation skills so that critical injuries may be recognized early.
   e. All except c
15. Special tests to accurately assess the severity of a brachial plexus injury include:
   a. active, but not passive, range of motion.
   b. passive, but not active, range of motion.
   c. a bilateral "break" test.
   d. a and c
   e. b and c

Video Review

Tom Gocke, MS, ATC

First Aid and the Football Helmet
Illinois Athletic Trainers Association, Inc (copyrighted 1992)
Mike Barnish, ATC/R
2745 N. Neva
Chicago, IL 60635
(708) 491-8867
or
Hal Hilmer, ATC/R
John Hersey High School
1900 E. Thomas
Arlington Heights, IL 60004
(708) 259-8505
Color-VHS
Playing time: 15-20 minutes (approximate)
Price: not listed

First Aid and the Football Helmet is copyrighted and distributed by the Illinois Athletic Trainers Association, Inc. This video program addresses the issues of how to properly fit a football helmet and how to care for the head- and neck-injured football athlete.

The first part of this video addresses the necessary steps to ensure an adequately fitting football helmet. The narrator comments on the importance of shell size, evaluation of the padding system, jaw and chin strap sizing, and methods in face mask removal.

The second portion of *First Aid and the Football Helmet* concerns itself with on-the-field evaluation and emergency care of the injured athlete. The Look-Listen-Feel method is used in checking the athlete's level of consciousness and in checking airway, breathing, and circulation. This video demonstrates how to gain access to the athlete's airway by using a pocket knife and a "Trainer's Angle" in removing the face mask. The IATA demonstrates the proper sequence essential to stabilize the head, neck, and body on a spine board. Lastly, guidelines and a procedure for removing the helmet are demonstrated.

First Aid and the Football Helmet is an instructional video program that contains important information for all athletic trainers. It incorporates proper helmet fitting as an injury prevention measure and gives instructions on how to manage potential head and neck injuries should they occur. This video would be a valuable part of any athletic trainer's library.

Book Review

Kenneth L. Knight, PhD, ATC

Taber's Cyclopedic Medical Dictionary, 17th Edition
Clayton L. Thomas, MD, MPH; editor
FA Davis Company, 1993
ph 800-523-4049
2600 pgs, 214 illustrations
$29.95 (w/thumb-index tab),
$27.50 (w/o thumb-index tab)

The top selling allied health dictionary just got better. The 17th edition of Taber's Cyclopedic Medical Dictionary has been extensively updated with over 2,500 new definitions, including "Athletic Trainer" and "training, athletic."

This, I believe, is the first dictionary, medical or otherwise, to define our profession. And since one of the sources of new definitions that lexicographers (dictionary writers) use in updating their lexicons (dictionaries) is new words from other dictionaries, we should soon see other dictionaries defining our profession also.

But Taber's has many features more important to athletic trainers than defining the profession. First, it was written especially for nurses and allied health professionals rather than for physicians, so its emphasis is slightly different than most medical dictionaries.

Second, it is "cyclopedic," it gives supplementary information in addition to the definitions. Most conditions include symptoms, etiology, treatment, nursing implications, etc. In fact, there are 16 different categories of information provided for various entries. Thus, the reader gets more general information than just a dictionary definition.

Third, it is richly illustrated, which helps to understand the terms. For instance, the simple illustrations of abduction and adduction add greatly to the textual definitions of these two terms. And the use of color to highlight and differentiate between various parts of the drawings is nice.

Fourth, the 25 appendices are very helpful. Appendices such as units of measurement and conversion charts are standard to most dictionaries, but Taber's also includes origin, insertion, action, and innervation for muscles; informal and formal names, origin, function, and distribution of nerves. Recommended Daily Dietary Allowances, vitamins (with chief functions, results of deficiency, characteristics, good sources, & RDA), nutritive values of foods, AIDS hotlines, poison control centers, abbreviations, and symbols are among the appendices. But they took out the computer glossary that was part of previous editions, probably because of the increasing computer literacy of people.

Fifth, it is packed but still very portable and readable. It has over 56,400 entries on almost 2600 pages (5-1/2 by 8 inches & less than 2 inches thick), with a type size and enough white space to be easy on the eyes. Its completeness and portability make it ideal for a busy student or professional.

Every athletic trainer should have a dictionary, and this is a fine one to have. In fact, it should be one of the first "text" books a student athletic trainer buys. You cannot function in any field without the proper vocabulary for that field. And at $27.50 (just over a penny a page), it is a bargain for anyone. There aren't many college textbooks for under $30, and none with as much information as Taber's Cyclopedic Dictionary.

Current Literature

Clint Thompson, MS, ATC

NUTRITION

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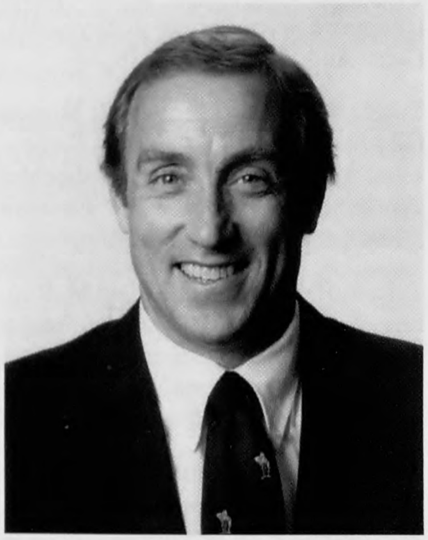
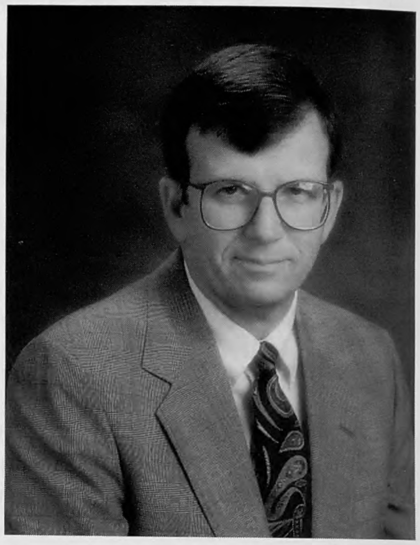
NATA Presidential Election Scheduled



Dennis A. Miller



James Douglas ''Doug'' May

The NATA Board of Directors' 1994 presidential election is a little over 1 month away. Ballots will be mailed to certified members on November 1, 1993 and they must be returned by December 1.

Incumbent Denny Miller, ATC, PT, is being challenged by former District 9 Director Doug May, MA, ATC. Both candidates have served the NATA in a number of different roles, and both feel strongly about the future of the profession and the association.

Dennis A. Miller

Denny Miller was elected president in January 1992 and assumed office in June of that year at the Annual Meeting and Clinical Symposium in Denver. Miller has been active in the NATA since the 1960s, when he joined as a student athletic trainer. Miller graduated from Iowa State in 1968 with a degree in physical education. In 1970, he received his master's degree from Syracuse University, and, in 1973, he received a postgraduate certificate of physical therapy from the University of Pennsylvania in Philadelphia.

Miller started what has turned out to be a long career at Purdue University in 1973 when he accepted an assistant athletic trainer position. In 1977, he became Purdue's head athletic trainer. Miller's previous professional experience includes a 2 year stint as an assistant athletic trainer at the U.S. Military Academy in West Point, NY, and 2 years as an assistant athletic trainer at Syracuse University.

Within District 4, Miller served as president-elect from 1980 to 1982, president from 1982 to 1984, and as district director from 1986 to 1988.

When asked why he is running for a second term as president of the NATA, Miller says without hesitation, "It's important to provide the continuity of two terms to our new executive director. I would also like the opportunity to proceed with the programs and projects that we have initiated during my first term. There is still a lot of work to do as we promote the athletic trainer as an important part of the health care system, and I feel I can make an important contribution."

One of Miller's most satisfying accomplishments during his term as president was participating in the selection of Eve Becker-Doyle as executive director. "The committee that selected the new executive director did a great job," Miller said. "I was proud to be a part, and very happy with the outcome."

Miller is also proud of his other accomplishments as president. "We have started the process of smoothing out some of the discord of the past few years," Miller said. "We have put committee chairs and programs in place that will help us in the future, and there is a new openness between the board of directors and the membership."

According to Miller, "The critical issue for the future is health care reform and how we get involved. We must also look very closely at our educational programs, job availability, and licensure in every state.

Miller sees involvement with health care reform at the federal, state, and local levels as important pieces to advancing the profession. "NATA is putting together a joint effort with key committees, involved members, and national office staff. We are looking at what we should do first and deciding how to best allocate our resources. The big challenge to the individual athletic trainer is to realize that medical care is changing and advancing and we are part of it."

James Douglas "Doug" May

Doug May believes that one individual can make a difference. And, that's one of the main reasons he is a candidate for the presidency of the NATA. "I believe that you should be involved in your organization," May said. "I have the knowledge and experience to be involved at the top level and make a positive impact."

May has made a positive impact in a number of ways during his 23-year career as an athletic trainer. He began his affiliation with the profession by serving as a student athletic trainer for Meridian High School in his home state of Mississippi from 1965 to 1967. Since then, he has worked in the college, high school, and clinical settings.

May received a degree in physical education from the University of Mississippi in 1971. He followed up with a Master of Arts in Physical Education from Tennessee Tech University in 1974.

May began his career as an assistant athletic trainer at Florida State University in 1970. In 1973, he accepted the head athletic trainer position at Mississippi State University. After making a few more stops along the way, May accepted a position as the head athletic trainer for the University of Tennessee at Chattanooga in 1983. May began his current position as head athletic trainer for the McCallie School in 1988. The McCallie School is a secondary day and boarding school in Chattanooga, Tennessee.

May has spent the past 13 years serving the NATA as a dedicated and involved volunteer. He was elected by the Southeast Athletic Trainers Association (SEATA) to serve as secretary/treasurer in 1980. During that time, he served one year as president of the Mississippi Athletic Trainers Association. He was elected president of SEATA in 1984, a position he held until joining the NATA Board of Directors in 1986. While on the Board of Directors, May served as NATA Vice-President from 1988 to 1989. His term on the board ended in 1990.

May is currently the chair of the SEATA Awards Committee and will be the host athletic trainer for the SEATA Student Trainer Workshop in February 1994. He is also a member of the NATA News editorial review board.

Although May has worked in a number of different settings, he feels unity is the key to success for the profession. "We have to look at ourselves as an association of athletic trainers and not a collection of special interest groups," May said. "I see us becoming an assortment of factions, and if we are to succeed we must let the overall health of the profession be the guiding principle for the various segments of our association."

May also believes the member should be the number one concern of the association. "The issue is the member," May said. "We have to make the members feel the association is doing something for them personally. We have to show the athletic trainer that being a member of NATA is beneficial. It is also important that we promote the involvement of the future, the student athletic trainer."

Working in a secondary school for the past 6 years has made May adamant about another point. "We shouldn't be teachers," May said. "We are professionals who provide an important service. We should sell ourselves as ATCs and nothing else. I think it can be done."

Another issue May would address as president is certification. According to May, "We should step back and take a long look at our certification process. I'm concerned about the elimination of the internship route. We should update the process and maintain it as part of the certification system. We should involve the educators and see if what they are teaching and testing for is at the entry level.

May believes the prospects for the future are good. But he adds, "Look to the future, but don't forget where you've been."

New Products

Barry Steele, MS, ATC

VHI Revises Exercise Kit

Visual Health Information (VHI) has produced a 1993 revision of the company's Exercise and Rehabilitation Prescription Kit, with 70 new exercises. The kit is a collection of 316 of the most commonly used rehabilitation exercises, with each exercise on a 3"x4" card.

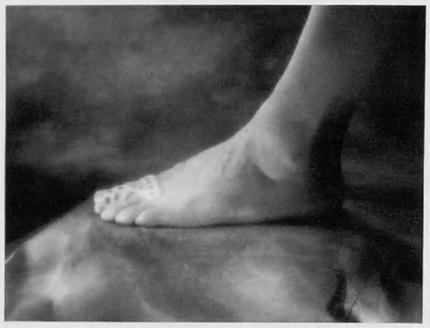
The kit allows athletic trainers to create individual prescriptive exercise and rehabilitation routines, with the assistance of a complete index which is coordinated numerically with the cards. As the exercise cards for a routine are chosen, the athletic trainer places them in a clear holder which can hold up to six cards. Blanks can be left, or cards made up for special exercises. When the routine is created in the holder, it is photocopied. The indexing system allows replacement of the cards in the kit.

In addition to the standard system, Closed Chain exercises are available as an upgrade to the kit. This is a completely new set of 74 Closed Chain functional rehab exercises.

This is a one-time purchase; athletic trainers are given the rights to create and reproduce as many routines as they need. No reordering is necessary. For more information, contact Visual Health Information, PO Box 44646 Dept. 153, Tacoma, WA 98444, or call (800) 356-0709, ext. 153.

Lockhart Unveils Rigid Toe Splints

Lockhart Designs has invented rigid toe splints designed specifically to help active people heal injured or broken toes with minimal pain.



The splints surround the top of the injured toe, using the foot structure for support. Available in three different shapes to fit big, middle, and lessor toes, the splints can be worn inside shoes. According to Lockhart, patients using these splints recover from toe injuries far more rapidly than with conventional treatments and are able to remain active during the healing process.

The splints are molded from low-temperature plastic and can be custom-fitted in the physician's or trainer's office.

For additional information, contact Bob Lockhart, Lockhart Designs, 370 Altair Way, Suite 188, Sunnyvale, CA 94086, (408) 733-3339, (408) 733-3570 (fax).

EFI Develops Testing Grids

Engineering Fitness International (EFI), maker of the TotalGym Therapy System, has announced the development of three Functional Testing Grids for use in rehabilitation and clinical testing.

The grids allow for assessment of movement patterns of the upper and lower extremities during functional ac-

tivities, eg, stepping, hopping, jumping, lunging, reaching, and throwing. They also can be used to train patients in functional exercises.

The Square and Circular Grids each assist different aspects of internal directional motor patterning and diagonal motor planning and control. The color wheel style and grid markings provide directional and spot location for movements by the patients, as well as providing ease of instruction of neurologically impaired, elderly, and pediatric patients.

Movement patterns can be performed in all directions, and functional ability can be assessed by both the patient and therapist. Functional Testing Grids can be used in motor control exercises, progression of movement, and proprioceptive activities, including visual training. The therapist can integrate other functional apparatus with grid training, eg, steps, balance board, and weighted therapy balls, to enhance specific functional training and testing of patients.

The grids can be wall mounted for upper extremity use or moved to any location in the clinical area. They are made of non-skid materials and can be rolled and stored under a treatment table.

Free video demonstration tapes are available. For more information, call (800) 541-4900 or write Functional Testing Grids, c/o EFI Inc, 9225 Dowdy Drive, Suite 221, San Diego, CA 92126.

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 athletic health care counseling and education). Manuscripts should conform to the following:

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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 8½- X 11- inch plain paper, double spaced, with one-inch margins. **Do not right justify pages.**
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   a. Title page
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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 also include the names, credentials, 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 and succinctly summarize the major intent of the manuscript, the major points of the body, and the author's summary and/or conclusions. It is unacceptable to state in the abstract words to the effect that "the significance of the information is discussed in the article". Also, do not confuse the abstract with the introduction.
14. List three to six key words or phrases that can be used in a subject index to refer to your paper. These should be on the same page as, and following your abstract. For **tips from the field**, the key wods 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 other's 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 **review of the literature** 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 superscripted number, 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* (italicized or underlined), volume, year, inclusive pages; b) books: author(s), title of book (italicized or 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 illustrated below. See the *AMA Manual of Style* for other examples.
    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.
21. Type legends to illustrations on a separate page followed by Xerox copies of the illustrations. Photographs should be glossy black and white prints. Graphs, charts, or figures should be of good quality and clearly presented on white paper with black ink in a form that will be legible if reduced for publication. 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. All artwork to be reproduced should be submitted as camera-ready black and white line art. If artwork is to be reproduced in black plus a second (or more) color, it should be submitted as black and white line art. Clearly mark each area of color, or areas of shading or screening (a percent or tint of black or a color), on a separate photocopy. Author pay for color.

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