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Volume 28, Number 4, Winter

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A Discussion of the Issue of Football Helmet Removal in Suspected Cervical Spine Injuries

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Christine Cassidy
Jamie Bentkowski, BS, ATC

Abstract: *In some areas, it is a commonly accepted emergency medical technician protocol to remove a helmet during the initial management of suspected cervical spine injures. After a comprehensive survey of relevant literature, four primary reasons why Emergency Medical Services professionals would desire to remove a helmet emerge. Sources suggest that the presence of a helmet might: 1) interfere with immobilization of the athlete; 2) interfere with the ability to visualize injuries; 3) cause hyperflexion of the cervical spine; and 4) prevent proper airway management during a cardiorespiratory emergency. Many available protocols are designed for the removal of closed chamber motorcycle helmets that do not have removable face masks. There are a great number of differing viewpoints regarding this issue. The varying viewpoints are results of the failure of many emergency medical technician management protocols to address the unique situation presented by a football helmet. We: 1) demonstrate that football helmet removal is potentially dangerous and unnecessary, 2) suggest that cardiorespiratory emergencies can be effectively managed without removing the helmet, and 3) provide sports medicine professional with information that may be used to establish a joint Emergency Medical Services/Sports Medicine emergency action plan.*

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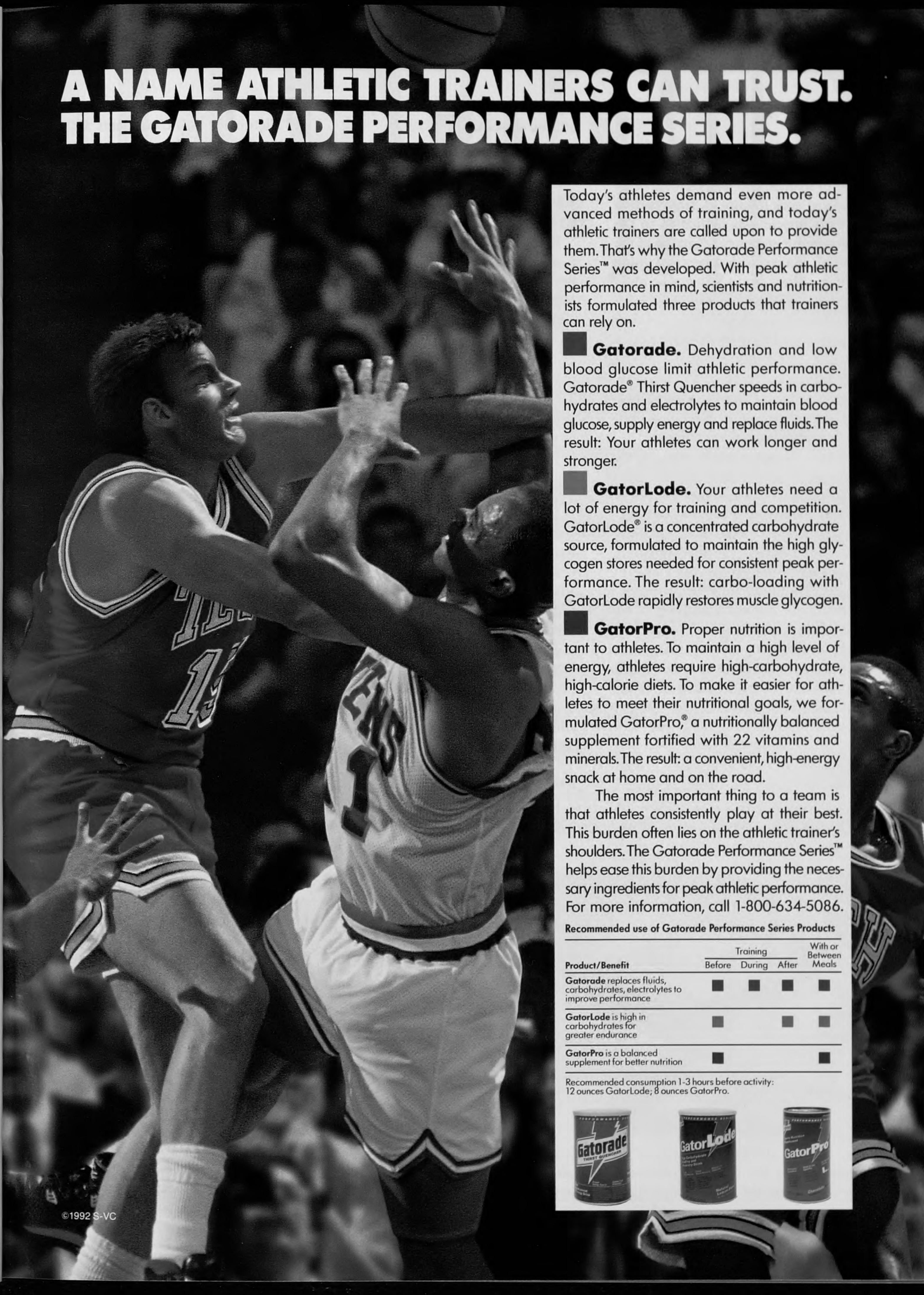
The issue of football helmet removal after possible cervical spine injury is a source of great controversy within many athletic training circles.[4–12] Much of the debate stems from the discrepancies between emergency medical technician (EMT) protocols and sports medicine protocols. In some regions of the country, it is a commonly accepted EMT protocol to remove a football helmet during the initial management of suspected cervical spine injuries.[5–8,12] Despite the established EMT protocols, sports medicine professionals almost universally discourage removing the football helmet when there is even the slightest question of a cervical spine injury.[1,2,5,6,8,10,12,14,15] The rationale for leaving the helmet in place is to prevent further injury.

Because there is considerable debate on this issue, we felt that taking an objective look at the arguments both supporting and refuting football helmet removal was warranted. After careful consideration of the available literature and evidence, it became clear that football helmet removal in athletes with a potential cervical spine injury is undesirable.

The purpose of this article is to: 1) demonstrate that football helmet removal is potentially dangerous and unnecessary; 2) suggest that cardiorespiratory emergencies can be effectively managed without removing the helmet; and 3) provide sports medicine professionals with information that may be used to establish a joint Emergency Medical Services/Sports Medicine emergency action plan.

Review of the Related Literature

Several notable articles touching upon the issue of football helmet removal have been written. Feld and Blanc[6] presented the rationale for current EMS protocols mandating helmet removal and demonstrated that the design of the football helmet and the manner in which it is used renders these protocols inapplicable. The authors concluded that a helmet should not interfere with the management of cardiorespiratory emergencies, visualization of injuries, and immobilization of an athlete on a spine board. In addition, it was suggested that further injury might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result from premature helmet removal.[6]

Similarly, Vegso and Lehman[14] presented a detailed description of the on-field evaluation and management of all head and neck injuries. A large portion of their article was dedicated to the management and immobilization of the football player with a cervical spine injury. They included many photographs to illustrate immobilization on a long spine board. The authors clearly stated that when managing a cervical spine injury, prevention of further injury is the foremost priority. They maintained that the football helmet should remain in place and only the face mask should be removed.[14]

Finally, Denegar and Saliba's[5] work dealt specifically with the management of potential cervical spine injuries in football players. The authors presented the arguments of both EMS officials and sports medicine professionals regarding helmet removal. The discrepancies between both protocols were clearly defined and a universal management protocol was suggested. They presented two situations that warrant helmet removal: first, when the face mask or visor interferes with adequate ventilation or the EMT's ability to restore an airway; and, second, when the helmet is so loose that adequate spinal immobilization cannot be obtained with the helmet in place.[5] The article emphasized a need for communication between athletic training staffs and local EMS units prior to athletic seasons.[5]

Why Current EMS Protocols Do Not Apply to Football Helmets

Feld and Blanc's article[6] presented four reasons why EMS protocols call for helmet removal and provided subsequent objections to each. EMS officials suggest that the presence of a football helmet might:

1. interfere with immobilization of the athlete;
2. interfere with the ability to visualize injuries;
3. cause hyperflexion of the cervical spine; and
4. prevent proper airway management during cardiorespiratory emergencies.[6]

Response to 1

A football helmet, when fitted properly, is secured to the head very snugly by its interior padding or air bladders, cheek pads, and chin straps. Very little motion of the head is possible. When the athlete is secured to a cervical immobilizing device, the head and helmet are immobilized as a unit. This allows minimal motion of the entire cervical spine.[6]

Response to 2

Feld and Blanc[6] brought up a very good point in their rebuttal to this particular point. They stated that, "Victims of traffic accidents are subjected to blunt force trauma and the incidence of facial soft tissue injury, depressed skull fracture, and cranial lacerations is high. This is not the case in football."[6] The signs and symptoms of injuries sustained in football can be visualized through the face mask and ear holes (ie, pupil size and reaction to light, otorrhea, rhinorrhea, etc). For the purposes of emergency management, adequate visualization is provided by virtue of the football helmet's fundamental design.

Response to 3

In the case of a motorcyclist with a cervical spine injury, the thickness of the helmet shell may cause hyperflexion, but in football, this is not an issue.[6] The thickness of the posterior portion of the shoulder pads offsets that of the helmet. The presence of both pieces of equipment creates a neutral alignment of the cervical spine. When the football helmet is removed, its shell is no longer present to offset the thickness of the shoulder pads. The end result is cervical hyperextension.[6] To illustrate this change in cervical alignment, plain film radiographs were taken laterally of the cervical spine with and without the helmet in place (Fig 1, a and b). Removal of the helmet hyperextends the cervical spine approximately 20° from C1 to C7. Despite the vari-

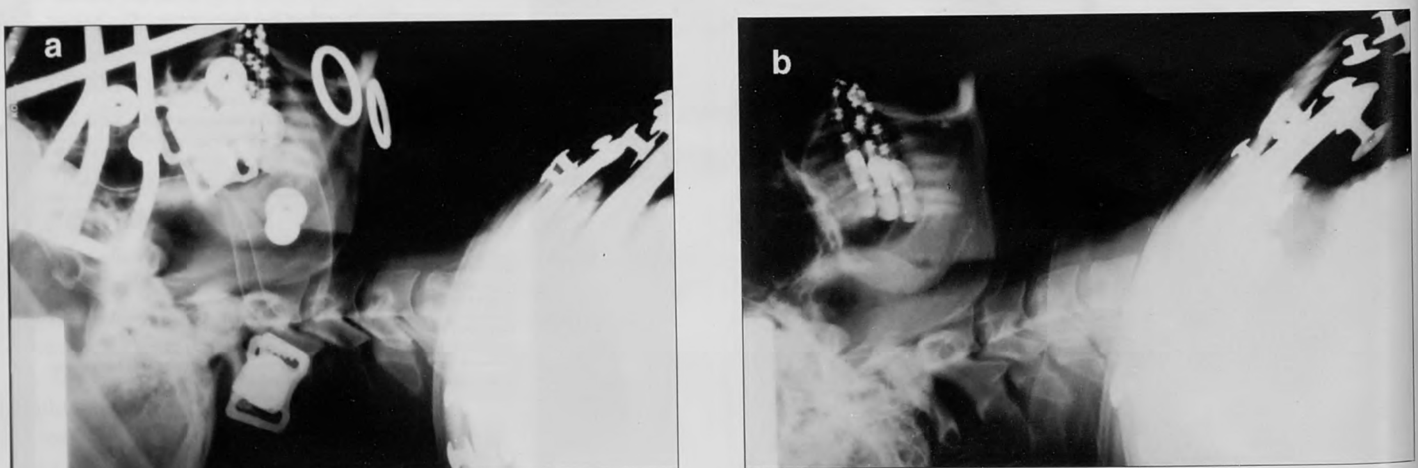

Fig. 1.—a, Lateral radiograph of the cervical spine with a football helmet and shoulder pads present. Note the neutral alignment of the cervical vertebrae. b, Lateral radiograph of the cervical spine after the football helmet has been removed. Note the increase in hyperextension (approximately 20°).

ances that occur between different body types and different equipment brands and sizes, cervical hyperextension will result from the removal of the helmet.[6]

Response to 4

In the management of cardiorespiratory emergencies, the ABC's are monumentally important and their maintenance constitutes the main thrust of our efforts. The fundamental differences between the EMS protocols and the sports medicine protocols is evident in the discussion of airway management. Current EMS protocols fail to address the unique situation presented by a football helmet. Most of these protocols are designed for the removal of the closed-chamber, full-coverage motorcycle helmet that does not have a removable face shield.[5–7] With the motorcycle helmet, it is easy to see why an emergency care provider would desire to remove the helmet. The football helmet is designed to allow for resuscitative efforts. With practice, the face mask can be removed quickly to allow access to the airway.

Fig 2.—Checking for unresponsiveness.

Management of Cardiorespiratory Emergencies in Football

In the unfortunate situation where a football player with a potential cervical spine injury goes into cardiac arrest, the need for quick decisive action by the attending medical staff cannot be overstated. The following chain of events is designed to address a potential cervical spine injury in a football player:

1. Check for unresponsiveness (Fig 2).
2. Note time of unconsciousness, stabilize the head and neck, and look, listen, and feel for breathing (Fig 3). All three events should take place simultaneously.
3. Using a suitable device, cut the plastic clips that secure the face mask. The Trainer's Angel is being used here (Fig 4a). While one person is cutting the clips, another should be cutting the jersey and the front string of the shoulder pads to allow access to the chest if compressions are indicated. A third person should be readying the one-way cardiopulmonary resuscitation mask (CPR) to give respirations (Fig 4b). Figure 4c shows a close-up of the equipment necessary to remove the mask, cut the jersey, and provide respirations.
4. Place the CPR mask over the nose and mouth and use a jaw thrust to open the airway. Give two ventilations and check the pulse (Fig 5).
5. Activate EMS.
6. Perform CPR until EMS arrives (Fig 6).

We have practiced the above-mentioned guidelines on CPR mannequins equipped with a football helmet and shoulder pads. We were able to provide sufficient respirations and adequate chest compressions during CPR. With careful organized practice, the face mask can be removed in less than 20 seconds, and the first breath can be given about 30 to 35 seconds after unresponsiveness has been determined.

Preseason Planning and Accessing EMS Officials

As with any sport, preseason is a time when athletes are supposed to be striving toward peak performance levels. As sports medicine professionals, we need to be at our peak levels before then so that we are ready to help our athletes. Sports medicine preseason is the time for planning, administration and review, and honing of skills.

Fig 3.—The person at the head is stabilizing the cervical region. Another person is assessing the breathing by listening for air exchange and by watching and feeling for the chest to rise. A third person is simultaneously noting the time of unconsciousness.

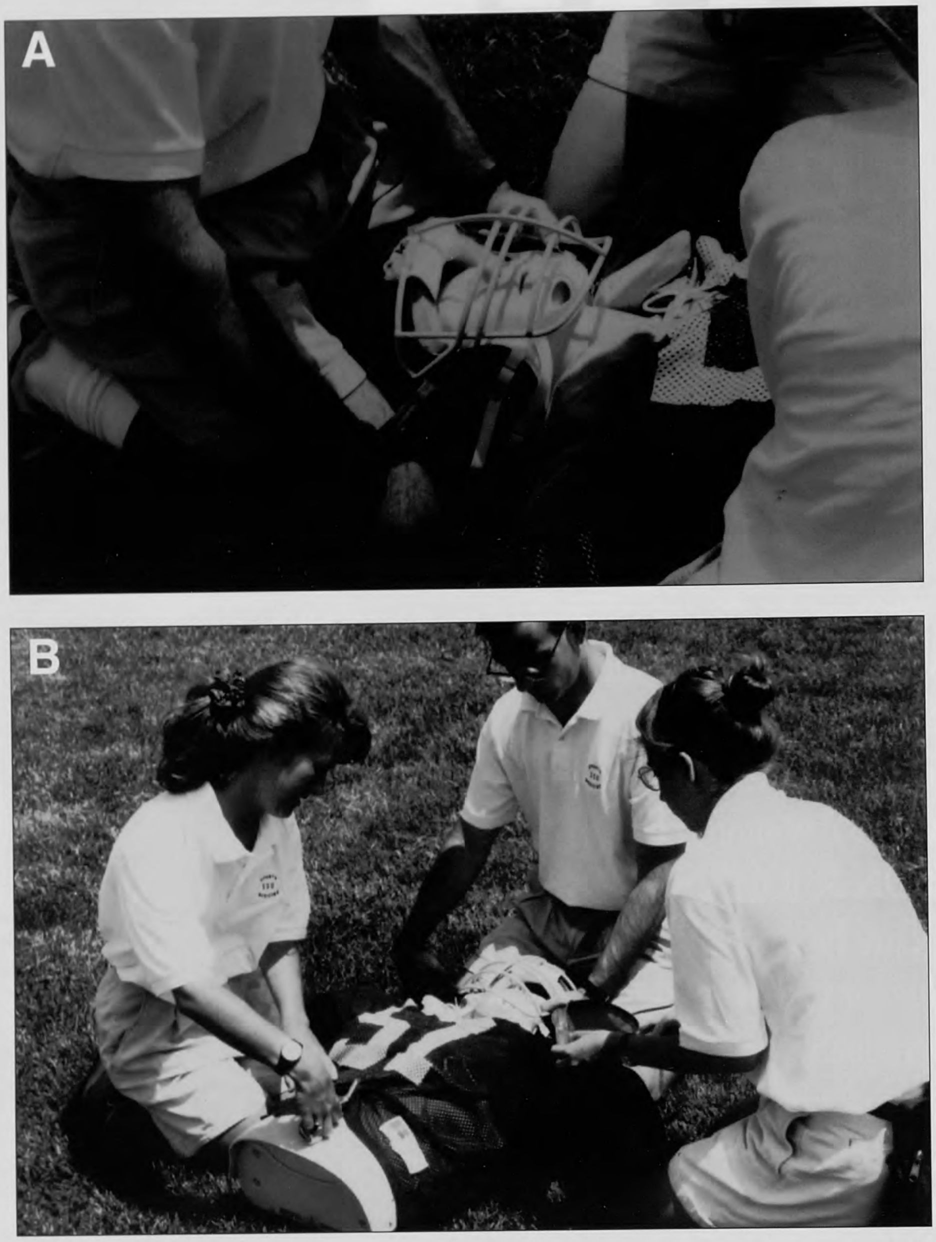

Fig 4.—A, The Trainer's Angel is being used by the person at the head to cut through the face mask clips. B, While the jersey and shoulder pad strings are being cut, a one-way CPR mask is being prepared so that respirations can be given. C, A close-up of the tools used. Top, Laerdal Pocket Mask; middle, EMT trauma scissors; bottom, Trainer's Angel.

This is the most appropriate time to plan for emergencies. It has been stated in previous articles that there is a need for communication between athletic training staffs and local EMS units.[5] When planning for emergencies, policies should be constructed so that they are concise and direct, but flexible enough to deal with unique situations. As current EMS protocols illustrate, an inflexible policy has the potential to create a great number of problems. In a conversation with Otho Davis, ATC (December, 1992), it was suggested that an annually reviewed interdisciplinary policy be instituted for each locality. However, it is not easy to establish a joint emergency action plan. Each state has its own governing agency that decides major policies. Some states are divided into regions that are autonomous. The policies set forth in these regions are subject to great variance.[5,7] However, the governing agency of each state should be able to describe the hierarchy of that particular state and provide the names of the people in charge at the county or regional level.

By contacting these people, an inquiring sports medicine professional should eventually be able to determine the following information: who is in charge of EMS within their own locality and who is in charge of establishing the protocols that govern EMS within that locality. This is admittedly a difficult task, but it is very important if a joint emergency action plan is to be established. Table 1 contains a current list of the governing EMS agencies in each state, along with phone and fax numbers. It is our hope that this will provide a means for establishing good communication.

Recommendations

During the completion of this article, various situations presented themselves, which added additional dimensions to the issue of football helmet removal and emergency care in general. The following recommendations are based on the literature we have reviewed, communications with many allied health care professionals, and

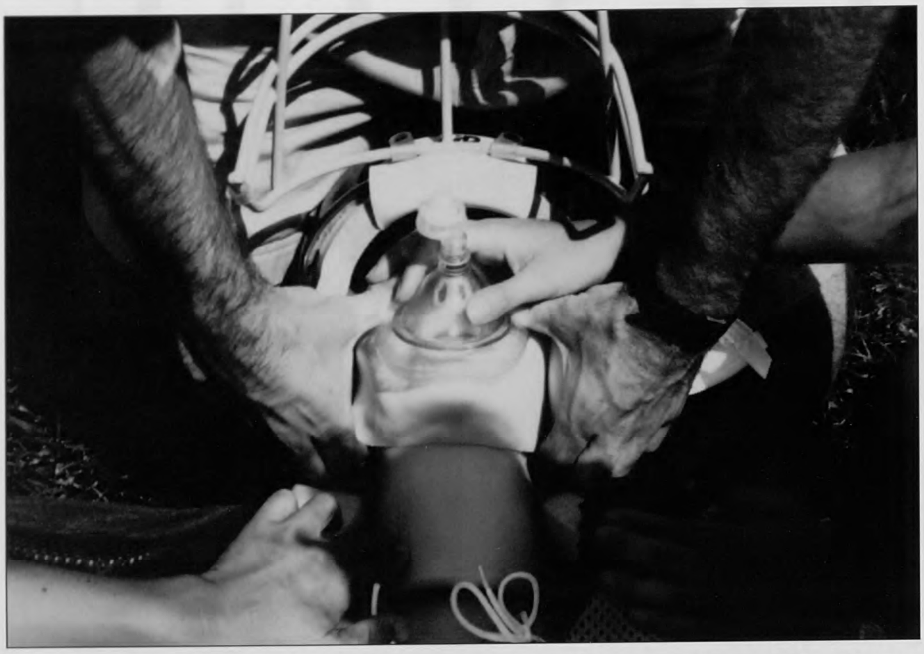

Fig 5.—With the mask in position, a jaw thrust is used to open the airway. Two breaths are given and the pulse is then assessed.

Fig 6.—After the access to the airway and chest has been established, CPR is then begun.

personal experience through practice.

1. All sports medicine staffs should open a line of communication with their local EMS systems and officials.
2. Currently, there is no direct communication between the National Athletic Trainers' Association and the National Association of State Emergency Medical Service Directors. With all of the discrepancies among protocols across the nation, it would seem that the formation of a joint EMS/Sports Medicine committee is in order. Such a committee would be well suited to establishing a universal protocol that deals specifically with the emergency management of potential cervical spine injuries in football players.
3. The management of a potential cervical spine injury in a football player needs to be practiced regularly by those responsible for providing emergency medical care (ie, sports medicine team, EMS personnel, hospital emergency room personnel). This should include performing CPR on a mannequin dressed in football equipment. Also, at some point in the emergency care, the helmet will need to be removed. All personnel should be trained to remove the helmet and shoulder pads in the safest manner possible with the least amount of cervical motion.
4. With the recent advancement in football helmet accessories, the question arises as to whether there is a need to adapt current or proposed management protocols. For example, Ridell manufactures the Cra-lite face mask, which is anchored to the helmet by clips composed of a dense polycarbonate material that require a special tool to cut them. Also, some athletes are now using the Pro-cap, which is an external helmet padding that is fastened to the shell. Additional padding increases the net thickness of the helmet and may alter cervical alignment. Finally shock-absorbing face mask clips are currently available in the United States. These may be constructed of a different material than the standard plastic clips. If so, they may slow face mask removal. Even though these accessories may not be standard equipment, their presence demands that emergency management protocols account for them.
5. The most efficient techniques to remove a face mask demand more attention. More research is needed to determine the devices that are most effective for face mask removal.

Conclusions

Although uncommon, catastrophic cervical spine injuries are an unfortunate reality in the realm of athletics.[3,13] Despite our best efforts to pre-

Table 1.—EMS Governing Agencies

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vent their occurrence, there is always the element of risk. We urge all who are responsible for the well-being of athletes to communicate with their local EMS units and practice these skills. One mismanaged cervical spine injury is far too many. In a recent editorial, Knight summed it up well by saying, "Every athletic trainer... has a moral obligation to know that he or she can remove the face mask quickly enough to apply CPR.... Practice taking off football helmet face masks.... Do it because it is the right thing to do."[9]

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A National Survey About Parent Awareness of the Risk of Severe Brain Injury From Playing Football

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Abstract: *A survey was conducted to determine the level of awareness among parents of high school football players about the risk of severe brain injury. A national sample of 1007 randomly selected households was interviewed by telephone during February, 1992. All interviewees were parents of high school football players who either were currently playing football or had played within the previous 5 years. Survey questions measured the extent to which parents were aware both of the risks associated with playing high school football and the existing helmet warnings about those risks. Overall, the survey results demonstrated that parents of high school football players were uninformed about both the risk of severe brain injury from playing high school football and the football helmet warnings about that risk. Specifically, unprompted, most parents mentioned broken bones, knee injuries, sprains, or shoulder injuries as hazards associated with playing football. Few parents mentioned severe brain damage, even when prompted. Further, the overwhelming majority of parents incorrectly believed that wearing a football helmet generally eliminated the risk of severe brain injury. Very few parents had received information from any source about the risks of head injury or had heard that no football helmet can provide complete protection against this hazard. Few parents were aware of the warning label on the helmet or knew what the label said, even when prompted. In short, parents were unaware of the risk of severe brain damage, misinformed about a football helmet's ability to protect against this risk, and uninformed about the football helmet warning label about this risk.*

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An analysis of product warnings, their purpose and potential impact, has some bearing on decisions relating to the use of football helmets designed to reduce the risk of serious head injury while playing football. The risk of injury from playing football is probably common knowledge. What may not be common knowledge, especially to parents, players, coaches, etc., is the full extent of the risk of injury. Stated another way, the potentially severe consequences associated with playing football may not be fully understood by those with a need to know, thus creating a condition of uncertainty among parents needing complete information to make effective decisions.

As testament to the severity of potential injury, one manufacturer of football helmets has stated in its promotional literature designed for football coaches, "when you get right down to it, the primary purpose of a football helmet is to protect the football player's brain from the damaging effects of external blows to his skull."[1] The National Operating Committee on Standards for Athletic Equipment (NOCSAE), warned that "head injuries had been traditionally the source of greatest concern in the game of football, accounting for 65 to 85% of all fatalities."

Football helmet manufacturers, recognizing the risk of such a severe hazard as brain injury, have used a variety of written, oral, and technologically driven communication channels to deliver safety messages to players and coaches about this risk. For example, catalogs and brochures have been mailed to high school football coaches; videotapes are available for coaches to show to players; interpersonal channels involving the manufacturers' sales force allow face-to-face exchange of information; posters are available for locker rooms; and warning labels have appeared for years both on and inside football helmets warning about the risk of severe brain injury and that a helmet may not prevent such injuries.

All of these methods and channels of communication may have provided safety information to coaches and players, but one key audience that may have been missed are the parents of those players, the very audience that may well be making the crucial decision about whether or not their child will play football. If they make this decision without the benefit of full knowledge about the potential risk of severe brain injury, they will predictably be making a decision in a state of uncertainty. The purpose of this study was to determine the level of awareness of parents of high school football players of the potential risk of severe brain injury from playing football.

Methods

Sample

A national sample of 1007 parents of high school football players was interviewed by telephone for this survey. Best Mailing Lists, Inc of New York City provided lists with names and phone numbers of 20,000 randomly selected households in the United States, stratified and organized by state according to 1990 US Census figures. Each household contained at least one male child between the ages of 13 and

19 years old. Households were screened for the presence of at least one child who either currently played high school football or had done so within the previous 5 years. Screening was achieved by asking, as the initial question during the telephone interview, whether or not a household had at least one male child between 13 and 19 years old who currently or previously played high school football. Ninety percent of the final sample of 1007 households had a child who was currently playing football, and 10% had a child who had played within the previous 5 years.

The sampling frame allowed for random selection of households and interview completion rates within each state to coincide with the exact proportion of households containing males between 13 and 19 years old within each state. Thus, for example, 71 interviews, or 7.1% of the total number interviewed, were from households in Texas; 7.1% was the exact proportion of the total number of households with males between 13 and 19 years old within the United States residing in Texas at the time the lists were purchased. The 71 interviews completed in Texas were from households randomly selected from the lists available of Texas households. Either the male or female head of the household was randomly selected to be interviewed, in accordance with a process stratified to represent the exact population proportion of males and females in such households. For example, the number of households in the United States containing males between 13 and 19 years of age that have a female adult parent present (either alone or with a spouse) is 60%; 61.8% of those interviewed in this survey were female adults, producing a very close "fit" to the overall population. Up to three callbacks were allowed in order to reach each household. A similar procedure was followed for each of the 50 states, resulting in a sampling error of ±3% for this national survey.

Interviewing

All interviews were completed by telephone between January 27 and February 8, 1992. Each completed interview lasted approximately 7 to 8 minutes. All calls were made on-site by members of the professional interviewing staff of Goldhaber Research Associates, a national opinion research organization located in Amherst, NY. Interviewees used a Computer-Assisted Telephone Interviewing (CATI) system supported by survey software provided by The Survey System of San Francisco. All interviewing was supervised on-site, as well as by use of a Melco silent monitoring system which allowed additional supervisors to listen to and monitor a random sampling of the interviews. Two short pilot tests were conducted approximately 2 weeks prior to the start of interviewing in order to pretest both the survey questionnaire (its length, language, etc.) and the interviewing procedures. Results of the two pilots, conducted in Buffalo, NY and Austin, Tex, indicated that the survey questionnaire and procedures, with very minor modifications, were appropriate for both the target audience and the study's intended objectives.

Results

Overall, parents surveyed were uninformed about both the risk of severe brain injury from playing high school football and the existing helmet warnings about that risk.

Risk Awareness

Unprompted, most parents mentioned broken bones, knee injuries, sprains, or shoulder injuries as being associated with playing high school football. While 546 (54%) of parents mentioned knee injuries and 406 (40%) mentioned broken bones, hardly any parents (less than 1%) mentioned severe brain damage as being associated with playing high school football (Table 1).

Even when prompted, the results were not much different. Almost all parents (better than 90%) again associated either knee injuries (972) or broken bones (916) with football, while very few (249; 25%) mentioned severe brain damage (Table 2). Not only did almost all parents fail to associate brain damage with football playing, but, almost 790 (80%) believed that wearing a football helmet would generally eliminate most of the risk of severe brain injury (Table 3).

Information Sources

Very few parents had received information from any source about the risks of head injury or had heard that a football helmet cannot provide complete protection against this risk. Only 108 (11%) of the parents had received such information, mostly from written notices or permission slips from their child's high school or from a newspaper or television documentary (Table 4). Of the 108 respondents who had received information from one or more sources, only 5 (<.5%) parents, had received such information from the football helmet's warning label. In a separate question, about one in four parents (278; 27.6%) had never heard that a football helmet cannot provide complete protection against the risk of severe brain injury.

Table 1.—Unprompted Risk Awareness of High School Football Injuries (N = 1007; respondents were allowed up to three responses)

Question: What types of injuries do you think of as being associated with playing high school football?

Type of Injury	n	%
Knee injuries	546	54.2
Broken bones	406	40.3
Sprain type injuries	219	21.7
Shoulder injuries	143	14.2
Broken neck	79	7.8
Mild concussions	78	7.7
Severe brain damage	6	.6

Table 2.—Prompted Risk Awareness of High School Football Injuries (N = 1007; multiple responses allowed)

Question: Now, I'm going to read you a list of injuries some people have associated with playing high school football. Please tell me if you associate each of the following with playing high school football.

Type of injury	n	%
Knee injuries	972	96.5
Broken bones	916	91.0
Mild concussions	839	83.3
Shoulder injuries	824	81.8
Broken neck	499	49.6
Severe brain damage	249	24.7

Table 3.—Beliefs About Football Helmet Protection (N = 1007)

Question: Do you believe that wearing a helmet while playing football generally eliminates the following risks?

Risk	n	%
Severe brain injury	790	78.4
Mild concussion	702	69.7
Broken neck	293	29.1

Table 4.—Sources of Information About Risk of Head Injury

Question: Have you received information from any source regarding head injury risks associated with high school football? (N = 1007)

Response	n	%
Yes	108	10.7
No	886	88.0
Not sure	13	1.3

Question: (If "yes"; N = 108) from what source or sources did you receive this information?

Information source	n	%
Written notice from school	34	31.5
Newspaper/TV documentary	23	21.3
Football coaches	17	15.7
Helmet manufacturer	7	6.5
Helmet warning label	5	4.6
Parents meetings	4	3.7

Warning Label Awareness

Few parents were aware of the warning label on the football helmet or knew what the label said, even when prompted. About one in three (372; 36.9%) parents had heard that there is a warning label on football helmets, but, unprompted, less than one in five could correctly identify at least one piece of information from that label (Table 5). Of those who had heard of the label, 304 (81.8%) either could not give any or gave an incorrect response when asked to tell what the label said. Of the 68 (18.2%; representing less than 7% of the entire sample interviewed) who correctly identified at least one part of the label, only eight respondents (2.2% of those who had heard of the label) mentioned the risk of severe brain injury. Even when prompted with portions of the warning label read to them, only 212 (21%) of the parents had heard of the message on this warning label (Table 6).

Discussion

Human communication is the process by which people create and exchange messages with each other to reduce the uncertainty we face from environmental factors. The more complex the task, the greater the number of decisions and, consequently, the greater the amount of uncertainty we confront, thus requiring more information from messages to reduce our uncertainty. Uncertainty is defined as the difference between the information available and the information we need to make decisions.[4–6,15,21] When we have adequate information to meet our needs, we reduce our uncertainty and make more effective decisions in our lives; the converse is true with inadequate information.

Contemporary communication theory argues that, while humans are information-processing units that interact with their environments to remove as much uncertainty as possible, they tend to process only those informational inputs that are relevant to them.[6,15] Such is also the case if one views safety warnings as a type of informational input.

Safety warnings are messages that are created and exchanged to allow individuals to cope with environmental uncertainty in their relationship with products they or their family members use. Effective warnings are messages that communicate to consumers that, based upon scientific knowledge, there is some danger associated with their use of a product.[7,18–22] Once a warning message has been communicated to its proper target audience (in communication theory, "the receiver"), those who must make decisions about a product's use, the receiver, assuming the message has been received and understood, is able to reduce his or her uncertainty and make an informed choice about appropriate behavior.

As indicated above, it is important that safety information be communicated to those who must make decisions about how to use a product safely. Studies that measure the impact of safety warnings have shown that whether an individual will tend to process information from warnings is directly related to his or her familiarity with the product.[2,3,8–14,16,17] The more

Table 5.—Unprompted Helmet Warning Label Awareness

Question: Have you heard that there is a warning label on football helmets? (N = 1007)

Response	n	%
Yes	372	36.9
No	598	59.4
Not sure	37	3.7

Question: Could you tell me what it said? (N = 372)

Response	n	%
No/don't know	261	70.2
Incorrect response	43	11.6
Correct response	68	18.2*
No helmet can prevent all injuries	61	16.4
Do not strike opponent with helmet	19	5.1
Risk of severe brain or neck injury	8	2.2
You use this helmet at your own risk	5	1.3

* Multiple responses possible.

Table 6.—Prompted Helmet Warning Label Awareness (N = 1007)

Question: There is a warning on high school football helmets that includes the following: "Do not strike an opponent with any part of this helmet or face mask. This is a violation of football rules and may cause you to suffer severe brain or neck injury, including paralysis or death." It also states "No helmet can prevent all such injuries." Have you heard that this information is on all scholastic football helmets?

Response	n	%
Yes	212	21.0
No	753	74.8
Not sure	42	4.2

familiar individuals are with the product, the less likely they will perceive the product as hazardous and notice or read a product warning message.[3,5,10,11,16] This finding is particularly true with regard to teenage males, an audience typically willing to assume greater amounts of risk and more likely to ignore warnings about safety risks.[10,11,22]

As the above results indicate, parents were unaware of the risk of severe brain damage from playing high school football, misinformed about a football helmet's ability to protect against this risk, and uninformed about the existence and contents of the warning label about this risk on the football helmet. If parents are indeed an important audience for the information about this risk and are expected to make informed decisions about granting permission for their child to play high school football, it is apparent that they are making these decisions without the appropriate information necessary to reduce their uncertainty. If the parent is expected to learn about the risk of brain injury from the typical parental consent form from the high school, that source of information would be quite inadequate to convey information about the specific consequences addressed in this survey. Many such forms use language addressing general rather than specific risks, with phrases such as "even though protective equipment is worn by the athlete whenever needed, the possibility of an accident still remains." Given that, according to this survey, parents would probably associate the words "possibility of an accident" with broken bones or knee injuries, this language is not adequate to warn about the risk of severe brain damage.

Another possible source of information about this risk could be the football player. Assume that the warnings about the risk of brain damage were effectively communicated by helmet manufacturers both to high school football coaches, and then to high school football players and potential players by the coaches. There is no evidence that the players have or would communicate this information to their parents (especially prior to a parent signing a permission form). While a national survey of football coaches might document the level of awareness among coaches about this risk and the degree to which they have communicated the relevant information to their players, there is ample evidence in this current survey to indicate that even those few parents who have received information about this risk did not receive it from their child who plays football. This is not surprising since high school football players, for the most part, would be teenage males, the audience least likely to receive, process, and adhere to safety and warning messages.[3,11,13,14]

Role of the Football Helmet Manufacturer

If football helmet manufacturers expect or hope that football players will communicate relevant safety information about this or any other risks associated with playing football to their parents, this would not be a reasonable assumption given the risk-taking propensity of teenage males. There are many better, direct, and potentially more effective means available to helmet manufacturers to communicate safety information to parents.

Given that helmet manufacturers have access to the available scientific literature, NOCSAE tests and standards, and information about the risk of severe brain injury from playing football, it is only appropriate that they be the source to communicate all necessary safety information and warnings to users and potential users of their helmets, as well as all concerned parties, including parents of potential or current football players.

Not only do manufacturers have the information and credibility behind the information, they also have the means to deliver the message to parents. Manufacturers could recommend, via letters, brochures, and face-to-face meetings with sales representatives, that coaches and athletic trainers hold parent meetings at which a videotape presentation containing risk and safety information is shown to parents. Manufacturers could also provide written information (brochures, letters, placards, etc.) to distribute to parents attending these meetings, or by mail to others. Further, since helmet warning labels need to be replaced when the helmet is reconditioned and many high schools regularly use reconditioned helmets, an additional card could easily be attached to the helmet for distribution to the parents providing them with relevant safety information.

Given that parents today are not aware of the risk of brain injury from playing football and incorrectly believe that a football helmet will protect their child from such risks, now is the time for helmet manufacturers to lead a concerted effort to provide parents with the information they need to make informed decisions about matters of safety concerning their football-playing children.

The Role of Athletic Trainers

Athletic trainers have an important role to play, both in gathering information essential for informed decision making and in effectively communicating necessary information to parents so that they have an opportunity to make an informed decision about their children's participation in organized football. On the information-gathering front, manufacturer and reconditioner testing of football helmets reveals a significant degree of variation in performance, depending on such factors as helmet brand, model, size, and age. Despite this fact, a critical information gap exists in the availability of catastrophic head injury incidence reporting that is linked with information about the particular brand, model, size, and age of the helmet involved. To date, the only entities that possess such information are the helmet manufacturers, who typically investigate reports of catastrophic injury occurrences when their product is believed to have been involved. Athletic trainers, both individually and through their group organizations, should exert pressure on helmet manufacturers to make this important information available for study and analysis. Perhaps more importantly, athletic trainers are ideally positioned to initiate and operate their own reporting network nationwide so that reliance on manufacturer cooperation would not be necessary in the future. This reporting network could collect information concerning incidents involving head trauma (from mild concussion to subdural hematoma) in practice or game situations and include relevant information about the particular helmet involved. Once gathered, this information could be analyzed and made available to the interested public and athletic trainers.

On the communication front, athletic trainers, in conjunction with coaches and other team officials, should actively participate in the process of providing relevant information about potential risks and hazards of participation in football to parents. Such activities could include face-to-face communication with parents, written "disclosure" statements included in parental consent forms that require parent signature prior to a child's participation in football, and acquiring films, videotapes, and other informational vehicles that are available through helmet manufacturers and other sources, and making them "required" viewings at parent meetings prior to the start of the football season.

In summary, the following conclusions can be derived from this survey:

1. Most parents associated knee or shoulder injuries and broken bones with playing high school football.
2. While very few parents associated severe brain damage with playing high school football, most incorrectly believed that wearing a football helmet would generally eliminate that risk.
3. Very few parents had received information from any source regarding the risk of head injury or were aware of the helmet warning label and its contents.
4. Overall, parents were uninformed about both the risk of severe brain injury from playing high school football and the existing helmet warnings about that risk.

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Enhancing Athletic Injury Rehabilitation Adherence

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Abstract: *Contemporary sports medicine literature has begun to address more centrally the idea that treatment adherence is a complex issue. Not only must certified athletic trainers (ATCs) possess knowledge about injuries and subsequent rehabilitation protocols, they also must be able to deliver essential services in a manner that predisposes treatment success. Effective treatment of athletic injuries necessitates consideration of various psychosocial factors shown to enhance rehabilitation adherence. Detailed explanations of several important ATC-athlete interaction patterns and motivational strategies are offered.*

Effective rehabilitation is confounded by the fact that there are more than 200 variables that can affect adherence.[16] Certainly some of these variables are subsumed under the heading of certified athletic trainers' (ATCs') competence (eg, anatomical understanding of injuries and selection of appropriate treatments). However, knowledge about injuries and rehabilitation can readily be undermined by poor delivery. Both ATCs[10] and injured athletes[9] recognize that such psychosocial factors as social support, ATC-athlete rapport, and goal-setting impact the success of any prescribed rehabilitation.

Most athletic training textbooks[1,2,6,20] contain material devoted to such topics as developing a relationship between an athlete and an ATC, setting attainable goals, and social support. However, coverage of these topics is brief, leaving the developing ATC with limited opportunity to either appreciate or integrate such information. It is necessary, of course, for textbooks to focus on prevention, description, explanation, and rehabilitation of athletic injuries, but the paradox is that ATCs' effectiveness may well reside with their people skills (eg, rapport, communication) as much or more than with their clinical skills.

Adherence to rehabilitation necessitates a partnership approach in which ATCs and athletes collaborate to produce desired end results. ATCs ply their rehabilitation skills on injured athletes who face a number of challenges[19,22]: *cognitive*—athletes need to understand the nature of the injury, treatment regimen, and prognosis for recovery; *emotional*—athletes need to deal with feelings of uncertainty, anxiety, blame, guilt, anger, hopelessness, and loss of control; and *behavioral*—athletes need to do something about their condition. Considering the above, it should be obvious that ATCs cannot realistically expect their injured athletes simply to comply with prescribed treatments, unless there are supports in place to deal with athletes' questions and concerns.

The purpose of this article is to offer some detailed and practical information on some of the more salient psychosocial factors that have been shown to have an impact on injury rehabilitation adherence.

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Education

Educating injured athletes about their particular circumstances is normally a necessary first step in the rehabilitation process (Fig 1). We need, however, to realize that athletes differ in how much information they want.[17] Some will desire specific details, whereas others will want to move immediately to the action phase of "Let's get on with it." And, as important as education is, it does not guarantee that athletes will adhere to their prescribed treatments.[13,16] Quite simply, increased insight and knowledge do not necessarily lead to an increase in motivated behavior. Failure to offer needed and expected information, however, may cause a loss of motivation.

It seems to us (reinforced by others[23]) that the important issues are: what to communicate, how much to communicate, and how to deliver the message. A great deal of relevant information could be discussed with the athlete, including the athlete's previous injury history, his/her particular role on the team, the athlete's motivational level, personal reactions to the injury, effects of the injury (eg, nature, severity, activity limitations, and pain expectations), treatment rationale, comparisons with previously injured and rehabilitated athletes, and prognosis.[21] Selecting the points that are important to each particular athlete is a challenge for the ATC.

Previous investigations dealing with ATCs'[10] and injured athletes'[9] attitudes and judgments about injury re-

Fig 1.—Using anatomical model to describe an injury.

habilitation reveal that the educational phase should focus more on rehabilitation methods than on details of the injury. This seems to depict the message as one of hope and recovery rather than despair and deficit. Given the vulnerability of athletes at the onset of their injuries, it is too easy for athletes to adopt the fatalistic perspective that recovery will be incomplete and performance will be permanently hindered. But, we are quick to point out that some explanation of the injured athlete's condition is warranted and caution ATCs not to assume that the athlete understands everything that an orthopedic surgeon, for example, might have said.

In addition to the usual rehabilitation treatment details all ATCs discuss with their injured athletes (eg, type, frequency, intensity, and duration), we suggest that ATCs consider some preliminary relapse-prevention training.[4,15] It is highly unlikely that injured athletes will be maximally motivated and committed to all aspects of the rehabilitation all of the time. Although there is no intent to give athletes a license to be irresponsible, the reality of adherence lapses needs to be recognized and at least mentioned. Treatment adherence needs to be seen as continuous and ongoing, not dichotomous (ie, all-or-none). There are optimal periods for recovery when conditions are right, but the essential feature of most rehabilitation is that recovery takes place; even if it is delayed by brief lapses in motivation. The real concern here is that athletes recognize that rehabilitation is a sequential and developmental process, not obliterated by the odd day off. Failure to grasp the reality of the inevitable may lead the athlete to totally discontinue the rehabilitation because the treatment plan was interrupted. (We remind you about the parallels with fitness program motivation and dropout and the vicissitudes associated with diet control plans.)

There is a certain infallibility of youth and denial of reality that often needs to be addressed. Injured athletes' microviewpoints lead them to emit such a claim as, "I'm 80% and that's good enough to play." After all, that is what highly visible athletes proclaim in their televised interviews. Sometimes when athletes are asked to think of rehabilitation in the long term, their thoughts might go forward to the beginning of the playoffs or maybe even to the end of the season. However, from your perspective you might have been suggesting a return to normal functioning for daily living, irrespective of sport participation. Injured athletes need to understand factors as the body's normal responses to injury, concomitant reductions in functional capacity, and objective criteria that must be met prior to release from rehabilitation.

The dilemma faced is the huge amount of potentially valuable information that could be shared with athletes. How much should be explained? Perhaps a good starting point might be to ask: "Do you want to know what's happened and what's to follow?" We would be surprised if that question failed to generate some questions from the athlete. Our suggestion is to key off athletes' questions or quizzical demeanor, meeting them at the point of their needing to know.

Certain questions do not permit discrete and definitive replies. For example, when the athlete queries: "How long am I going to be out?," a most appropriate response might be: "How hard are you prepared to work at your rehab?" Two important messages are inherent in this answer. First, it lets the athlete know that this is indeed a partnership arrangement, one in which he or she is expected to play a major role. ATCs work with and support injured athletes' rehabilitation efforts; they do not do the work for injured athletes. We feel it is very important that athletes understand their place in the partnership and accept maximum responsibility for the outcome. Second, it is evident from what we know about the complexities of treatment adherence that a discrete and categorical response is often not possible. The success of the rehabilitation depends not only on the character of the athlete undergoing the treatment but also on the quality of the personal healing environment that is created by the interactions of the ATC and the athlete. But, if the issue of length of treatment is pressed by the athlete, then perhaps the best response is to offer a time range, with minimums and maximums derived from your personal experiences.

Substantial evidence indicates that there are gaps in people's comprehensions of medically related information.[16] A couple of humorous anecdotes might cause us to conclude that the following individuals needed to receive more information about their rehabilitation. One athlete was told that he would have to achieve more than 90% on the upcoming Cybex test in order to return to action. He responded: "How do I study?" The explanation of the criterion of functional capacity apparently did not register here. A patient with a back problem was told to stretch every 2 hours. When he returned the next day, he looked terrible. He indicated, with some appreciation, that his back was substantially better, but his awaking every 2 hours certainly played havoc with his sleep. The rehabilitation assignment worked but not quite like the physical therapist had intended. Some excellent suggestions and guidelines for prescribing treatment regimens and giving information are offered in Meichenbaum and Turk's[16] illuminating book on facilitating treatment adherence.

Communication

Although what and how much information to disseminate is important, how it is communicated may determine the degree to which the information is received and processed. ATCs seem to recognize clearly the significance of a positive and sincere communication style.[22,23] This necessitates a degree of honesty and realism (eg, severity of an injury, effort needed, and pain and difficulties to be encountered), interspersed with healthy doses of optimism (eg, others have done it before you). More specifically, the following guidelines are germane to injury rehabilitation adherence.

1. "Establish a trusting supportive relationship and demonstrate interest in the patient (athlete). Use a warm and empathic manner, conveying competence, confidence, and knowledge concerning treatment regimen, and a sense of optimism."[16]
2. "Be specific, clear, detailed, concrete, and simple in communicating and giving instructions... Use down-to-earth, non-technical language without medical jargon."[16]
3. "Repeat important information when possible. Reinforce essential points."[16]
4. "Use oral and written material together.... Supplement when appropriate with... anatomical models.... take-home booklets, newspaper or magazine articles."[16]
5. "When providing patients (athletes) with a course of action to be adhered to, stress how important it is."[16]
6. "Promote active reworking of material (eg, ask the patient (athlete) to restate the information given)."[16]

The above suggestions highlight how important it is for athletes to listen to what ATCs tell them. In fact, it has been reported elsewhere that a willingness to listen to ATCs' directions and suggestions is the most important characteristic for athletes in coping with their injuries.[23] But, the essence of effective communication is that both parties listen to what the other has to say (ie, two-way communication). What appears paradoxical is that ATCs do not rate their own capacity to listen as that significant.[23] Because communication is so crucial, we implore our colleagues to become better listeners.

Perhaps our best estimate of the degree of rehabilitation adherence we can expect from an injured athlete comes from the response to the following question: "Do you sense that you'll be able to handle the rehab?"[16] To the degree that the athlete does not hesitate, affirms your realistic and optimistic viewpoint, and indicates that she or he is ready to begin, you have received the response most likely to predispose adherence.

It is important that coaches reinforce the information athletes receive from ATCs. Consistency about matters such as the date of return to practice and competition, the likely role upon return, and performance expectations is essential to rapport. Contradictory messages tend to confuse athletes, leading them to assume that someone is not telling the truth. You can imagine what that might do to trust and mutual respect.

ATC-Athlete Rapport

Getting injured athletes started on their rehabilitation with the attitude that they can carry out the prescribed treatment is an important first step. Long-term motivation or adherence, however, will depend in large part on the rapport that develops between the ATC and athlete. Rapport is perhaps best characterized as a sympathetic or empathic relationship between the two parties. When this relationship is born out of mutual respect, a true partnership forms, wherein each party takes responsibility for the rehabilitation outcome.

ATCs can demonstrate their interest in athletes by having enough working knowledge to discuss things as: the position the athlete plays, the athlete's role on the team, and dates of upcoming games. For the partnership to work, ATCs must listen to athletes and address some of the agenda items that athletes perceive are important. In a recent investigation,[9] it was reported that previously injured and rehabilitated athletes expect the following from ATCs: caring attitude, firm treatment, assistance in dealing with their pain, assessment of needed effort, consideration of their other commitments, treatment efficacy expectations, supervision, monitored progress, and honest feedback. It seems very clear that athletes enter the rehabilitation arena not only with specific expectations they hope will be fulfilled but also with the anticipation that there will be some ground rules on which their rehabilitation regimens will be based. For example, being firm and demanding with athletes does not hinder rapport; athletes want structure.

Another essential feature of rapport is trust, more so on the part of the athlete. ATCs need to demonstate their competence, especially if their reputation is not well established in their present setting. We are not suggesting that you create highlight films of your successful rehabilitations or publish endorsements from previously rehabilitated athletes. But, there is a need to reassure the injured athlete that you have the knowledge and experience to deal with his or her particular condition. A confident demeanor, punctuated with relevant comparisons to other injured athletes with whom you have dealt, will certainly make the injured athlete feel more comfortable with you.

Social Support and Encouragement

The weight of the available evidence reveals a positive relationship between social support and medically related adherence.[3,8] The essence of social support is caring, listening, and encouraging. In order for ATCs to be classed as "significant others," they need to encourage athletes to have positive self-thoughts, understand the individual nature of motivation, and enhance athletes' self-confidence.[23]

ATCs are in the position to orchestrate a very powerful system of social support from injured athletes' coaches and teammates.[7] Coaches can be notified of the date and time of rehabilitation sessions, and they can be encouraged to show up at a session personally. Teammates can also be requested to drop in on injured colleagues to help them maintain a degree of contact with their sport. Interestingly, findings indicate that teammates are not seen as important sources of social support for injured athletes.[9] However, that is only because athletes have seldom been intentionally placed into the support system by coaches. If that oversight is remedied, then we predict that teammates will indeed be a powerful supportive force on injured athletes' rehabilitation adherence.

Anything that can minimize the psychosocial distance between the injured athlete and the sport environment would likely enhance adherence.[10,23] Transporting a bicycle ergometer or resistive equipment to the practice field or gym for injured athletes' on-site rehabilitation will tend to keep athletes involved with their teams, a significant factor in treatment adherence (Fig 2).

Earlier we addressed the partnership concept relative to rapport, and we believe this concept can be extended to social support. Where there are athletes undergoing similar rehabilitation (eg, bicycle riding and resistance training), they can be matched. This will tend to offer each of them a more realistic comparison of the quantity and quality of work done, rather than placing them in a situation where their physical deficiencies are amplified.

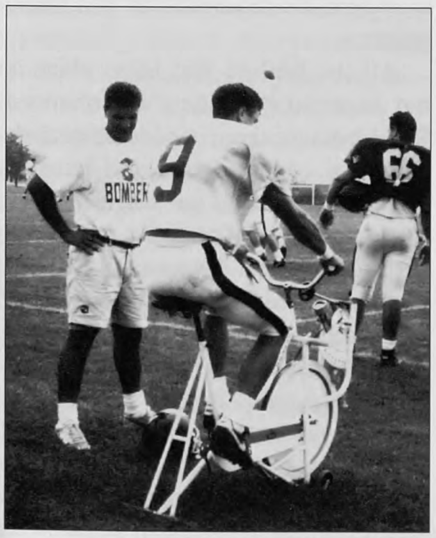

Fig 2.—Injured athlete using bicycle ergometer on the practice field.

Based upon athletes' comments, Weiss and Troxel[21] suggested that ATCs consider two supportive strategies—peer modeling and injury support groups. The former involves putting a currently injured athlete in touch with a previously injured and rehabilitated athlete, possibly with a similar injury. Empathy, honest realism, and optimism are the anticipated outcomes of this supportive interaction. For those injured athletes who seem to have less coping capacities, it might be useful for them to have a circle of peers with whom they interact about various aspects of their injuries and rehabilitation. The injury support group might provide the motivation for the injured athlete to deal with all that recovery from injury entails.

Although it might seem that parents would be a logical support source for injured athletes, previous findings indicate that parent support is not seen as essential.[23] Also, it may well be a breach of confidence to involve parents in the rehabilitation process without the athlete's permission. These points notwithstanding, we still think it is a good idea to ask the question: "Have you talked with your folks about your injury?" Our basic stance is to attempt to invoke social support from all potential avenues, because it is so crucial to treatment adherence.[3]

Personalize Treatment

To be effective, ATCs must match the rehabilitation regimen (ie, type, intensity, frequency, and duration) with their perceived assessment of injured athletes' characteristics.[11] For example, it would not seem wise to expect a lesser motivated athlete to perform all exercises to the same extent as a highly self-motivated athlete. Although there may well be ideal rehabilitation schedules that can be used as models, the key to rehabilitation effectiveness is that the work indeed gets done. It might be preferred from ATCs' and coaches' perspectives that athletes complete their rehabilitation in the shortest time possible, but it seems clear that athletes are best served if they complete the rehabilitation, no matter the length of time. Essentially, the rehabilitation prescription is characterized more by its manageability than by its efficiency.

This, then, leads us to the concept of tailoring. Because athletes' injury treatment progress is as individually different as the type and severity of their injuries, it seems only reasonable to conclude that treatment be criterion-based. If specific functional progressions are used as criteria to return to sport participation, then ATCs will be more able to deal with athletes' and coaches' typical queries: "Can I play this Saturday?"; "Will she be ready for the playoffs?"; "How much can he do?" Depending on the general and specific tasks that can be performed, ATCs will be able to assess whether a particular athlete is a day ahead or three days behind the anticipated schedule. The inescapable conclusion is that ATCs need to focus more on actual people progression than on expected textbook progression (Fig 3).

In addition to individualizing treatment, ATCs might consider an individualized behavioral approach, such as goal setting,[5,7,12] to assist their injured athletes along the path of treatment adherence. More pointedly, it has been argued in the athletic training literature that behavioral facilitation is severely

Fig 3.—Using functional progressions to measure rehabilitation progress.

underestimated and underused in the field of injury rehabilitation.[5]

Goal Setting

Even though we recognize that an injured athlete's rehabilitation protocol is sometimes clearly delineated by healing restraints and/or a physician's prescription, there are many other occasions when ATCs might find it beneficial to help injured athletes set particular rehabilitation goals and strive to attain them.

It is our experience that as many as 90% of the injuries we see are short-term (ie, not more than 1 week in duration). Remediation in these cases is by necessity criterion-based, emphasizing the attainment of daily goals. Once the athlete can perform the general and then the specific task demands of her or his sport and position, that athlete can return to participation.

Elsewhere it has been argued that striving for and attaining goals may separate previously injured athletes who will return to competition within the prescribed time frame from those who do not,[5] may serve to motivate athletes through effort and persistence,[21] and may provide a sense of accomplishment that is motivating and a real confidence builder.[10,21,22] Goal attainment is rewarding, so much so that rehabilitation adherence is doubled for those individuals who achieve their goals.[14]

To maximize the effectiveness of goal setting in your rehabilitation endeavors, specific suggestions are offered. Long-term goals are certainly important but they do not provide the needed motivation for daily workouts.[9,10] Short-term goal attainment (eg, 5° increase in knee flexion by the end of the week) imbedded in a long-range plan allows the injured athlete to see much needed immediate improvement, thereby creating optimism that enhances rehabilitation adherence.[5,12]

"Do your best" goals do not work as well as goals that are explicit, specific, and numerical.[12] DePalma and DePalma[5] offer a good example of the latter: "After determining the athlete's (ACL injury) aerobic capacity, the Tuesday and Thursday workout might be presented as 30 minutes of cycling at 2 kp, 50 rpm, followed by 3 minutes of step-ups on a 6-inch step, all performed pain free."

Goal setting works to change or reinforce behavior, but what kind of goals will injured athletes strive for? Goals need to be set high enough to offer a real challenge and yet be realistic enough to be attainable.[12] For example, at a certain point in ankle, knee, and/or hip injury rehabilitation, an ATC might set the goal of balancing on the BAPS Board for 30 seconds.

Once goals are set, they are often viewed as permanent and unchangeable, even if their attainment is problematic. Goals need to be viewed as flexible, much like plans for doing anything else. Inflexible goals will tend to frustrate injured athletes and may even demotivate them and hamper their progress—just the opposite of the intended outcome. If a return-to-competition goal appears too ambitious, then both the athlete and ATC need to reassess that goal. Even though the athlete may be frustrated and disappointed, striving for an unrealistic goal may create even additional problems (eg, aggravated injury and negative attitude).

It has been suggested that target dates and subsequent strategies for goal attainment ought to be identified.[12] Following knee surgery, certain milestones might be outlined: stitches out in 10 days, 90° knee flexion by 3 weeks, and off crutches by 5 weeks. Unfortunately, the discomfort associated with rehabilitation (eg, soreness, fatigue, and pain) can deter injured athletes from pursuing their rehabilitation goals. It might be useful, therefore, to lessen the sensory impact by using distraction techniques.[7] Teaching injured athletes to focus on their breathing, to concentrate on playing again, or to "do 10 more" offers them strategies that will assist them in working through their inevitable discomfort.

It is important that goal attainment be recorded, either daily or weekly. Consider the "expect, record, and inspect" strategy. As an athlete completes the *expected* rehabilitation goal (eg, three sets of 10 reps using 25 pounds of resistance), he or she *records* that on the rehabilitation report. Periodically, the ATC in charge of that athlete's rehabilitation *inspects* the progress. The athlete recognizes the achieved goal, and the ATC verifies and validates that satisfactory progress is being made. Feedback is absolutely necessary for continued goal striving,[12] and data from the rehabilitation report offer the substance to address.

The following cautions are offered to avoid pitfalls in goal setting:[12]

- Setting too many goals too soon.
- Setting goals that are too general.
- Failing to recognize individual differences.
- Failing to modify unrealistic goals.
- Failing to create a supportive atmosphere in which goals can be attained.

Monitor Progress

Injured athletes must come to accept what ATCs already know—rehabilitation gains come in relatively small increments. Just as the person on a diet expects rapid weight loss, many athletes expect a miraculous speedy recovery. At the onset of rehabilitation counseling, prior to the initiation of the workout regimen, we suggest that it would be useful to guide athletes' expectations of progress. There are several potentially valuable constructs that could be used to explain the reality of how the rehabilitation will likely progress.

All the healing that takes place is not necessarily evident in enhanced ROM because there need to be periods of neural consolidation and integration. These periods are often referred to as plateaus, a flattening out of the progress curve. However, without these so-called plateaus, there will be no incremental gains. As long as the injured athlete is positively stressing the injured area, there is bound to be some advancement, whether apparent or not. This is a basic theme of growth and development (Principle of Spiral Reincorporation), and it applies as well to rehabilitation as it does to learning.

At an advanced point in the rehabilitation process, gains will be realized in smaller and smaller increments. This again parallels what athletes probably already recognize about how they acquired their sport skills. A few bouts of practice to a highly skilled athlete cannot be expected to lead to major increases in skill. Athletes, therefore, need to come to grips with this Law of Diminishing Returns and not expect the same rate of progress toward the end of the rehabilitation period that they experienced in the beginning. Athletes are likely to face unnecessary frustration unless they recognize this ceiling effect.

The practical application of this information for ATCs is not to overdo progress assessments. For example, repeated girth measurements on the quadriceps are not going to be very enlightening or pleasing unless adequate elapsed time between assessments is allowed. Rehabilitation exercises require time to produce effects. To draw a parallel: Nothing is more depressing to a person on a restricted diet and an exercise program than weighing in *every* day and seeing little initial weight loss; sometimes weight is even increased from day to day. Give the program a chance to show its inevitable subsequent benefits.

Return to competition results when the rehabilitation is completed to the satisfaction of the sportsmedicine staff. ATCs can depersonalize the monitoring of progress by turning responsibility over to the system. This tends to reduce friction between athletes and ATCs. Sometimes, an ATC might decide to accentuate or strengthen the physician's suggestions. Rather than stating, "You can return to play only when your rehabilition is complete," the assertion is made that "The doctor indicated that you cannot play until you've been cleared."

Alternatively, the return to competition can be based on some specific criteria. For example, the printed results of isokinetic testing are very tangible and visible to athletes (Fig 4). They can be informed that they will be able to return to play once the contralateral quadriceps deficiency falls below 10%, based on Biodex peak torque, total work, and maximum work readings.

Additionally, because ATCs see injured athletes on a daily basis, they have the advantage of using functional progressions to monitor rehabilitation progress (Fig 3). Athletes are making progress when they can successfully meet the general task demands of their sport (eg, walk without a limp, jog, jog around corners, and jog on uneven surfaces). They are ready to return to play when they can meet the salient specific task demands (eg, throw 50 pitches without shoulder pain, throw 80 mph, and twist 180° and make a throw). Functional progressions afford both ATCs and athletes the opportunity to measure the progress of their joint rehabilitative efforts against some very concrete and meaningful criteria. Once athletes recognize and accept the established criteria, the groundwork for return to competition is laid.

Oldridge and Jones,[18] using a cognitive behavioral approach, describe a self-monitoring strategy that could be readily adapted to the rehabilitation arena. Athletes can record relevant information in a small notebook or on diary sheets (eg, time of day, intensity of workout, duration of workout, and subsequent feelings about such accomplishments). Progress across reasonable time frames (ie, weekly) might be plotted on graph sheets. The more involved injured athletes get with their rehabilitation and its successes, the more likely they are to commit themselves to the prescribed program's completion.

Fig 4.—Sharing isokinetic testing results with athlete.

Make Athletes Responsible

In an earlier investigation,[10] ATCs suggested that athletes need to feel responsible for their own rehabilitation. Adherence to rehabilitation is more likely if athletes also feel some degree of responsibility to others (eg, teammates and coaches).

Rehabilitation has both passive and active components; modalities are passive and temporary but participation is active and enduring. ATCs can monitor and record progress and reinforce expectations, but athletes' self-responsibility will be enhanced by having them participate in these matters. Even though you set standards for specific workouts (eg, a sequence of Williams' flexion exercises), you might consider setting minimum and maximum standards and then holding athletes accountable for attainment. Sometimes it might be useful to give athletes choices as to which workout they prefer (eg, treadmill, bicycle, or stair climber) (Fig 5). It seems reasonable to believe that athletes will be more responsible if they play a part in the decision making.

Threats and Scare Tactics

Negative reinforcement is considered by some to be motivational, but it appears that there is a certain inherent danger in using large doses of threats and ultimatums. Perhaps the biggest drawback is deciding what to do if the threat does not work. At best it is a lose/win situation. The ATC who threatens the athlete with a "do it or else" ultimatum runs a high risk of harming rapport with that athlete, even if the athlete passes the test. However, it can even end up being a lose/lose situation if the athlete does not adequately complete the stipulated task. Then, the ATC is in the position of having to withdraw services or prevent the athlete from returning to competition.

Fig 5.—Giving athlete the choice of exercise apparatus.

ATCs have reported mixed attitudes and judgments about the effectiveness of negative reinforcement.[10] Over three-quarters of those surveyed indicated that threats and scare tactics are the least successful rehabilitation adherence strategy. And, yet, threatening to withdraw sport participation for those athletes who do not satisfactorily comply with rehabilitation dictates was seen by 7% of these ATCs as a successful adherence strategy.

Likewise, over half (58%) the injured athletes surveyed claimed that threats and scare tactics would not work for them.[9] Moreover, some of them commented that they would lose respect for any ATC who attempted to use such a strategy.

Negative reinforcement appears to be a double-edged sword. It may work to achieve certain rehabilitation goals, but it may just as readily work against the ATC wielding the threat. Our experience tells us that threats work for some people some of the time. And, it is to this point that the following suggestions are made.

Where possible, change the threat into a challenge. Rather than dictating a 90° knee flexion by the end of the week or else, why not consider asking, "Can you get to 90° knee flexion by the end of the week? I believe you can, with a good week of workouts. Let's do it!"

The emotional component of the threat can be removed by personalizing the demand by involving the athlete in the rehabilitation process or by depersonalizing the demand and making it a matter of fact. As we described earlier, using functional progressions (both general and specific) removes the onus of the ultimate decision from the ATC. If there is any "blame" to be allocated following unsuccessful progression testing, it does not fall on the ATC.

Use threats, if you must, as your last resort when all other motivational strategies have failed. At this point, the athlete's rehabilitation is not progressing, and you have little to lose. If they work and the athlete can see the progress, then maybe the rehabilitation goals will be pursued vigorously enough to complete the prescribed regimen.

Conclusion

All of the strategies explained herein were triggered by previously surveyed ATCs.[10] We expanded on these suggestions in the hopes that ATCs would see the value, as we do, in offering motivational support to their rehabilitating athletes. From the smorgasbord of strategies offered, we would ask you to consider implementing those that seem comfortable for you and/or those that seem like they would enhance your athletes' rehabilitation adherence. Your goal, like ours, is to return injured athletes to normal function, whether it be in the sports realm or life following sport participation. We believe that you will be even more effective if you integrate some of these suggestions into your rehabilitation prescriptions.

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Cryotherapy and Sequential Exercise Bouts Following Cryotherapy on Concentric and Eccentric Strength in the Quadriceps

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Abstract: *We investigated the effects of cryotherapy followed by sequential exercise bouts on concentric and eccentric strength of the quadriceps. Nineteen males (18–27 years) participated in a two-stage design involving four sequences: ice and exercise, ice and rest, no ice and exercise, and no ice and rest. We gathered concentric and eccentric strength measures (torque) using a kinetic communicator (KIN-COM) prior to exercise, immediately following treatment, and 20- and 40-minutes post-treatment. There were significant decreases in concentric and eccentric strength immediately following the 25-minute cryotherapy treatment. This suggests that applying ice immediately prior to participation or returning an athlete to competition immediately following cryotherapy treatment may adversely affect his/her ability to perform. It appears that the reduction in strength following cryotherapy is of short duration (less than 20 minutes). The delayed effect of the ice treatment and sequential exercise appears to affect concentric and eccentric strength differently. Ice did not have a delayed effect on concentric strength, but there was a significant difference in eccentric values. This difference was a failure to improve during post-tests at the rate of those not treated with ice. Exercise did not have a significant effect on eccentric strength recovery, but there was a significant difference in concentric values. Moderate exercise following cryotherapy appears to help the recovery of concentric strength.*

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Cryotherapy is an important component in the established management of acute musculoskeletal injuries.[5,6,10,11,15] Trauma during practices or games may require that ice treatment be applied, usually for 20 to 30 minutes.[6,11,15] If the evaluation of the injury reveals it to be minor, the individual is usually returned to play.

Most research concerning strength changes following cold applications has been limited to isometric contractions.[2,3,9,14,16] The results of these studies are not conclusive; strength may increase[2,14,16] or decrease[3,9] following cold application. Only one study documenting the effect of cold on concentric strength was found. Cote[4] reported that a 30-minute cold-pack application to the quadriceps had no effect on the time required to reach constant velocity, nor on the peak torque produced on an isokinetic dynamometer.

Possible strength changes following cryotherapy should be a concern of sports medicine practitioners. If isotonic strength deficits are evident immediately following cold applications, we need to be aware of this, as well as the duration of the effects. We felt it was also of interest to investigate whether moderate intensity exercise by the treated musculature affects the rate of recovery of isotonic strength following cryotherapy treatment. Returning the athlete to competition before any cryotherapy-induced decrement in strength has disappeared could negatively affect the athlete's ability to perform.

The purposes of this study were primarily to determine the immediate effects of cryotherapy on concentric and eccentric strength of the quadriceps, and, secondarily, to investigate the effects of sequential exercise bouts and the delayed effects of cryotherapy on concentric and eccentric strength of the quadriceps.

Methods

We used a two-stage design with four sequences (Table 1). Each subject participated in each of the four sequences in a randomly selected order. All sequences started at the same time of day and were separated by 48 hours. Our dependent variables were concentric and eccentric strength (represented by the mean of the differences in mean peak torque in newton meters between the pretest and each of the post-tests) of the quadriceps as measured on the KIN-COM dynamometer.

Nineteen male intercollegiate wrestlers volunteered to participate (21.6 ± 2.5 years). They met the criteria of having no history of injury or leg pain, as well as being pain-free throughout their complete knee range of motion.

Table 1.—Experimental Design

Sequence	Pretest	Immediate effects: Exercise, 15 min	Treatment, 25 min	Test 2	Delayed effects: Exercise (E) or rest (R)	Test 3	Exercise or rest	Test 4
I	X*	X	Ice	X	E	X	E	X
II	X	X	Ice	X	R	X	R	X
III	X	X	No ice	X	E	X	E	X
IV	X	X	No ice	X	R	X	R	X

* X = all subjects in the sequence participated

All subjects attended an orientation session 2 days before the pretest, during which they signed an informed consent, were randomly assigned a sequence order, set up on the bicycle ergometer, and familiarized with the actual testing procedure on the dynamometer.[8]

We first pretested all subjects. Next, they exercised for 15 minutes. We then treated them with ice or nothing (Table 1). Subjects then performed Test 2, either rested or exercised as assigned, performed Test 3, rested or exercised again, and then performed Test 4 (Table 1).

We administered the treatments as follows:

Ice

We filled a 10″ × 25″ × 4″ plastic bag with ice and placed it directly on the right quadriceps for 25 minutes. The filled bag weighed 5 lb. We held the bag in place with a 6″ × 5′ elastic wrap.

Exercise

Subjects rode a bicycle ergometer at 960 kpm/min for 15 minutes. We judged this rate of cycling to be approximately 60% of VO^2 max for college-age wrestlers.[17]

Rest

Subjects rested, sitting in a chair, for 15 minutes.

No ice

We did not apply ice to the right quadriceps during the 25-minute treatment time.

We administered the isokinetic strength testing as previously outlined.[1,7] Subjects were attached to the testing seat with velcro straps across the chest, pelvis, and the distal aspect of the right thigh. Subjects gripped the side of the table during testing to maximize stability.

Subjects performed four submaximal warm-up repetitions before each test to familiarize themselves with the velocity and sensations of the unit. They then rested for 2 minutes. We set the dynamometer at 60°/s in the concentric/eccentric mode. The subjects then performed six maximal extension and flexion movements of the right knee. We averaged the peak torques of the six maximal repetitions in each direction for each strength testing period to calculate each subject's torque production. Because we were interested in strength change within individuals, we used the differences of the mean peak torque between the pretest and Tests 2 through 4 to determine the effects of ice and exercise.

We tested the immediate effects of cryotherapy, using two separate (concentric and eccentric strength) repeated measures 1 × 2 analysis of variance (ANOVA) with ice versus no ice as the two levels of the independent variable and the difference in strength between the pretest and Test 2 as the dependent variable. Individual subject's scores for groups I & II and III & IV were combined for this analysis since the subjects had not yet rested or exercised; subject and ice interaction was the error term.

To test the delayed effects of ice and the effects of exercise on recovery, we used two (concentric and eccentric strength) 2 × 2 repeated measures multivariate analyses of variance (MANOVA). The dependent variables were the difference between the pretest and Test 3, and the difference between the pretest and Test 4. The two independent variables were ice (yes or no) and exercise after the initial ice treatment (yes or no).

Results

Individual cell means and standard error of the mean are presented in Table 2. There was no difference between experimental groups on the pretest for either concentric ($F(1,18) = .47$, $p = .71$) or eccentric ($F(1,18) = .15$, $p = .93$) strength. There was a significant immediate decrease in strength (pretest to Test 2) for both concentric ($F(1,18) = 16.21$, $p < .01$) and eccentric ($F(1,18) = 9.72$, $p < .01$) strength due to cryotherapy (Table 3).

The delayed effect of ice on concentric and eccentric strength varied. There was no delayed effect on concentric strength ($F(1,18) = .42$, $p = .53$), but there was on eccentric strength ($F(1,18) = 4.99$, $p = .04$; Table 3).

Exercise had no effect on the recovery of eccentric strength ($F(1,18) = 2.16$, $p = .16$), but it did affect concentric strength recovery ($F(1,18) = 6.45$, $p = .02$; Table 4).

Discussion

Strength changes following cold applications have been primarily studied with regard to isometric strength.[2,3,9,14,16] Our results concur with the majority of studies that have investigated the immediate effect of cryotherapy on isometric strength.[2,3,9] We do, however, disagree with McGown,[14] Oliver and Johnson,[16] and the only previous study[4] we found dealing with concentric strength following cryotherapy. Cote[4] reported that a 30-minute cold pack application to the quadriceps had no effect on the time required to reach constant veloci-

Table 2.—Strength Scores for Experimental Treatments (Peak Torque; Mean ± SE)

Sequence	Ice: Exercise I	Ice: Rest II	No ice: Exercise III	No ice: Rest IV
Concentric				
Pretest	213.1 ± 9.1	210.6 ± 10.3	200.1 ± 9.0	213.1 ± 7.4
Test 2	192.6 ± 7.9	184.4 ± 8.4	202.3 ± 8.6	207.1 ± 8.7
Test 3	214.9 ± 9.0	202.2 ± 8.5	200.8 ± 9.4	210.4 ± 7.3
Test 4	216.7 ± 9.1	200.9 ± 8.1	202.2 ± 9.7	206.5 ± 7.2
Eccentric				
Pretest	257.5 ± 18.1	255.9 ± 22.4	240.9 ± 19.6	251.2 ± 18.2
Test 2	245.0 ± 18.6	232.9 ± 17.7	254.0 ± 20.4	257.5 ± 20.1
Test 3	255.7 ± 18.7	250.7 ± 19.0	252.7 ± 19.0	260.4 ± 16.5
Test 4	257.7 ± 17.5	244.4 ± 18.2	252.8 ± 18.5	259.2 ± 18.3

Table 3.—Effects of Ice on Quadriceps Strength are Illustrated as Differences in Strength Between the Pretest and Post-tests for Ice and No-ice Conditions. Data for Groups I & II and III & IV were combined (Torque; Mean ± SE).

	Source	N	Ice effects pre to Test 2	20-min Delay pre to Test 3	40-min delay pre to Test 4
Concentric	Ice	38	−23.3 ± 4.0*	−3.3 ± 3.9	−3.0 ± 3.6
	No ice	38	−1.6 ± 2.2	−1.0 ± 2.3	−2.3 ± 2.8
Eccentric	Ice	38	−17.7 ± 5.4*	−3.5 ± 5.1†	−5.6 ± 4.8†
	No ice	38	9.7 ± 4.4	10.6 ± 5.4	10.0 ± 4.4

* $p < .01$, ANOVA between ice and no ice.
† $p < .05$, MANOVA.

Table 4.—Effects of Exercise on Previously Cooled Quadriceps are Illustrated as Differences in Strength Between the Pretest and Second and Final Post-tests of Exercise and Rest Conditions. Only data for Groups I and II were used here (Torque; Mean ± SE).

	Source	N	20-min post ice application, pre to Test 3	40-min post-application, pre to Test 4
Concentric	Exercise	19	1.8 ± 5.0*	3.6 ± 3.9*
	Rest	19	−8.4 ± 5.8	−9.7 ± 5.8
Eccentric	Exercise	19	−1.7 ± 6.5	0.2 ± 6.6
	Rest	19	−5.2 ± 8.0	−11.5 ± 7.1

* $p < .05$, MANOVA between exercise and rest.

ty nor in the peak torque produced on an isokinetic dynamometer. A recent study of the effect of cold water submersion on isokinetic strength of the plantar flexors also confirmed our results.[13]

We conclude that both eccentric and concentric strength is decreased immediately following a 25-minute ice treatment. Therefore, we recommend that the clinician avoid applying ice immediately before participation or immediately returning athletes to competition following musculoskeletal cryotherapy (ie, within 10–15 minutes). The immediate strength decrement following ice-pack treatment may adversely affect the athlete's ability to perform, but specific research on this point is lacking.

We have no definitive conclusions concerning the delayed effects of ice following cryotherapy treatment and the effect of sequential exercise involving the iced musculature on the recovery of strength. We suggest, however, some interesting areas for further exploration. First, it appears that the duration of the strength loss following cryotherapy is not long. By Test 3, administered 20 minutes after the ice treatment, the concentric and eccentric values were not significantly lower than the pretest values (Table 3). This agrees with Coppin[3] but Oliver and Johnson[16] reported strength increased 40 to 80 minutes after treatment. Further research is needed to establish the minimum time required to regain pretreatment strength.

Second, the delayed difference in eccentric values between those treated with ice and those not treated was not a strength decrease below pretest values, but rather a failure to improve in the post-tests at the rate of those not treated with ice (Table 3). The no-ice group experienced a substantially increased strength score by Test 2 which was maintained in Test 3 and Test 4. The iced group experienced a significant decrease in strength at Test 2, but by Test 3 were almost back to their pretest scores, and remained virtually unchanged at Test 4. We do not have an explanation for this. Measurement error is a possibility, but, because the pattern is consistent over two testing periods, this is unlikely. Although reliability coefficients are consistently lower between occasions than among repetitions, the overall reliability of the KIN-COM has been found to be very high.[7] Perhaps there was a learning effect associated with repeated eccentric testing in the no-ice group that was inhibited in the ice group due to the cold.

Third, the effects of sequential exercise by the involved musculature following cryotherapy were also different for concentric and eccentric strength. Exercise did not have a significant effect on eccentric strength recovery, but it did for concentric strength. Interestingly, those who rested had decreased values from those who exercised (Table 4). Exercise appears to speed recovery in concentric strength.

We recommend further research to investigate the noted differences in the delayed response to cryotherapy and exercise evidenced in concentric and eccentric contractions.

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Comparison of Inversion Restraint Provided by Ankle Prophylactic Devices Before and After Exercise

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Abstract: *The prudence of prophylactic ankle taping continues to be questioned as recent studies have identified other forms of ankle stabilization as more effective means of injury prevention. The purpose of our study was to compare the effectiveness of three ankle prophylaxes (adhesive taping, lace-up brace, and semirigid orthosis) with a control condition (no support) in limiting inversion under dynamic loads imposed by repetitive walking (4 mph) and running (9 mph) on an 8.5° laterally tilted treadmill. Ten subjects participated in four separate testing sessions in which they were videotaped while walking and running on a tilted treadmill before and after 20 minutes of vigorous exercise. Average maximum inversion angle was determined through biomechanical analysis of rearfoot motion for each experimental condition and analyzed with repeated measures ANOVA and Scheffé post hoc tests. There were significant differences in the average maximum inversion angle between the ankle devices at 4 and 9 mph, and between pre-exercise and postexercise measurements at 4 mph, between the semirigid orthosis and the control condition at 4 and 9 mph, and between the lace-up brace and the control condition at 4 mph. Overall, the semirigid orthosis provided the most inversion restraint during dynamic loading, followed by the lace-up brace, tape, and control condition. We concluded that the lace-up brace and semirigid orthosis evaluated were very similar in restricting inversion, and that both devices limited postexercise inversion significantly more than ankle taping.*

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Historically, external support for the prevention of ankle joint injuries in sport has been confined to adhesive taping techniques such as the Gibney boot or closed basketweave procedures. The nature and duration of the injury protection provided by these adhesive taping procedures has been investigated by numerous authors during the past three decades.[1,2,8,10–12,14,17,21,23–27,29,30,32–34,38,39] Experimental results have been conflicting with regard to the effectiveness of ankle taping. Thirty years ago, Rarick and associates[30] reported that tape lost 40% of its initial ankle support after only 10 minutes of exercise. In 1980, Laughman et al[23] concluded that ankle taping was effective in limiting the extremes of motion associated with inversion ankle sprains. Wilkerson[39] recently described a modified ankle adhesive taping technique that may provide enhanced protective capabilities when compared with existing methods.

Recent laboratory and clinical studies indicate that a lace-up ankle stabilizer is a more effective, alternative method of protecting the ankle from excessive inversion.[3,16,18,28] In their in vitro study comparing ankle taping with five lace-up ankle braces, Bunch et al[3] reported that tape provided the greatest initial level of support but lost 21% of its initial inversion restraint after 20 minutes of mechanical inversion. In a 6-year retrospective study of college football ankle injuries, Rovere et al[32] concluded that a lace-up ankle stabilizer was more effective in preventing injury and reinjury than ankle taping.

Semirigid orthotic devices were originally used to protect the injured ankle from further trauma during the healing phase.[35,36] Kimura and associates[22] suggested that the semirigid ankle orthosis be used as a prophylactic ankle brace. Unlike ankle taping and lace-up ankle braces, semirigid orthoses primarily limit inversion and eversion but not plantarflexion and dorsiflexion.[4,20,22,35–37] Kimura et al[22] found a semirigid orthosis to be effective in preventing passive inversion, but suggested further research be conducted to determine the effectiveness of the orthosis in actual sport and movement participation situations.

Despite numerous studies documenting the limited duration of effectiveness of ankle taping,[8,10,12,17,21,23,26,27,32] this traditional method of injury prevention continues to be the most commonly used external ankle prophylactic support in organized athletics. The most recent comparisons of lace-up braces, semirigid orthoses, and/or ankle taping techniques employed either physical performance tests (vertical jumping ability, torque output) or open kinetic chain passive loading of the ankle and foot to evaluate the efficacy of these prophylaxes.[5,13,15,16,18] In our review of the literature, we found three published studies which evaluated the degree or duration of support provided by ankle prophylactic devices under cyclic, dynamic loads imposed by closed kinetic chain activities of walking and running.[19,26,37] However, the most recent of these studies was published in 1988, and none made comparisons between contemporary ankle prophylaxes.

The purpose of our study was to compare the effectiveness of closed basketweave inversion ankle taping, a lace-up ankle stabilizer, and a semirigid ankle orthotic device in limiting inversion under dynamic loads imposed by repetitive walking (4 mph) and running (9 mph) on an 8.5° laterally tilted treadmill before and after a 20-minute vigorous exercise bout.

Methods

Five male (ht = 175.1 ± 10.1 cm, wt = 71.5 ± 13.6 kg) and five female (ht = 167.5 ± 4.0 cm, wt = 63.9 ± 5.3 kg) apparently healthy college students (age = 23.4 ± 2.5 years, maximum passive inversion 18.4 ± 3.1°) volunteered to participate in this study. Volunteers were solicited from the student population at San Jose State University and screened prior to selection. All met the following criteria for inclusion in the study: (a) no prior history of a significant (grade 2+ or worse) injury to either ankle, and (b) no current participation in intercollegiate sports, so as not to become injured and thus be lost to or confound the results of our study. All subjects had less than 30° of passive inversion in both ankles. None had a positive anterior drawer sign, defined by Cox et al[6] as greater than 2-mm difference in talar displacement in neutral position when compared with the opposite normal ankle. Prior to participation in our study, each subject gave informed consent according to the guidelines for the protection of human subjects at our institution.

Each subject completed four separate test sessions, one for each of four experimental conditions: (a) control (no prophylactic device), (b) ankle taping, (c) lace-up ankle brace, and (d) semirigid orthosis. The four sessions for any given subject were conducted within a 1-week period, with testing conducted on alternate days. The order in which subjects were exposed to the experimental conditions was counterbalanced to control for learning effects and fatigue. Subjects walked and ran on the laterally tilted treadmill without shoes, enabling us to measure frontal plane (inversion) motion accurately.

Two dependent variables were analyzed for each subject: closed kinetic chain average maximum inversion angle and open kinetic chain active inversion range of motion.

Instrumentation

A treadmill (Quinton model 18-60, Seattle, Wash) was tilted laterally to 8.5° to simulate the dynamic forces applied to the ankle and subtalar joints while walking and running on cambered roads and city streets.

A shuttered video camera (Panasonic model AG-450, Osaka, Japan) was used to record the various walking and running trials on the tilted treadmill, providing two-dimensional kinematic data to quantify the rearfoot motion the subjects experienced. The framing rate of the video camera was 60 fields per second (60 Hz); the selected shutter rate was 1/250 second. The camera was placed behind the subject, perpendicular to the frontal plane of motion.

The videotape records of all subjects' treadmill performances were manually digitized by one of us using a Peak 2D Motion Measurement System (Peak Performance Technologies, Englewood, Colo). The Peak 2D system software employs a fourth-order, zero-lag Butterworth digital filter to correct for small measurement errors in the digitizing process. We selected a cutoff frequency of 4 Hz to smooth the 4-mph walking trial data, while a cutoff frequency of 7 Hz was employed for the 9-mph running trial data.

Ankle Prophylactic Devices

In our study, the support provided by three different ankle prophylaxes was compared against a control condition (no ankle support).

Closed Basketweave Ankle Taping. We used 3.75-cm-wide, porous athletic adhesive tape for all closed basketweave taping procedures (Zonas Porous, Johnson and Johnson Co, New Brunswick, NJ). The taping technique used was a combination of the Gibney basketweave and continuous figure-8 heel locks described by Rarick et al.[30] The tape was applied following the application of an adherent, sponge heel and lace pads lubricated with a petroleum jelly lubricant, and a thin layer of underwrap, as this procedure is common in the routine taping of athletes. Two anchor strips were attached to the skin at the musculotendinous junction of the gastrocnemius and Achilles tendon and two anchor strips around the tarsal arch of the foot. Following the anchor application, the basketweave was applied. A total of three vertical U-shaped tape strips (stirrups) and three horizontal U-shaped tape strips (horseshoes) were used to support the ankle. One stirrup was applied, followed by one horseshoe, and this pattern was repeated three times. Two continuous figure-8 heel locks were wrapped under the foot, behind the heel, and around the lower leg.

Davies[7] suggested application of heel locks with a medial to lateral force to slightly evert the foot away from the inversion sprain mechanism. Felder[9] emphasized stirrup application with medial to lateral force, thus placing the ankle into a slightly everted, pronated position. The recommendations of these authors were followed in the taping of the subjects. All ankle taping was done by the same certified athletic trainer and each subject had both ankles taped for uniformity.

Lace-up Ankle Stabilizer. A new Swede-O-Universal® lace-up ankle stabilizer (Swede-O-Universal, North Branch, MN) was used by each subject during testing. Subjects were fitted with the appropriate brace based upon shoe size following the manufacturer's guidelines. The lace-up stabilizer was worn over the top of the subject's sock.

Proper ankle stabilizer application according to the manufacturer's protocol was explained and demonstrated to each subject. The application of the brace was supervised by one of us to ensure that it was done correctly. The lace-up brace was considered to be properly applied when the subject was unable to rotate the brace from side-to-side on the foot. The laces of the brace were double-knotted to prevent them from becoming untied during the test session. Once the brace was properly applied, it was not adjusted for the duration of the experimental session, allowing us to measure the amount of inversion restriction provided before and after the exercise bout. The lace-up stabilizers were worn on both ankles during this experimental condition.

Semirigid Orthotic Device. The Aircast Sport-Stirrup® ankle brace (Aircast, Inc, Summit, NJ) was used as the semirigid orthosis in our study. The application of the semirigid orthosis was explained and demonstrated to each subject. The Sport-Stirrup allows individual fitting by adjusting the air pressure in each of the upright air bladders to accommodate various lower leg sizes. The application was supervised by one of us to ensure proper fit. As with the ankle stabilizer, the semirigid orthosis was considered to be properly applied when it could not be moved side-to-side on the lower leg. New semirigid orthoses were worn on both ankles over the subject's socks during the testing session.

Experimental Protocol

Active inversion range of motion was assessed with the subject in a non-weight-bearing position using a hand-held goniometer, with care taken not to allow plantarflexion or dorsiflexion of the ankle. Inversion active range of motion measurements were made by the same individual (N.M.) prior to exercise after application of the appropriate ankle prophylactic device and again at the completion of the exercise bout.

Prior to the pre-exercise walking and running on the treadmill, the following anatomical reference points were marked on the posterior aspect of the right limb: (a) the center of the popliteal space at the knee, (b) the Achilles tendon at the level of the subtalar joint, and (c) the calcaneal apophysis. These reference points were marked directly on the skin or sock, or on the prophylactic device.

Five minutes of cycling on a stationary bicycle ergometer (Monark model 818, Valberg, Sweden) at 60–90 rpm and 20 N of resistance served as a warm-up prior to participation in the obstacle course exercise bout. An obstacle course was created in an indoor gymnasium to apply a standardized amount (20 minutes) of vigorous physical activity to all subjects. The obstacle course was a modification of a protocol used by Robinson et al,[31] and consisted of forward sprinting, lateral movements, vertical jumping, and backward running. These movements are present in many sport and recreational activities and were included in our exercise bout to stress the ankle and subtalar joints while causing the subjects to perspire. Each subject repeated the obstacle course pattern until 20 minutes of exercise was performed, with rest intervals spaced according to the subject's fitness level.

A typical data collection session lasted approximately 50 minutes and involved: (a) the application of the appropriate experimental condition (control, ankle taping, Swede-O-Universal brace, or Aircast Sport-Stirrup); (b) marking of the anatomical reference points on the subject; (c) measurement of pre-exercise inversion active range of motion; (d) pre-exercise videotaping of walking and running on the laterally tilted treadmill; (e) a 5-minute stationary cycling warm-up period; (f) completion of 20 minutes of vigorous exercise over an obstacle course; (g) postexercise inversion active range of motion measurements; and (h) postexercise videotaping of walking and running on the treadmill.

Data Analysis

Field-by-field videotape analysis of the eight pre-exercise and eight postexercise trials (footfalls) during treadmill walking and running under each of the four experimental conditions was used to quantify inversion in the frontal plane. The criterion measure used to compare the efficacy of the ankle prophylaxes was the maximum inversion angle during each footfall. This angle was determined through manual digitization of three anatomical reference points marked on the right lower limb of each subject. Only the maximum inversion angle during the right limb support phase of walking and running was used in our analysis. An eight-trial average maximum inversion angle was then calculated for each subject for each experimental condition, and this value was used as the closed kinetic chain dependent variable.

Using the SYSTAT 5.0 software package (SYSTAT, Inc, Evanston, Ill), we performed a two-way repeated measures analysis of variance (ANOVA) on both the treadmill walking (4 mph) and running (9 mph) data to determine the statistical significance of pre-exercise to postexercise changes in average maximum inversion angle among the ankle prophylaxes. A two-way repeated measures ANOVA was also completed for the inversion active range of motion open kinetic chain measurements.

Since we conducted three statistical tests and wanted to maintain an experiment-wise alpha level of .05, we adjusted the per comparison alpha level using the Bonferroni correction to protect against Type I error. Thus, differences were accepted as significant at the .017 level (.05/3 = .017). Significant main effects disclosed by the repeated measures ANOVAs were evaluated further through Scheffé post hoc analysis (α = .05) to determine where the significant differences occurred.

Results

Average Maximum Inversion Angle Measurements

Laterally Tilted Treadmill Walking at 4 mph—Average maximum inversion angles were significantly different ($F(3,27) = 9.40$, $p = .001$) among the four experimental conditions during treadmill walking (Fig. 1). Average maximum inversion angles were less when subjects wore Aircast Sport-Stirrup braces than when wearing no ankle prophylaxis during the control condition (Scheffé post-hoc, $p < .05$). Postexercise average maximum inversion angles were greater than pre-exercise measurements ($F(1,9) = 15.01$, $p = .004$). In this closed kinetic chain measurement, the Sport-Stirrup semirigid orthosis permitted the least amount of inversion during laterally tilted treadmill walking, both prior to and following exercise (Table 1).

Laterally Tilted Treadmill Running at 9 mph—Average maximum inver-

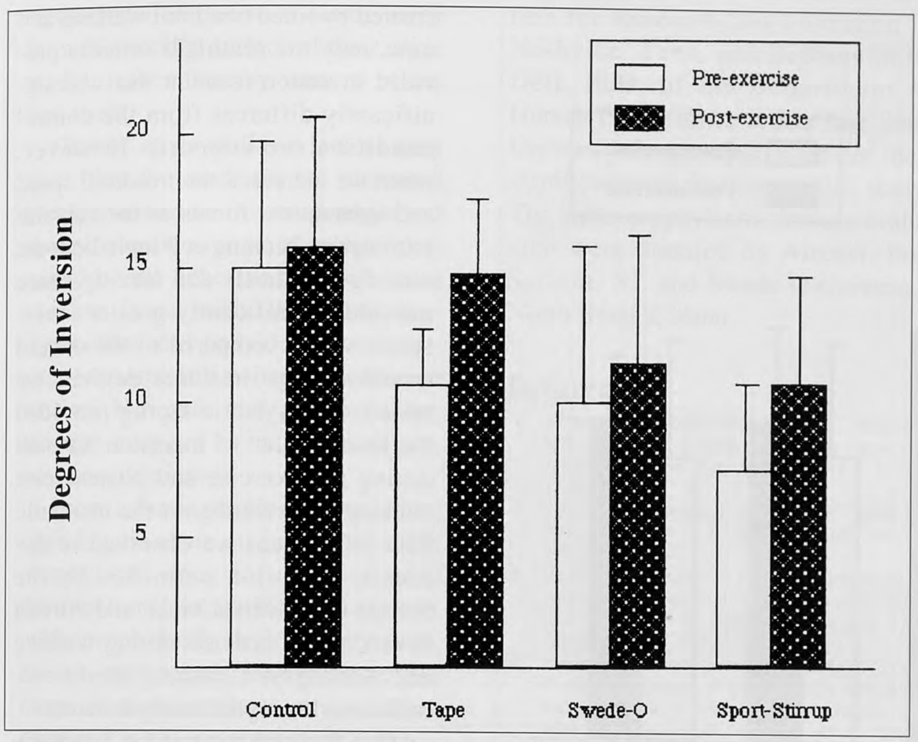

Fig 1.—Average maximum inversion angle during laterally tilted treadmill walking at 4 mph (mean ± SD; n = 10).

sion angles were also significantly different (F(3,27) = 10.84, p = .001) among the four experimental conditions during laterally tilted treadmill running at 9 mph (Fig. 2). Subjects' average maximum inversion angles were less while wearing the Swede-O-Universal lace-up ankle braces and Aircast Sport-Stirrup orthoses than during the control condition (Scheffé post-hoe, p < .05). The semirigid orthosis allowed an average of 0.2° less inversion than the lace-up brace before exercise, while the Swede-O-Universal and Sport-Stirrup devices permitted identical amounts of inversion after vigorous exercise (Table 1).

Inversion Active Range of Motion Measurements

Significant differences (F(3,27) = 24.01, p = .001) were observed among the four ankle experimental conditions, and between the pre-exercise and postexercise inversion active range of motion values (F(1,9) = 130.09, p = .0001). Inversion active range of motion was less with ankle tape, lace-up brace, and semirigid orthosis compared with the control condition (Scheffé post hoc, p < .05). Ankle taping was not as effective as both the Swede-O-Universal lace-up brace and the Sport-Stirrup semirigid orthosis in limiting inversion active range of motion (Scheffé post hoc, p < .05). There was no significant difference between the amount of inversion active range of motion permitted by the Sport-Stirrup and Swede-O-Universal prophylactic devices (Table 1).

Analysis of this open kinetic chain measurement of inversion active range of motion revealed that the Swede-O-Universal lace-up ankle stabilizer permitted the least average amount of motion of any ankle prophylaxis prior to and following exercise (7.6° and 11.7°, respectively). The greatest change in pre-exercise to postexercise inversion active range of motion occurred with the ankle tape experimental condition, allowing an average increase of 6.4° of inversion following 20 minutes of exercise.

To compare overall effectiveness, we ranked the three ankle prophylactic devices based upon the actual number of degrees of pre-exercise and postexercise inversion permitted during the closed and open kinetic chain activities. The device which provided the most inversion restraint in a given experimental condition, eg, average maximum inversion angle during postexercise running at 9 mph, was ranked "1," and the condition which provided the least inversion restraint was as-

Table 1.—Range of Motion (degrees; mean ± SD) and Rankings for the Four Experimental Conditions

Experimental condition	Average maximum inversion (walking at 4 mph)		Average maximum inversion (running at 9 mph)		Open kinetic chain inversion active ROM		Average rank*
	Pre-exercise	Postexercise	Pre-exercise	Postexercise	Pre-exercise	Postexercise	
Control (no support)	15.0 ± 4.8° (4)*	15.8 ± 4.8° (4)*	18.1 ± 5.3° (4)*	16.9 ± 4.5° (4)*	15.5 ± 3.2° (4)*	17.9 ± 2.9° (4)*	4.00
Ankle taping	10.7 ± 2.1° (3)	14.8 ± 2.9° (3)	12.0 ± 4.2° (3)	15.4 ± 6.5° (3)	9.9 ± 3.3° (3)	16.3 ± 3.1° (3)	2.83
Swede-O Universal	10.0 ± 5.9° (2)	11.5 ± 4.8° (2)	10.7 ± 4.2° (2)	11.9 ± 3.5° (1.5)	7.6 ± 2.5° (1)	11.7 ± 3.0° (1)	1.58
AirCast Sport-Stirrup	7.6 ± 3.1° (1)	10.7 ± 4.0° (1)	10.5 ± 4.4° (1)	11.9 ± 2.2° (1.5)	10.3 ± 4.6° (3)	13.4 ± 4.6° (2)	1.58

*Rankings in parentheses. A rank of "1" indicates the most inversion restraint, while a rank of "4" indicates the least amount of inversion restraint.

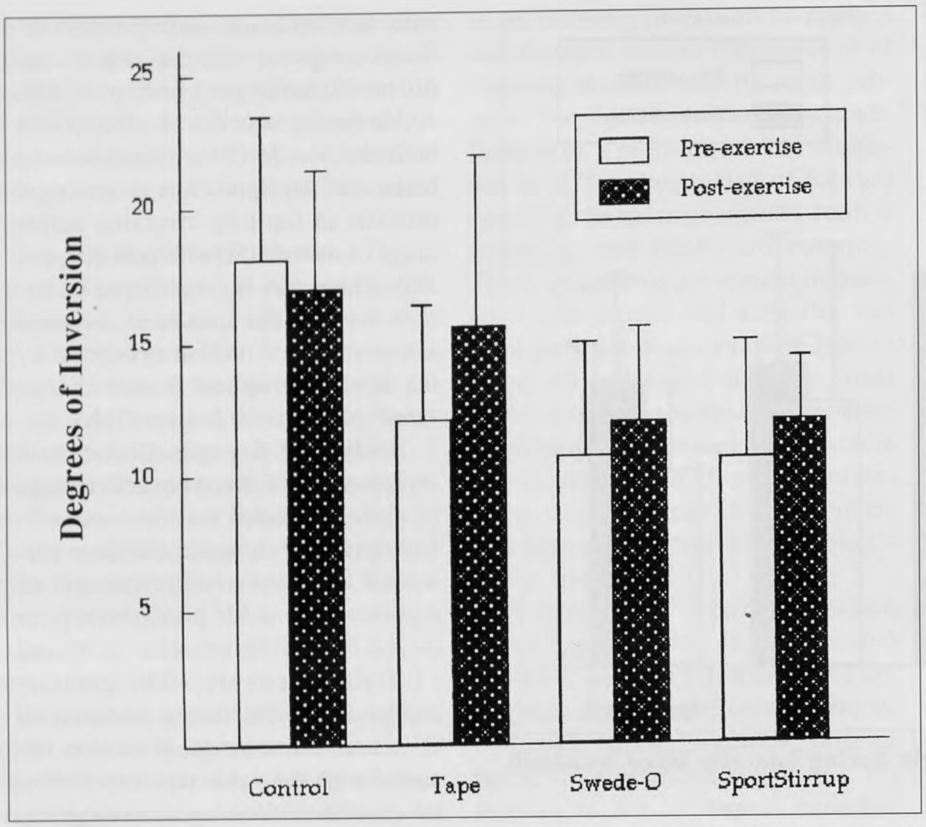

Fig 2.—Average maximum inversion angle during laterally tilted treadmill running at 9 mph (mean ± SD; n = 10).

signed a rank of "4." We then calculated an overall rank by averaging the rankings from the six different experimental measurements. The Swede-O-Universal ankle stabilizer and the Sport-Stirrup orthosis had identical average rankings, 1.58 (Table 1). Adhesive ankle taping had an average rank of 2.83, and the control condition (no support) had a mean rank of 4.0. While the average rankings for these two devices were numerically equal, we consider the Sport-Stirrup orthosis to be a slightly more effective inversion restraint, for it was ranked first or tied for first in all four closed kinetic chain parameters measured during laterally tilted treadmill exercise.

Discussion

We contend that the primary determinant of ankle prophylactic device efficacy is the ability to limit pathological inversion while undergoing the dynamic stresses encountered during exercise. Several recent laboratory and clinical studies have compared the static or passive restraint provided by various ankle prophylactic devices during open kinetic chain activities.[5,13,15–18,39]

The study most similar to ours compared the abilities of the same three devices (ankle tape, Swede-O-Universal, Aircast Sport-Stirrup) to restrict inversion and eversion before and after 10 minutes of exercise.[18] They used a robotic isokinetic dynamometer (Biodex) to impose passive 3-ft-lb inversion and eversion torques on 16 subjects and to measure the resulting passive ranges of motion. Gross et al[18] reported that all ankle support systems they tested significantly reduced inversion and eversion passive ranges of motion following application (pre-exercise) and following exercise.[18] Following exercise, the amount of passive inversion increased significantly in the taping group; however, postexercise differences in passive inversion permitted by the Swede-O-Universal and Aircast Sport-Stirrup devices were not significantly different.

When we evaluated these same ankle protective devices under loads created by tilted treadmill walking at 4 mph, only the semirigid orthosis provided inversion restraint that was significantly different from the control condition (no support). However, when we increased the treadmill speed and subsequent forces at the subtalar joint during running at 9 mph, both the semirigid orthosis and lace-up brace provided significantly greater inversion restraint compared to the control condition. Of the three devices we tested, prophylactic taping provided the least amount of inversion restraint during pre-exercise and postexercise walking and running on the treadmill. The differences we observed in dynamic inversion permitted by the Swede-O-Universal brace and Aircast Sport-Stirrup orthosis during walking and running on a laterally tilted treadmill were not significantly different.

Our findings suggest the Swede-O-Universal lace-up ankle stabilizer and the Aircast Sport-Stirrup semirigid orthosis were similar in restricting inversion range of motion prior to and following exercise. Although each prophylactic device provided more inversion restraint before exercise than after, a more important consideration of these devices is their ability to protect the ankle from injury by providing support during exercise. The findings of our study indicated significant differences in the levels of support after a specific type and duration of exercise. Closed basketweave ankle taping provided the least support after the 20-minute exercise session at both the 4- and 9-mph conditions. Other researchers have reported similar losses of restrictive effects following exercise.[10,15,17,18,30]

Previous research suggests that the diminished restraint provided by adhesive tape following exercise can be attributed to a separation or tearing of tape fibers resulting from mechanical strain and/or moisture on the skin surface which adversely affects the prophylactic qualities of the technique.[3,18,21,28–30] In their in vitro evaluation of several ankle taping methods, Pope et al[29] reported that when 420 Nm (94.4 ft-lb) inversion torques were applied, the ankle taping methods failed due to shearing away from the wooden surface of their ankle model, rather than by rupture of the tape itself.

One or more of these factors may have been the cause for the increased average maximum inversion angle and inversion active range of motion permitted by the adhesive tape following exercise. In our study, the athletic taping method did provide some inversion restraint following the exercise session. However, this amount of restriction may not be sufficient to prevent an ankle injury.

From a biomechanical perspective, open kinetic chain evaluation of ankle prophylaxes does not measure fully the functional capabilities of a given ankle prophylactic device. We reported our open chain inversion active range of motion values only to allow comparison of our results with previous research efforts. We strongly recommend that subsequent studies of ankle prophylaxes use dynamic, closed kinetic chain evaluation techniques in deference to open kinetic chain and/or passive motion assessment parameters.

In conclusion, our study provides new information regarding the comparative effectiveness of closed basketweave ankle taping, a lace-up stabilizer, and a semirigid orthosis before and after a 20-minute exercise session. Our results revealed the inability of athletic taping to restrict inversion under dynamic loads following a brief period of exercise. These results are particularly relevant to those involved in the prevention and management of ankle injuries. The semirigid orthosis and the lace-up stabilizer evaluated were nearly equivalent in effectiveness of limiting inversion range of motion during walking and running on a laterally tilted treadmill designed to induce inversion. The continued use of the closed basketweave ankle taping method described in our study as a prophylactic measure was not supported by our findings.

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Fifteen Years of Amateur Boxing Injuries/Illnesses at the United States Olympic Training Center

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Abstract: *We examined the incidence of health problems in elite-level amateur boxing athletes who sparred, trained, or competed at the United States Olympic Training Center in Colorado Springs, Colorado from January 1, 1977 through June 30, 1992. We think this is the first study to examine both injuries and illnesses in a population of elite-level athletes. We collected data on 1,776 reported problems (1219 injuries, 557 illnesses) from standard medical report forms completed by the permanent and volunteer sports medicine staff. We classified the information based on type, body region, location, description, and occurrence. There were significant differences between the frequency of injuries and illnesses and between the classifications and regions for each type of problem. Collectively, serious injuries represented only a relatively small percentage (6.1%) of all problems. We concluded that illnesses comprised a small but important portion of problems, that most illnesses involved respiratory tract infections (71%), that there is only a small risk for serious injury, and that injuries occur in a hierarchy of upper extremity (441, 25%), head/face (344, 19%), lower extremity (267, 15%), and spinal column (167, 9%) for amateur boxers.*

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The sports and medical literature is largely lacking in studies assessing boxing injuries in populations of elite amateur athletes.[6] Estwanik et al[1] have studied injuries from the 1981 and 1982 USA/Amateur Boxing Federation National Championships, while Jordan et al[6] examined boxing injuries at the United States Olympic Training Center (USOTC) over a 10-year period (1977 to 1987). Both of these studies found that most boxing injuries occurred in the upper extremity, specifically to the hand and wrist, but differed in their findings of cerebral injuries. Several international researchers[2–4,7–9,11,12,14] have also studied boxing injuries, but have also reported differing results.

Although important, this base of knowledge on amateur boxing injuries is far from complete, since the studies to date have examined only competitive events,[1] training periods of a short duration (typically less than 2 years),[8] or only selected types of injury, such as brain damage and thenar carpometacarpal dislocation,[2–4,7] rather than the totality of all possible instances of training, competition, and injury. The study by Jordan et al[6] is a partial exception to this trend. In addition, a further problem with most of the boxing articles published to date is that they have described only orthopaedic, neurological, or event-related injuries and have failed to address the aspect of the medical illnesses that might have been present in their athletic populations. The analysis of both injury and illness information would present a more complete picture of the epidemiology of elite athletes involved in the sport of amateur boxing.

The purpose of this article is to present a descriptive analysis of amateur boxing injuries and illnesses which have occurred at the USOTC in Colorado Springs from January 1, 1977 through June 30, 1992. A secondary purpose of this article is to examine the issue of the safety of boxing as a sport in regard to serious injuries. The injuries occurred in sessions of sparring, training, or competitive events. While inclusive of the database generated through the study by Jordan et al,[6] this article expands the existing knowledge of amateur boxing epidemiology through the use of a long-term time frame (15.5 years) and by incorporating information on both injuries and illnesses into the descriptive presentation.

Methodology

We collected data on athlete injuries and illnesses from the standard medical report forms used by the permanent and voluntary staff at the USOTC to record the cause, nature, and disposition of problems reported by athletes who sought the services of the Division of Sports Medicine from January 1, 1977 through June 30, 1992. The report forms had been completed by athletic trainers, chiropractors, family practitioners, and orthopaedic physicians. In order to ensure consistency and to limit possible variation in the diagnoses, all recorders used the same documentation procedures, which were reviewed and supervised by the permanent USOTC staff.

Data on boxing were then separated from the main database and compiled for descriptive analysis. The problems reported by the boxing athletes were classified on the basis of general type (injury versus illness), body region, location within a particular body region, and description of the problem within each location. Once the data were classified, the resultant frequencies were statistically analyzed with Chi-square tests of association.[10,13]

We also examined the data relative to the issue of the safety of amateur boxing as a sport and to the occurrence of serious injuries. The term "safety" has been defined as "the implementation of principles to reduce the hazards and risk of serious injury and illness in sports."[5] The term "serious" has been defined as "a condition which results in significant time loss from participation in sports or activities of daily living, or is nonrepairable by either physiologic means or medical intervention."[5] For this study, the term "serious" was modified to mean "a condition which could not be remediated through the typical services of an athletic trainer at the USOTC." For example, a concussion would be classified as serious, for it might require the services of a physician in order to ensure proper management of the problem, while an inversion ankle sprain would not be classified as serious, for it is usually treated appropriately by an athletic trainer. For this study, the term "safety" meant "a proportion of serious injuries less than 10%."

In relative terms, several limitations existed with the methodology of this study. The standard procedure for reporting medical problems does not lend itself to rigorous experimental control and randomization of subjects in order to maximize the degree of internal validity. Another limitation is that the methodology could not account for any illnesses or injuries among the boxing athletes that were not reported to the USOTC sports medicine staff; unreported problems or pre-existing conditions that were not detected would obviously change the reported results. Another limitation is that information on the total number of athletes involved in the study was not obtainable, and, therefore, expression of additional descriptive data, such as injuries per athlete, is not available. The final limitation is that the study involved only elite amateur athletes at the USOTC; the results may not be the same in the broader population of all amateur boxers or in professional athletes. These relative limitations are offset by the fact that the study occurred in the actual and typical training and performance environment of the athletes, thus enhancing the overall external validity of the methodology.

Results

A total of 1,776 problems were reported at the USOTC over the 15.5-year period of survey. There were more injuries (1219/1776; 68.6%) than illnesses (557/1776; 31.4%; $\chi^2(1) = 246.8$, $p < .001$). The injuries were further classified relative to general regions of the body: upper extremities (441/1776; 24.8%), head/face (344/1776; 19.4%), lower extremities (267/1776; 15.0%), and spinal column (167/1776; 9.4%).

Both injuries and illnesses were further classified based on a general description of the type of reported problem (Table 1 and 2). Injury descriptions ranged from meniscal/plical disorders (5/1219; 0.4%) to contusions (304/1219; 24.9%)($\chi^2(14) = 1615.6$, $p < .001$), while illness descriptions ranged from an "other" description (5/557; 1.0%), which included such problems as a foreign body in the eye and impacted cerumen within the ear canal, and infections (397/557; 71.3%)($\chi^2(9) = 2380.0$, $p < .001$).

There were exceptions to the overall trend; specific significant differences existed in the frequencies of contusion and muscle strain, joint sprain and tendinitis, and tendinitis and concussion injuries, and in the frequencies of infection and gastrointestinal, gastrointestinal and inflammation, and inflammation and respiratory illnesses (Tables 1 and 2). All other comparative differences were not statistically significant.

Reported injuries were also classified relative to locations within each body region (Table 3). Significant differences existed between locations within each body region (upper extremities $\chi^2(8) = 180.7$, $p < .001$; head/face $\chi^2(6) = 245.6$, $p < .001$; lower extremities $\chi^2(6) = 104.7$, $p < .001$; spinal column $\chi^2(4) = 35.21$, $p < .001$). Table 3 also presents specific information on the description and occurrence of the injuries which were reported within each location and body region.

Analogous to the management of the data on reported injuries, illnesses were also classified by location (Table 4). Locations included the cardiopulmonary system (236/557; 42.4%), gastrointestinal system (66/557; 11.8%), skin (62/557; 11.1%), throat (49/557, 8.8%), genitourinary system (43/557; 7.7%), head/face (32/557; 5.8%), ear (22/557; 3.9%), nose (20/557; 3.6%), eye/orbit (14/557; 2.5%), mouth (12/557; 2.2%), and chest/ribs (1/557; 0.2%)($\chi^2(10) = 827.29$, $p < .001$). Table 4 also presents specific information on the description and occurrence of the illnesses that were reported within each location.

Discussion

The primary importance of this study is that it was the first to examine the incidence of illnesses in a population of elite amateur athletes. Although illnesses occurred with a significantly lower frequency than injuries, the fact that they represented more than 30% of all reported problems should be of interest to sports medicine professionals who work with amateur boxing athletes. Also of interest is that most (71.3%) of the illnesses involved some type of an infection and that the majority of these infections occurred in the cardiopulmonary system, more specifically the upper and the lower respiratory tracts and related passages. It would be interesting to compare these findings to the relative percentages of infections found in other types of sports and to the general population, both athletic and nonathletic, in order to determine the overall importance of infections. This infor-

Table 1.—General Classification of Injuries

Description	Occurrence		Incidence %
Contusion	304	*	24.9
Muscle strain	254		20.8
Joint strain	213	*	17.5
Tendinitis	112	*	9.2
Concussion	74		6.1
Fracture	60		4.9
Laceration	50		4.1
Abrasion	41		3.4
Epistaxis	27		2.2
Degenerative changes	25		2.1
Neural disorders	17		1.4
Sublaxation/dislocation	16		1.3
Perforation/rupture	11		0.9
Bursitis/chondritis	10		0.8
Meniscal/plical disorder	5		0.4
Total	1219		100.0

* $p < .05$.

Table 2.—General Classification of Illnesses

Description	Occurrence		Incidence %
Infection	397	*	71.3
Gastrointestinal	66	*	11.8
Inflammation	32		5.7
Respiratory	14		2.5
Neural disorder	11		2.0
Cardiovascular	9		1.6
Contusion	9		1.6
Epistaxis	8		1.4
Dental	6		1.1
Other	5		1.0
Total	557		100.0

* $p < .05$.

mation is not currently available. Such data would be helpful in order to determine the overall safety of amateur boxing as compared to other sports and relative to nonathletic pursuits and activities.

Regarding the issue of safety in boxing, this study found fewer injuries of a serious nature than previous investigations. Jordan et al[6] reported surprise in finding only 29 cerebral injuries (26 mild concussions, two moderate concussions, and one traumatic headache in 447 total injuries; 6.5%), which they attributed to the fact that boxing at the USOTC is largely noncompetitive and involves more sparring and training than actual matches. This contrasts with the report of Estwanik et al,[1] who found that 48% of all injuries during boxing competition involved a blow to the head. They reported that the rate of head blows was 4.38 per 100 exposures,[1] but did not provide specific information about how many of the blows to the head resulted in an actual cerebral injury. Several Swedish researchers[2–4,8,12] used prospective and retrospective experimental designs to compare the brain and neurological functions of matched groups of amateur boxers, military conscripts, soccer players, and track and field athletes. They examined past medical histories of the subjects; performed neurological, physical, and psychological examinations on all subjects; and tested them, using either CT or MRI scans. They concluded that amateur boxing in Sweden did not lead to chronic brain damage and did not differ from other activities in terms of injuries which involved neuropsychological impairment.[2–4,8,12] The present findings of 74 concussions, or 6.1% of the total number of injuries, is slightly less than the results of Jordan et al,[6] but consistent with the totals from the Swedish investigations.[2–4,8,12]

While the importance of a cerebral injury cannot be understated, this study supports the conclusions of the Swedish researchers that amateur boxing is a safe sport secondary to the risk of serious brain injury. The risk does exist, as it exists with any sport as well as with nonathletic activities of daily living, but is relatively low compared to orthopaedic problems and illnesses. However, further research is necessary in this area to strengthen the validity of this conclusion.

The issue of safety might also be raised regarding the findings of 60 fractures, 25 situations of degenerative changes, 17 neural disorders, 16 subluxations or dislocations, and 11 perforations or ruptures (Table 1). While these problems represent only small percentages of the overall number of injuries, 4.9, 2.1, 1.4, 1.3, and 0.9%, respectively, they might detrimentally impact an athlete's career on his/her long-term health status. However, several international researchers[7,9,11,14] have concluded that the use of appropriate headgear and hand wear will decrease the risk of these problems. Further research of a longitudinal nature is necessary to determine the influence of these types of injuries on athletes' long-term health in order to more appropriately address this aspect of the relative safety of amateur boxing. The absence of such long-term information is a relative limitation of this investigation and of previous studies.[1,6,8]

With a few notable exceptions, the findings of this study parallel the results of Jordan et al.[6] This is not sur-

Table 3.—Injuries by Body Region

Body region	Location	Occurrence	Incidence Region %	Incidence Body %	Percent of problems*
Upper extremities	Hand	107	24.3	8.8	6.0
	Shoulder	86	19.5	7.0	4.8
	Thumb	60	13.6	4.9	3.4
	Fingers	59	13.4	4.8	3.3
	Wrist	45	10.2	3.7	2.6
	Elbow	44	10.0	3.6	2.5
	Forearm	16	3.6	1.3	0.9
	Upper Arm	16	3.6	1.3	0.9
	Clavicle	8	1.8	0.6	0.4
	Subtotal	441	100.0	36.0	24.8
Head/face	Face/Scalp	146	42.4	12.0	8.2
	Nose	71	20.6	5.8	4.0
	Eye/Orbit	44	12.8	3.6	2.5
	Mouth	30	8.7	2.5	1.7
	Jaw/Chin	28	8.2	2.3	1.6
	Ear	22	6.4	1.8	1.2
	Throat	3	0.9	0.2	0.2
	Subtotal	344	100.0	28.2	19.4
Lower extremities	Knee	78	29.2	6.4	4.4
	Ankle	68	25.5	5.6	3.8
	Thigh	40	15.0	3.3	2.2
	Leg	30	11.2	2.5	1.7
	Foot	24	9.0	2.0	1.4
	Hip/Groin	16	6.0	1.3	0.9
	Toes	11	4.1	0.9	0.6
	Subtotal	267	100.0	22.0	15.0
Spinal column	Lumbopelvic	49	29.3	4.0	2.8
	Chest/Ribs	46	27.5	3.8	2.6
	Neck	41	24.6	3.4	2.3
	Thorax	21	12.6	1.8	1.2
	Abdomen	10	6.0	0.8	0.5
	Subtotal	167	100.0	13.8	9.4
	Total	1,219		100.0	68.6

*Includes injuries and illnesses.

prising, for, as was stated previously, the present study is both an expansion and an extension of the prior study's database. While both studies reported that the greatest number and percentage of injuries occurred in the upper extremity and the fewest occurred in the lower extremity, differences exist between the two investigations on head/face and lower extremity injuries (Table 3).[6] Jordan et al found more lower extremity injuries than head/face injuries, 23.9 and 20.6% ($p > .05$), while this investigation noted a reverse relationship, 28.2 and 22.0% ($p < .01$) (Table 3).

Other differences noted are that Jordan et al found more finger than thumb injuries in the upper extremities, a fewer number of thigh injuries in the lower extremities, and a fewer number of face/scalp injuries in the head/face region as opposed to the results presented in Table 3. These differences may reflect a product of the longer period of data collection for this study compared to the prior study, a specific change in the trend of amateur boxing injuries over the past 5.5 years at the USOTC, or variability due to turnover in the personnel who recorded the data. Further research is necessary to determine the nature of this difference, as well as to more completely elucidate the factors of injury and illness in amateur boxing.

Conclusions

We conclude that:

1. illnesses comprise an important portion of health problems which affect elite-level amateur boxing athletes,
2. most illnesses in elite-level amateur boxers are infections in the upper or lower respiratory tracts,
3. serious injuries represent only a small percentage of all problems

Table 4.—Illnesses by Location

Location	Occurrence	Incidence	Percent of problems
Cardiopulmonary	236	42.4	13.3
Gastrointestinal	66	11.8	3.7
Skin	62	11.1	3.5
Throat	49	8.8	2.8
Genitourinary	43	7.7	2.4
Head/Face	32	5.8	1.8
Ear	22	3.9	1.2
Nose	20	3.6	1.1
Eye/Orbit	14	2.5	0.8
Mouth	12	2.2	0.7
Chest/Ribs	1	0.2	0.1
Total	557	100.0	31.4

which might affect elite-level amateur boxers, and

4. most elite-level amateur boxing injuries occur in the upper extremities, followed by the head/face region, the lower extremities, and the spinal column.

Acknowledgments

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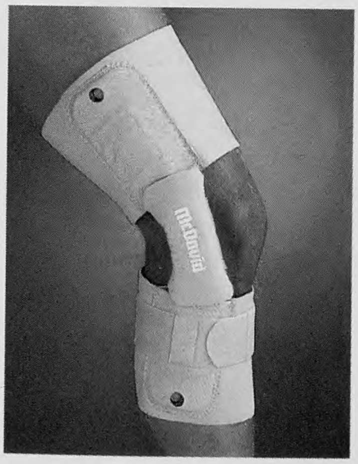

Muscular and Functional Performance Characteristics of Individuals Wearing Prophylactic Knee Braces

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Freddie H. Fu, MD

Abstract: *The efficacy of prophylactic knee bracing has been refuted with regard to reducing the incidence and/or severity of injuries to the knee joint. This is thought to be a result of the prophylactic knee brace's ineffectiveness in protecting the knee joint from valgus loads. Furthermore, discrepancies exist regarding the prophylactic knee brace's detrimental effect on functional performance. The purpose of this study was to measure the effect of the prophylactic knee brace on selected isokinetic muscular characteristics and forward sprint speed. Twenty physically active, healthy, male college students with no prior history of brace use participated in this study. The subjects were randomly tested both with and without the prophylactic knee brace worn on various performance parameters. The dependent measures assessed included peak torque (PT) and torque acceleration energy (TAE) at 60 and 240°/s. A 40-yard forward sprint was selected to assess sprint speed. A paired t-test analysis revealed mean values which were significantly less for PT at 60°/s ($p < .05$), 240°/s ($p < .01$), and TAE at 240°/s ($p < .05$) with the prophylactic knee brace applied during knee extension. Analysis also revealed slower times for sprint speed ($p < .01$), while the subjects were wearing the prophylactic knee brace. Muscular strength (PT) and power (TAE) scores were not correlated ($p > .05$) with sprint speed. This study suggests that wearing the prophylactic knee brace may consequently inhibit muscular and functional performance of the athlete, but that specific population has yet to be studied.*

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Epidemiological studies have recognized that knee joint injuries are the most common disabling injuries in athletics.[24,28] Consequently, the use of prophylactic lateral knee braces in football has increased in an attempt to reduce the incidence and/or severity of injuries to the knee joint.[10–12,14,27–31] The efficacy of such knee braces has been refuted by researchers regarding prevention of laterally applied valgus loads that may induce ligamentous injuries to the knee joint.[1,2,6,21,22] The discrepancies in the efficacy of the prophylactic benefits of the prophylactic knee brace have led to inconsistencies among clinicians recommending their use.

Inconsistencies in the available literature have elicited further scrutiny regarding the effects and possible decrements in functional performance while wearing the prophylactic knee brace. The prophylactic knee brace may inhibit leg muscle function and sprint speed, both of which are essential to athletic performance.[7,13,25] Thus, the term "functional" as used in this manuscript implies dynamic muscular activity objectively measured for comparative analysis.

The purpose of this study was to address these discrepancies in the literature by objectively measuring selected isokinetic muscular characteristics and sprint speed under the braced and nonbraced conditions. We hypothesized that the isokinetic muscular test scores would be significantly decreased and forward sprint times would be significantly slower in the braced condition, suggesting functional inhibition.

Furthermore, there has been some debate suggesting that sprint speed is related to muscular strength and power.[15] Since these three performance parameters were measured in this study, we also hypothesized that strength measured as peak torque (PT), power measured as torque acceleration energy (TAE), and sprint speed would be positively correlated all during the nonbraced condition.

Methods

Twenty physically active, healthy, male college students (age = 21.3 ± 3.6 yr, ht = 68 ± 2.4 in, wt = 167 ± 7.2 lb) with no prior history of brace use voluntarily participated in this study. Exclusion criteria included any previous knee pathology requiring surgical intervention, anterior cruciate ligament deficiency, and/or patellofemoral dysfunction. Informed consent approved by the Institutional Review Board at the University of Pittsburgh were reviewed and signed by each subject prior to testing. The subject acted as his own control and was tested on two separate sessions for both conditions (braced versus nonbraced).

The test conditions (brace or nonbrace) were randomized, thus preventing the occurrence of any learning effects. The subjects attire consisted of a t-shirt, gym shorts, and athletic shoes.

Two commercially available prophylactic knee braces were used according to the manufacturer's specifications. They were selected due to their popular use among intercollegiate football players. The McDavid Knee Guard (MKG) (M-155; McDavid Knee Guard Inc, Clarendon Hills, Ill) has a single-hinge design, while the Omni (Omni Scientific Inc, Lafayette, Ill) has a double or polyaxial design (Fig 1). The two prophylactic knee braces were randomly assigned to subjects with 11 wearing the MKG and 9 the Omni. The prophylactic knee brace was worn unilaterally on the dominant leg for the isokinetic tests (Fig 2), and bilaterally for testing sprint speed (Fig 3).

Subjects were tested with identical protocols on two separate days, and the sessions were separated by 48 hours to allow for proper recovery. Test protocol consisted of testing for strength and power on the Cybex unit and sprint speed on an indoor track.

Isokinetic muscular testing was computed using the Cybex II isokinetic testing device (Lumex, Inc, Ronkonkoma, NY). Subjects completed a 5-minute warm-up on a Monarch stationary bicycle at a preset cadence (70 rpm) and resistance (.04 kg) relative to the subject's body weight (eg, 60 kg × .04 = 2.4 kp). Cybex testing was conducted in an isolated, thermoneutral environment. The parameters selected for testing included PT and TAE measured at two angular velocities (60 and 240°/s). Peak torque is defined and measured as the greatest torque produced during a given set of contractions, while TAE is defined and measured as the amount of work performed in the first one eighth of a second of torque production.[5] Peak torque is recorded as a strength measure, and TAE is recorded as an anaerobic power output measure in this study.[17,23] Each subject was tested using gravity correction, and standard stabilization was employed at the chest, waist, and distal thigh.[3,4] The Cybex was calibrated prior to testing of the subjects. Each subject received verbal instructions prior to testing, followed by five pretrial submaximal repetitions at 60°/s in order to accommodate to the test speed. After a 30-second recovery, subjects completed four maximal repetitions and the highest value was recorded as PT. A 1-minute recovery was given before continuing at the next test speed. Ten submaximal repetitions were used as a pretrial for testing at 240°/s in order for the subject to accommodate with the faster test speed. After a 30-second recovery, subjects completed four maximal repetitions and the highest values were recorded as TAE and PT.

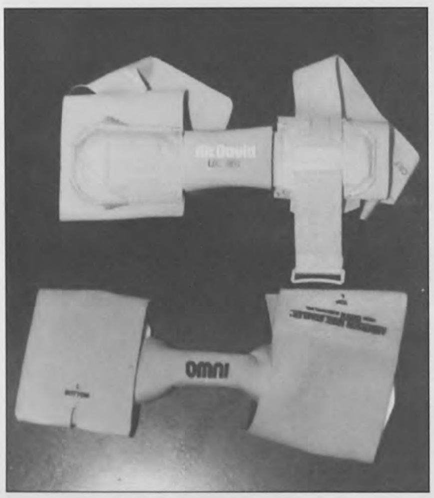

Fig 1.—The McDavid Knee Guard (*top*) is a single-hinge design, while the Omni (*bottom*) is a double- or poly-hinge design.

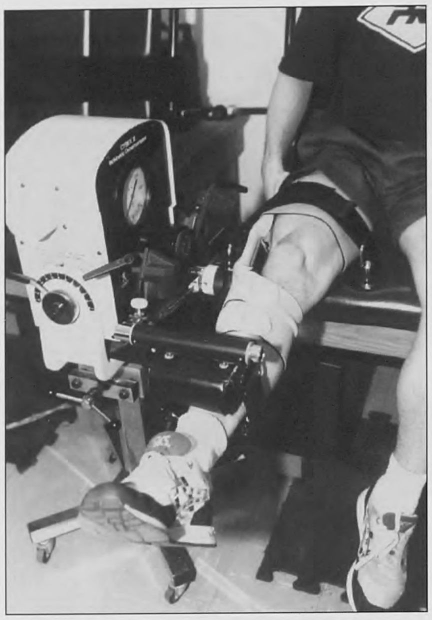

Fig 2.—During isokinetic testing, the prophylactic knee brace was worn unilaterally.

For testing sprint speed, the subjects went through a warm-up consisting of light jogging for 800 meters and large muscle group flexibility exercises. Each subject familiarized himself with the sprint distance by completing two submaximal trial runs. The 40-yard forward sprint was selected, due to its reproducibility and relevance to college football. The sprint was performed at maximal speed with the mean time (seconds) of three trials recorded as the criterion measure. A 1-minute recovery period was given between trials. Sprint times were recorded by the same investigator using a hand-held stopwatch measured to the nearest tenth of a second.

Analysis of variance (ANOVA) was used to identify significant ($p < .05$) differences between the two prophylactic knee brace designs on the various testing parameters. The selected isokinetic and sprint speed tests were treated as four separate tests and paired *t*-test analyses ($p < .05$) were used to compare the braced and the nonbraced (control) conditions for the

Fig 3.—Frontal view of the prophylactic knee brace.


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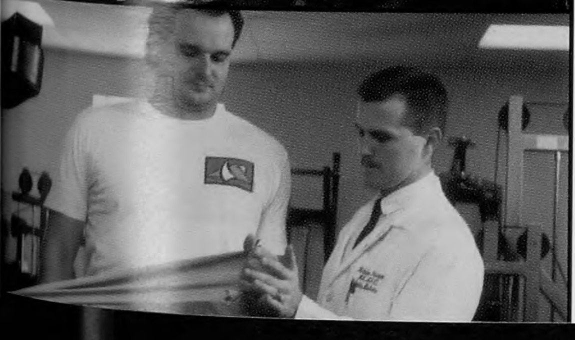

Table 1.—Means and Standard Deviation for Knee Extension With and Without the Brace

	Brace	No brace
Knee extension (ft-lb)		
Peak torque 60°/s	152.9 (26.3)	158.3 (23.9)
Peak torque 240°/s	51.7 (11.9)	54.4 (12.4)
TAE 240°/s	29.6 (5.6)	31.2 (5.2)
40-Yard forward run (seconds)	5.3 (0.3)	5.2 (0.4)

selected measures. Also, Pearson Product Moment Correlations were computed to determine significant ($p < .05$) correlations between strength (PT at 60 and 240°/s), anaerobic power (TAE) at 240°/s, and sprint speed (40-yard forward sprint).

Results

There were no statistically significant ($p < .05$) differences between the two designs on the various testing parameters ($F(1,18) > 3.73$, $p > .07$). Therefore, the data were pooled, and further analyses were performed without regard to brace design.

Isokinetic strength and power scores were significantly lower while wearing the brace during knee extension for PT at 60°/s ($t(19) = 1.80$, $p = .04$) and 240°/s ($t(19) = 2.66$, $p = .008$), and TAE at 240°/s ($t(19) = 2.19$, $p = .02$; Table 1). Subjects ran faster (40-yard forward sprint) when the braces were not worn ($t(19) = 3.05$, $p = .003$; Table 1). Correlations between strength (PT at 60 and 240°/s), and sprint speed were low and not significant ($p < .05$) (PT at 60°/s and sprint speed ($r = .21$), and PT at 240°/s and sprint speed ($r = .11$)). Also, correlations between power and sprint speed were low and not significant ($p < .05$) (TAE (240°/s) and sprint speed ($r = .37$)).

Discussion

The original premise for wearing prophylactic knee braces was to prevent or reduce the incidence and/or severity of knee joint injuries. Retrospectively, researchers began conducting longitudinal studies comparing injury rates before and after the prophylactic knee brace was being used. Subsequently, the results of these long-term epidemiological studies suggest that prophylactic knee bracing does not reduce the incidence and/or severity of injuries to the knee joint of college football players, specifically injuries to the medial collateral ligament, anterior cruciate ligament, and medial meniscus.[10,12,14,27–31] This has led other investigators[1,2,6,21,22] to conduct biomechanical in vivo and in vitro studies designed to measure brace function under simulated conditions. Paulos et al[6,21,22] and Baker et al[1,2] have pioneered these studies evaluating the static stabilizing qualities of the prophylactic knee brace using both cadaveric and surrogate knee models. They concluded that the prophylactic knee brace does not prevent valgus loading of the knee joint from laterally applied contact blows. Other investigators[26,32] speculated that the prophylactic knee brace is not designed and constructed sufficiently to transfer valgus loads away from the knee joint (Fig 4).

In addition to the prophylactic knee brace's questionable efficacies, many researchers are unclear as to the effect the prophylactic knee brace has on various performance parameters. To date, the degree to which the prophylactic knee brace inhibits functional performance is inconsistent in the literature and has resulted in considerable controversy.[7,13,23] Therefore, if the prophylactic knee brace fails to perform as initially prescribed and also inhibits athletic performance, then it should not be recommended for athletic use.

This study revealed that prophylactic knee braces do indeed inhibit specific performance parameters in subjects unaccustomed to wearing prophylactic knee braces, and this inhibition may result in subsequent decrements in athletic performance. In our study, generation of PT and TAE during knee extension at 60 and 240°/s was found to be significantly inhibited while wearing the prophylactic knee brace, as was forward sprint speed. Others reported similar findings; higher PT values at four angular velocities (30, 90, 180, and 300°/s) without the brace[13] and forward sprint speed deficits when the prophylactic knee brace was worn.[7,25] These findings are inconsistent with reports by Hansen[11] and Clover (unpublished research, Riverside, Calif, 1984) suggesting that prophylactic knee brace's have no effect on isokinetic muscular function.

Houston and Goemans[13] reported significant differences in maximal anaerobic power output on the Margaria-Kalamen (M-K) step test, suggesting that the knee braces may have an inhibitory or "dampening" effect on peak anaerobic power output. This finding supports our study in that peak anaerobic power output decreased significantly when the braces were worn. Anaerobic power output was measured in our study using the TAE value recorded at 240°/s on the Cybex (Table 1). TAE, as defined earlier in the text, is a measure of instantaneous power output

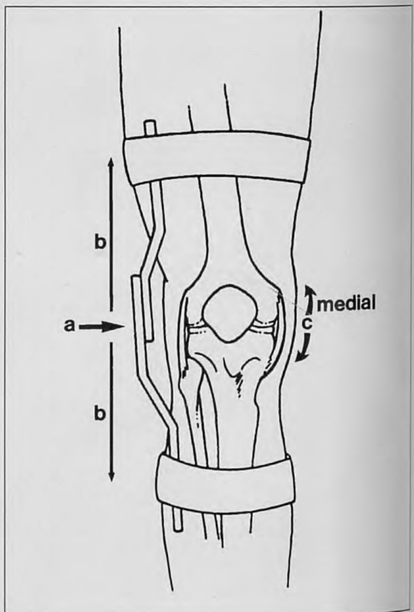

Fig 4.—The prophylactic knee brace is designed to: (*a*) absorb the lateral blow, (*b*) redirect the forces away from the knee joint, and (*c*) prevent opening of the medial knee joint.

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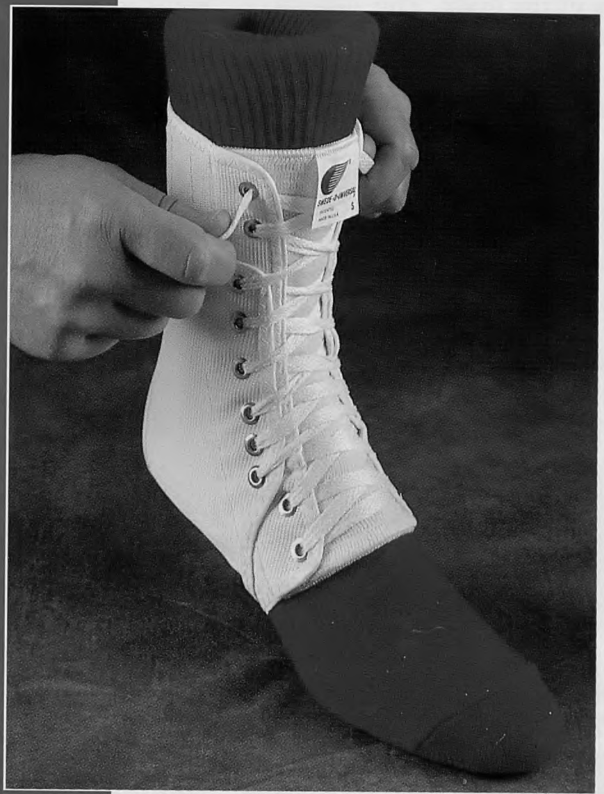

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and is done under completely anaerobic conditions.[16,20]

Lephart et al[17] reported TAE to correlate well with anaerobic power (M-K step test; r = .73), although further investigations should substantiate these findings. Similarly, Kalamen[15] reported a high correlation (r = .97) between the time of running the 50-yard dash and the M-K step test. This suggests that the 50-yard forward sprint may be used as a valid measure of anaerobic power. Although our study used the 40-yard forward sprint, we feel this distance is comparable to the distance used by Kalamen,[15] and may also be used as a valid measure of anaerobic power.

Peak torque and TAE during knee extension is a reflection of the quadriceps maximal tension generating capacity[4] and any deficits in the quadriceps capacity to generate tension should affect the potential for forward sprint speed. The relationship between muscular strength and sprint speed has not been extensively investigated and strong relationships are not widely reported.[5,8,18] The hip flexors are most active during sprinting; apparently because they are closely linked to the knee extensors in propelling the body forward.[19] This suggests that the biarticular knee extensors/hip flexors may provide the necessary impetus for sprint speed due to their high activity during sprint running. According to our study, there appears to be little relationship between quadriceps strength/power and sprint speed. This may be due in part to the small subject size. Overall, when comparing muscular strength and sprint speed, few have revealed consistencies between muscular and functional inhibition indicating the necessity for further investigation.

Since wearing the prophylactic knee brace appears to inhibit isokinetic muscular strength parameters and sprint speed, we speculate that the brace may inhibit some other functional performance parameters. Studies identifying the effects of prophylactic knee bracing on agility are limited[7,25] and results are not consistent within the literature. Again, further studies are necessary.

In addition to the results from the muscular function inhibition studies, some researchers have suggested that other factors may affect sprint speed. Van Horn et al[32] reported that when prophylactic knee braces were worn, significant differences in gait patterns were observed. These alterations were speculated to be some form of compensatory motions to counter the effects of the brace. This may have implications for future improvements in brace design and placement.[26,33]

Prophylactic knee braces have been under investigation for some time. Most researchers have found the prophylactic knee brace to be ineffective in preventing injury to the knee joint, yet many clinicians and athletes continue to recommend and use the brace. The results of this study reveal that the prophylactic knee brace does indeed inhibit selected isokinetic muscular characteristics and forward sprint speed in subjects who are unaccustomed to wearing prophylactic knee braces, and both of these factors may ultimately inhibit athletic performance. Furthermore, the difference between the two mean sprint times appears to be small for this study (Table 1), yet deficits as small as one tenth of a second may be practically significant for athletes who demand maximal speed. Therefore, the use of prophylactic knee braces for athletes who require maximal muscular function and sprint speed should be scrutinized with regards to the limited reported prophylactic benefits of such braces.

This study used subjects unfamiliar with prophylactic knee brace use, thus providing a novel motor task for the subjects. Conversely, athletes who are accustomed to wearing prophylactic knee braces have conditioned an ingrained (habituated) motor task relative to their performance. The novelty of the task for the subjects in this study may affect the external validity of the study. Therefore, any significant effects demonstrated by the subjects in this study may be due to the unfamiliarity of the tasks and will make generalizability to the athletic population difficult. For future research, we recommend using athletes who are accustomed (habituated) to wearing the prophylactic knee brace in order to increase the generalizability of our results to a more habituated athletic population. We also recommend investigating further the relationship between muscular strength/power and sprint speed, as well as investigating the braces' effects on other performance variables, such as proprioception, metabolism, kinetics, and kinematic function.

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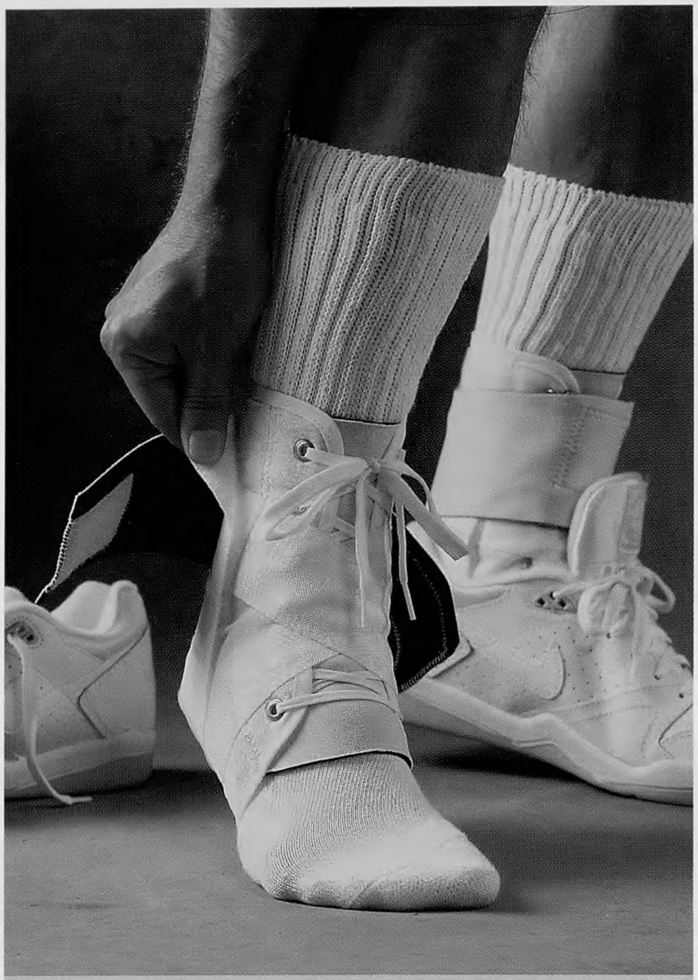

Posterior Rotator Cuff Strengthening Using Theraband® in a Functional Diagonal Pattern in Collegiate Baseball Pitchers

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Abstract: *The deceleration phase of the pitching mechanism requires forceful eccentric contraction of the posterior rotator cuff. Because traditional isotonic strengthening may not be specific to this eccentric pattern, a more effective and functional means of strengthening the posterior rotator cuff is needed. Twelve collegiate baseball pitchers performed a moderate intensity isotonic dumbbell strengthening routine for 6 weeks. Six of the 12 subjects were randomly assigned to an experimental group and placed on a Theraband® Elastic Band strengthening routine in a functional-diagonal pattern to emphasize the eccentric contraction of the posterior rotator cuff, in addition to the isotonic routine. The control group (n = 6) performed only the isotonic exercises. Both groups were evaluated on a KIN-COM® isokinetic dynamometer in a functional diagonal pattern. Pretest and posttest average eccentric force production of the posterior rotator cuff was compared at two speeds, 60 and 180°/s. Data were analyzed with an analysis of covariance at the .05 level with significance at 60°/s. Values at 180°/s, however, were not significant. Eccentric force production at 60°/s increased more during training in the experimental group (+19.8%) than in the control group (−1.6%). There was no difference in the two groups at 180°/s; both decreased (8 to 15%). Theraband was effective at 60°/s in functional eccentric strengthening of the posterior rotator cuff in the pitching shoulder.*

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Recent biomechanical and electromyographic (EMG) studies have determined that the muscles of the posterior rotator cuff (the external rotators; supraspinatus, infraspinatus, and teres minor) experience eccentric contractions during the deceleration and follow-through phases of baseball pitching.[3,5,12,17,23,24,28,31] Because the deceleration phase is strenuous to the shoulder in regards to torque during deceleration,[3,5,23,24] strong decelerators are vital in the posterior rotator cuff. Effective strengthening of eccentric muscles may be difficult to attain through traditional isotonic resistance exercises using light weights (approximately 5 lbs) in uniform movement patterns. Therefore, a more practical, functional, and effective means of eccentric strengthening of the posterior rotator cuff must be developed.

The purpose of this study was to determine if there was a significant increase in eccentric strength of the posterior rotator cuff through resistance exercise using Theraband Elastic Band (Hygienic Corporation, Akron, Ohio) in a functional-diagonal pattern as opposed to a traditional isotonic resistance exercise routine using light weights in uniform movement patterns during an in-season maintenance program for collegiate baseball pitchers.

Methods

For this study, two randomly assigned groups exercised for 6 weeks using a moderate-intensity isotonic maintenance program. One group exercised with Theraband (experimental group); the other did not (control group). Each group was pretested and posttested for average eccentric strength of the posterior rotator cuff.The independent variable was the mode of strengthening. The dependent variable was average eccentric strength, measured in pounds of force. Inferentially, analysis of covariance (ANCOVA) was used to determine any significant difference, with the pretest scores statistically controlled.

Subjects (n = 12) were volunteer members of the baseball team pitching staff participating in fall drills. By using preseason athletic participation physicals, we screened for any contraindications to exercise before the onset of the investigation. We randomly assigned six subjects to each of two groups.

Testing Procedures

Subjects were pretested and posttested on a KIN-COM 125E isokinetic dynamometer (Chattecx Corp, Hixson, Tenn). The dynamometer was calibrated according to the manufacturer's protocol before both testing

sessions. Isokinetic testing has been found to be reliable in assessing strength.[15,20,37]

Testing was performed within the week before and the week after the 6-week strengthening trial. We tested individuals in each group over the course of 2 days; right-hand dominant first, then left-hand dominant. The same examiner administered the tests to insure adherence to the testing procedure through consistent positioning, instructions, and encouragement. Uniform instructions explaining the study, the procedures, and techniques of the test were read to the participants.

Each subject was positioned on the seat in a uniform fashion to adhere to the test position protocol (Fig 1). The KIN-COM dynamometer head was tilted at 30° and rotated as needed to allow the axis of rotation to pass through the axilla. The seat level and table-top length were positioned forward to accommodate this axis of rotation through the axilla. Spacers were placed between the subject's back and the table seat for stabilization of the back. A stool placed under the feet supported the legs. The sensor attachment pad was aligned in the middle of the forearm between the wrist and the elbow. The upper body was secured to the seat with a velcro-fastened strap across the chest, and the pelvis was stabilized with a seat belt. Mechanized stops were placed just beyond the computer stop and start angle to prevent any motion beyond the range of motion defined by the pattern tested.

Each test was performed as follows:

1. Subject stretched his/her dominant shoulder for 5 minutes.
2. Subject was positioned on the dynamometer and secured, as noted above.
3. Uniform instructions were read.
4. Subject was instructed to perform the following: one repetition at "50% perceived maximum"; one repetition at "75% perceived maximum"; three repetitions at "100% perceived maximum."

   Each repetition consisted of resisted lengthening of the posterior rotator cuff in a functional pattern of deceleration: D2-extension starting position, then abduction/flexion/external rotation, and ending with adduction/extension/internal rotation (Fig 2). As the subject performed the eccentric contraction of the posterior rotator cuff in the D2-extension pattern, the hand was kept open. For the return movement to the original starting position, the subject eccentrically contracted the anterior rotator cuff in the D2-flexion pattern in order to rest the posterior rotator cuff. In this movement, the hand was closed.
5. The test was given at two speeds, first at 60°/s and again at 180°/s in the same position after a 1-minute rest.
6. Verbal motivation was given only as needed to keep the athlete in proper motion during the testing.

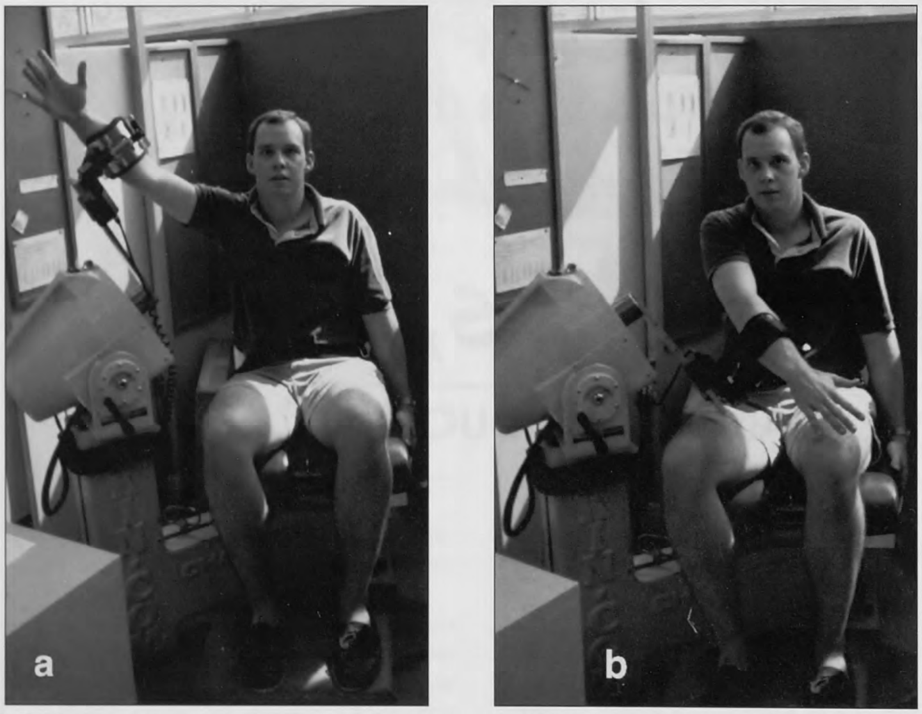

Fig 1.— Isokinetic test protocol start (*a*) and isokinetic test protocol finish (*b*).

Strengthening Procedures

Both groups stretched the rotator cuff and performed isotonic exercises using a 5-lb dumbbell, as recommended for shoulder strength maintenance.[5,25,29,36] Each exercise was performed three times per week for one set of 10 repetitions each. This traditional isotonic routine (Fig 3) included the following exercises:

Circumduction
Abduction
Biceps Curls
Triceps Extensions
Standing supraspinatus "Empty-can"
Posterior Cuff External Rotation
Horizontal Abduction

The control group performed only the isotonic exercises in their daily routine. The experimental group performed these exercises in addition to eccentric and concentric strengthening, using the Theraband Elastic Band three times per week. The Theraband eccentric strengthening was preceded by the traditional isotonic maintenance routine.[11]

The Theraband routine consisted of exercise in the D2-diagonal pattern of proprioceptive neuromuscular facilitation (PNF) patterns.[27] Subjects attached the fixed end of the elastic band to the wall hooks even with the iliac crest (Fig 4). Standing with the opposite shoulder and side nearest the fixed origin, the subjects faced 90° in either direction to keep the opposite shoulder nearest the origin. The distance between the base of the wall hooks and the nearest foot was 3 ft. The dominant hand was placed on the opposite hip (nearest the origin), similar to the starting position for the D2-flexion pattern (Fig 2). The Theraband length was 3 ft from the origin to the hand, with no tension or slack in the elastic band.

Subjects performed the D2-flexion pattern concentrically to a position of full abduction, flexion, and external rotation by stretching the Theraband, paused 1 second, and performed the D2-extension pattern eccentrically by allowing the elastic band to pull the arm slowly back to the starting position of adduction/extension/internal rotation. We monitored subjects for correct posture during the exercise to ensure that all movement occurred only at the shoulder and that they maintained a smooth, slow, fluid motion. Care was taken to ensure that subjects did not "cheat" by engaging other muscles of the upper and lower body. Subjects performed the repetitions in about 10 seconds (3 seconds for the concentric phase, 2 seconds rest, and 5 seconds for the eccentric phase). They rested for 2 seconds between repetitions with the hand at the opposite hip (Fig 4) and for 1 minute between sets.

Subjects performed three sets of repetitions per day. They began with 10 repetitions per set during the first sets of a new resistance. Each session added five more repetitions, as tolerated by the subject, up to 25 repetitions. The resistance of the Theraband is color-coded in progressive strengths. The resistance began with light (yellow band) and increased progressively in strength (yellow, red, green, and blue) based on the ability of the subject to properly complete the prescribed sets and repetitions without soreness or perceived excess fatigue. After three sets of 25 were accomplished, the resistance was

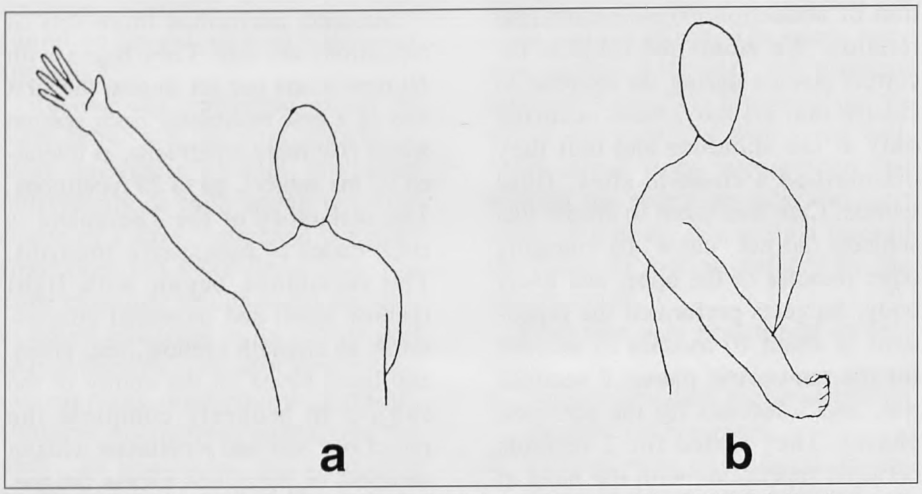

Fig 2.—PNF D2-extension pattern start (*a*) and stop (*b*); PNF D2-flexion pattern start (*b*) and stop (*a*).

increased and the repetitions decreased to three sets of 10, again progressively increasing. The goal of three sets of 25 repetitions was established to ensure that the subjects were working at a light weight with high repetitions, thus improving endurance and aerobic capabilities, while providing for strength gains. These exercises were performed 3 days per week after the isotonic routine in the experimental group. We instructed subjects to stretch their shoulders on their own for 5 minutes before and after exercise.

We performed two one-way analyses of covariance on the data to determine if the posttest scores of the two groups were significantly different, with pretest scores as the covariate.

Results

At 60°/s, the experimental group increased 19.8 ± 7.1% in eccentric posterior rotator cuff strength while the control group decreased (−1.6 ± 14.8%; (Table 1). Both groups decreased in strength at 180°/s (−14.8 ± 25.3% and −8.1 ± 25.6%, respectively). The experimental group was significantly stronger following train-

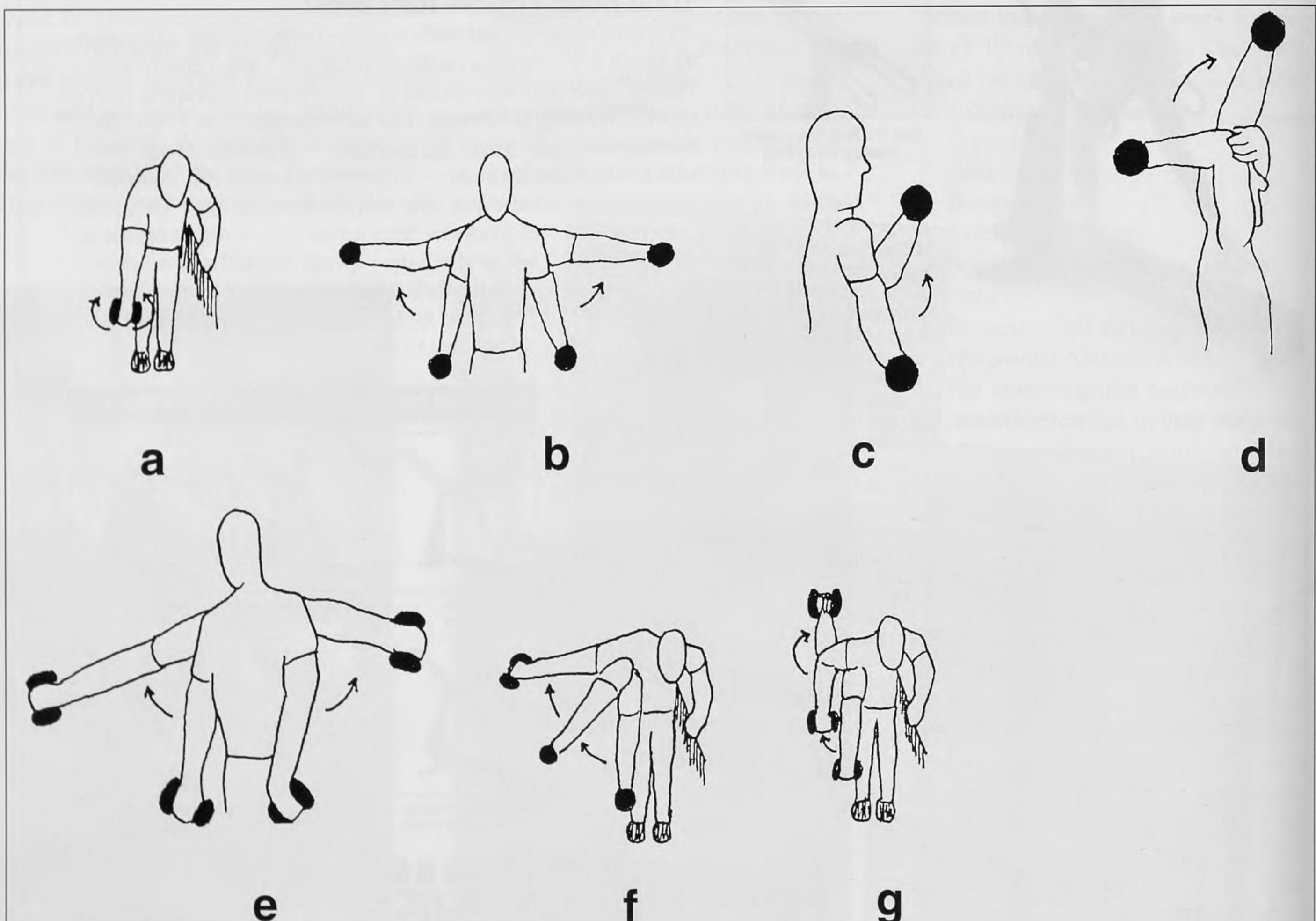

Fig 3.—Isotonic exercises: (*a*) circumduction; (*b*) abduction; (*c*) biceps curls; (*d*) triceps extensions; (*e*) standing supraspinatus; (*f*) posterior cuff external rotation; (*g*) horizontal abduction.

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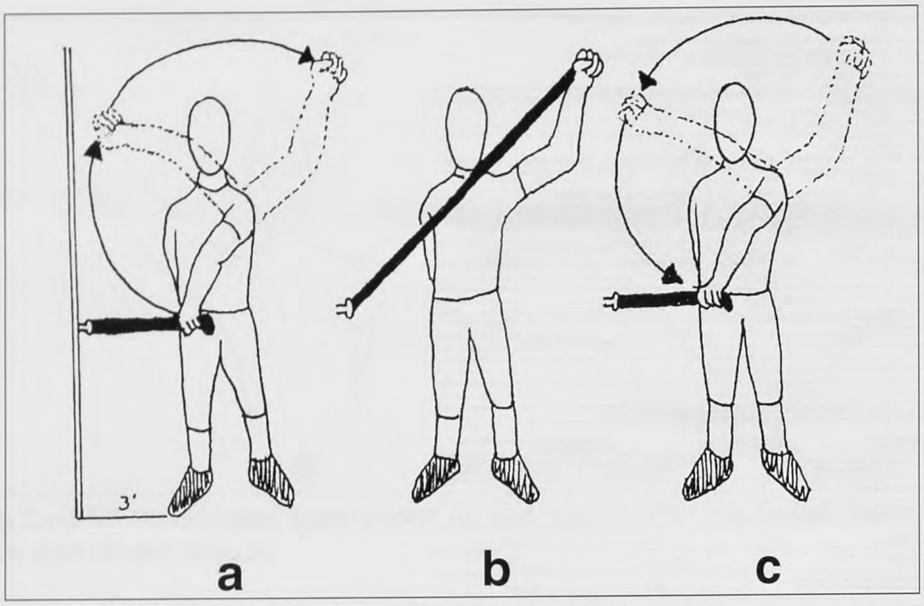

Fig 4.—Theraband routine start (*a*), middle (*b*), and finish (*c*).

ing than the control group at 60°/s ($F(1,9) = 11.75$, $p = .008$), but there was no significant difference between groups at 180°/s ($F(1,9) = .20$, $p = .66$).

Discussion

While this study indicated that Theraband strengthening may increase eccentric strength in the diagonal pattern, it raises further issues and questions for discussion. Little research exists regarding Theraband, eccentric functional shoulder testing, or strengthening studies involving pitchers. There have been no previous studies regarding the effectiveness of Theraband strengthening, and there are very few regarding elastic-band exercise. Most literature provides only suggested exercises.[4,5,25,29,36,38] Many use elastic tubing exercise as a strengthening device; however, most do not know the extent or actual value of its resistance. Elastic resistance exercise has not been labeled as being specific to a mode of contraction (ie, isotonic or isokinetic) because of its elastic properties. There is some question as to sets, repetitions, and resistance. It may be assumed to be isodynamic or accommodating resistance, because the resistance can be effectively changed by varying the band length or lever arm. No norms or recommendations have been established. Research is needed to substantiate claims by practitioners regarding both. Therefore, this study provides a basis for much needed further research in this area.

Speed and Mode of Contraction

The posterior rotator cuff (decelerator) muscles must contract eccentrically during the deceleration pattern; therefore, we evaluated the extent of eccentric strengthening of these muscles, specific to speed and mode of contraction. Both speed and mode were influenced. The strength gain by our subjects was only significant at the slower testing speed, 60°/s, which is still much slower than the actual angular velocity of the pitching arm (6180°/s).[31] Isokinetic technology does not allow for such high velocity functional testing; therefore, speed protocols had to be established for the hypotheses of this study.

The two testing speeds, 60 and 180°/s, were chosen because they are commonly used in isokinetic testing of the shoulder.[14,19] Different speeds may be used, but these two speeds seemed to be the limits of accurate testing. Below 60°/s, the speed was very slow, thus increasing muscle fatigue due to the prolonged eccentric contraction; above 180°/s, the speeds were much faster than the subject would have been comfortable with, due to the diagonal pattern.

The reasons for the difference in significance between speeds is uncertain. Duncan and associates[13] report that eccentric training at higher speeds increased the tension-generating capacity of connective tissue. Hageman et al,[19] however, report inconsistent increases in eccentric torque production at higher speeds. The increase in eccentric strength of the experimental group at the slower isokinetic testing speed could indicate that the 60°/s may have been more specific to the strengthening speed, since the strengthening repetitions were slow and controlled to emphasize the eccentric contraction. Conversely, the specificity of training principle of speed may then lead one to assume that a faster strengthening speed would have produced a significant gain at 180°/s, contrary to the slow and controlled motion in this study.

The difference may also be attributed to the order of testing of speeds during evaluation. Because 60°/s was evaluated first, it may have fatigued the decelerator muscles to the point of not providing a significant contraction

Table 1.—Average Eccentric Force of Posterior Rotator Cuff (ft-lb)

	Experimental	Control
60°/s		
Pretest	**22.7 ± 7.4**	**23.3 ± 5.7**
Posttest	**28.2 ± 8.1**	**22.7 ± 4.5**
% difference	**19.8 ± 7.1**	**−1.6 ± 14.8**
180°/s		
Pretest	**31.5 ± 8.1**	**27.5 ± 6.9**
Posttest	**27.3 ± 5.9**	**24.5 ± 5.5**
% difference	**−14.8 ± 25.3**	**−8.1 ± 25.6**

at the higher speed for the second test. Future eccentric testing might first evaluate the faster speeds, followed by slower speeds, or randomize the order of testing speeds.

The concentric phase of the strengthening pattern may have also contributed to an increase in eccentric strength. In order to facilitate the eccentric contraction using Theraband in the diagonal pattern, the subjects had to concentrically contract the posterior rotator cuff to the starting position (Fig 4). Some authors suggest that concentric contractions may be sufficient to provide gains in eccentric-strength.[34,35] This strength gain, however, may not be specific to the functional mode of contraction.

Testing Protocol and Deceleration Patterns

The testing and strengthening pattern in this study was an important issue; however, there was some question as to the reliability of this testing position. This specific eccentric testing position has never been used in research involving the pitching shoulder. Diagonal patterns testing the concentric strength of the pitching shoulder are used on other dynamometers, however.[8,10] By combining the literature on the biomechanics of the deceleration pattern and studies using the diagonal testing pattern, we developed the subject positioning for testing (Fig 1).

Jobe et al[23] used EMG analysis to determine the contraction of muscles during the deceleration phase. Electromyographic analysis of the muscles of the posterior rotator cuff during this deceleration pattern strengthening and testing may be needed to establish the validity of the testing position. Through EMG studies, the decelerator muscles can be evaluated for their function as well as their contraction pattern during strengthening or testing.[5] This may lead to a better understanding of eccentric exercises used to train the decelerator muscles.

Because no studies were available on this specific eccentric testing pattern, no posterior rotator cuff norms have been established. This pattern must be evaluated to establish norms on baseball pitchers or other throwing athletes to determine adequate levels of conditioning for competition, or to establish goals for strength training. This may also lead to the establishment of normal ratios for vital agonist/antagonist balance[2,8,16,18,21,25,38] of the anterior and posterior rotator cuff using eccentric and concentric contractions. Cook et al[8] report muscle asymmetry between rotator cuff muscle groups in baseball players. Norms are reported in regards to internal rotation/external rotation in concentric testing.[2,9,10,22] This, however, is not functional to both the movement pattern or muscular contraction type during deceleration.

Other studies evaluate isokinetic strength in pitchers at different arm positions[2,6,8] and compare strength to pitching velocity.[32,33] Most studies report a 3:2 concentric internal rotation-to-external rotation ratio.[2,10,22] The functional-diagonal pattern we used may be used to evaluate anterior rotator cuff concentric strength specific to acceleration. It can then be used to correlate the strength with other variables specific to pitching or throwing, or to shoulder injuries.

Injury Prevention Through Conditioning

The deceleration pattern used in this study has numerous implications regarding shoulder injuries, including preventive strengthening and evaluation. The strengthening pattern may be used to specifically train the decelerators and thereby prevent injury to the posterior rotator cuff. The biomechanics of the deceleration pattern as well as the agonist/antagonist balance are important in injury prevention. McLeod[28] stated that deceleration forces are twice as great as acceleration forces and act for a much shorter time, with peak torque reaching 300 ft-lb. Biomechanically, the shoulder joint is "thrown" toward the target in pitching, and has a natural tendency to follow the ball after release. This can cause the humeral head to separate from the glenoid fossa, due to distraction forces. Only the rotator cuff muscles, joint capsule, and glenohumeral ligaments provide stabilization for the shoulder. Unlike the decelerator muscles, capsular and ligamentous tissue cannot be strengthened or tightened with resistive exercise. The distraction of the humeral head and glenoid fossa may lead to microtrauma of the rotator cuff, glenoid labrum, capsule, or ligaments.[3,28] Therefore, strong posterior rotator cuff muscles must eccentrically contract to decrease the joint distraction during follow-through and subsequent injury.[12,21,23]

Pitchers may experience posterior shoulder soreness following extensive throwing. There are many theories regarding the cause of this soreness. Eccentric contractions of the decelerators may cause delayed-onset muscle soreness.[1,7,30] Specific eccentric training may enhance muscular recovery following pitching, thus reducing soreness. This soreness may also be attributed to microtrauma of the shoulder, secondary to muscular weakness or imbalance.[3,28]

Conclusion

This study has provided evidence that Theraband exercise of the posterior rotator cuff in the deceleration pattern is effective in increasing eccentric strength at slow speeds, but not at fast speeds. These findings can be used to substantiate some claims of strength gains using elastic-band exercise, but much further research is necessary. An ideal design would include two larger experimental groups—one group using isotonic strengthening alone and one using Theraband strengthening alone, and a larger control group using no strengthening. This would easily be accomplished using an untrained subject sample or performing the study during the off-season of athletes. However, we were interested in evaluating an in-season maintenance program of collegiate baseball players. Elastic rubber tubing should also be compared with a more aggressive isotonic program.[26] Research from different areas could be tied together and could benefit throwing athletes in prevention, maintenance, and rehabilitation of the shoulder.

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Tip from the Field

A Test for Eliminating False Positive Anterior Cruciate Ligament Injury Diagnoses

David O. Draper, EdD, ATC
Shane Schulthies, PhD, PT, ATC

It seems that many of the new ideas aimed at improving athletic training/sports medicine have to do with rehabilitation and treatment of injuries. Seldom do we see a *Tip from the Field* directed toward improving our evaluation techniques. According to the 1989 NATA Role Delineation study, athletic trainers spend 21% of their time evaluating injuries.[3] Based on this, a major focus of athletic trainers should be directed toward better evaluation techniques. Our purpose in writing this article is to help you improve your evaluation of knee injuries. We will introduce a test that may be used to rule out the false positive ACL injury diagnosis.

One of the most commonly injured entities in sports and recreation is the knee.[1,2] Several evaluation or field examination procedures for the knee are found in the literature and are used frequently by athletic trainers, physicians, and physical therapists. Still, with these many techniques available to us, incorrect diagnoses are often made. In a recent study,[4] physicians and physical therapists used the Lachman test to determine integrity of the anterior cruciate ligament (ACL) in 32 subjects with unilateral knee problems. Fifty-three percent of subjects who had torn ACLs were misdiagnosed as having negative tears. Thirty percent of subjects with no ACL tear were told that the ACL was damaged.[4]

One difficulty in evaluating knee injuries has to do with the false positive test. This situation can occur when a posterior cruciate ligament (PCL) is damaged, causing the tibia to sag posteriorly on the femur (Fig 1a). Thus, when an athletic trainer is performing the *anterior drawer* or the *Lachman* tests, the tibia gives the impression of moving forward on the femur with an associated instability in the anterior direction (Fig 1b).

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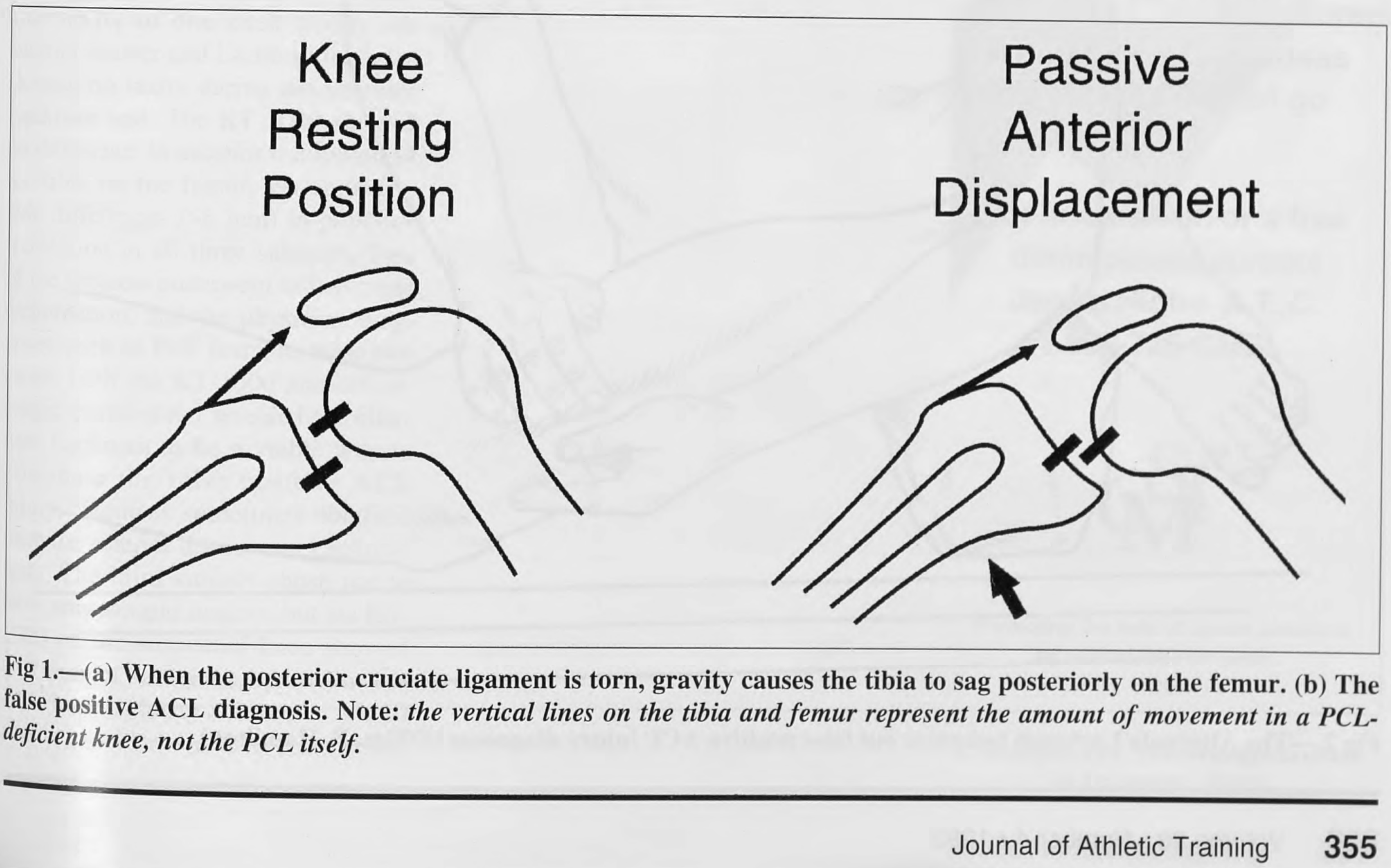

Fig 1.—(a) When the posterior cruciate ligament is torn, gravity causes the tibia to sag posteriorly on the femur. (b) The false positive ACL diagnosis. Note: ***the vertical lines on the tibia and femur represent the amount of movement in a PCL-deficient knee, not the PCL itself.***

An athlete in my care was once given conflicting diagnoses by two orthopedists. One physician diagnosed the injury as a torn PCL, while the other diagnosed it as a torn ACL and recommended ACL reconstruction. Arthroscopic evaluation revealed that the athlete had suffered a rupture of the PCL. The one physician gave the incorrect diagnosis due to this false positive phenomenon obtained while performing the anterior drawer and Lachman tests. If the physician would have performed the test described below, he may have given the correct diagnosis.

Description

The name of this test is the alternate Lachman, and it is normally used to help diagnose ACL injuries.[6,8] The athlete lies on the examining table in a prone position. The knee is flexed to 30° and supported by the examiner's knee or thigh under the patient's ankle. The examiner palpates the anterior joint margin of the knee by placing one finger on either side of the patellar tendon. The examiner's free hand applies a downward and forward pressure to the posterior aspect of the proximal tibia. If excessive translation (>6 mm bilateral difference) of the tibia on the femur is detected through palpation, the individual probably has an ACL lesion (Fig 2). If there is little or no bilateral difference when performing this test, the ACL is considered intact. Hence, any anterior movement of the tibia on the femur that was experienced during the anterior drawer and Lachman tests would be due to a torn PCL.

Daniel and Stone[5] have developed a technique for testing PCL instability with the aid of the KT-1000. This is accomplished using a contraction of the quadriceps with the knee flexed approximately 90°. At 90° of knee flexion, the patellar tendon in a normal knee is directed slightly posteriorly. Contraction of the quadriceps at this angle produces either no movement or minimal posterior movement of the tibia. In the PCL-deficient knee, the tibia sags posteriorly; thus, the patellar tendon is directed anteriorly. Contraction of the quadriceps of a PCL deficient knee will result in 4 to 6 mm of anterior translation. We used this technique to validate the alternate Lachman test as beneficial in eliminating the false positive ACL tear.

Discussion

Müller,[7] has stated the importance of examining the knee in a prone position. He suggests that acutely injured knees should include roentgenographic evaluation, possibly under stress. Along with the traditional lateral and anterior-posterior views, he employs tunnel and patella axial sunrise views while the patient is prone.

Part of the problem associated with false positive ACL injury diagnoses has to do with the supine positioning of the athlete during the anterior drawer and Lachman functional tests. In this position, if the PCL is torn, gravity may cause the tibia to slide back on the femur. When the examiner performs these two tests, the excessive sliding felt during the test may be mis-

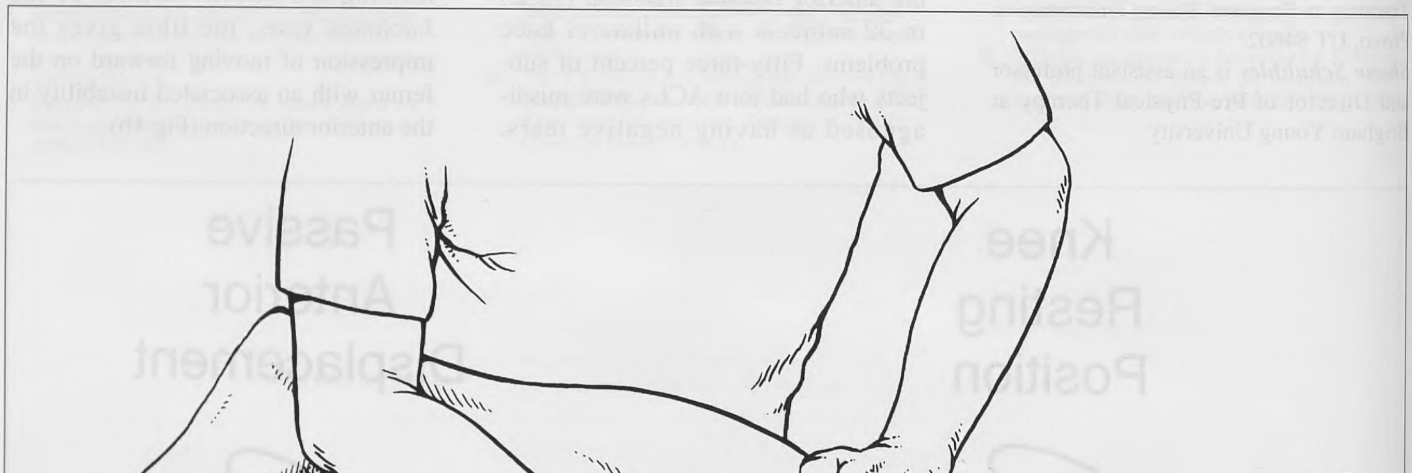

Fig 2.—The Alternate Lachman test rules out false positive ACL injury diagnoses (©Wm. P. Hamilton).

taken as an ACL injury. One strength of the alternate Lachman test is that it is performed with the athlete prone, and gravity will cause the tibia to remain in its normal position even if the PCL is torn. Another strength is that the joint line is palpated during the entire test so that the quality and direction of an end feel is more easily detected. Hence, any forward translation of the tibia on the femur must be due to a torn ACL. If there is no movement during this test, yet there was during the anterior drawer and Lachman tests, a disruption of the PCL may be at fault. The examiner should then use the *posterior sag* and *posterior drawer* tests to confirm the PCL lesion diagnosis.

While conducting a research study aimed at improving ACL field examination tests, we discovered the viability of this test in ruling out false positive ACL injury diagnoses. During this research project, we performed the anterior drawer, Lachman, and alternate Lachman tests on both knees of subjects. We recorded which knee we felt was less stable with respect to ACL translation observed during each test. Our findings were then compared with the results obtained during KT-1000 tests on each subject.

Three subjects exhibited considerable laxity of one knee during the anterior drawer and Lachman tests, yet showed no laxity during the alternate Lachman test. The KT-1000 showed no difference in anterior translation of the tibia on the femur, yet considerable differences (>6 mm) in posterior translation in all three subjects. Two of the subjects underwent arthroscopic examination, and the physician diagnosed each as PCL tears. In these two cases, both the KT-1000 and arthroscopic examination revealed the alternate Lachman to be a viable way to eliminate the false positive ACL injury diagnosis sometimes obtained from the anterior drawer and Lachman tests. The third subject chose not to have arthroscopic surgery, but his KT-1000 on the suspected knee showed >10 mm of laxity compared to his other knee. A laxity differential of >10 mm is considered a severe instability and is highly suggestive of a ligament tear.[7,9]

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Duplicate Publication of "Nerve Injury in Athletes Caused by Cryotherapy" by Malone, et al.

The following three articles are essentially the same and constitute duplicate publication. You should be aware that the 18 case studies presented in these three articles are not independent; rather they are replications of the six cases first published in the *Journal of Athletic Training*.

Malone TR, Engelhardt DL, Kirkpatrick JS, Bassett FH III. Nerve injury in athletes caused by cryotherapy. *J Athl Train.* 1992;27:235–237.

Bassett FH, Kirkpatrick JS, Engelhardt DL, Malone TR. Cold-induced nerve injury. *Am J Sports Med.* 1992;20:516–518.

Covington DB, Bassett FH. When cryotherapy injures; the danger of peripheral nerve damage. *Phys Sportsmed.* March 1993;21:78–93.

16th Annual NATA Student Writing Contest

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

1. The contest is open to all undergraduate members of the NATA.
2. Papers must be on a topic germane to the profession of athletic training and can be case reports, literature reviews, experimental reports, analysis of training room techniques, etc.
3. Entries must not have been published, nor be under consideration for publication by any journal.
4. The winning entrant will receive a cash award and the paper will be published in the *Journal of Athletic Training* with recognition as the winning entry in the Annual NATA Student Writing Contest. One or more other entries may be given honorable mention status.
5. Entries must be written in journal manuscript form and adhere to all regulations set forth in the "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. *J Athl Train*. 1990;25:47–50. NOTE: a reprint of this article, along with other helpful hints, can be obtained by writing to the Writing Contest Committee Chairman at the address below.
6. Entries must be received by March 1, 1994. Announcement of the winner will be made at the Annual Meeting and Clinical Symposium in June.
7. The Writing Contest Committee reserves the right to make no awards if, in their opinion, none of the entries are 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

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 15 March 1994.**

A passing score is 70% and those who pass are entitled to .5 CEU credit. Letters will be sent to all persons who participate, and will serve as proof of CEUs for those who pass. It is the individual's responsibility to report his/her CEUs to the NATA Board of Certification at the end of the year or when asked. Participation is confidential.

Answers to Fall '93 CEU Credit Quiz
Volume 28, Number 3

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

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

Borsa, et al. *Muscular and functional performance characteristics of individuals wearing prophylactic knee braces.*
Draper/Schulthies. *A test for eliminating false positive ACL injury diagnoses.*
Fisher, et al. *Enhancing athletic injury rehabilitation adherence.*
Martin/Harter. *Comparison of inversion restraint provided by ankle prophylactic devices before and after exercise.*
Page, et al. *Posterior rotator cuff strengthening using Theraband in a functional diagonal pattern in collegiate baseball...*
Ruiz, et al. *Cryotherapy and sequential exercise bouts following cryotherapy on concentric and eccentric strength...*
Timm, et al. *Fifteen years of amateur boxing injuries/illnesses at the United States Olympic Training Center.*

CEU CREDIT QUIZ

Name (Dr., Mr., Mrs., or Ms.) ____________________
Institution or Team ____________________
Mailing Address ____________________
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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. (Please write legibly.)
2. Read the articles listed above.
3. Answer the questions.
4. Mail with $15 fee (checks made payable to Indiana State University) postmarked by March 15, 1994, to

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

Circle the correct answer:

1. Elastic resistance exercise has been specifically labeled as:
   a. isotonic.
   b. isokinetic
   c. isodynamic.
   d. none of the above.
   e. all of the above.

2. One strength of the alternate Lachman test is that it is performed with the athlete prone, and gravity will cause the tibia to remain in its normal position even if the PCL is torn.
   a. true.
   b. false.

3. A comparison of three ankle prophylaxes in limiting inversion in walking and running on a laterally tilted treadmill showed that:
   a. overall, the semirigid orthosis provided the most inversion restraint during dynamic loading.
   b. the lace-up brace provided the most inversion restraint during dynamic loading.
   c. adhesive taping restricted inversion significantly more than either brace.
   d. neither adhesive taping, the lace-up brace, nor the semirigid orthosis were successful in limiting postexercise inversion.
   e. both a and d.

4. Prophylactic knee braces are ineffective in preventing knee joint injuries, and inhibit athletic performance so they should not be recommended for athletic use.
   a. true.
   b. false.

5. The incidence of health problems in elite-level amateur boxing athletes at the USOTC indicated that:
   a. injuries involved primarily the head/face region.
   b. there was a high percentage of serious injuries.
   c. there was a higher frequency of illnesses than injuries.
   d. lower extremity/spinal column injuries occurred with less frequency than other types of injuries.
   e. none of the above.

6. Effective athlete rehabilitation:
   a. is confounded by the fact that there are more than 200 variables affecting adherence.
   b. is far more dependent on the ATC's clinical skills than his/her people skills.
   c. necessitates a partnership approach between ATCs and athletes.
   d. all of the above.
   e. a and c only.

7. The relationship between cryotherapy and strength in sequential exercise bouts indicates that:
   a. reduction in strength following cryotherapy lasts a minimum of 20 minutes.
   b. ice has a delayed effect on eccentric strength.
   c. exercise after cryotherapy has a significant effect on eccentric strength recovery.
   d. none of the above.
   e. all of the above.

8. Recent biomechanical and electromyographic (EMG) studies have determined that the muscles of the posterior rotator cuff experience concentric contraction during deceleration and follow-through phases of baseball pitching.
   a. true.
   b. false.

9. In the evaluation of knee injuries:
   a. the Lachman test to determine the integrity of the ACL is almost foolproof.
   b. a false positive ACL test can occur.
   c. if the posterior cruciate ligament is damaged, the tibia could sag anteriorly on the femur.
   d. the anterior drawer test would not result in a false positive result.
   e. a and d.

10. When considering motivation strategies to enhance rehabilitation adherence,
    a. threats should never be used.
    b. treatment should be personalized.
    c. athletes should play a part in the decision making.
    d. all of the above.
    e. b and c only.

11. A study of injuries at the USOTC indicates that amateur boxing is a relatively safe sport.
    a. true.
    b. false.

12. When using the alternate Lachman test to diagnose ACL injuries,
    a. the athlete must lie supine.
    b. if there is > 6 mm bilateral difference of the tibia on the femur, the individual probably has a PCL lesion.
    c. ACL and PCL injuries are more readily distinguished.
    d. knee flexion should be at 60°.
    e. all of the above.

13. Adherence to rehabilitation is more likely if athletes feel some degree of responsibility to others (eg, teammates and coaches).
    a. true.
    b. false.

14. Unlike ankle taping and lace-up ankle braces, semirigid orthoses:
    a. primarily limit inversion, but not eversion.
    b. primarily limit inversion and eversion, but not plantarflexion and dorsiflexion.
    c. primarily limit plantarflexion and dorsiflexion, but not inversion and eversion.
    d. primarily limit plantarflexion, but not dorsiflexion.
    e. primarily limit dorsiflexion, but not plantarflexion.

15. Knee braces worn by athletes unaccustomed to them:
    a. significantly decrease peak anaerobic power output.
    b. have no effect on sprint speed.
    c. increase peak torque.
    d. adversely affect agility.
    e. do not affect athletic performance.

Call For Abstracts

NATA RESEARCH AND EDUCATION FOUNDATION
CALL FOR ABSTRACTS
1994 National Athletic Trainers' Association Annual Meeting · Dallas, Texas · June 1994
[Deadline for submission: January 15, 1994]

INSTRUCTION FOR SUBMISSION OF ABSTRACTS AND PROCESS FOR REVIEW OF ALL SUBMISSIONS

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.

INSTRUCTIONS FOR SUBMITTING AN ABSTRACT:

1. Abstracts are to be typed or word processed using a LETTER QUALITY printer with no smaller than elite (12 cpi) or 10-point typeface. Do not use a dot-matrix printer.
2. Type the title of the paper or project in all CAPITAL letters on the left margin on the abstract form provided.
3. On the next line, indent 3 spaces and type the names of all authors, with the author who will make the presentation listed first. Type the last name, then initials (without periods), followed by a comma; continue with the other authors (if any), ending with a period.
4. Indicate the institution (as well as city, state, and zip) where the research or case report was conducted on the same line following the author(s) names.
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 preferably in WordPerfect or ASCII format would be appreciated also.
7. Abstracts postmarked after January 15, 1994 will not be accepted.
8. Abstracts that do not meet the submission criteria listed above **will not be reviewed.**

SPECIFIC CONTENT REQUIREMENTS:

CASE REPORTS. 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.
- **Observational/Informational Studies—**Includes studies involving surveys, questionnaires, and descriptive programs, among others, that relate to athletic training and sports medicine.

NATA RESEARCH AND EDUCATION FOUNDATION

CALL FOR ABSTRACTS

1994 National Athletic Trainers' Association Annual Meeting · Dallas, Texas · June 1994

[Deadline for submission: January 15, 1994]

MAILING ADDRESS OF PRESENTING AUTHOR (Please type; provide full name rather than initials.)

Name ______________________________

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City ______________ State ______ Zip ______________

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Abstract type (check √ one only): ☐ Case Report ☐ Free Communications

For Case Reports, collaborating physician's signature: ______________

(See accompanying instructions.)

For Free Communication Abstract:

1. Indicate the most appropriate CATEGORY for the presentation (check √ one only):
   ☐ Basic Science ☐ Clinical Studies ☐ Educational Research
   ☐ Sports Injury Epidemiology ☐ Observational/Information Studies
2. Indicate presentation preference (check √ one only; choice does not influence acceptance):
   ☐ Poster ☐ Oral ☐ Indifferent

Mail this ORIGINAL, two copies of the original, and 10 blind photocopies showing no information about authors' institutions, or grant information (see accompanying instructions) by JANUARY 15, 1994, to:

Dr. Russell Cagle, ATC
NATA-REF Free Communications
Department of Athletics
Williamette University
Salem, OR 97301

Abstracts

Clint Thompson, MS, ATC

Beard DJ, Kyberd PJ, Furgusson CM, Dodd CAF. Proprioception after rupture of the anterior cruciate ligament. ***J Bone Joint Surg.*****1993;75B:311–315.**

Deficiency of the anterior cruciate ligament (ACL) is a common cause of disability in young active patients. The indication for surgery is often the failure of conservative management to restore the desired level of function, but this level is often assessed only by the patient's own evaluation. There are no reliable, objective assessments which can help in the decision for or against surgery. Some recent research has focused on the proprioceptive, rather than on the biomechanical role of the ACL. The hypothesis was that an objective measure of the protective ability of the hamstrings, in terms of reflex contraction latency, will provide an indirect measure of the proprioceptive ability of the joint. This measurement could give an objective indicator of the efficacy of conservative management for chronic deficiency of the ACL, and this could be useful for the crucial decision as to the need for surgical intervention. It was postulated that complete rupture of the ACL results in impairment of a reflex protective mechanism, probably because of the loss of proprioceptive receptors in the ligament. Equipment was designed and constructed to measure the latency of reflex protective contraction of the hamstrings, using the same subject's normal contralateral knee as the control. The hamstrings were examined because of their known role in protecting the ACL in the flexed knee. Thirty patients, 27 male and 3 female, with arthroscopically diagnosed deficiency of the ACL were studied. Subjective knee function was assessed by using the validated Lysholm and Gillquist functional scoring scale. Passive sagittal laxity was measured using a KT1000 arthrometer. Reflex hamstring reaction latency was measured by an experiential apparatus constructed for the study, the Vicon Interface Knee Displacement Equipment. Twenty normal subjects were measured for validation purposes. There was no significant difference in RHCL between limbs in the normal subjects. Of the 30 patients with ACL deficiency, 29 showed an increased RHCL on the injured side: the hamstrings did not react as quickly to the displacement force. There was a significant positive correlation between the RHCL differential and the level of reported instability, derived from the functional score was the frequency of "giving way" episodes. This study has shown that the reflex response to a controlled passive movement is significantly slower in a recently injured ACL-deficient knee than in the contralateral knee, or a normal control knee.

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Berkhead WZ, Rockwood CA. Treatment of instability of the shoulder with an exercise program. ***J Bone Joint Surg.*** **1992;74A:890–896.**

The purpose of this paper is to report on the effect of a specific rehabilitation program for the shoulder on a group of patients who had traumatic or atraumatic and multidirectional instability of the shoulder. The cases of 115 patients (140 shoulders) were available for review. In addition to the hospital charts, the preoperative and postoperative radiographs were available. The diagnosis and classification of the shoulders into the traumatic and atraumatic groups were based on a carefully taken history, a physical examination, and evaluation of radiographs. After the cause of the instability had been evaluated and classified, the patients began performing a specific set of exercises designed to strengthen the deltoid and the muscles of the rotator cuff. The fact that exercises improve the dynamic stability of the shoulder and can often obviate the need for operative intervention is not a new concept. We found a substantial difference in the number of satisfactory responses between patients who had traumatic and atraumatic instability. Of the shoulders that had traumatic instability, 15% had a good or excellent result; of the shoulders that had atraumatic subluxation, 83% had a good or excellent result. The information that was gained from this study has helped us in the care of our patients. Patients who have a clear-cut history of a traumatic anterior injury and also have the telltale osseous changes on the glenoid rim or humeral head are told that the proposed rehabilitation program has only an 18% chance of success. Patients who have a history and physical findings that are indicative of an atraumatic problem and who have no radiographic abnormalities in the shoulder joint are thrilled to learn that an operation is not imminent and that the rehabilitation program has a success rate of 83%. Because of the high rate of complications associated with a routine reconstructive procedure on a shoulder that has atraumatic and multidirection subluxation, and because of the high rate of success of rehabilitation exercises for this problem, we recommend a trial of specific resistance exercises before reconstruction of the shoulder is considered. In addition,during the exercise program, the physician has ample time to determine if the patient has any additional complicating factors, such as psychological or psychiatric disorders, that could compromise the result even if the best reconstructive procedure is performed.

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Bohannon RW. Comparability of force measurements obtained with different strain gauge handheld dynamometers. *J Orthop Sports Phys Ther.* 1993;18:564–567.

With multiple handheld devices now available for measuring muscle strength, clinicians need to know if the measurement obtained with the different devices are comparable. This study was performed to determine the comparability of force measurements obtained with two different strain gauge handheld dynamometers. Specifically examined to establish comparability were differences, reliabilities, and correlations between measurements obtained with the different devices. Thirty one healthy volunteers were tested with each device during a single session. The muscle groups tested isometrically were the elbow flexors, shoulder external rotators, and hip flexors. Although the magnitude of forces measured with the two dynamometers differed significantly, they demonstrated good high reliabilities and correlations. Thus, dynamometers should not be used interchangeably on the same patient. Either of the dynamometers, however, can be used (alone) to document muscle force production.

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Malebra JL, Adam ML, Harris BA, Krebs DE. Reliability of dynamic and isometric testing of shoulder external and internal rotators. *J Orthop Sports Phys Ther.* 1993; 18:543–552.

Advances in isokinetic technology allow the physical therapist to assess concentric, eccentric, and isometric muscle performance at the shoulder in various positions. Research is limited, however, on the reliability of isokinetic measurements. The purposes of this study were: 1) to determine the test-retest reliability of concentric, eccentric, and isometric muscle performance measurement of shoulder external and internal rotation in the scapular plane test position and 2) to compare this reliability between the involved and uninvolved limb of subjects with a history of unilateral shoulder pathology. Fourteen males and 10 females (17–58 years) were tested on two occasions at 1-week intervals with the Biodex isokinetic dynamometer. Peak torque, total work, and average power were recorded for concentric tests at angular velocities of 60 and 120°/sec and for eccentric tests at 60°/sec. Maximum average isometric torque was recorded in two positions. Means, standard deviations, and mean differences between sessions with 95% confidence intervals were calculated. Intraclass correlation coefficients (ICCs) were used to determine test-retest reliability. Isometric tests were generally more reliable (ICC = .81–.93), followed by concentric (ICC = .60–.95) and eccentric tests (ICC = .44–.92). Isokinetic and isometric reliability were usually higher for involved than uninvolved shoulders. The implications of these findings is that there appears to be greater variability with eccentric than concentric or isometric testing of shoulder rotation. Factors that possibly contributed to variability are discussed. Clinicians should recognize potential sources of test error when obtaining isokinetic measurement for use in clinical decision making. Further refinement of isokinetic testing protocols at the shoulder is recommended.

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

Picciano AM, Rowlands MS, Worrell T. Reliability of open and closed kinetic chain subtalar joint neutral positions and navicular drop test. *J Orthop Sports Phys Ther.* 1993;18:553–558.

Subtalar joint (STJ) measurements are commonly made in the clinic to assess foot and ankle positions because of the high incidence of lower extremity dysfunctions. The proposed objectives of this study were to investigate the intratester and intertester reliability of the open kinetic chain subtalar joint neutral (OKC STJN) and closed kinetic chain subtalar joint neutral (CKC STJN) positions and the navicular drop test (NDT). Two inexperienced testers performed repeated measurements on 15 subjects (n = 30 feet) during two testing sessions. Intratester and intertester reliability (ICC 1,1) and standard error of measurement (SEM) were determined for each dependent variable. For OKC STJN, the intratester ICC values .06 and .27 and the intertester ICC value was .00. The intratester SEM values were 1.81 and 2.29°, and the intertester was 2.51°. The CKC STJN intratester ICC values were .14 and .18, with SEM values of 2.46 and 2.40°. The intertester CKC ICC value was .15, with a SEM of 2.43°. For the NDT, the intratester ICC values were .61 and .79, and the SEM values were 1.92 and 2.57 mm. The intertester ICC value was .57 and SEM was 2.72 mm. The results reveal that both OKC and CKC STJN yield poor intratester and intertester reliability and the NDT yields poor to moderate intratester reliability and poor intertester reliability. We conclude that these foot and ankle measurements are not reliable when performed by inexperienced testers. Therefore, clinicians should practice these measurement techniques and determine their measurement error.

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

Chapman CE. Can the use of physical modalities for pain control be rationalized by the research evidences? *J Physiol Pharmacol.* May 1991;69:704–712.

Physical modalities, especially heat and cold, are frequently used to test musculoskeletal injuries. Tradition indicates they are effective in reducing the pain associated with musculoskeletal injuries, but is there a scientific basis for such practices? This review is a critical analysis of the published research dealing with the effects of five groups of physical modalities on the management of pain (cold, superficial heating agents, deep heating agents, pulsed ultrasound and diathermy, and low-power laser). There is evidence that cold and shortwave diathermy provide short-lived analgesic effects and so may contribute to more pain-free function in the short term. But existing evidence does not support the use of physical modalities in long-term pain control. Most researchers compared various modalities with each other, and did not include a control group. Thus, Chapman remarked "Do the results of these studies indicate that all modalities are equally effective, or equally ineffective?" Further research is necessary to justify the continued use of physical modalities in clinical practice and to define their short- and long-term therapeutic value. Such research should be designed with randomized controlled trials, including a control group not receiving any other physical modality. And, since most physical modalities are used to prepare the patient for subsequent exercise therapy, these studies should also include trials with the exercise component.

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Robinson ME, O'Connor PD, Shirley FR, MacMillan M. Intrasubject reliability of spinal range of motion and velocity determined by video motion analysis. *Phys Ther.* 1993;73:626–631.

Background and Purpose: The purpose of this study was to investigate the repeatability of spinal range of motion (ROM) and movement velocity measurements of patients with chronic low back pain, using a two-dimensional motion analysis system. This apparatus used reflective markers placed on anatomical landmarks and video digitization to derive ROM measurements from three segments of the spine and associated velocities through the respective ROMs. *Subjects*: Forty-two patients with chronic LPB underwent ROM and movement velocity testing. *Methods*: Each subject was tested twice without removal of the markers to minimize error contribution from differences in marker placement. *Results*: Results indicated that both the ROM measures and the velocity measures were highly repeatable. Intraclass correlations for the ROM measures ranged from .77 to .96. Velocity measures were also reliable, with Intraclass correlation coefficients ranging from .75 to .97. *Conclusion and Discussion:* Overall, the results seem to indicate that the video motion analysis system used in this study yields repeatable ROM and velocity measures of a clinical population. In practice, however, the measures may reflect greater errors due to the need of examiners to relocate markers at different testing sessions. These systems also offer distinct advantages over other means of obtaining ROM and velocity measures. The results of this study indicate that these measures may be obtained without undue concern for measurement artifact due to the instrumentation reliability.

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Current Literature

Clint Thompson, MS, ATC

BODY COMPOSITION: BIOELECTRIC IMPEDANCE

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Video Review

Tom Gocke, MS, ATC

Therapy in Motion—An Effective ACL Reconstruction Rehabilitation Program
Therapy in Motion
3720 W. Robinson, Suite 124
Norman, OK 73072
(405) 329-5050
Color, VHS
Playing time: 52 minutes
Price: $19.95 plus shipping and handling

Therapy in Motion - An Effective ACL Reconstruction Rehabilitation Program is a video designed to supplement the injured person's rehabilitation through a home program, but not intended to take the place of physician, athletic trainer, or therapist care. However, the video may be used in situations that prohibit direct care due to geography, extended travel, or other reasons which may keep the patient away from his/her rehabilitation specialist.

The video begins by stressing the factors of successful rehabilitation, such as early mobilization, compliance, periodic physician evaluation, and knowledge of possible complications. A review of terminology and anatomy is also included.

The rehabilitation is divided into the following phases:

Phase I	Week 1
Phase II	Weeks 2 & 3
Phase III	Weeks 4 & 5
Phase IV	Weeks 6 through 12
Phase V	Months 3 & 4
Phase VI	Months 5 & 6

Therapy in Motion provides the viewer with an overview of the entire rehabilitation program. Each phase begins by describing goals to be completed during that rehabilitation period. Exercises are described in detail as models demonstrate proper technique in an easy-to-understand presentation. Complications and overuse are also discussed, with physician referral frequently recommended for any complication.

The video was partially sponsored by five companies. The companies have a small product description at the beginning of the tape and the products are used and mentioned throughout the video.

I found this video to have a purpose. I believe this video describes proper exercise technique and that the ACL rehabilitation program is reasonable. However, I do feel that physician approval should be obtained.

Scott A. Street, MS, ATC

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Nashville, TN 37207
Telephone (800) 822-5678
Color, VHS
Playing Time: 25 minutes
Price: $195.00

Steroids—The Real Story is a video tape which describes the abuse of anabolic steroids by former users. The host of the video is David Sinnott, a weight lifter, model, and columnist for the *Joe Weider Fitness Magazine*. Sinnott, along with Steve Courson, former Pittsburgh Steeler and author of *False Glory*, and others describe the physical and psychological trauma that they suffered due to anabolic steroids. In addition to the personal testimonies, Dr. Chuck Yesalis of Penn State University, describes the medical implications of anabolic steroid use.

The video begins with each person describing how they came to the reality of thinking of steroids as a drug. Several were arrested for selling and distributing the drug. Others told of side effects, such as hair loss, lack of sexual performance and interest, and the inability to conceive, as a result of taking anabolic steroids. Dr. Yesalis reviews the medical implications and dangers of steroid abuse. Additionally, the availability of counterfeit anabolic steroids and the increased danger associated with bogus drugs are mentioned.

Steroids—The Real Story provides the viewer with an overview of the dangers of anabolic steroids. The former users used street terms and talked in language that high school or college-age individuals could understand. Dr. Yesalis spoke using medical terms but explained each condition in lay terms. I do not feel that this video is appropriate for athletic trainer or student athletic trainer education. I also question how high school or college student athletes would react to viewing this video, as it was predominantly about weight lifters and body builders, with the exception of Steve Courson, a former NFL player.

Scott A. Street, MS, ATC

New Products

Barrie Steele, MS, ATC

Carapace, Inc offers an economical alternative to heavy, uncomfortable Lower Leg Walkers

Carapace, Inc introduces the new Pacesetter II Lower Leg Walker, one of the lightest (2.5 lbs) and most comfortable walkers available, thus improving patient comfort while decreasing fatigue.

The Pacesetter II Lower Leg Walker has a functional low heel height that promotes a smoother gait pattern, reducing the chance of low back and hip pain. A durable Air Cushioned Heel™ with sealed pneumatics improves energy absorption and return. Versatility is increased with a unique heel strap that pivots to fit the patient as either a closed or open heel walker.

The Pacesetter II Lower Leg Walker allows the mobility and comfort necessary to carry out routine movements or even light exercise. For effective rehabilitation results, choose the Pacesetter II Walker, superior quality at an affordable price.

For further information contact Gary W. Silvers, RN/OTC, Marketing Manager, Carapace, Inc, 1-800-223-5463.

New Dry-Up Towel from Scott Perfect for after Work-out Showers

For today's fitness centers and athletic institutions concerned with managing operational costs, yet providing high quality products, Scott Wipers has developed Dry-Up® Towel, a highly absorbent, over-sized towel with the softness of cloth at a fraction of the price.

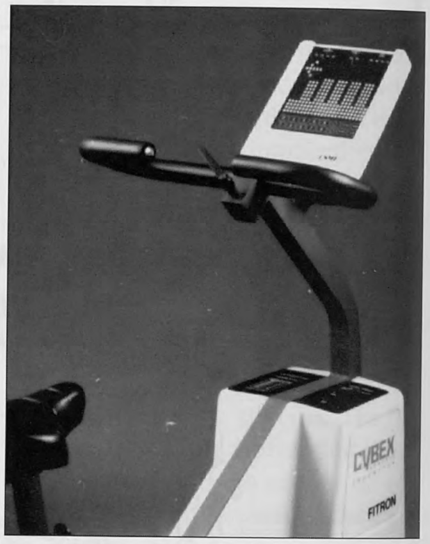
The towels, made of bonded cellulose, are available in a 200-count, center-flow dispensing carton for added convenience and product protection from moisture or dirt. The fresh, bright white towels are 19" by 42". One at a time dispensing helps to reduce product waste.

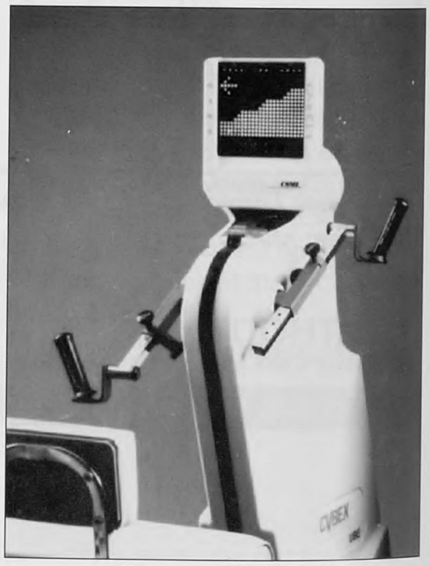
Dry-Up Towels® were designed specifically with the needs of athletes and athletic facilities in mind. They absorb up to six times their weight in water.

For more information on Dry-Up® Towels, call 1-800-472-6881.

CSMI Introduces New Digital Display Upgrade for CYBEX Fitrons and UBEs

Computer Sports Medicine, Inc recently announced the release of its new Digital Display for CYBEX Fitron and UBE ergometers. The Digital Display replaces the pressure gauge on the Fitron and UBE ergometers enabling clinicians to provide concrete goals for patients to achieve during exercise training. At the conclusion of each exercise routine Total Work Done is provided to monitor a patient's effort and progress. Simple user interface allows patients to operate the display independently. It includes manual and pace modes plus four fixed and four custom protocols and easily installs on all Fitron and UBE ergometers.

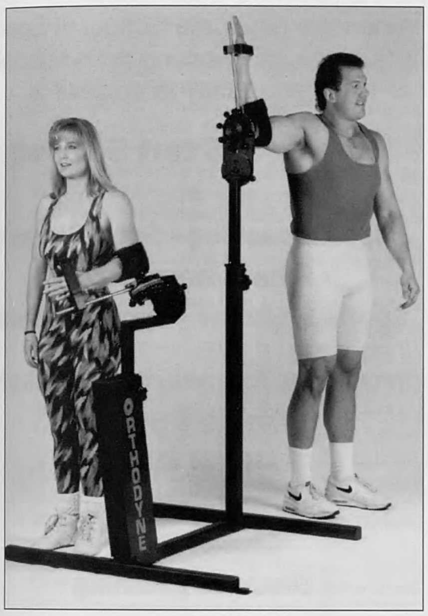




For more information call (617) 894-7751 or write Computer Sports Medicine, Inc., 135 Beaver St., Waltham, MA 02154.

Deluxe Rotator Cuff Therapy/Gym Unit

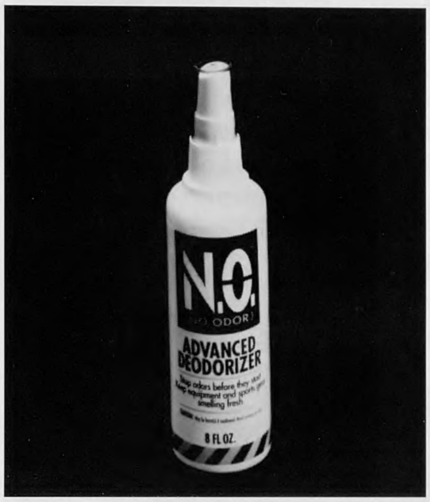
The Orthodyne Deluxe Rotator Cuff Therapy/Gym Unit is an economical and efficient way for pro, college, high school, or the therapy clinic ATC to accommodate their injured and non-injured athletes a safe and effective means for the rehabilitation and prevention of shoulder and rotator cuff injuries.



The Orthodyne Deluxe Rotator Cuff Therapy/Gym Unit is designed to provide biomechanically correct isolation of the rotator cuff muscles, while offering a wide variety functions, uses, and adjustment for athletes of various sizes. This unit has range limiters and range indicators for testing and monitoring, and allows for adjustment of any plane of use from 0 thru 90°. It can be used standing or seated. The resistance is isotonic and adjustable, as well as being safe with no backlash movement. The two stands allow for two athletes to work out at one time, while still being compact in size (40" × 40"), so as not to take up valuable floor space. For more information, contact Orthodyne International Ltd, 637 So. Broadway, Suite 338, Boulder, CO 80303. Tel: 1-800-432-0861.

New Odor Control Product for Athletic Equipment

N.O. (No Odor)™ Advanced Deodorizer is a ready-to-use compound specifically designed to prevent, as well as remove, stubborn athletic equipment odors that conventional deodorizers can't. It works on the causes of odor forming a chemical shield that remains active between applications. Pump spray intermittently on your treatment tables, protective gear, weight training equipment, laundry hampers, and other tough-to-treat, odor-prone equipment, surfaces, and storage areas to create a more pleasant, healthy, and productive setting.



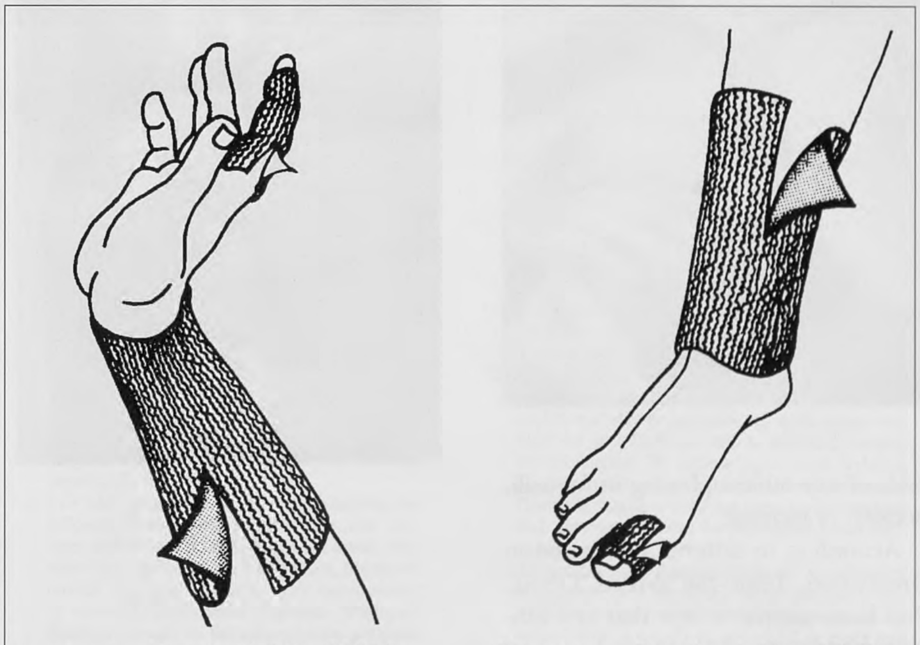
Featured in the new products's section of School Health Supply Co's sports medicine and school nurse catalogs, it can be purchased from them by phone: 800-323-1305, or fax: 800-235-1305, in 8-fl oz and 1-gallon sizes. You may purchase it by the case, or by the bottle.

Silipos Inc. Introduces Mesh Tubing

The Mesh Tubing is a comfortable elastic mesh tube lined with the Silipos patented tri block polymer gel. This product has multiple uses including: post-op use, for use on upper and/or lower extremities, absorbs friction, will protect broken digits, provides slight compression and lubrication to kerotic lesions, and softens skin.

The product is worn over an injured limb or deformed digit as a glove is worn over a hand. Mesh Tubing can be designed by the professional, simply by cutting, to achieve the desired size. The fabric of the product will not fray when cut.

Mesh Tubing helps lessen the digit's sensitivity and has a beneficial effect to the sutured area. The product is available in two sizes and is fully washable and reusable. For more information and a sample of the gel,



Narrow - Product No. 1085
Wide - Product No. 1084

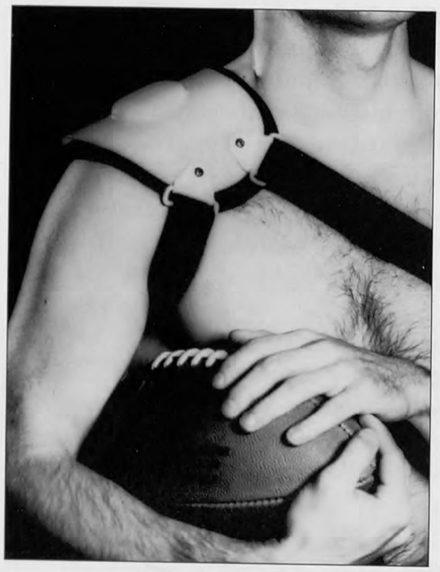
Narrow - Product No. 1085
Wide - Product No. 1084

contact Silipos Inc, 2150 Liberty Drive L.P.O. Box 211, Niagara Falls, NY 14304. Tel: 716-283-0700; Fax: 716-283-0600; Toll Free USA: 800-229-4404.

ärthron, inc Introduces Off-the-Shelf Protection For A-C Injuries

The IMPACT™AC Pad (patent pending), featuring the revolutionary ShockRing™to disperse forces away from the A-C joint line, has successfully resolved the problems of conventional padding. Due to its design and ability to be resized with only steaming hot tap water, the pad can be used by different players over several seasons thus saving money on materials that have been traditionally discarded when the player no longer needed the protection.

Two thicknesses of foam pads are provided: 5/8" for recent injuries and 1/4" for use as tenderness subsides. Neoprene straps eliminate the need for taping to the body. The IMPACT™ AC Pad fits securely under the shoulder pads of any athlete playing in football, hockey, or lacrosse.



According to ärthron, inc, based in Brentwood, Tenn, the IMPACT™AC Pad is so simple to use that any athlete, once instructed, can easily put on the device without assistance. Call (800) 758-5633 for more information.

Cramer Introduces the Medi Pack Holster

Cramer has designed a new Medi Pack Holster for athletic trainers who dislike the bulkiness of fanny packs but still have trouble fitting all their taping and biohazard needs in a regular tape and scissors holster.

The Medi Pack is designed to hold the instruments used most often when treating injured athletes, including biohazard protection materials. Made of tough Vandura™nylon, the Medi Pack Holster consists of a main pouch in front, perfect for accommodating biohazard supplies, gauze pads, and adhesive bandages. Three accessory compartments hold additional items, such as scissors, pen light, tongue depressors, a Cramer Zip-Cut, forceps, and more. Instruments stay in place with a protective Vandura™nylon cover that fastens with Velcro®. A tape loop fastens in front and can hold two rolls of tape.

For more information about the Medi Pack Holster, call Cramer Products customer service at 1-800-345-2231.

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:

SUBMISSION POLICIES

1. Submit one original and three copies of the entire manuscript (including photographs, artwork, and tables) to the editor.
2. All manuscripts must be accompanied by a letter signed by each author, and must contain the statements below. By signing the letter, the author(s) agrees to comply with all statements. Manuscripts that are not accompanied by such a letter will not be reviewed. "This manuscript contains original unpublished material that has been submitted solely to the *Journal of Athletic Training*, is not under simultaneous review by any other publication, and will not be submitted elsewhere until a decision has been made concerning its suitability for publication by the *Journal of Athletic Training*. In consideration of the NATA's taking action in reviewing and editing my (our) submission, the author(s) undersigned hereby transfers, assigns, or otherwise conveys all copyright ownership to the NATA, in the event that such work is published by the NATA."
3. Materials taken from other sources, including text, illustrations, or tables, must be accompanied by a written statement giving the *Journal of Athletic Training* permission to reproduce the material. Photographs of individuals must be accompanied by a signed photograph release form. Accepted manuscripts become the property of the National Athletic Trainers' Association, Inc.
4. The *Journal of Athletic Training* uses a double blind review process. Authors should not be identified in any way except on the title page.
5. Manuscripts are edited to improve the effectiveness of communication between the author and the readers, and to aid the author in a presenting work that is compatible with the style policies found in the *AMA Manual of Style*, 8th ed. (Williams & Wilkins) 1989. The author agrees to accepts any minor corrections of the manuscript made by the editors.
6. Published manuscripts and accompanying work cannot be returned. Unused manuscripts will be returned when submitted with a stamped, self-addressed envelope.

STYLE POLICIES

7. The active voice is preferred. Use the third person for describing what happened. "I" or "we" (if more than one author) for describing what you did, and "you" or the imperative for instruction.
8. Each page must be typewritten on one side of 8.5 × 11 inch plain paper, double spaced, with one-inch margins. **Do not right justify pages.**
9. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:
   a. Title page
   b. Acknowledgements
   c. Abstract and Key Words (first numbered page)
   d. Text (body of manscript)
   e. references
   f. Tables-each on a separate page
   g. Legends to illustrations
   h. Illustrations
10. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.
11. Titles should be brief within descriptive limits (a 16-word maximum is recommended). The name of the disability treated should be included in the title if it is the relevant factor; if the technique or type of treatment used is the principle reason for the report, it should be in the title. Often both should appear.
12. The title page should also include the names, titles, and affiliations of each author, and the name, address, phone number, and fax number of the author to whom correspondence is to be directed.
13. A comprehensive abstract of 75 to 200 words must accompany all manuscripts except **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 words should follow immediately after the title on the first numbered page.
15. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly developed and stated. Tell why the study needed to be done or the article written and culminate with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In the one to two paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences between others' results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in *brief* specific statements and reference them. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction.
16. The body or main part of the manuscript varies according to the type of article (examples follow); however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.
    a. The body of an **Experimental Report** consists of a methodology section, a presentation of the results, and a discussion of the results. The methodology section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics, and a few well planned and carefully constructed illustrations.
    b. The body of a **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 in alphabetical order, 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 (underlined), city state of publication, publisher, year, inclusive pages of citation. Examples of references to a journal, book, presentation at a meeting are illustrated below. See the *AMA Manual of Style* for other examples.
    a. Knight K. Tips for scientific/medical writers. *Athl Train, JNATA*. 1990; 25:47–50.
    b. Day RA. *How to Write and Publish a Scientific Paper*. 3rd Ed. Phoenix, Ariz: Oryx Press; 1988;5:4–55.
    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. Type legends to illustrations on a separate page. See references cited in #5 or #19a for table formatting.
21. Photographs should be glossy black and white prints. Graphs, charts, or figures should be of good quality and clearly presented on white paper with black ink in a form that will be legible if reduced for publication. 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. Authors will pay for color.

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