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Editor-in-Chief

Comments

Steve Yates, MEd, ATC
Wake Forest University
Winston-Salem, NC 27109

I would like to commend all those responsible from District 3 for the fine Symposium in Baltimore. This was the largest attended convention in our history by the membership.

Exhibitors

Comments from the exhibitors indicated that it was the most successful NATA Convention ever attended.

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Closing

It was very informative and interesting meeting with my peers in Baltimore. Many new ideas and improvements for the Journal are to be implemented over the coming year. Thank you for your constant support and input. Have healthy fall season.

Letters

July 26, 1988

Dear Steve:

This is an open letter to our membership.

I write this letter with deep remorse. During the National Convention in Baltimore, there were 2 video tapes that disappeared from the Media Room sponsored by the Audio Visual Aids Committee. If the whereabouts of these tapes are known, PLEASE return them to either your District Director or myself. This has been a very embarrassing situation for me since I am the Chairman of the Audio Visual Aids Committee of the National Athletic Trainers Association. The tapes that disappeared are:

1. Head & Neck Injuries from the Player Down Series sponsored by the Athletic Institute.
2. Soft Tissue Injuries sponsored by Johnson & Johnson.

An immediate response to this delicate situation would be greatly appreciated. My address is:

continued on page 260

Steve Yates, MEd, ATC
Wake Forest University
Winston-Salem, NC 27109
Research in Athletic Training: A Frill or a Necessity?
Kenneth L. Knight

Is research a necessity for the athletic training profession? Lou Osternig thinks so. In an article elsewhere in this issue entitled “Research in Athletic Training: The Missing Ingredient”, he states that ongoing research concerning athletic training practices by athletic trainers is essential in establishing the credibility of athletic training.

This is not a new idea. In the keynote address of our 1983 National Convention in Denver, Gary Delforge asked, “Why haven’t we, as athletic trainers, taken the time to seriously evaluate our professional endeavors? Why haven’t we critically assessed our current level of professionalism and attempted to see ourselves as others see us? ...although we are well advanced in the process (of becoming a profession), in the strictest sense we have not yet established athletic training as a profession... research remains as a significant and very noticeable void in our professional growth.”

Without research we will die as a profession, or as Delforge stated, fail to become a true profession. Knowledge cannot be gained without some type of research, and if knowledge is not gained, we digress. Other professions will step in and take over our functions.

It is not easy to do research. It is difficult and time consuming. The results of many research projects that took years to complete can be presented in less than one class period. And most people who have published research will relate that they threw it away many times because they were scared of being made to look foolish.

Most athletic trainers do not have the time or the skills to do basic laboratory research. But most of us can and have conducted clinical research.

My edition of Webster's dictionary defines clinical as “having to do with the direct treatment and observation of patients, as distinguished from experimental or laboratory study”, and research as “careful, systematic, patient study and investigation on some field of knowledge, undertaken to discover or establish facts or principles.” Putting these together, with an athletic training application, results in the following: athletic training clinical research is a careful, systematic, detailed study of injured, or potentially injured athletes, undertaken to discover or establish facts or principles.

Now, using the above definition, what are some examples of clinical research in athletic training? How many of you have conducted the following research projects? “I can see that the shoes you have been wearing are too tight for that ingrown toenail. Try each of these other three pairs. See if one of them will be more comfortable.” Or “When do you get that shooting pain down your leg? When you walk, or only when you run? Does it always happen when you run, or just at certain times? Could you do something right now to make it happen?” Or “Coach, 99 could probably practice if he wore a pair of Donzis pads.” Many of you have numerous experiences of this type every time you go into the training room. So you have conducted numerous clinical research projects. Or have you?

While injury evaluation and management involve many of the same steps as research does, there are some differences. Both processes involve formulation of a problem, hypothesizing a possible solution, and testing to see if the hypothesis is true or not. But research also requires that you systematically record your observations, summarize your results, compare your results to others’ observations, and write the material into a journal manuscript.

Everyone who has taken a philosophy class, and many who haven’t, have heard the following argument. If a tree in the forest crashes to the ground, but there is no one there to hear it, does it make a noise? Is there any noise if no body hears it? Clarke wrote that “the worth of research is not in the finding but in the interpretation of the finding.” If research isn’t presented to the public to examine, interpret, and question, it has little value.

With some extra effort many of you can complete some of the “research projects” you have started or will start the next time you walk into your training room. Many feel they don’t have the extra time, and are right. But many can find the time. Somebody must do so. The survival of our profession depends on it. We must lead out in the acquisition of new knowledge. We must control our destiny. We must become the authorities that others look to for “expert opinion” concerning sports injury management. We must define the body of knowledge that is athletic training.

This publication is available in microform from University Microfilms International.
Dear Members:

It is a great honor to have the opportunity to serve you as President of the National Athletic Trainers Association. As with everything the “glory” has worn off, but the honor, excitement, and challenge prevail. I have had the opportunity to serve as an officer of this Association for the past nine years as a Secretary-Treasurer and Director of District 10. Not only has that been enjoyable, but it has allowed me to gain some valuable experience for what lies ahead in this new role.

As your new President, it is my goal to represent the Board of Directors and the members of this great profession in a positive way so that we may continue on a smooth and steady course toward rapid growth and enhancement consistent with the past six years. This will be a difficult task. The growth we have experienced in the last six years has been healthy.

Through your guidance the Board of Directors will pursue moving the National Office, hiring a full time person to assume increased responsibility of NATA affairs, a full time executive director, and a third corporate sponsor. These changes will create “growing pains” for all of us. However, we must adapt to these changes if we are going to get better.

In conclusion, I urge each and every one of you to voice not only your concerns, but your IDEAS on how we can improve in the years ahead.

Sincerely,

Mark J. Smaha

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Fluid Replacement, Gastrointestinal Function, and Exercise

Robert Murray, PhD

Abstract

This article reviews the characteristics of gastrointestinal function and control that determine fluid absorption rates. The rate at which fluid enters the body water is strongly influenced by the composition of the ingested beverage. Rapid fluid absorption is attained by rapid gastric emptying and intestinal absorption of the ingested beverage. The stomach isolates ingested fluid from the body proper and meters the emptying of fluid into the small intestine at a rate influenced by feedback from stomach and small intestine receptors. The rate of fluid absorption in the small intestine is enhanced by the presence of sucrose, glucose, and sodium. Beverages containing moderate amounts of carbohydrate (i.e., 8 to 8% sucrose or glucose) and electrolytes (e.g., sodium and potassium) are well formulated to take advantage of the mechanisms of gastric emptying and intestinal absorption that result in rapid fluid absorption.

During vigorous exercise in a warm environment, it is not uncommon for athletes to lose one to two liters of sweat per hour. If the majority of this fluid loss is not replaced during exercise, cardiovascular and thermoregulatory function will be impaired, the risk of heat illness will be increased, and exercise performance will be hampered.

Although the benefits of drinking fluids during vigorous exercise are obvious, there is debate as to which beverage is best to drink (18,24,28). In addition to tap water and assorted homemade concoctions, athletes, coaches, and athletic trainers can choose from a variety of commercial fluid replacement beverages, i.e., sport drinks.

Simply stated, if any beverage other than tap water is to be an effective fluid replacement beverage during exercise, it should be formulated to optimize the rate of fluid absorption and at the same time provide ample carbohydrate energy for use by working muscles and enough electrolytes (particularly sodium) to aid in maintaining fluid homeostasis. This article briefly reviews aspects of gastrointestinal physiology that influence the absorption of fluids ingested during exercise. Extensive reviews of fluid absorption and gastrointestinal function during exercise have recently been published (3,18,24) and the interested reader is referred to these articles for more detailed information.

Principle: The Stomach Isolates Ingested Food and Fluid From The Body Proper

A common misconception held by many coaches, athletic trainers, and athletes is that ingesting beverages containing sugar and electrolytes may cause fluid to rush into the stomach to dilute gastric contents to a form acceptable to the body. Such is not the case. The gastric membrane is anatomically designed to prevent absorption of fluid and most nutrients, a structural feature that allows the stomach to function as an isolated holding tank for ingested foods and fluids (7).

It should be noted that most of the foods and fluids humans consume are of an osmolality* quite different than that of extracellular fluid (280 to 300 mOsmol/kg water). For example, carbonated beverages such as Coca Cola and Pepsi Cola range in osmolality from 600 to 800 mOsmol/kg water while tap water usually has an osmolality less than 20 mOsmol/kg water. If the gastric membrane were extremely permeable and allowed net unidirectional fluid movement, the osmotic gradient between an ingested beverage such as soda pop or water and that of extracellular fluid would result in uncontrolled movement of fluid across the gastric membrane, a situation that would not be conducive to physiologic homeostasis. For instance, if the gastric membrane were highly permeable, consumption of fruit juice, soda pop, or any fluid hypertonic to body fluid would produce an osmotic gradient that would result in movement of extracellular fluid into the stomach. Conversely, consumption of tap water (or any beverage hypotonic to body fluid) would result in movement of fluid through the gastric membrane into the body. This would lead to red blood cell hemolysis, regional dilution of extracellular solutes, osmotic imbalance between intra- and extracellular fluid, and disruption of fluid/electrolyte homeostasis would result. Rapid movement of fluid across the gastric membrane in response to prevailing osmotic gradients simply does not occur because the tight junctions between gastric cells effectively limits such movement (7).

*Osmolality is an index of the number of particles dissolved in a solution and is therefore a reflection of the osmotic pressure that could result if the solution is placed on one side of a semi-permeable membrane, such as a cell-membrane. Differences in osmotic pressure across a semi-permeable membrane will result in fluid movement across the membrane until an osmotic equilibrium is established. Osmolality, the term used throughout this paper, is expressed in units of milliosmols per kilogram of solvent. Since the solvent in this case is water, the unit in abbreviated form is ‘mOsmol/kg water’. Osmolarity, a term that is often used synonymously with osmolality, is expressed in units of milliosmols per liter of solution. In a strict technical sense, the osmolality and osmolarity of a solution may differ but the two are usually so similar that the terms are often used interchangeably.
It should be noted that the osmolality of gastric contents can be altered by hydrolysis of nutrient molecules and by the addition of gastric secretions. Regardless, gastric contents are known to empty at widely ranging osmolalities similar to the osmolality of the ingested foot or fluid (7).

**Principle: Gastric Emptying Rate Varies As A Function of the Caloric Content of the Ingested Beverage**

"Gastric emptying rate" refers to the rate at which ingested foods or fluids are introduced to the small intestine. Gastric emptying rate can be measured by a variety of techniques, but the most commonly used method is gastric aspiration. At a predetermined time (e.g., 20 minutes) following the ingestion of a test beverage, gastric contents are removed (aspirated) via a gastric tube. Adding a non-absorbable marker to the test solution enables researchers to calculate the contribution that gastric secretions may have made to stomach contents.

Gastric emptying rate is often expressed as the volume of fluid emptied by the stomach (in milliliters/minute). Although gastric emptying research has been conducted since the turn of the century (4), studies by Hunt and colleagues (13-17) beginning in the 1950's systematically uncovered many of the factors associated with control of gastric emptying rate. Recent research by other investigators (2,5,21) has refined our understanding of the mechanisms by which nutrients are introduced to the absorptive surface of the small intestine.

Within approximately one minute following consumption, 20-30 ml of an ingested fluid is released into the duodenum (7). Thereafter, gastric emptying slows and a relatively steady rate of emptying is established (2,21). Steady state emptying may range from less than 5 ml/min for highly concentrated carbohydrate solutions (e.g., > 20% carbohydrate) to more than 25 ml/min for dilute saline solutions.

It is important to keep in mind that the stomach does not provide a steady flow of fluid, but rather spurts its contents into the duodenum with each gastric contraction. The motor activity of the muscularis externa surrounding the stomach determines the frequency of the spurts. The most rapid gastric emptying occurs when the interval between spurts is minimal (21).

The rate at which an ingested beverage leaves the stomach has been shown to vary in response to a large number of variables. The volume of fluid ingested, the temperature and pH of that fluid, the fluid's caloric content and osmolality, the individual's emotional and physical state, the phase of the menstrual cycle, the environmental temperature, the time and contents of the previous meal, and the hormonal response to that meal all can influence the rate at which the fluid is emptied from the stomach (3,23,24).

Although no single variable exerts complete control over the gastric emptying of fluids, recent research has shown that the rate at which ingested fluid leaves the stomach is primarily an inverse function of the beverage's caloric content (2,16,17,21). Simply stated, the greater the caloric content of the ingested beverage, the slower the emptying rate (see Table 1). This type of gastric control makes good sense because the small intestine receives a manageable amount of fluid and nutrients and is thereby protected against nutrient and osmotic overloading (21).

The substitution of maltodextrins (often referred to as glucose polymers) for some of the simpler sugars in sport drinks has been touted by some as a superior means of supplying carbohydrate during exercise (12,28). Maltodextrins—a byproduct of corn processing—are commonly used in the food industry as additives for altering the viscosity, sweetness, and solubility of certain foods. The maltodextrins used in sports drinks consist of five to 10 glucose molecules bonded together in linear chains. Consequently, a solution of commercial grade maltodextrin exerts a proportionally lower osmotic pressure than a glucose solution of equal concentration.

It was once thought that maltodextrin solutions would empty from the stomach faster than solutions of simpler sugars because of the differences in beverage osmolality. However, research has failed to show any difference in gastric emptying among isocaloric solutions of glucose or maltodextrins (8,10,25). Equal gastric emptying rates for isocaloric glucose and maltodextrin solutions are in keeping with the control of gastric emptying exerted by the caloric content of the ingested fluid (2,21). In addition, ingestion of isocaloric loads of glucose and maltodextrins result in identical blood glucose and insulin response curves (12), further indicating that consumption of maltodextrin solutions confers no advantage over consuming fluid replacement beverages containing simpler sugars.

Interestingly, isocaloric solutions of fat, protein, or carbohydrate are known to empty from the stomach at similar rates (21). Such tightly controlled feedback mechanisms function to provide a gastric effluent containing a relatively constant caloric content (2,17,21). As a result, calorically concentrated beverages empty from the stomach at a slower rate than do beverages that are comparatively dilute (e.g., less than 2.5% glucose).

In summary, while gastric emptying is affected by many variables, the caloric content of an ingested fluid is the primary factor determining the rate at which the beverage is emptied into the small intestine. Solutions containing few calories empty faster from the stomach than do solutions containing many calories.

**Principle: Gastric Emptying Rate is Controlled by Feedback from Small Intestine Receptors**

The human gastrointestinal tract is exposed to a smorgasbord of foods and fluids with widely varying physical characteristics. A thick steak, a bowl of Texas chili, a carrot, a chocolate milkshake and a slice of watermelon certainly have divergent physical form, texture, and nutrient composition yet each are effectively digested and absorbed, usually without gastrointestinal distress. This remarkable constancy and efficiency is due in large part to the fact that the stomach and upper small intestine are anatomically and physiologically well designed and integrated for the task of processing a vast array of foods and fluids. The stomach and small intestine work as a team, the function of one coordinated with and complemented by the function of the other (7).

The rate at which an ingested fluid is absorbed into the body is a combined function of the rate at which the fluid is delivered to the absorptive surface of the small intestine (i.e., the gastric emptying rate) and the actual rate at which the fluid is then absorbed (18,24). Both the gastric emptying rate and the fluid absorption rate are influenced by the physical and chemical characteristics of the ingested beverage (18,24).
The rate at which the stomach empties its contents must in some way be linked to the ability of the small intestine to effectively process the gastric effluent. In fact, feedback control of gastric emptying is known to occur via neural and hormonal avenues, mediated by receptors located within the stomach (stretch receptors), duodenum and jejunum (glucose, osmolality, pH, amino acid and fat receptors), and receptors possibly located in the portal blood system and liver (15,21-23).

In brief, stomach and small intestine receptors provide feedback via neural or hormonal pathways so that the emptying of foods and fluids from the stomach is effectively regulated.

Principle: Osmotic Equilibration of Ingested Fluids Occurs in the Proximal Small Intestine

Upon entering the proximal small intestine (duodenum and jejunum), the gastric effluent quickly mixes with existing intestinal contents. In the fasted state, the intestine contains a variable amount of fluid (.5 to 1.5 liters) similar in composition to extracellular fluid (7). The “loose” junctions between intestinal cells allows fluid and electrolytes to move freely in both directions across the intestinal membrane in response to the osmotic gradient existing between the intestinal contents and the body’s extracellular fluid. This movement of fluid and electrolytes rapidly results in osmotic equilibration of intestinal contents. The rapid attainment of osmotic equilibrium is important because the majority of absorption occurs from the isotonic contents of the intestinal lumen (7,26,27). In summary, regardless of the osmotic characteristics of the ingested beverage, the gastric effluent is rapidly made isotonic in the proximal small intestine.

Principle: Fluid Absorption Occurs As A Result of the Osmotic Gradient Produced by Absorption of Solute

The proximal small intestine is anatomically and functionally well suited for nutrient and fluid absorption. Fluid absorption occurs as a result of the osmotic gradient produced by the movement of solutes such as amino acids, carbohydrates, and electrolytes into intestinal cells. As osmotically active solutes leave the intestinal lumen and are absorbed into the body, an osmotic gradient is created — the intestinal cells having a greater osmolality than that of the fluid in the lumen — and water molecules follow. As water crosses the intestinal membrane, electrolytes such as sodium and chloride are carried, dragged along, further reinforcing the osmotic gradient (1,7,9,11,26,27).

Principle: Sucrose, Glucose, and Sodium Stimulate Fluid Absorption in the Proximal Small Intestine

Sucrose, glucose, and sodium significantly enhance fluid absorption in the proximal small intestine (1,9,11,20,26,27,29). This forms the scientific basis for the use of carbohydrate-based beverages in athletic and clinical settings.

Glucose is a particularly potent stimulus for water absorption in the small intestine because both glucose and sodium cross the mucosal border of the small intestinal epithelial cell by means of a common protein carrier molecule (7,22,24). The presence of glucose or sucrose strongly potentiates sodium uptake, creating an extremely effective osmotic gradient for water absorption (1). Consequently, the addition of moderate amounts of glucose or sucrose results in significantly enhanced water absorption (see Table 2).

The effectiveness of a carbohydrate-electrolyte beverage for purposes of combating dehydration is well illustrated in the treatment of diarrheal disease such as cholera (30). The bacterial enterotoxins associated with cholera stimulate the intestinal membrane to secrete rather than to absorb fluid. As a result, large volumes of watery diarrhea are produced. Unless quickly corrected, the resulting dehydration can be deadly. If the diarrhea loss is replaced via intravenous administration of an equal volume of fluid with a similar electrolyte profile, dehydration can be avoided. However, if the same volume is given orally, the ingested fluid is only added to the diarrhea and is therefore ineffective in preventing dehydration. But, if glucose is added to the electrolyte solution, fluid absorption is stimulated and the ingested solution is completely absorbed. Administration of such an oral glucose-electrolyte solution is the most widely used and recommended therapy for treating diseases in which diarrhea-induced dehydration is a threat (1,7,30).

The carbohydrate in such beverages may also benefit exercise performance. Carbohydrate consumed during exercise has been shown to be metabolically available and is oxidized in substantial amounts (19). Carbohydrate feeding during exercise has repeatedly been shown to enhance exercise performance, a topic that has been extensively reviewed elsewhere (6,18,24).

The carbohydrate content of commercially available sport drinks varies from one percent to over 10 percent carbohydrate. The type of carbohydrate found in sport drinks may include various combinations of sucrose, glucose, fructose, and maltodextrins. In addition, while some sport drinks contain electrolytes, others do not. In those drinks containing electrolytes, both the amount and the type of electrolytes may vary (see Table 3).

Practical Considerations for Fluid Replacement During Exercise

It is in the athlete’s best interest to be well hydrated during exercise to help assure optimal performance and to diminish the risk of heat illness.

Optimal hydration during exercise results from ingesting beverages that enhance fluid absorption. Such beverages should be formulated to take advantage of the physiologic principles underlying fluid, carbohydrate, and electrolyte absorption in the proximal small intestine. Consequently, an optimal fluid, carbohydrate, and electrolyte replacement beverage for athletes should contain a moderately dilute source of carbohydrate (e.g., 5% to 8% carbohydrate as glucose or sucrose), and electrolytes (e.g., sodium, potassium), solutes known to stimulate fluid absorption and maintain fluid homeostasis. Use of flavored, sweetened beverages during exercise can encourage fluid consumption and help assure optimal hydration and maintenance of physiologic function, and can also supply an exogenous source of carbohydrate for use by working muscles. In the absence of such beverages, athletes should be encouraged to consume cool tap water. While plain water supplies neither carbohydrates nor electrolytes, water is a good fluid replacement alternative.

During vigorous exercise — and particularly during prolonged exercise in the heat — the health and performance of athletes hinge to a significant extent upon adequate fluid replacement. Athletic trainers and athletes should follow established fluid replacement guidelines:

1. Consume 600 ml (about 20 ounces) of cold (about 50 degrees Fahrenheit) fluid 20 to 30 minutes prior to exercise.
Table 1
Representative Gastric Emptying Characteristics of Saline or Glucose Solutions*. Note that gastric emptying slows as the caloric content of the ingested beverage rises.

<table>
<thead>
<tr>
<th>% of Total Volume Emptied</th>
<th>Mean Gastric Emptying Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>saline</td>
<td>65%</td>
</tr>
<tr>
<td>2.5% glucose</td>
<td>60%</td>
</tr>
<tr>
<td>5.0% glucose</td>
<td>31%</td>
</tr>
<tr>
<td>10.0% glucose</td>
<td>5%</td>
</tr>
</tbody>
</table>

17 ml/min

16 ml/min

8 ml/min

1 ml/min

*Adapted from Costill and Saltin (5). Data are based upon gastric aspiration of resting subjects 15 min following consumption of 400 ml of test solution. All values are approximate.

Table 2
Examples of Intestinal Absorption Rates of Saline and Glucose Solutions Infused into the Small Intestine*.

<table>
<thead>
<tr>
<th>Water Absorption (in ml/hr/30 cm intestine)</th>
</tr>
</thead>
<tbody>
<tr>
<td>saline</td>
</tr>
<tr>
<td>1% glucose</td>
</tr>
<tr>
<td>1.6% glucose</td>
</tr>
<tr>
<td>2.5% glucose</td>
</tr>
</tbody>
</table>

20

320

320

300

*Adapted from Sladen and Dawson (29). All values are approximate.

Table 3
Characteristics of Selected Sport Drinks (all values are approximate)

<table>
<thead>
<tr>
<th>Beverage</th>
<th>CHO Content</th>
<th>CHO Type</th>
<th>Electrolytes* Na</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodyfuel 450</td>
<td>4.5</td>
<td>MD, FR</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Exceed</td>
<td>7.0</td>
<td>MD, FR</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Gatorade</td>
<td>6.0</td>
<td>SU, GL</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Gookinaid ERG</td>
<td>5.0</td>
<td>GL</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Isostar</td>
<td>7.0</td>
<td>SU, GL, FR</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Max</td>
<td>7.5</td>
<td>MD, FR</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Recharge</td>
<td>7.6</td>
<td>FR, GL</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

* = electrolyte values in mM/1; some beverages contain electrolytes other than sodium and potassium

MD = maltodextrin; FR = fructose; SU = sucrose; GL = glucose

2. Consume 100 to 200 ml (3 to 6 ounces) of fluid every 15 minutes during exercise.
3. Rehydrate without restriction following exercise.
4. Pouring cold fluid on the head or body may provide momentary and invigorating relief but such practices are absolutely ineffective in lowering core temperature or producing favorable cardiovascular changes. Make certain your athletes put more fluid in their stomachs than on their heads.
5. You should be aware of the existing temperature and relative humidity and suggest adjustments in the athlete’s training schedule or competition strategy.
6. In hot weather, athletes should always be encouraged to wear minimal clothing. When clothing is required, light colored, loose fitting, porous clothing is best.
7. The athlete’s pre- and postexercise body weights should be charted to identify the extent of fluid loss and to assure adequate rehydration prior to the next exercise session.
8. Athletes should avoid alcohol and caffeine ingestion prior to exercise as both are diuretics and can add to dehydration.
9. Be aware of the signs and symptoms of heat illness. These include unusual fatigue, weakness, dizziness, irritability, disorientation, and nausea. Exercise should be drastically curtailed or stopped if such symptoms occur.
10. Athletes should make drinking a habit during training. Limiting fluid consumption only to competitive settings is an unfortunate habit since heat illness can occur just as easily during training. Consuming fluids will help protect your athletes from dehydration and heat illness and will allow them to train safer and harder.

References

Editor’s Note: We regret there was an error in the first question of the Summer issue CEU Quiz, “Ankle Fractures.” Question #1 concerning the range of motion of the ankle joint should have stated for answer #2, “20% of dorsi­flexion” and for answer #3, “50% of plan­tar­flexion.” The question was voided and was not considered in the grading of the test.

ANSWERS TO PREVIOUS CEU CREDIT QUIZ

"Ankle Fractures: Common Mechanisms, Classifications, Complications"

1. (voided)
2. a
3. a
4. d
5. b
6. e

7. c
8. c
9. b
10. a
11. b
12. e


As an organization accredited for continuing medical education, the Hahnemann Medical College and Hospital certifies that this continuing education offering meets the criteria for .3 hours of prescribed CEU credit in the program of the National Athletic Trainers’ Association, Inc., provided the test is used and completed as designed.

To participate in this program, read the material carefully and answer the questions in the test. Mark the answers you select by placing an X in the proper square. Then xerox the test sheet, fill in your name, address and other information, and mail with $1.2 for processing to Hahnemann University, School of Continuing Education, Broad and Vine, Philadelphia, PA 19102. The NATA National Office will be notified of all members with passing scores over 70%. CEU credit will be issued to each member’s record at that time. Participation is confidential.

Questions

1. Gastric contents are known to empty at widely ranging osmolalities
   a. True
   b. False

2. The rate at which an ingested beverage leaves the stomach has been shown to vary in response to the
   1. pH of that fluid.
   2. individual’s emotional state.
   3. environmental temperature.
   4. time and contents of the previous meal.
   a. 1,2,3
   b. 1,3
   c. 2,4
   d. 4 only
   e. 1,2,3,4

3. There is ______ relationship between the caloric content of a beverage and rate of gastric emptying.
   a. a direct
   b. an inverse
   c. no

4. Which of the following statements is/are true regarding isocaloric glucose and maltodextrin solutions?
   a. There is a faster gastric emptying rate for the maltodextrin solutions.
   b. There is a greater blood glucose and insulin response curve for the glucose solutions.
   c. both a and b above
   d. none of the above

5. Factors which are known to provide feedback control of gastric emptying include
   a. neural pathways.
   b. hormonal pathways.
   c. both a and b above
   d. none of the above
   e. all of the above

(May be xeroxed)
<table>
<thead>
<tr>
<th>Questions</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Fluid absorption in the proximal small intestine is significantly enhanced by</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. sucrose.</td>
<td>a. 1,2,3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. glucose.</td>
<td>b. 1,3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. sodium.</td>
<td>c. 2,4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. potassium.</td>
<td>d. 4 only</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>e. 1,2,3,4</td>
<td></td>
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</tr>
<tr>
<td>7. Which of the following statements is/are true regarding commercially available sport drinks?</td>
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</tr>
<tr>
<td>a. The carbohydrate content is at least 10%</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>b. All sport drinks contain maltodextrins.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Some sport drinks do not contain electrolytes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. b and c above</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. all of the above</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8. Of the following sport drinks, which has the highest carbohydrate content?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Exceed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Gatorade</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Isostar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Recharge</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>9. During exercise, the athlete should consume fluid every 15 minutes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. True</td>
<td>a. 1,2,3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. False</td>
<td>b. 1,3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Prior to exercise, athletes should avoid drinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. alcohol.</td>
<td>c. 2,4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. milk.</td>
<td>d. 4 only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. coffee.</td>
<td>e. 1,2,3,4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. anything very cold.</td>
<td></td>
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</table>

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Research in Athletic Training: The Missing Ingredient

Louis R. Osternig, ATC, PhD

Abstract

Research in athletic training has evolved much more slowly than the components of practice and education. Much of what is practiced in athletic training and what is taught about athletic training does not have a base of principles and practices which have been subjected to scientific scrutiny. There is a need to determine those factors impeding progress in this area. Ongoing research is essential if the field is to be credible within the paramedical disciplines and must play a far greater role if athletic training is to continue to be recognized as a true allied health profession.

As a discipline evolves, three major ingredients coalesce to define its functional nature. These ingredients are:

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

These three components are fundamental to all allied health professions and their successful integration is critical to the development and longevity in the field. In the evolution of athletic training, the practice component emerged first and has a long history. Education and the professional preparation of athletic trainers followed in the 1960's with certification becoming the key to the professionalism of the discipline. The subsequent growth and development of university curriculums provided the impetus for innovation and progress in the systematic preparation of athletic training professionals.

Research in athletic training, however, has evolved much more slowly than practice and education. In spite of the development of graduate programs, athletic training research has lagged. Yet ongoing research is critical if the field is to survive credibly within the allied health arena. It is particularly critical due to the rapid expansion of literature and technology which directly effects the practice of our discipline. Research is the “missing ingredient” that must play a far greater role if athletic training is to be recognized as a true, allied health profession rather than a trade or craft.

What makes a true profession different from a craft or trade? Turner and Hodge (4) indicated that if one extracts common factors from among the most commonly cited definitions of a “profession,” one factor is repeatedly noted:

... a profession has an essential underpinning of abstract principles which have been organized into a theory, set of theories or at least a complex web of theoretical orientations (p26).

Hence, the process of professionalism requires a body of systematic theory and the necessary skills of professional practice that are developed by individuals in a formal academic environment.

Much earlier, Parsons (3) noted that the extent to which an occupational group encourages research into its work activities is an important determinant of the degree of its professionalism. Apart from its search to further understand the phenomena basic to professional concern, research is also undertaken in the quest for valid new theories to serve as the abstrat underpinnings of improved occupational practice.

Monford (2) discussed the need for scholarship in physical education and his comments seem relevant to athletic training. Substituting “athletic training” for the term “physical education” in the following quotation may be appropriate:

... it requires but only a minimum comprehension of the situation to realize that [athletic trainers] inasmuch as they may aspire to professional status, actually do so in name only and that, in fact, they can make no legitimate claims at all to such status. For, in spite of the fact that aspirants to this occupation are trained in a university or college environment, and in spite of the fact that these institutions still award a baccalaureate (or masters degree) for mastery of the requirements of a major in [athletic training], it is, nonetheless, plainly evident that the contents of the vast majority of these programs are, in the main, technical and skill-oriented rather than scholarly and theoretical (p8).

Difficulties exist in our field when the techniques we rely upon in practice, and in some instances teach, do not have solid research foundations. Every discipline requires that its methods and principles be regularly and systematically tested and validated.

Much of what is practiced and taught as athletic training does not have a sound base of principles and practices which have been subjected to and validated by scientific scrutiny. One example of this is the treatment modalities used in injury management. If one were to ask a group of athletic trainers how effective a particular modality is for a particular condition, a wide variety of opinions would be expressed. Many of the opinions would be based on anecdotes, testimonials and sales representatives’ pitches. Few would be based on systematic and scientific assessments of actual effects. Another example of athletic training practice without scientific study has been the extensive use of prophylactic knee braces prior to sufficient research on their effectiveness.

Louis R. Osternig is Professor and Head of the Division of Graduate Studies, Department of Physical Education and Human Movement Studies, University of Oregon. He served from 1973-85 as Program Director of Graduate Athletic Training Program, Oregon. He serves the NATA as Project Director, Educational Research, Professional Education Committee and as a member of the Research and Injury Committee.

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Unfortunately, there is little research upon which the clinical athletic trainer can base judgements. Nonetheless, as allied health professionals, we cannot continue to rely on manufacturers' advertising to guide the decisions we make caring for athletes. It can be argued that much research conducted in allied health fields can be generalized to athletic training. To a considerable extent this is true. Athletic trainers apply research findings from such fields as biomechanics, exercise physiology, motor learning and sport psychology. Interestingly, these fields are modern-day outgrowths of the more established disciplines of physics, biochemistry and psychology, and have finally developed the essential research bases to warrant acceptance as unique bodies of knowledge. Similarly, athletic training is an outgrowth of medicine but without an established theoretical foundation defining its specific body of knowledge. Although athletic training draws liberally from research in other disciplines, such a practice can supplement, not replace, the need for a unique research base developed from within the profession to link athletic trainers' skills to underlying theory.

Harries-Jenkins (1) expressed the conviction that:

> It is the linking of the professional skill with the prior or coincidental mastery of the underlying theory that is the difference between the skills of a higher professionalized group and other less professional groups (p. 74).

**Status of Research in Athletic Training**

What is the present state of research in athletic training? Although such research has been slow to evolve, there can be no question that research activity by athletic trainers is increasing rapidly. More sophisticated research papers are being published by athletic trainers and athletic training educators in professional journals each year. In recent years several badly needed texts have been written by athletic trainers. The NATA Research and Injury Committee is presently conducting systematic epidemiological studies that could provide valuable information on athletic training. More and more masters theses are being chaired by athletic trainers in graduate programs and many of these are presented at national and regional meetings. Yet, as an allied health discipline, a much greater effort is needed to:

1. Promote research by athletic trainers;
2. Provide vehicles for dissemination of these research findings; and
3. Increase the quality and quantity of research in our profession.

**Impediments to Research**

Unfortunately, the present nature of athletic training is not particularly conducive to research efforts. The clinical nature of athletic training and the demands on trainers' time leaves little room for data collection and writing. Also, most athletic training positions are primarily clinical and employers rarely demand or provide the time for research. Even student research at the graduate level is hampered by the extensive clinical component of most programs. This reduces the time available for course work and "hands-on" experiences in research design, evaluation and data collection. As more athletic training educators receive tenure related positions, however, the demand for research will increase.

The athletic training field provides fertile ground for research. Since our profession is still young, there are many unanswered questions regarding our clinical techniques and the validity of our instructional methods. Another major impediment to research in athletic training is limited financial support for released time, equipment purchases, and travel. While the procurement of external funding requires time, effort, and skill, it is critical to the development of research projects.

Numerous private and public institutions routinely fund studies in sports injury management. Major pharmaceutical and medical supply firms generally are affiliated with foundations which review and fund proposals in a variety of sports medicine areas. Also, the federal government, recognizing the need for research to support many currently recommended practices in sports injury management, has recently announced at least three major grants and contracts for studies in sports medicine (5).

Opportunities such as these are ready-made for athletic trainers and athletic trainer educators. Who but trainers are most able to conduct data based studies in these areas? If athletic trainers do not avail themselves of such grants, others will, and a valuable source of research funding will be lost to other disciplines.

**Information Needed**

If the Professional Education Committee or the NATA is to take an active role in promoting research by athletic trainers, basic information must be obtained. Some questions that need to be addressed include:

1. What is the extent of current research efforts by athletic trainers and program directors? Where is such research being done and are centers of research in athletic training being established?
2. What are the major impediments to research in athletic training? How can these barriers be overcome?
3. To what extent is there a desire for athletic trainers and program directors to commit the energy essential for good research?
4. To what extent do athletic trainers perceive educational and clinical research as important to the continued growth and sophistication of the athletic training discipline?
5. To what extent do institutions encourage and support research in athletic training?
6. To what extent are athletic training educators encouraging and supervising graduate theses?
7. What are the priority research needs in clinical and educational athletic training?
8. Can the Professional Education Committee assist program directors and athletic training faculty in research efforts? If so, how?
9. To what extent are currently available journals appropriate for the publication of athletic training research?
10. How high or low do athletic trainers and program directors evaluate their ability to conduct research? If the perception is generally low, how can this be remedied?

A systematic effort by the NATA to elicit responses from athletic trainers to these and other questions may help determine the direction of research in athletic training and the factors impeding progress. Once these factors have been identified, regular and continued dialogue among athletic training educators and clinicians can determine the direction that the NATA should take to overcome the impediments to research in our field.
Conclusion

In conclusion, a statement by Morford (2) aptly summarizes the current state of research endeavors in our discipline:

Surely there comes a critical time in the life of all organizations and institutions when the need to undergo sudden and extensive change is apparent. It is sudden and extensive because such organizations tend to resist change for extension periods only to suddenly find themselves facing a sizeable gap in societal expectations that won't narrow. The [athletic training] field of today, and increasingly in the future, operating in an educationally, intellectually and technologically advanced super-society, will have to accelerate its progress toward a more complete understanding of itself, through research, if it is to keep in step with the new demands that society is placing on it (p. 15).

Failure to meet this need for systematic inquiry into our educational and clinical practices and thereby more adequately meet society's needs, can only lead to the eventual demise of the profession.

References


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Hamstring Facilitation in Anterior Instability of the Knee

Robert P. Engle, PT, ATC

Abstract
The role of hamstring function in dynamic stabilization of the knee is well documented. Hamstring action plays a key role in mitigating anterior tibial subluxation secondary to anterior cruciate ligament and associated capsular injury. Techniques of rehabilitative exercise in cases of anterior instabilities should be directed at correcting the specific biomechanical abnormalities present. Surgical and non-surgical approaches to knee instabilities have emphasized muscle strengthening programs. Identifying the specific functions of the dynamic stabilizers on the tibia is essential if therapeutic exercise techniques are to achieve their goal of functionally stabilizing the knee. Traditionally, this aspect of treatment has been based on the principle of muscle overload in uniaxial knee motion on exercise machines. Available equipment has provided enough resistance but the resistive motion is rarely optimized to treat specific biomechanical problems encountered in knee ligament rehabilitation. Manual exercise techniques can effectively isolate dynamic knee stabilizers that exert tension on the postero medial and postero lateral corners of the tibia. Basic positions and procedures are presented as alternatives in therapeutic exercise for facilitation of the hamstrings. Combining tibial rotated positions with knee flexion and extension rehabilitation exercises is important for training the dynamic restraints to control the pathomechanics of knee instability. The procedures and techniques presented should be applied selectively depending on the instabilities present. Anteromedial instability requires emphasis of the internal tibial rotators. Conversely, the external tibial rotators and flexors must be trained with anterolateral instability.

Trauma to the knee in sports often results in injury to the anterior cruciate ligament (ACL), capsular structures and the menisci. Much has been written (2,7,9,11,14,15,19,20) about the function and biomechanics of static knee stabilizers, i.e., capsule-ligamentous tissue. But the theoretical and practical significance to the neuromuscular dynamic stabilizers have only been superficially discussed. The critical role of rehabilitation in knee injury management is now well accepted by everyone who deals with the athlete. However, in-depth investigation is needed to clarify the role of the dynamic stabilizers of the knee.

At the present time, strength training principles and techniques applicable to normal subjects seeking hyperfunction are often used in the rehabilitation of abnormal knees without consideration of the specific pathomechanics present. In order to affect the greatest change in knee function, therapeutic exercise should address specific biomechanical and neurophysiological abnormalities.

Merely lifting as much weight as possible on an exercise device and using muscle overload only as a facilitation technique in simple uni-axial knee joint motion is an inadequate method of knee rehabilitation. Rotary components of joint motion must also be incorporated with knee flexion movements during exercise. Manual techniques provide an opportunity for the athletic trainer to give specific facilitatory sensory input in conjunction with the appropriate rotational movements to evoke a specific motor response in re-education. Rehabilitation must be directed at the exact neuromuscular dysfunction present with the existing knee pathology considered. Muscle function should be completely assessed and all deficits restored through treatment.

Role of Dynamic Stabilizers in Rotatory Instability
Soft tissue stabilizers of the knee can be divided into two separate categories. The non-contractile connective tissues, i.e., ligaments, capsule and menisci, are classified as "static" stabilizers. The musculotendinous units crossing the joint are considered "dynamic" stabilizers. Knee stability depends on ligament tautness, joint surface congruency with meniscal contributions and the synergistic action of all musculotendinous units (9). Therapeutic exercise can affect the latter stabilizers and thus enhance functional knee stability by improving their dynamic action.

Posterosmedially, the capsule is augmented by the attachment of the semimembranosus capsular arm. It attaches by four tendons to the medial tibial condyle, medial capsule, postero medial capsule and the medial meniscus (2). Besides bolstering the areas of insertion, the semimembranosus internally rotates the tibia along with the semitendinosus, gracilis, sartorius and popliteus (11) and retracts the medial meniscus (2,7,9).

The popliteus, which arises from the medial tibia, attaches to the lateral femoral condyle posteriorly, the lateral meniscus, and the fibular head. It is primarily an internal rotator of the knee with some activity in the initial state of flexion to unlock the fully extended knee (1). As flexion progresses, however, popliteus activity greatly decreases. It also functions to protect the lateral meniscus and assist the posterior cruciate ligament with stabilizing the femur on the tibia (1).

Laterally, the biceps femoris has two thick heads which form a common tendon inserting on the fibular head. Marshall (16) reported rather intimate and complex attachments to the lateral compartment of the knee. Before reaching the lateral collateral ligament on its way to the fibular connection, the biceps femoris divides into three layers. A superficial, a middle and a deep layer (16). The superficial layer has three expansions that surround or attach near the lateral collateral ligament: the anterior, middle and posterior expansions. From the deep layer of the common biceps tendon arises a tibial component attaching to Gerdy’s
Figure 1. Resisted knee flexion with tibia in external rotation and knee extended.

Figure 2. Resisted knee flexion with tibia in external rotation and knee fully flexed.

Figure 3. Resisted knee flexion with tibia internally rotated.

Hamstring Dysfunction

Knee injury with or without surgical intervention is inevitably followed by the disabling process of disuse atrophy. Direct trauma, knee immobilization and reflex inhibition patterns may all lead to neuromuscular dysfunction.

Dynamic hamstring restraint of anterior tibial translation in cases of anterior cruciate ligament disruption is important and must be maximized by specific rehabilitative techniques. Atrophy and its resultant neuromuscular dysfunction affects both the motor and sensory function of the hamstrings. Motor deficits with isokinetic testing can be seen in the peak motor output, time and position parameters relative to torque, total work and endurance capabilities, agonist-antagonist relationships and relationship of synergists (17,18).

Hamstring action in dynamic knee stabilization can be divided into two separate components. As discussed earlier, the actions of the semimembranosus and the semitendinosus help control anteromedial tibial forces, whereas the biceps femoris group acts as a dynamic restraint to anterolateral tibial movement.

Rehabilitation must aim to elicit effective and highly specific neuromuscular responses of these dynamic stabilizers to produce positive functional results following injury. Facilitation of the desired hamstring group must be based on appropriate neurophysiological principles and applied selectively in conjunction with the necessary considerations of knee anatomy, pathology and surgery.

Knott and Voss (13) describe nine techniques for neuromuscular facilitation: maximal resistance, manual contacts, commands and communication, stretch, traction and approximation, normal timing, reinforcement, combining patterns and recuperative motion. By using proprioceptive neuromuscular facilitation (PNF) techniques in the treatment of rotational knee instabilities, the medial and lateral hamstrings can be effectively isolated and selectively facilitated in diagonal and spiral patterns of movement. Specific techniques for the hamstrings will be discussed later in this paper.
Utilization of manual resistive patterns of exercise presents many obvious advantages for the patient and athletic trainer. Most important is the control of the patient’s program by the athletic trainer. Where a specific neuropsychological response is to be elicited, the direct intervention of a skilled person is essential.

Hands-on techniques can incorporate stretching into the strengthening program and emphasize muscle contraction throughout the entire range of motion. Proprioception is enhanced by manual contacts. Resistance is accommodating and can be altered according to the specific deficiencies encountered in the injured joint. Motion can be limited as indicated by the condition and changes can be made throughout the exercise pattern as neuromuscular function dictates.

Testing the Hamstrings

Manual hamstring testing should occur with the patient prone (3,8,12). With knee flexion the tibia can be held in internal rotation to isolate the semimembranosus and semitendinosus and in external rotation to test the biceps femoris. A maximal effort is then elicited with knee flexion and the tibia in extreme rotation comparing the contralateral sides.

Isolating the tibia and testing rotation as recommended by Cybex (Cybex, Ronkonkoma, New York) and correlating it with data from the knee flexors can also be used to assess compartmental function. An adaptation of isokinetic equipment can be used to test the medial and lateral hamstring groups individually with flexion in a rotated position. Unfortunately, the rotational component cannot be resisted, only flexion.

None of these approaches, although more introspective than standard knee flexion-extension tests, really test the hamstrings as they function normally, i.e., in spiral and diagonal movements combining flexion-extension with rotation. A compartmental hamstring specificity theory explains patients with subtle degrees of instability and functional instability who exhibit seemingly adequate hamstring torque using traditional protocols testing the hamstring as a group rather than two separate compartmental units.

Compensatory mechanisms appear to be at work where the uninvolved compartment is producing more than adequate torque but its specific function will not counteract the rotatory instability present. Meanwhile, the involved group does not receive enough specific rehabilitative training to reverse its dysfunction. Grouped together and tested, their peak torque looks good. A simple but subjective way of testing this is to position the patient prone with the knee in extension and the tibia in either internal or external rotation. Have the patient flex with simultaneous rotation of the tibia. Resistance can be applied at the medial border of the first metatarsal and calcaneus to test the medial hamstrings in flexion-internal rotation and at the base of the fifth metatarsal and lateral calcaneus to test the lateral hamstrings in flexion-external rotation.

Specificity of hamstring function or compartmental instabilities of the knee is an interesting but unproven concept. Attempts to facilitate the medial hamstrings with AMRI and the lateral hamstrings with ALRI makes good anatomical and biomechanical sense and has been helpful to many rehabilitation specialists who deal with treatment of instabilities.

Still relatively unknown is the effect of eccentric muscle action utilizing these concepts. New instrumentation should aid investigative efforts in this area. Eccentric action may very well be the most important mode of muscle loading in these cases (13).

Normal concentric-eccentric quantitative relationships between the medial and lateral hamstring groups must be defined. Correlation to the rehabilitation and prevention of injuries can then be made.

Specific Techniques

There are two basic patterns of movements performed in the sitting position to facilitate the hamstrings: 1) Knee flexion with tibial external rotation, isolating the biceps femoris and 2) Knee flexion with tibial internal rotation, isolating the semimembranosus and semitendinosus.

The degree of tibial rotation and knee flexion-extension can be controlled by manual contact by the athletic trainer. Stress on repairing tissues can be avoided and, unlike conventional machine-oriented exercise, a more specific response of the tibial rotators can be elicited with knee flexion movements.

Disuse atrophy is a neuromuscular, not simply a muscular, problem. Its resolution must be based on sound neuropsychological treatment and principles. Providing specific sensory stimuli through manual contacts and other techniques, we can re-educate the key musculotendinous units enhancing their stabilization effect on the knee.

Tibial External Rotation

Facilitating the biceps femoris begins from a position of knee extension-tibia internal rotation (Figure 1). As the pattern begins and the knee flexes, the tibia begins its spiral motion into external rotation. Resistance is given at the medial border of the foot along the first metatarsal-phalangeal joint with the fingers positioned underneath on the plantar surface of the toes and distal metatarsals to resist toe flexion. The other hand cups the calcaneus posteriorly to control the tibia’s spiral motion.

The ankle goes in plantar flexion and inversion with toe flexion. Timing is distal to proximal beginning with toe and ankle motion and progressing to flexion of the knee. With full flexion the tibial reaches the desired degree of external rotation and full ankle plantar flexion-inversion (Figure 2).

Tibial Internal Rotation

Tibial internal rotation with knee flexion is accomplished primarily by the semimembranosus. Facilitation of this pattern begins from knee extension with tibial external rotation. Manual contacts are given again at the calcaneus to control tibial motion and at the lateral border of the foot along the fifth metatarsal and fifth toe with the fingers making contact again over the plantar surface of the toes and distal metatarsals.

Ankle plantar flexion and evasion is the distal component of the pattern. Motion begins at the toes with flexion, followed by ankle plantar flexion-eversion and finally knee flexion-tibial internal rotation (Figure 3).

Isolating the medial and lateral hamstring groups can be accomplished from positions other than sitting. Various changes can be made in the hip, placing it in flexion or extension while supine. The patient can also be placed prone on the table.

These techniques are not meant to replace isotonic and isokinetic exercise equipment, but to supplement their use and serve as a basis for a more fundamentally sound neuromuscular approach to treatment. Many new diagnostic methods have been developed to detect early subtle forms of knee pathology before they progress to gross instability, arthritis and disability. Sports thera- continued on page 285
The Injury Toll
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A Manual Resistance Technique For Strengthening Tibial Rotation

William E. Prentice, PhD, ATC, LPT

Abstract

Tibial rotation is a critical component in normal movement of the knee joint. Sports medicine personnel routinely evaluate tibial rotation following injury to the knee. Yet tibial rotation is very often neglected in rehabilitation programs. Because there is little exercise equipment available with the capability of selectively strengthening tibial rotation, the athletic trainer must rely on a manual resistance technique. This article discusses a PNF technique which may be used as a means of strengthening tibial rotation. The value of this technique is that it provides an effective means for improving the functional strength of tibial rotation throughout a movement pattern while simultaneously strengthening the other components of lower extremity motion.

The knee joint is generally considered to be a hinge joint. The implication of the term hinge joint typically means motion in only one plane. However, the tibial-femoral joint is capable of not only flexion and extension movements, but also of rotational movement. Thus, the knee is not a true hinge joint and is capable of three dimensional motion. The literature clearly documents the importance of the rotational component of motion in the normal knee joint (3,4,5,6). Likewise, sports medicine personnel are keenly aware of rotational instabilities which may be evident during an evaluation following acute injury. But for some reason, the importance of the rotational movement of the tibia with respect to the femur is often totally neglected in programs of rehabilitation.

Flexion and extension exercises have long been accepted as part of a basic standard protocol in the rehabilitation of a majority of injuries to the knee. Various types of exercise equipment have been developed which facilitate strengthening in a single plane. Both isotonic and isokinetic equipment is available which can provide resistance in both flexion and extension movements. However relatively little equipment exists which has been designed for providing resistance in internal and external tibial rotation. Thus, the athletic trainer must rely primarily on manual resistance strengthening techniques to provide appropriate resistance for strengthening tibial rotation throughout the range of motion.

Appropriateness of PNF Technique

Perhaps the most effective manual resistance method for strengthening internal and external rotation of the tibia is based on a proprioceptive neuromuscular facilitation (PNF) technique, although no research evidence is currently available to support this. PNF strengthening techniques allow the injured patient to work at the maximal physical capabilities within the limitations of the injury.

There is little question that continued activity during a rehabilitation program is critical for improving strength. Therefore an intense program of strengthening throughout a full range of motion should offer the greatest potential for recovery (7).

The PNF technique for strengthening tibial rotation incorporates strengthening of synergistic movement patterns of the entire lower extremity. This is important because the brain recognizes only gross joint movement and not individual muscle action (7). It is also true that the strength of a muscle contraction is directly proportional to the activated motor units. Therefore, to increase the strength of a muscle, the maximum number of motor units must be stimulated in order to facilitate the remaining muscle fibers (1,2). This is referred to as an irradiation or overflow effect and it occurs when the stronger muscle groups assist the weaker muscle groups in completing a particular movement. This cooperation leads to the rehabilitation goal of return to optimal function (2). Since the tibia must rotate to allow normal knee flexion and extension, a manual resistance technique which can provide appropriate resistance for the purpose of strengthening tibial rotation specifically should facilitate the rehabilitation process.

Lower Extremity Patterns

The lower extremity PNF technique strengthening tibial rotation involves two separate diagonal patterns of movement both of which require flexion, extension, abduction/adduction, and internal/external rotation of the joints in the lower extremity. These patterns are concerned with gross movement as opposed to specific muscle actions. All PNF techniques are composed of both rotational and diagonal exercise patterns which are necessary in most sport and normal daily activities (2).

The movement patterns labeled as Diagonal 1 and Diagonal 2 in Tables 1 and 2 make use of a specific PNF strengthening technique known as slow-reversal. The slow-reversal technique involves an isotonic contraction of agonistic muscle groups followed immediately by an isotonic contraction of antagonistic muscle groups which together produce full range motion in opposite directions. Tables 1 and 2 provide a verbal description of the starting positions and the terminal positions for both Diagonal patterns. Figures 1 through 8 show starting and terminal positions for both agonistic and antagonistic movement patterns in each Diagonal. It should be added that these specific patterns have been slightly modified from the Knot and Voss (2) techniques to facilitate tibial rotation throughout the movement patterns.

The correct performance of these sequential movement patterns requires close cooperation between the patient and the athletic trainer. Initially, a learning period will be required during which the athletic trainer must
Figure 1 - Diagonal 1 movement pattern moving into flexion (starting position).

Figure 2 - Diagonal 1 movement pattern moving into flexion (terminal position).

Figure 3 - Diagonal 1 movement pattern moving into extension (starting position).

Figure 4 - Diagonal 1 movement pattern moving into extension (terminal position).

Figure 5 - Diagonal 2 movement pattern moving into flexion (starting position).

Figure 6 - Diagonal 2 movement pattern moving into flexion (terminal position).

Figure 7 - Diagonal 2 movement pattern moving into extension (starting position).

Figure 8 - Diagonal 2 movement pattern into extension (terminal position).

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### Table 1
**Diagonal 1 Movement Patterns**

<table>
<thead>
<tr>
<th></th>
<th>Moving into Flexion</th>
<th>Moving into Extension</th>
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<tbody>
<tr>
<td><strong>Starting Position</strong></td>
<td>FIGURE 1</td>
<td>FIGURE 2</td>
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<tr>
<td><strong>Terminal Position</strong></td>
<td>FIGURE 3</td>
<td>FIGURE 4</td>
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<tr>
<td><strong>Starting Position</strong></td>
<td>FIGURE 1</td>
<td>FIGURE 2</td>
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<tr>
<td><strong>Terminal Position</strong></td>
<td>FIGURE 3</td>
<td>FIGURE 4</td>
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<tr>
<td><strong>Starting Position</strong></td>
<td>FIGURE 1</td>
<td>FIGURE 2</td>
</tr>
<tr>
<td><strong>Terminal Position</strong></td>
<td>FIGURE 3</td>
<td>FIGURE 4</td>
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<tr>
<td><strong>Hip</strong></td>
<td>Extended</td>
<td>Flexed</td>
</tr>
<tr>
<td></td>
<td>Abducted Internally Rotated</td>
<td>Adducted Internally Rotated</td>
</tr>
<tr>
<td><strong>Knee</strong></td>
<td>Extended</td>
<td>Flexed</td>
</tr>
<tr>
<td><strong>Position of Tibia</strong></td>
<td>Externally Rotated</td>
<td>Internally Rotated</td>
</tr>
<tr>
<td><strong>Ankle and Foot</strong></td>
<td>Plantar Flexed Everted</td>
<td>Dorsi Flexed Inverted</td>
</tr>
<tr>
<td><strong>Toes</strong></td>
<td>Flexed</td>
<td>Extended</td>
</tr>
<tr>
<td><strong>Hand Position</strong></td>
<td>Right hand on dorsomedial surface of foot</td>
<td>Right hand on lateromedial plantar surface of foot</td>
</tr>
<tr>
<td></td>
<td>Left hand on anteromedial thigh near patella</td>
<td>Left hand on posteriomedial thigh near popliteal crease</td>
</tr>
<tr>
<td><strong>Verbal Commands</strong></td>
<td>Pull</td>
<td>Push</td>
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</tbody>
</table>

*For Right Leg

### Table 2
**Diagonal 2 Movement Patterns**

<table>
<thead>
<tr>
<th></th>
<th>Moving into Flexion</th>
<th>Moving into Extension</th>
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</thead>
<tbody>
<tr>
<td><strong>Starting Position</strong></td>
<td>FIGURE 5</td>
<td>FIGURE 6</td>
</tr>
<tr>
<td><strong>Terminal Position</strong></td>
<td>FIGURE 7</td>
<td>FIGURE 8</td>
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<tr>
<td><strong>Starting Position</strong></td>
<td>FIGURE 5</td>
<td>FIGURE 6</td>
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<td>Extended</td>
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<td><strong>Toes</strong></td>
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<td>Extended</td>
</tr>
<tr>
<td><strong>Hand Position</strong></td>
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<td>Right hand on mediolateral plantar surface of foot</td>
</tr>
<tr>
<td></td>
<td>Left hand on anterolateral thigh near patella</td>
<td>Left hand on posteriomedial thigh near popliteal crease</td>
</tr>
<tr>
<td><strong>Verbal Commands</strong></td>
<td>Pull</td>
<td>Push</td>
</tr>
</tbody>
</table>

*For Right Leg
instruct the patient in the appropriate technique. It must be emphasized that rotation is a critical component in any movement pattern and the patient should concentrate specifically on simultaneous rotational movement of the tibia with respect to the femur in either flexion or extension from the starting position to the terminal position.

Proper positioning of the athletic trainer is essential in applying appropriate pressure and resistance. The trainer must stand in a position close to the patient so that accommodating resistance can be applied throughout the range of movement in a diagonal direction. Tibial rotation is generally a relatively weak movement compared to flexion and extension. Basically the athletic trainer is attempting to make use of the stronger components of the movement pattern to facilitate the weaker components.

The patient will contract isotonically against maximal resistance until fatigue is evidenced by strength decrease in the weak components of the movement pattern. The specific amount of resistance given should vary so as to accommodate to differences in strength of the patient throughout the range of motion but should not be so great as to prevent smooth, coordinated movement. Generally the patient will fatigue to the point of failure after 8-10 repetitions of each of the two diagonal patterns.

Begin with the Diagonal 1 movement patterns alternating flexion and extension movements, followed by the Diagonal 2 patterns, again alternating flexion and extension movements.

Hand position is perhaps the most critical single element of this technique, since manual contact with appropriate pressure is essential for influencing the direction of movement and facilitating a maximum effort. Recommended hand position is indicated in Tables 1 and 2 relative to each individual movement pattern. It should be re-emphasized that the purpose of this technique is to provide resistance to those muscles that collectively rotate the tibia. Thus, concentration on the tibial rotational portion of the pattern is essential. The athletic trainer is advised to make use of whatever hand position he/she feels is most effective in resisting tibial rotation.

A specific sequence of muscle contractions occurs in any movement pattern which results in a coordinated movement (2). The distal movements should occur first and should be completed by no later than halfway through the pattern. Thus, foot and ankle movements should initiate the pattern and be completed before the midpoint in the movement pattern is reached. The athletic trainer may accomplish this by combining appropriate pressure signals through the hands with verbal commands to facilitate correctly timed movements. The patient should be commanded to “push” or “pull” depending on the desired direction of the diagonal pattern as indicated in Tables 1 and 2. It is important to keep both manual and verbal commands short and clear particularly in the initial learning stages of the Diagonal patterns.

While it is true that tibial rotation is an essential component of gross motion at the knee joint, isolated tibial rotational movement without flexion or extension of the knee joint is of little importance. The manual resistance techniques described above, provide an effective means for improving the functional strength of tibial rotation throughout a movement pattern, while simultaneously strengthening the other components of lower extremity motion. Incorporation of this technique into a knee rehabilitation program at the appropriate time should facilitate return to full functional activity.

References


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U.S. Patent 4,632,097; foreign patents pending.
High and Low Frequency Tens in the Treatment of Induced Musculoskeletal Pain: A Comparison Study

Craig R. Denegar MEd, ATC  
C. Bradley Huff BS, ATC

Abstract

Delayed onset muscle soreness (DOMS) was induced bilaterally through repeated eccentric contractions of the elbow flexors in 24 subjects. They were treated 48 hrs after exercise with either high frequency, short pulse width, monophasic, or low frequency, long pulse width, biphasic transcutaneous electrical nerve stimulation (TENS) on either their dominant or non-dominant arm. Both treatments were equally effective in reducing the sensation of pain bilaterally measured using Talag’s pain scale (23), immediately, 1 hr, 2 hrs, 3 hrs, and 4 hrs after treatment. All subjects exhibited a decrease in elbow extension concomitant with delayed onset muscle soreness. The reduction in perceived pain following treatment was not accompanied by an increase in volitional elbow extension. The results failed to substantiate hypothesized differences in the physiological analgesic mechanisms of the two treatments. The results do indicate that the two TENS treatments are equally effective in treating pain associated with DOMS. The results also suggest the need for rehabilitative exercise in conjunction with TENS induced analgesia to effect change in joint range of motion limited by musculoskeletal injury.

The physiological mechanism of transcutaneous electrical nerve stimulation (TENS) induced analgesia has been proposed to be dependent upon the parameters of the electrical stimulus (3). High frequency, short pulse-width TENS or simply high TENS (pulse rate 80-100 pps, pulse-width less than 100 microseconds, with intensity failing to elicit muscle twitch) initiates a blocking of the pain message in the dorsal horn through a gating mechanism (1,11,19) or activation of enkephalin interneurons (3).

Low frequency electroacupuncture initiates an increase of beta-endorphin production by the anterior pituitary (10,13,21). Beta-endorphin is a powerful endogenous opioid which produces a narcotic like analgesia (17). Low frequency, long pulse width TENS or low TENS (pulse rate 1-5 pps, pulse width greater than 200 microseconds with intensity to tolerance) produces a naloxone (narcotic antagonist) reversible analgesia implicating beta-endorphin as the active endogenous agent in low TENS induced analgesia (4,22).

The purpose of this study was to compare the efficacy of high and low TENS in managing pain induced by repeated eccentric muscle contraction. We selected eccentrically induced DOMS to represent musculoskeletal pain because of the predictable course of the soreness and because DOMS can be induced with minimal risk to the subjects. Subjects were assessed for changes in elbow extension and perceived pain in the treated and untreated arm.

Because the pain relief induced by high and low TENS is thought to occur through different physio-chemical mechanisms (1,3,5,22), a difference in the longevity of pain relief over the first four hours following treatment was expected. We hypothesized that the improvement in range of motion (ROM) and pain perception would be longer lasting in subjects treated with low TENS because of the associated beta-endorphin release (3,18). It was further hypothesized that subjects treated with low TENS would demonstrate greater improvement in ROM and pain perception in the untreated arm when compared to subjects treated with high TENS due to the systemic effects of beta-endorphin.

Methods:

Twenty-four college females (age = 21.4 ± 1.7 yrs, ht = 64.4 ± 2.9 in, wt = 129.9 ± 15.8 lbs) were recruited to participate in the study. None were currently participating in weight training programs or intercollegiate athletics. All subjects demonstrated normal elbow extension (> -5 degrees) bilaterally and denied having soreness worse than a dull, vague ache in the upper arms before exercise. All subjects gave informed consent and were instructed that they could leave the study at any time.

Initially the 24 subjects were randomly assigned to one of four groups (group 1 - high TENS treatment of the dominant arm, group 2 - high TENS treatment of the non-dominant arm, group 3 - low TENS treatment of the dominant arm, group 4 - low TENS treatment of the non-dominant arm). Subjects received a trial treatment according to their group assignment to familiarize them with the sensation of TENS.

DOMS was induced in the elbow flexors through repeated eccentric muscle contractions. Initially each subject lowered a 25 lb dumbbell from full elbow flexion to complete extension over three seconds. When subjects were unable to control the weight for the full three seconds the weight was decreased to 20 pounds. This process continued in 5 lb decrements until the subject could not control 5 lbs or had completed 40 repetitions with five pounds. All concentric lifting was done by us or our assistants.

Upon completion of exercise each subject was assessed for maximal volitional elbow extension using a standard goniometer and indicated perceived upper arm soreness using Talag’s seven point (0 = no pain, 1 = vague, dull...
ache, 2 = slight persistant pain, 3 = more slight pain, 4 = painful, 5 = very painful, 6 = unbearably painful) pain scale (23). Each subject was instructed to refrain from vigorous exercise involving the upper extremities and not to use any analgesic or anti-inflammatory medications.

All subjects returned 48 hours after exercise and were reassessed for elbow extension and upper arm pain. Three subjects failed to report perceived pain greater than 1.0 on the pain scale and were dropped from the study. Three new subjects gave informed consent, received a trial treatment and performed the same eccentric exercise protocol. Forty eight hours after exercise each reported pain greater than 1.0 on the Talag pain scale and were assigned to take the place of one of the three subjects omitted from the study.

At 48 hours after exercise subjects received their assigned treatment which lasted 30 minutes. Electrodes for both treatments were positioned using a bipolar technique with one electrode placed over the superior musculotendinous junction of the biceps brachii muscle and the second placed over the site of greatest tenderness, usually over the belly of the brachialis muscle. High TENS (80 pulses per second, pulse width approximately 90 microseconds) was delivered with a monophasic wave form using the Intellect 700 High Voltage Stimulator (Chattanooga Corporation, Chattanooga, TN). Low TENS (2 pulses per second, pulse width 200 microseconds) was delivered with a biphasic wave form using the Intellect VMS Stimulator (Chattanooga Corporation, Chattanooga, TN). Subjects were reassessed for elbow extension and perceived pain immediately, 1 hr, 2 hrs, 3 hrs, and 4 hrs after treatment.

Results

Subjects experienced a significant increase (F(1,47)=225.40, p < .01) in perceived pain and a decrease (F(l,47)=109.97, p < .01) in elbow extension from pre to 48 hours post exercise. The results support the presence of DOMS prior to treatment. Group means for pain and elbow extension are summarized for each measurement time in Tables 1 and 2 respectively.

There was a significant decrease (F(5,100)=35.13, p < .01) in perceived pain across time (before treatment and five post-treatment measurements) found in all four groups. Post-hoc Tukey tests indicated that there were significant (p < .05) differences between pre-treatment and all five post-treatment measures. The raw data indicates that subjects treated with high TENS were much less painful immediately following treatment while subjects in the low TENS group experienced smaller decreases in pain. This difference is not as apparent over the last four measurement times.

Post-hoc results also indicate that perceived pain was significantly (p < .05) decreased between immediately post-treatment and 2, 3 and 4 hours post-treatment measures. Table 1 illustrates that perceived pain continued to decline for 2 hours after treatment before leveling out for the last two measurements.

There were no overall differences between high and low TENS treatments (F(1,20)=1.96, p > .05) or between treated and untreated arms (F(1,20)=1.46, p > .05). There were no significant main effects or interactions on the analysis performed on the elbow extension data. Specifically, there were no significant changes in range of motion across time (F(5,100)=1.20, p > .05), and no significant differences (F(1,20)=1.92, p > .05) between the two treatments.

Discussion:

The fact that the treated and untreated arm response similarly indicates that either the TENS treatments were ineffective or that both protocols had a bilateral effect. A control group was not employed because we could not justify inducing soreness simply to document the normal course of DOMS. Previous work reported that DOMS increased for about 48 hours following exercise, decreased slightly (< .25 on the pain scale)
between 48 and 72 hours (23,24) and gradually disappeared over 5-7 days (24). Factors such as a placebo effect, the passage of time or investigator influence cannot be ruled out as contributing to the decrease in pain perception. Subjects were not questioned regarding their abstention from upper body exercise and medication, however there was no indication that any subjects failed to comply with our instructions. The timing and magnitude of the analgesic response suggests that the decrease in perceived pain was primarily due to the TENS treatment.

High and low TENS analgesia is thought to occur through different physio-chemical mechanisms (1,3,5,22). Low TENS induced analgesia is believed to result from increased beta-endorphin release (4). Beta-endorphin in a 31 peptide chain derived from the pituitary secretion beta-lipotropin/ACTH (6,17) which acts as an opiate receptor agonist resulting in centrally mediated analgesia (4). Increased beta-endorphin production is associated with diminished pain perception for a period approximating its half life (2-3 hours) (17).

High TENS induced analgesia is elicited through local or segmental mechanisms (9), possibly through a dorsal horn "gating" of the pain message or an enkephalin release in the dorsal horn of the spinal cord (3,11,19). Enkephalins, with a half life of less than two minutes (3,17) and dorsal horn gating have been related to short term analgesic responses although prolonged analgesic responses to high TENS have been reported (16,20).

Beta-endorphin produces a centrally mediated analgesic response (3,15). We predicted a bilateral reduction in pain perception in subjects treated with low TENS. High TENS has been reported to diminish pain perception in contralateral extremities (8,18) when the treatment stimulated afferent fibers entering at the same spinal cord level as those afferents originating in the painful area (8). Low TENS has been reported to have extrasegmental effects helping substantiate a central or systemic mechanism for low TENS induced analgesia (9). The extrasegmental application of high TENS has not been effective in reducing pain (9). Our treatments stimulated afferent fibers entering the spinal cord segment associated with the painful area which may explain the bilateral analgesic response. Because our treatments were intrasegmental, no determination of possible systemic beta-endorphin effects can be made based on bilateral versus unilateral analgesic responses.

While the physio-chemical mechanisms may differ for high and low TENS analgesia, in this study the end result of both treatments was the same. These results agree with those of others who have found no difference in patient response to high and low TENS in clinical patients treated with electrodes placed "usually interferentially (crisscrossed over the center of pain)". A different electrode placement pattern may have yielded different results. Cheng et al. (6) reported that low frequency electroacupuncture at known acupuncture sites on horses resulted in increased hypothalamic-pituitary-adrenal (HPA) axis activity while stimulation of non-acupuncture sites failed to alter HPA activity. It may be necessary to place the electrodes used in the low TENS treatment over acupuncture or trigger points to elevate beta-endorphin levels.

The two stimulators used in the study were chosen because of their availability at the time of the study. The difference in the wave form produced by the two machines represents another factor that could have influenced the results. We are not aware of any studies indicating that the wave form effects the physiological responses to TENS if other parameters remain constant. However this is a question that has not been addressed fully and requires further research.

An inverse relationship between pain and ROM has been reported (2,7,12). The relationship between increasing pain and decreasing ROM supports the concept of a pain-spasm cycle (2,7). The pain-spasm cycle theory suggests that if pain perception decreases, a concomitant increase in range of motion should be observed. The results of this study do not support that prediction. While caution should be used in generalizing TENS treatments of DOMS to all pain-spasm conditions, the significant improvement in perceived pain in the absence of significant changes in elbow extension in our study indicates the necessity of physical activity if increased ROM is a goal in the treatment of DOMS.

In a broader sense, these findings emphasize that the application of electro-therapeutic modalities serve to control pain perception in preparation for therapeutic exercise. The athletic trainer cannot impact upon joint range of motion simply through the application of high or low TENS. TENS induced analgesia serves to facilitate therapeutic exercise rather than directly influence musculoskeletal function.

References

The Use of Hyperoxic Gas in Athletic Trauma

Phillip Hossler, ATC

Abstract

Oxygen is a life-sustaining element which plays a major role in all activities. In athletics, the availability and delivery of oxygen can be the crucial element in not only sporting activities but also in the handling of athletic trauma. This article explores guidelines for considering supplemental oxygen for various conditions, acute and chronic, which may occur in athletics. Instructions are presented in the care and handling of oxygen cylinders as well as suggestions for those athletic departments considering the purchasing of an oxygen cylinder.

Hyperoxic gas has a variety of essential, often lifesaving applications. Although its use has been standard practice by medical emergency personnel, several ideas should be considered before an athletic department uses hyperoxic gas. The use of supplemental oxygen should not be taken casually; its use is more than merely assisting an ailing athlete to breathe. The indiscriminate application of supplemental oxygen in those medical conditions seen in athletics must be avoided. Oxygen should be administered and maintained by trained personnel only.

“ALWAYS REMEMBER THAT OXYGEN IS A MEDICATION. This means that you will have to decide if it is needed, how much to provide, what results are expected, and what harm may be done. The use of oxygen is a special responsibility that can be given only to someone of professional status.” (6) Coaches, athletic trainers, and physicians should be familiar with those conditions in which the introduction of cylinder oxygen may be useful, of no value, or potentially harmful. Following are some suggestions:

1) Traumatic Shock—lack of oxygen will precipitate and/or accelerate the incidence of traumatic shock. Any athlete who demonstrates signs and symptoms of traumatic shock should be given oxygen. A few assisted breaths by a ventilatory apparatus with added oxygen usually raises the athlete’s blood oxygen levels to acceptable levels (1).

2) Hyperventilation—The incidence of hyperventilation in an athlete does not appreciably affect the oxygen content of the blood (4). In cases of hyperventilation, the introduction of oxygen would serve no useful purpose and the time spent doing so would be better spent performing the standard protocol procedure of placing a paper bag over the athlete’s nose and mouth. This procedure causes the athlete to re-breathe a higher than normal concentration of carbon dioxide to stimulate deeper breathing and thereby increase the amount of oxygen inhaled.

3) Exercise Induced Asthma—Children with asthma are often excluded from physical activity by the physical education teacher, parents or physician, or by their own reluctance to provoke attacks of exercise induced asthma (11). However, children with asthma can engage in running programs and increase their work tolerance and fitness without deleteriously affecting their asthmatics (10). Due to the possibility of inducing oxygen toxicity, oxygen should not be given to an athlete suffering from an asthma attack. The use of the athlete’s inhalator would be more prudent and steps should be taken to ensure that those athletes who suffer from exercise induced asthma have their inhalators on the field during practice and games, not locked in their lockers.

4) Heat Stress—Heat disorders (e.g., heat cramps, heat exhaustion and heat stress) are caused by failure of the cardiovascular system to circulate sufficient fluid to dissipate the heat built up from activity. The key to handling heat stress is increasing blood volume by fluid ingestion or in severe cases, intravenous feedings. The use of hyperoxic gas would serve little useful purpose and should be considered secondary to the standard protocol of heat stress treatment.

5) “Stitch in the Side”—The explanation of the “stitch” that many athletes experience in the lower right quadrant of the abdomen while exercising remains difficult to explain definitively. Several theories have been proposed. Among these is the idea that the stitch is caused by a cramp in the diaphragm or intercostal muscles. It seems reasonable that, as the rate of breathing increases, the muscles directly affected might be more prone to physiological “shut down” such as a cramp or spasm. This seems plausible to this author, but more studies are needed.

Another commonly given explanation is the engorgement of the liver with blood during exercise which may be relieved by pressing this area with the hand. Rowell (13) showed that during exercise the hepatic blood flow may be reduced by as much as 80 percent. Evdokimova (5) studied 162 distance runners, skiers and cyclists and found that of those who complained of pain in the area of the liver, the majority (ratio of 49:14) had enlargement of the liver. She also reported that when these suffering athletes bent forward and pressed on the liver area, the pain diminished. It would seem from these two studies that the reduction in blood flow does not preclude the engorgement of the liver.

Would the introduction of hyperoxic gas alleviate this discomfort more rapidly? From empirical evidence, when the rate of breathing diminishes, so does the level of discomfort. This can be accomplished by either slowing down the speed of the activity or by stopping until the pain diminishes. As the level of conditioning improves, the occurrence of the stitch diminishes and usually becomes altogether absent.

From a practical standpoint, by the time the athlete has concluded the event and obtained an oxygen cylinder...
the discomfort has usually subsided anyway, making supplemental oxygen of little value. From a physiological standpoint, atmospheric air is capable of saturating the blood in excess of 90% which should be sufficient if the discomfort were caused by oxygen deprivation to the diaphragm.

6) **Blow to the Solar Plexus**—The apprehension experienced by an athlete who has received a significant blow to the area of the solar plexus can be more disabling than the blow itself. The sudden inability to inhale and exhale will be frightening for many athletes. While there may be little physiological justification for the administration of hyperoxic gas in this incidence, the psychological comfort for the ailing athlete may be significant.

7) **Anaphylactic Shock**—Anaphylaxis is defined as a "hypersensitive state of the body to a foreign protein or drug...Reactions which constitute anaphylactic shock occur suddenly. They include increased irritability, dyspnea, cyanosis, convulsions, unconsciousness, and death...Such conditions as asthma (other than exercise induced asthma), hay fever and...hives are thought to be of an anaphylactic nature, being caused by the irritation of a food or by the pollen of some plants and flowers. Treatment includes the use of oxygen inhalations and treatment for shock". (14) It has been suggested that the use of oxygen be restricted to those cases where blood analysis has determined that the athlete is hypoxic (8). If an athlete is suffering from a severe anaphylactic reaction with resulting severe breathing difficulty, very high concentrations of oxygen would be useful to counteract the severe restriction of the trachea that the athlete is experiencing.

8) **Exercise in High Altitudes**—It has been well documented that exercising at varying altitudes will produce varying, often significant, changes in blood chemistry and physiological reactions to stress. The oxygen requirements for a given submaximal work load are the same at all altitudes (7,12) but the maximum oxygen intake progressively decreases as the altitude increases; therefore, a given amount of work will require a greater proportion of the aerobic capacity and the athlete will be working closer to his physiological limit than at sea level.

While the percentage composition of the atmosphere remains unchanged, the number of gas molecules per unit of volume is reduced resulting in a "thinning" of the air. Therefore, with each breath, the athlete is unable to inhale as many oxygen molecules.

The dynamics of anaerobic reactions at high altitude have not been studied as intensively as those of aerobic reactions. It is generally conceded, however, that the anaerobic release of energy is not affected at high altitudes (2).

To aid athletes in recovery from aerobic capacity depletion, they should acclimate to high altitude training and utilize cylinder oxygen to aid in recovery during the acclimatization process. This idea can be seen when a football game is telecast from Mile-High Stadium in Denver. The use of hyperoxic gas is apparent by those teams who have had no chance to acclimate to the higher altitude. In addition, although there is no NFL rule requiring oxygen on the sidelines during games, its use appears to be common practice. This practice probably has more psychological than physiological benefit.

9) **Head Trauma**—the use of cylinder oxygen would be beneficial to those athletes who have suffered head trauma (see traumatic shock).

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**Storage, Handling and Use of Oxygen Cylinders**

Oxygen is an element which at atmospheric pressure exists as a colorless, odorless, tasteless gas. About one-fifth of the atmosphere is oxygen. The outstanding property of oxygen is its ability to sustain life and to support combustion. Although oxygen is non-flammable, materials which normally will not burn in air may burn in an oxygen rich atmosphere. Materials which burn in air will burn more vigorously and at a higher temperature in an oxygen rich atmosphere. Some combustibles, such as oil, burn in oxygen with near explosive violence if ignited by flame, impact, or other energy source.

The characteristics of any gas confined in a closed container are to increase in pressure with rising temperature. Because of this the possibility always exists that a cylinder with gas at a safe pressure at normal temperatures might reach a dangerously high pressure at higher temperatures. To prevent this situation, federal regulations limit the amount of gas that may be charged into a cylinder.

Cylinders should never be allowed to reach temperatures exceeding 130° Fahrenheit, due to the accompanying rise in pressure within the cylinder. Cylinders should never be placed near furnaces, radiators or any other source of heat.

Oxygen cylinders should be protected from abnormal mechanical shock which is liable to damage the cylinder, valve or safety devices. Such a shock may damage the cylinder producing a mechanical explosion. With few exceptions, oxygen cylinders are required by federal regulations to have pressure relief devices. These devices consist of a fragile disc designed to burst under excessive pressure, a core of fusible metal with a low melting point designed to melt and release the gas in case of fire, or a combination of these devices.

All valves on the cylinder should be closed when not in use. The cylinder, valves, regulators, gauges and fittings should always be free of oil and grease. They should never be lubricated with oil or handled by gloves or hands which are contaminated with oil or grease.

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**Rules for Withdrawing Oxygen from the Cylinder**

Oxygen, outside of the hospital setting, is found in a seamless steel or lightweight alloy cylinder containing oxygen at pressures of 2000 to 2200 pounds per square inch (psi). Although cylinders come in various sizes, in the athletic setting the standard size is a “D” size cylinder containing about 350 liters of oxygen. The length of time that a cylinder can be used is based on the pressure in the cylinder and the flow rate. Oxygen cylinders should never be allowed to empty below the safe residual level. The safe residual level is considered 200 psi. It is important to remember that it is not possible to tell how much oxygen is in a cylinder by lifting it.

Compressed gases should be handled only by properly instructed persons following these guidelines:

1) Place the cylinder so that it cannot be knocked over.
2) Remove the valve protection cap, if applicable, just before withdrawing oxygen or connecting cylinder to a manifold.
3) After removing the valve protection cap, open the valve slightly for an instant to clear the opening of dust, being careful to point the valve opening away from any person.
4) Make certain that the oxygen pressure-reaching regulator is connected to the oxygen cylinder. Never use oxygen from the cylinder without the regulator.
5) Make certain that the threads on regulators correspond to those on cylinder valve outlets. Never force connections which do not fit.

6) Never permit oxygen to enter the regulator suddenly. Open the cylinder valve slowly.

7) Always close the cylinder valve when finished. After the cylinder valve is closed, release all gas from the regulator and release the pressure adjusting screw.

**Oxygen Delivering Devices**

There are several oxygen delivering devices in common use for emergency care. For athletic purposes, the nasal cannula and two types of oxygen masks will be explained.

A simple rule to determine the percentage of oxygen being delivered to the athlete is:

For every one liter per minute increase in oxygen flow, there is an increase of 4% in the concentration of oxygen delivered from the cylinder.

**Nasal Cannula**

The nasal cannula delivers oxygen directly into the nostrils through two small plastic prongs (Figure 1). The efficiency of this device is reduced by nasal injuries, colds and other types of nasal obstructions. In common usage, a flow rate of 4 to 8 liters per minute will produce a concentration of 30 to 50% oxygen in the air delivered to the athlete's lungs. The relationship of oxygen concentration to liter per minute flow is:

- 1 liter/minute    24% oxygen
- 2 liters/minute    28% oxygen
- 4 liters/minute    36% oxygen
- 8 liters/minute   52-54% oxygen (after 8 liters/minute the device does not deliver higher concentrations and proves to be uncomfortable for most patients).

**Simple Face Mask**

A simple face mask is a soft, clear plastic mask that conforms to the athlete’s face (Figure 2). There are small perforations in the mask to allow atmospheric air to enter and the athlete’s exhaled air to escape. The mask is used to deliver moderate concentrations of oxygen (35 to 60%) with a flow rate of 6 to 10 liters per minute. With the simple face mask, the administrator should start with a minimum of 6 LPM to avoid the build up of carbon dioxide within the mask. The simple face mask is preferred on trauma patients.

The flow of oxygen in the mask shown in Figure 3 is controlled on demand automatically by the athlete's inspiration or manually triggered by the operator to serve as a positive resuscitator in the performance of cardio-pulmonary resuscitation.

**Partial Rebreathing Mask**

A partial rebreathing mask combines a face mask with a reservoir bag (Figure 4). The mask must fit the athlete's face well and the reservoir bag must be filled with oxygen before the mask is put into place. When the athlete breaths, part of the exhaled air will be mixed with the oxygen in the reservoir bag, while the rest escapes through perforations in the mask. With flow rates of 6 to 10 LPM, concentrations of 35% to 60% can be delivered.

If an athletic department deems it advisable to purchase an oxygen cylinder, the following recommendations are offered:

1) Contact the local first aid squad, team physician or hospital to investigate the unit most appropriate for
2) Provide in-service training so that appropriate members of all medical and coaching staffs have a thorough knowledge of the proper use of the equipment as well as the indications and contraindications of oxygen use.

3) Be prepared to spend approximately four hundred dollars for regulator, gauges, valves, and fittings. The oxygen cylinder must be purchased separately.

4) The unit should have an on-demand valve so that the unit can be used in the performance of cardio-pulmonary resuscitation.

5) Purchase a mask plus a nasal inhalator (make certain that you purchase masks that will fit the population you work with).

6) The regulator valve should provide constant flow as well as be able to administer oxygen on demand.

7) The unit should also be purchased with the capability of providing suction to withdraw any foreign material or vomitious from the athlete’s airway. This is accomplished via a plastic drainage bag attachment.

8) Once you have a unit, work cooperatively with your local first aid unit to ensure that all trained personnel are using all pieces of equipment correctly. There should also be periodical refresher seminars.

9) Check locations where you can get your oxygen cylinder recharged.

10) Remember the explosive nature of compressed gases, including oxygen. Oxygen for emergency care is stored at pressures of 2000 to 2200 psi. If the cylinder is punctured or a valve breaks, the cylinder can become a projectile. Oxygen supports combustion such that a small flame becomes a torch. Avoid its use near any type of flame at all time. Oil when mixed with oxygen will produce a chemical reaction of explosive nature.

11) Follow the manufacturer’s guidelines in cleaning and care of all equipment. Make certain to have all gauges checked as suggested in warranties. Be aware of the life expectancy of the cylinder and make certain to have it checked for leakage and corrosion as per manufacturer’s guidelines.

Acknowledgements

The following persons provided assistance in accumulating material for this article: David W. Hill, Research Associate, Mount Sinai Medical Center, Miami, Florida; John Thatcher, ATC, Head Athletic Trainer, East Stroudsburg State University, East Stroudsburg, Pennsylvania; Robert Sauers, ATC, Athletic Trainer, Rutgers University, Piscataway, New Jersey; and Steven Scott, M.D., Team Physician, Rutgers University, Piscataway, New Jersey.

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Piriformis Syndrome: A Hidden Cause of Sciatic Pain
A. Todd Carter, MS, ATC

Abstract
Low back pain, with or without sciatica, is a common complaint in the training room. Most often, serious structural problems are classified as lumbar intervertebral disc herniation, spinal stenosis or facet syndrome. Treatment such as laminectomy, vertebrae fusion, bed rest and other modalities are then prescribed, often without any success or decrease in pain. Being relatively uncommon, piriformis syndrome is often ignored as a possibility in the diagnosis of low back pain. It is important for the athletic trainer to be able to differentiate piriformis syndrome from other common low back pain problems so that athletes can quickly and safely return to competition.

Piriformis syndrome is characterized by pain and/or disability in the low back, buttocks or posterior upper thigh due to hyperirritability of the piriformis muscle, which consequently puts pressure on the sciatic nerve. The syndrome was first described by Yoemans (6) in 1924 and later expanded by Freiberg (1) in 1937. More recently Pace and Nagle (6) reported that in some cases low back pain may be due to a trigger area in the muscle itself. Previous work has been published in medical journals, however, and thus may not be readily available to athletic trainers, coaches and other professionals providing medical care to athletes. It is the purpose of this article to review piriformis syndrome and provide information on how to evaluate and treat it.

Anatomy
The piriformis muscle arises from the anterior surface of the sacrum, the gluteal surface of the ilium near the posterior iliac spine and the capsule of the sacroiliac joint. It then passes through the greater sciatic foramen and attaches by a rounded tendon to the upper border of the greater trochanter (2) (Figure 1).

The significance of the syndrome is revealed in the fact that the muscle lies in close proximity to the sciatic nerve and its peroneal and tibial branches, all of which innervate the lower extremity. In 85% of the cadavers studied by Robinson, the piriformis muscle lay directly over the tibial and peroneal branches and in 10% the peroneal portion penetrated the muscle. In 2%-3% of the cases, the muscle bisected both branches and in 0.8% both branches laid directly within the muscle itself (8).

Along with the obturators internus and externus, the gemelli and the quadratus femoris, the piriformis is an external rotator of the hip. It also can be considered an abductor of the flexed thigh (9).

History
Obtaining an accurate history from the athlete is the first step in diagnosing any injury, although with piriformis syndrome this may be difficult to achieve. There is no discernible common causative factor in piriformis muscle syndrome. Trauma or history is elicited in approximately half of the cases and the nature of trauma is seldom dramatic (6). In Mizuguchi's (4) study of 14 patients, none reported a history of trauma as the cause of the syndrome although Robinson (7) found a history of a fall on the buttocks can usually be elicited. In female patients, dyspareunia or painful intercourse is often present (6).

Pain is often located over the hip, buttock or low back and usually radiates over the course of the sciatic nerve down the posterior thigh and leg (6). The patient may have difficulty giving the exact site of pain and just proclaim, “it is over my low back and shoots down my leg”. The pain may be intensified after prolonged sitting, getting up from a sitting position, or at night.

The initial injury may be from lifting a heavy object, from a fall or from overuse. Differentiating piriformis syndrome from disc problems, spinal stenosis or other common low back complaints from a history is often too difficult, so the athletic trainer and athlete must have a good communication channel with the attending team physician.
Observation

In acute cases, athletes with piriformis syndrome might not display any observable signs except limping or dragging the limb of the involved side. The lumbar spine’s range of motion is usually good despite the severity of the symptoms.

One important observable sign in chronic cases is gluteal atrophy on the involved side. This is due to the close proximity and involvement of the first and second sacral nerves.

Palpation

Palpation can be a very important tool in differentiating piriformis syndrome from the other common low back problems. The athlete will complain of point tenderness over the sciatic notch in almost all instances (7,8,9,6).

The sciatic notch can be found by having the athlete lie on the unaffected side and by flexing both the involved hip and knee. Next, bisect a line between the greater trochanter and ischial tuberosity. The sciatic nerve and the deep piriformis muscle lie directly below this point (3) (Figure 2). A circular shaped mass may also be felt in this area which is tender to touch.

The medial, intrapelvic portion of the muscle may be palpated more directly, by the team physician, through rectal examination (8). Point of tenderness can be found by either rectal or vaginal examination (5). Once the tender areas have been located, piriformis syndrome may be confirmed with stress procedures.

Stress Test

Stress tests are used once the history, observation and palpation components of the evaluation are complete. One stress test generally positive on the affected side with piriformis syndrome is the Laseque test (4,5,7). This test is performed by having the athlete lie supine while the examiner flexes the involved side’s hip and knee. If positive, pain will be elicited along the back of the thigh and/or over the sciatic notch as the knee is passively extended. The Laseque test is not to be confused with the straight-leg raising test which has the involved knee actively extended as the foot is dorsiflexed.

A more consistent stress test in diagnosing piriformis syndrome is resistance to abduction-external rotation of the hip (5,6,8,9). This test is performed by having the athlete sitting with knees together and his/her feet hanging over the edge of a table. The examiner then resists as the athlete tries to push his/her knees apart (Figure 3). If weakness and/or pain is present and the athlete complains of point tenderness over the sciatic notch area, then piriformis syndrome is likely.

Differential Diagnoses

Piriformis syndrome is just one of many conditions that may lead to low back pain with or without sciatica. The syndrome is not very common (9). Pace and Nagle (9) looked at 750 cases at the Rancho Los Amigos Hospital’s Problem Back Service and found piriformis syndrome in only 45 instances, an incidence of only 6%. Thus, most athletic trainers, coaches and other professionals may not suspect piriformis syndrome when evaluating low back problems. This then may lead to the athlete receiving many unnecessary, costly and useless treatments.

With careful analysis, one should be able to differentiate piriformis syndrome from the other common problems. First of all, however, the athletic trainer and team physician should always be certain that the more serious conditions, such as fractures or dislocations of the vertebrae, have been ruled out.

When comparing piriformis syndrome with the common disc herniations, the physician will usually have a myleogram or discogram taken which will radiographically show if the nucleus pulposes is herniated. When palpating the athlete, pain from herniation is usually over the lumbar spine region and may radiate down both legs while pain from piriformis syndrome is more over the buttocks and usually radiates over only one side.

If point tenderness is bilateral, then spinal stenosis may be suspected. One must also be aware of the other deep hip external rotator muscles near the piriformis which may also impinge upon the sciatic nerve.

Piriformis syndrome is characterized by unilateral hip pain, point tenderness over the sciatic notch with a possible sausage-shaped mass felt, gluteal atrophy and positive stress findings with the Laseque Test and resistance to hip abduction-external rotation. It’s important to remember that not all of these signs and symptoms will be present in all circumstances.
Therapy

Before the recent medical advancements, the treatment for piriformis syndrome was surgical sectioning of the muscle itself (1,4,7). In 1940, Robinson (7) explained a technique in which a five inch incision was made below the sacrosciatic notch after which gluteus maximus fibers were cut to expose the piriformis which then was cut 1½ inches from the greater trochanter. The sectioning of the piriformis does not interfere with any hip movements and causes no disability since the other hip external rotators take up the slack (7). Mizuguchi (4), in 1976, expanded this technique and obtained an 85% success rate by sectioning the piriformis on its tendinous insertion on the greater trochanter.

Today, surgery is no longer the first alternative, as now the deep muscle is directly injected with an anesthetic (2,5,6,8,9). A technique used by Pace (6) has the patient lying on the unaffected side with the involved leg and hip flexed. The muscle is then palpated by either the rectal or vaginal route. Wyant (9) prefers the vaginal route in females. A needle is then inserted and aimed at the piriformis muscle. Once the needle is felt by the palpating finger, the muscle is then injected first with the anesthetic. The physician should then wait five minutes to rule out possible sciatic nerve involvement. The athlete is awake and will let it be known if the sciatic nerve has been hit (9). The second injection consisting of anesthetic with steroid is then administered. Pace and Nagle (7) reviewed their treatment of 45 patients and had success with only two recurrences and no complications.

Other treatment such as rest, ultrasound, the fitting of heel lifts and “spray n’ stretch” have been utilized, but their success ratios have not been reported (2,8). The athlete, athletic trainer and team physician must work together to decide the appropriate treatment. The athletic trainer then can follow the team physician’s directions to safely return the athlete to competition.

References

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Functional Splint for Jones Fracture

A Jones Fracture [fracture of the proximal diaphysis of the fifth metatarsal, distal to the tuberosity (1)] most commonly results from a direct blow or from forced inversion of the foot on an uneven surface. Unfortunately, even after adequate immobilization and restricted weightbearing, there often is delayed union or a non-union of this fracture. This is a result of sclerosis or hardening of the medullary canal, which destroys the processes of bone repair and maintenance (2).

In the case of a delayed union or non-union, the competing athlete may have to choose between surgical fixation or participation with a chronically painful condition. If the athlete does not elect to have surgery, or chooses to delay surgery, a rigid orthosis can be made to allow participation. Following is a guide to construct a functional splint for a Jones Fracture.

This splint allows return to activity with minimal pain and reduces the risk of re-injury. The orthosis serves two purposes: 1) to transmit force along the length of the fractured metatarsal into the adjacent metatarsals, and 2) to stabilize the fracture site. It was worn throughout the 1987 football season by three players, a receiver, tight end and long snapper. The results were very successful in two cases and moderately successful in one case. Although the splint may seem bulky and burdensome, the athletes were able to wear it comfortably in their regular practice and game shoes. One athlete chose to wear the splint routinely in his street shoes.

**Materials**
- pen and paper
- felt-tip marker
- orthoplast material
- 1/4 inch foam or moleskin
- scissors
- file
- hot water

**Methods**

1. Mark the proximal and distal heads of the fifth metatarsal, to use as landmarks when constructing a pattern. Also evaluate the general structure of the medial longitudinal arch (pes cavus versus pes planus). This will aid in molding and shaping the splint into the arch.

2. Construct a paper pattern for the splint. It should be the length of the fifth metatarsal and wide enough to reach from the fifth metatarsal laterally around

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*Figure 1.* Orthoplast splint prior to molding and being covered with moleskin.

*Figure 2.* Lateral view of splint. Note moleskin covering the orthoplast.

*Figure 3.* Medial view of splint. Note the fit of the splint into the arch.
into the medial longitudinal arch. (See Figures 1 & 2)

3. Using the paper pattern as a guide, cut the splint out of orthoplast type material. Mold the splint to the foot following the manufacturer’s instructions. Trim and file the splint for best comfort and fit; be sure to maintain the length of the splint.

4. Cover the inside and edges of the orthoplast with foam or moleskin.

5. Apply to the foot using elastic tape. (Figure 3)

References


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BI-AXIAL DESIGN

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MEDIAL FIXATION

The Medial Fixation Strap accessory system helps to retain the natural alignment of the knee joint. The force from an impact at the knee causes the brace to pull tension on the strap system which in turn pulls the medial pad against the knee in extension. The result is 3 point fixation as shown in the diagram.
A Tip From The Field

Adaptations of Orthotron II: Set-Ups for Elbow Flexion/Extension, Shoulder Internal/External Rotation, and Back Flexion/Extension

Mark Amundson, MS, RPT, ATC

The Orthotron II (Lumex, Inc., Ronkonkoma, NY) is a versatile piece of rehabilitation equipment. It can be used for isokinetic rehabilitation of the ankle, knee, hip, and shoulder joints. Because of an interest and demand to rehabilitate other joints and motions, adaptations of the Orthotron II were developed. These adaptations include the ability to do elbow flexion/extension, shoulder internal/external rotation, and back flexion/extension.

Elbow Flexion/Extension

Elbow flexion/extension can be achieved by having the patient lie in the supine position with the arms and the seat of the Orthotron II pushed completely back. The knee attachment is placed on the input shaft in the hip position and the input shaft is aligned with the axis of motion of the elbow (Figure 1). The length of the attachment should be set so the patient can grasp the shin pad with the hand while the forearm is in a pronated position and the fingers hanging over the edge of the shin pad. The strap is pulled snugly around the dorsum of the hand and the arm stabilized by the athletic trainer grasping firmly over the biceps area and applying a downward pressure (Figure 2).

Shoulder Internal/External Rotation

Shoulder internal/external rotation is done in the supine position with the athlete’s arm abducted to 90 degrees at the shoulder and the elbow flexed to 90 degrees. The knee attachment is aligned with the axis of rotation of the shoulder joint (Figure 3). The attachment is strapped to the athlete’s hand in the same manner as described above for the elbow. The athletic trainer can also stabilize the arm during exercise by grasping the biceps area and applying a constant pressure downward (Figure 4).

Back Flexion/Extension

Back flexion/extension is done in the seated position at the end of the Orthotron II. The two end panels of the Orthotron II, which are movable, are placed in the up position and the athlete hangs the lower legs over the edge of the bench with the feet resting on the base of the...
Orthotron II (Figure 5). The input shaft of the actuator is aligned with the anterior/posterior midline of the lumbar spine at the L5-S1 level (1). The knee attachment with the special hip pad is fixed to the chest by means of a velcro strap placed around the body. If back extension is the focus of the exercise, the pad is best placed on the back rather than the chest. The height of the pad must be set so that during the desired motion there is minimal shifting of the pad either superiorly or inferiorly. This placement is variable for each person and the athletic trainer must experiment with each athlete to achieve optimal positioning. Stabilization of the subject can be done using a strap around the thighs or by the athletic trainer holding down on the anterior thighs (Figure 5).

Conclusion

The adaptations described above are ways of setting up the Orthotron II when the athletic trainer desires to isokinetically exercise an athlete for elbow flexion/extension, shoulder internal/external rotation, or back flexion/extension. These adaptations are specific to the Orthotron II and represent an expansion of the original set ups described by Cybex (2).

References

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The Gore-Tex Anterior Cruciate Prosthetic Ligament: New Questions and Opportunities In Anterior Cruciate Management

Jennifer Carstens

Abstract

The Gore-Tex Anterior Cruciate Prosthetic Ligament (ACPL; Gore-Tex is a Trademark of the W. L. Gore Company) is a new and tremendously controversial option in management of anterior cruciate ligament (ACL) instability. The graft is indicated by the F.D.A. for salvage procedures, but it is available for primary use also. There are many factors that must be evaluated when an athlete is considering an artificial graft to regain stability of the knee. Design, mechanical properties, clinical results, complications, and surgical procedures are functions of the graft that must be investigated. Longevity, functional graft qualities, performance, advantages, disadvantages, and reconditioning protocol are all characteristics that can help the athlete make the most advantageous and educated decision for his or her individual situation. The goal of managing ACL injuries with any graft, artificial or natural, is to effectively return the athlete to competition and maintain knee stability for the rest of his/her active years.

An acute or chronic injury to the ACL for any individual poses questions as to which method will return the athlete to normal functional stability. For competitive athletes their original, normal functional stability can be more difficult to return to after injury to the ACL. In the Fall of 1986 the F.D.A. approved one more option for returning the ACL deficient knee back to normal functional stability. The Gore-Tex Anterior Cruciate Prosthetic Ligament (ACPL) has brought a new dimension of questions and issues. The Gore-Tex prosthesis has some tempting advantages over previous methods of management, but it also has some uncertainties and questions as to its functional use.

Graft design, mechanical properties, and short-term clinical data can all be objectively evaluated. Data gathered from long-term clinical results, the extent of complications, and a clear understanding of the advantages and disadvantages is much more difficult to address. These limitations, at present, restrict F.D.A. approval to last-resort procedures. However, this does not limit the functional use of the graft. An athlete considering a Gore-Tex ACPL to manage instability as a primary or secondary procedure must have as much valid relevant information as possible to make a decision in his or her best interest.

Graft Design

The device is manufactured in lengths from 16 cm to 24 cm long. It is made of one continuous looped, braided strand of polytetrafluoroethylene (PTFE). The prosthesis is looped over 180-190 times, divided in three bundles, and braided. Eyelets are formed at each end through a process of heat and compression and make up the strongest portion of the graft. The ligament is made of one continuous strand, with no free ends other than the two of the original single strand (Figure 1)(3). The microstructure is solid PTFE nodes connected by thin, flexible filaments. The internodal distance is about 60 micrometers and the graft is about 70% air by volume (1). This expanded polytetrafluoroethylene is one of the most inert polymers and biocompatible materials known. It is not thought to be broken down or catabolized by the body and will remain in place most effectively if the knee is kept at 90 degrees for at least 6 months. If the knee is allowed to become hyperflexed, the graft can begin to slide. An athlete must follow a strict rehabilitation protocol with the guidance of a physical therapist to achieve proper stability and a successful outcome.

Jennifer Carstens is a third-year student athletic trainer at Washington State University, Pullman, Washington, completing undergraduate degrees in General Physical Education and Athletic Training.

*Gore-Tex is a Trademark of the W. L. Gore Company
body. It is a strong, porous material that has been successful in vascular grafts, sutures, and cardiovascular patches (3).

![Figure 1](image1.png)

**Figure 1.** Macro- and micro-structure of the Gore-Tex Anterior Cruciate Ligament Prosthesis. Courtesy of the W. L. Gore Company.

**Figure 2.** Incidence of return to activities of daily living with the Gore-Tex ACPL. Courtesy of the W. L. Gore Company.

**Indications and Contraindications for Use**

The current Gore-Tex ACPL is indicated for use as a permanent replacement for the anterior cruciate ligament (ACL) of the knee in those patients who have had at least one failed autogenous intra-articular reconstruction of their ACL (5).

The use of this device is contraindicated 1) in knees with incomplete closure of the epiphyseal plate. In questionable cases, skeletal maturity should be radiographically documented; 2) in the presence of systemic infection or localized infection near the affected knee (5). In addition to the contraindications for use, posterior cruciate ligament instability cannot be managed with the Gore-Tex ACPL. The graft is intended to be used as a long-term replacement of the ACL. The Gore-Tex ACPL is a true prosthesis because it does not require intra- or extra-articular repair or reconstruction for strength. Due to its design, the ligament provides immediate stability when it is implanted and does not require additional host tissue growth for strength (1).

Open or arthroscopic surgical techniques are both effective for correct placement of the device. In compliance with F.D.A. guidelines, all surgeons using the Gore-Tex ligament have been trained by the manufacturer to use the prostheses through a series of workshops and instructional sessions.

**Mechanical Properties, Clinical Data, and Complications**

The Gore-Tex ACPL has been compared to the human ACL in mechanical testing in many areas. Most important similarities are tensile strength, design, and longevity. One mechanical difference between the Gore-Tex graft and the natural ligament is that ACL strength is positionally dependent. Strength of the Gore-Tex is not dependent on the position of the knee. The human ACL can withstand tensile forces up to 1,730 Newtons (N) in full extension, and 690 N at 60 degrees of flexion. The Gore-Tex graft averages 4,830 N ± 28 N throughout a full range of motion. The Gore-Tex graft absorbs up to 4,300 N of tensile strain, with only 8%-10% elongation at failure (3).

Longevity has been determined with a bending fatigue test. The graft was placed on an apparatus similar to the tibiofemoral configuration experienced in vivo. This included a 1.5 mm bending point and a 12.7 mm roller oriented at the same angles of an actual knee. The graft was loaded under the same physiologic force the knee naturally experiences. Longevity of the graft was estimated at 20 years in an 84 million cycle bending
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fatigue test. Twenty years is based on the number of times a normal knee is flexed and extended in a year. Reduction in tensile strain after 84 million cycles was only 25% (3). Other mechanical testing has proven the ligament in the equivalent of 50 years, without any broken strands or stretching (2). It is unknown whether the graft will perform like this in the joint.

Clinical data were drawn from 186 of 1,021 patients who received the graft in a two-year clinical trial. Approximately 28 objective and subjective criteria were used to evaluate the two-year data. Subjective criteria included: change in stability, pain, giving way, ascending and descending stairs, range of motion, overall knee status, and complications.

Of the 187 various injuries in the study, 62% occurred in sports as outlined in Table 1 (5).

Return to daily activities improved 69% from preoperative to 41 months postoperative (Figure 2) (5).

At 26.2 months, postoperative knee status was rated as improved in 92% of 158 patients. Overall knee status was rated as worse by 4%, 26.2 months postoperative. In the remaining 4%, knee status was rated as unchanged (3).

Complications over a three-year investigation included: device failure, instability, infection, effusion, screw revision, and other associated problems. In the three-year investigation, complications occurred in 20.9% of the 187 grafts. (Some patients experienced more than one complication, therefore, the data are not additive.)

Complications over a three-year investigation included: device failure, instability, infection, effusion, screw revision, and other associated problems. In the three-year investigation, complications occurred in 20.9% of the 187 grafts. (Some patients experienced more than one complication, therefore, the data are not additive.)

Table 1
Overview of Injuries in Clinical Trials (5)

<table>
<thead>
<tr>
<th>Injuries</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Football</td>
<td>33</td>
</tr>
<tr>
<td>Skiing</td>
<td>21</td>
</tr>
<tr>
<td>Basketball</td>
<td>19</td>
</tr>
<tr>
<td>Baseball</td>
<td>10</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>5</td>
</tr>
<tr>
<td>Soccer</td>
<td>4</td>
</tr>
<tr>
<td>Tennis</td>
<td>4</td>
</tr>
<tr>
<td>Other Sports</td>
<td>20</td>
</tr>
<tr>
<td>Trauma</td>
<td>49</td>
</tr>
<tr>
<td><strong>Total Injuries</strong></td>
<td><strong>187</strong></td>
</tr>
</tbody>
</table>

Table 2
Summary of Complications Reported Up to 36 Months (5)

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Instability</td>
<td>11.90</td>
</tr>
<tr>
<td>* Effusion</td>
<td>8.93</td>
</tr>
<tr>
<td>** Other</td>
<td>2.05</td>
</tr>
</tbody>
</table>

*Sufficient to require surgical intervention.

**Includes operative complications, intra-operative fractures, postoperative fractures, and wound flap necrosis.

Numbers of devices under observation for this ranged between 118-122.

What Can Be Expected in a Gore-Tex Repair

The steps immediately post-injury through returning to full functional ability are similar to the process of an autogetic reconstruction. Surgery is usually about an hour and fifteen minutes to an hour and forty-five minutes depending on the other structures involved. A notchplasty, or widening of the intercondylar notch, is performed to prevent the femur from impinging on the graft. The amount of bone removed from the notch varies, as does natural notch width among individuals. Approximately 3-5 mm of the medial aspect of the condyle is removed to allow adequate room for the graft to pass properly, without impingement. All bony areas of the graft passes over are reamed or chamfered. This inhibits abrasions and sharp edges from causing a premature weakening of the graft.

The graft is routed through a tibial drill hole allowing it to pass through a similar anatomical position the natural ACL experiences. The graft is then routed through the joint space, out the posterior capsule, and “over-the-top” of the lateral condyle of the femur (6). The femoral tunnel is drilled in an area that will allow the graft to pass through the popliteal surface before entering the tunnel.

Continuous Passive Motion (CPM) is started immediately in recovery, to begin early range of motion, and overload pain receptors. These steps decrease pain medication dosage earlier. Extended immobilization and bracing are not needed due to the immediate strength characteristics of the graft. Some patients have been known to leave the hospital the same day with or without the use of crutches.

The reconditioning process begins immediately post-surgery with the CPM machine and continues with cautious, additional ROM work, strength exercise, and daily activity until sutures are removed. Once incisions heal, the reconditioning proceeds as rapidly as pain will allow.
How Does the Gore-Tex Work?

The Gore-Tex prosthesis works to stabilize the tibiofemoral joint by changes in the knee through the full range of motion. Similar to the human ACL, the prosthesis varies in tension from full flexion to full extension. This is partially due to its braided configuration and its position in the joint (Figure 3) (4).

The angle that the graft experiences the greatest tensile strain is in full extension. At full extension the ligament takes on an elongated “S” shape at the interossseous drill tunnel sites. As the graft approaches 20 degrees ROM tensile strain begins a decrease in intensity. The graft changes shape to an almost straight position. As flexion continues through to 90 degrees, the prosthesis takes on a slightly curved position. Through this ROM, the graft decreases in tensile strain and posterior cruciate ligament (PCL) tensile strain increases. The prosthesis assumes more tensile strength at full extension than at full flexion, to prevent impingement of the graft. This position of the graft in the knee deters premature fiber fraying that can lead to early failure.

Federal Drug Administration Guidelines

The F.D.A. is the Federal governing and reviewing body for safety and efficacy of new medical products and drugs. A product like the Gore-Tex graft must be proven safe and effective in clinical investigations before it is released for use in the general population.

Safety simply means that all elements of the graft have been proven biocompatible with the body. Efficacy is a bit more difficult to define. Efficacy can be determined by the performance of the graft. The degree to which the graft performs as outlined by the investigator determines how effective it is (12).

Efficacy, defined in this manner, allows the investigator to take the most favorable data and establish uses based on advantageous information (10).

The Gore-Tex ACPL is indicated as a salvage procedure and is contraindicated in cases of incomplete epiphyseal plate and infection. Using the Gore-Tex graft in a primary procedure has been a source of controversy since the graft first gained F.D.A. approval. The Gore-Tex ACPL has advantages and disadvantages, to be discussed later, that make the issue of use as a primary procedure difficult.

The term “unapproved” use can range from unstudied use to thoroughly studied, but detrimental use (11). Unapproved uses of the Gore-Tex are listed as contraindications and were discussed earlier. A decision by a physician to use a product outside labeled, indicated technique can still be considered good medical practice if three steps are accounted for:

1. The physician is educated with current, relevant information about the product or procedure;
2. Theory for use is based on solid scientific evidence and patient interest; and
3. Patient records regarding the use of the device or procedure are maintained (7).

Advantages of the Gore-Tex ACPL

Technology in regaining ACL stability has dramatically changed recently. The Gore-Tex ACPL has many advantages based on sound principles of joint instability, surgery, morbidity, and healing. There is obviously a need for another option other than the presently accepted methods. If all biologic grafts or procedures were completely successful for all individuals, there would be no need to develop new solutions. The Gore-Tex ACPL is not a revolution in ACL management, rather a step in the evolution of returning stability to the knee.

The three most important advantages of the Gore-Tex ACPL include:

1. Surgical implantation;
2. Reconditioning time;

Ultimately, the athletes’ best interest is the biggest consideration. If a surgeon feels they are this skilled with an arthroscope, the long-term morbidity will be decreased. The proprioception components, vascular structure, synovial membrane, articular cartilage, and surrounding soft tissue are not as disrupted surgically and immobilized until they heal. The delicate environment of the knee is not entered like an open procedure, potentially decreasing adhesions and scar tissue. The purpose of reconstructing the ACL is to restore natural, stable biomechanics. A goal of the developers of the prosthesis was to allow a relatively simple and atraumatic method of implantation (1). Arthroscopic placement of the graft accomplishes this goal as the morbidity of a complete arthrotomy is, for the most part, avoided.

Another important consideration of the Gore-Tex ligament is the reduced reconditioning period. In an intra-articular biologic reconstruction the reconditioning period can last 9-12 months before complete return to activity. For extra-articular procedures, the activity time loss can be 4-6 months. In both procedures the reconditioning process is long, mentally demanding, and often painful. The period spent away from teammates, coaches, and activity can have compounding effects. Six to twelve months away means the individual has to deal with re-educating the injured limb, as well as learning proprioception, coordination, timing, execution, and balance again. For the athlete, a fraction of a second or deviation of foot placement can mean the difference between a successful and an unsuccessful execution. The Gore-Tex ACPL can provide an earlier
return to activity, reducing the effects of prolonged reconditioning.

Due to Gore-Tex ligament's inherent strength, the athlete can work at his or her reconditioning program with unlimited determination and effort as the knee can tolerate. This scenario is very similar to how athletes perform in their activity. Their success is based on their efforts. For injured athletes, with the Gore-Tex ACPL, progress is generally in their control and not limited by ROM stops, strength gains, or isolated muscle groups. Reconditioning can be much more aggressive and their return to functional activity is much more rapid. Inherent graft strength permits the athlete to immediately start reconditioning since the graft has peak strength at implantation. Revascularization and tissue ingrowth are not necessary for graft strength. Only other damaged structures and operative incisions limit reconditioning.

Other advantages of the Gore-Tex ACPL include:
1. All natural tissues are still available if a biologic graft is necessary in the future. This is not possible with a primary natural graft. Structures are exhausted as they are harvested to regain stability (9).
2. If the graft fails prematurely or expires over time, reimplantation is relatively simple and atraumatic compared to secondary autogenous surgical procedures. Theoretically, it would be possible to have four Gore-Tex grafts in the same time period of one natural reconstruction.
3. The bending fatigue test estimates the graft has approximately 20 years of functional longevity. Orthopedic technology is increasing at a rate faster than the anticipated life of the graft. If a graft were to fail prematurely, it is likely improved methods of managing ACL instability will be available.
4. The history of prosthetics is very unsuccessful, but that does not mean the Gore-Tex ligament is also following this reputation. The Gore-Tex is a step in the evolution of ACL stability, not a detrimental revolution.

Disadvantages of the Gore-Tex ACPL

The Gore-Tex prosthesis is not the ultimate answer in improving tibiofemoral joint instability. It is a step in the right direction, but still has some difficult questions that remain unanswered. Unknown facts can turn this option of ACL instability management into a gamble. Among these unknown variables are:
1. Anticipated return and degree of disability;
2. Possible sacrifice of full extension;
3. Misconception of prosthesis capabilities in ACL instability management.

Presently, longevity and long-term success are unknown. Being inert, the graft will decrease in strength and eventually break. The Gore-Tex passes over too many bony surfaces to maintain strength over time. Naturally, when a ligament is irritated, torn, or frayed, it can be repaired with proper care. This is not possible with any artificial graft. Graft design and implantation gives it immediate ultimate strength that decreases with time. Extent and degree of tensile strength loss is, at present, unknown.

When the prosthesis is inserted, the knee is in 20 degrees of flexion. Potentially the graft can elongate over time, as demonstrated in the bending fatigue tests. If the graft were positioned while in full extension, instability could return prematurely. It is possible to lose almost five degrees of ROM due to the implantation of the knee (10).

It is not likely that extension loss this small will physically limit functional or athletic activity because the only real need for 0 degrees of flexion is standing still. Even so, it is an additional characteristic with unknown factors. Extent and degree of lost ROM, if any, cannot be predetermined in any case. As part of the implantation procedure, full ROM tests are performed. A small loss is still possible due to knee position necessary for graft tensioning.

Gore-Tex grafts are capable of returning immediate joint stability. The graft is not capable of immediately returning the athlete to previous activity, or changing the fact that the injury has occurred. The Gore-Tex graft has some tempting advantages over autogenous reconstructions, but it is not an overnight functional return. The athlete will still experience pain, morbidity, a reconditioning process, and increased awareness of the knee in activity. The athlete will still experience future characteristics typical of surgical repair; increased risk of tendinitis, sensitivity to weather changes, etcetera. The Gore-Tex ACPL does not erase the fact that the ACL has been torn. Other disadvantages of the Gore-Tex ACPL include:
1. Neither a natural or artificial is a guarantee that the athlete will return to activity. There have been a number of successful and unsuccessful attempts at regaining stability with both natural and artificial grafts.
2. If an artificial graft is attempted, there is a good possibility that it will not last the life of the individual. Therefore, instability may return again at some point in the athlete's life. It is difficult to tell whether at that time the instability will be a disability (9).
3. It is possible that overall reconditioning is typically a single, concentrated method. Autogenous reconditioning is typically a single, concentrated process. More than one short duration reconditioning process may be necessary as Gore-Tex grafts have the potential to periodically fail.
4. The Gore-Tex ACPL is designed to correct ACL instability only. If an athlete damages multiple structures in the knee, a Gore-Tex graft will only solve part of the instability.
5. No matter what procedure is attempted, the athlete's knee has been permanently changed, although functional stability will most likely return.

Conclusion

The evolution of ACL management has brought us to synthetic ligaments. It is doubtful that in the near future the technology will completely reverse itself and artificial ligaments will become a thing of the past. As athletic trainers, we need to be sensitive to the needs and questions athletes have when their ACL is torn. The Gore-Tex and other artificial options are readily available and athletes are requesting them. An athlete determined to have a new or controversial procedure will seek a surgeon that sees his or her situation in the same light. The question of the medical and ethical issues associated with the Gore-Tex is not as important as providing the athlete with the most recent and correct information available. It is up to the athlete to decide the legal and ethical issues involved in what is done with his or her unstable knee. The role of the athletic trainer is to present as much valid information as possible. It is easy to become involved with sensationalized treatments or popular theory. It is important that all options are
presented and evaluated properly, based on sound medical principles. There are still very valid questions that must be addressed no matter what graft, artificial or synthetic, is used to correct ACL instability. Athletes can evaluate advantages and disadvantages, apply these to their present situation, and determine their long-term activity goals. It is important that athletes have as much information about the design, structure, surgical procedure, longevity, and complications involved in order to make the right decision in management of their ACL instability.

References
The American Red Cross addresses the most often asked questions about AIDS and the workplace:

**CAN AN EMPLOYEE WITH AIDS INFECT OTHER EMPLOYEES?**

The AIDS virus cannot be spread by everyday contact in the workplace. An employee with AIDS can infect another employee only if they have sexual contact or share intravenous drug needles.

**CAN THE AIDS VIRUS BE SPREAD BY USING A TELEPHONE OR WATER FOUNTAIN?**

No. The AIDS virus is not spread through air, water, or on surfaces, such as telephones, door knobs, or office machines. The virus is spread mainly through an exchange of body fluids during sexual activity, or the exchange of blood as occurs through sharing contaminated IV drug needles.

**SHOULD I PROVIDE OR DESIGNATE SEPARATE BATHROOM FACILITIES FOR EMPLOYEES WITH AIDS?**

There is no need to. The AIDS virus is not spread through ordinary use of toilets, sinks, or other bathroom facilities.

**CAN I TELL IF SOMEONE IS INFECTED WITH THE AIDS VIRUS?**

There are many carriers of the virus who do not have the symptoms or signs of the disease and may or may not develop the disease. A carrier of the AIDS virus can infect other people but not through ordinary workplace contact.

**WHAT IF I TOUCH A COWORKER WITH AIDS WHO HAS A BLEEDING CUT?**

There is no reason to believe that AIDS could be spread this way. Whether a person has AIDS or not, all open, bleeding cuts should be taken care of by observing good health and hygiene practices.

**HOW SHOULD EMPLOYEES WITH AIDS BE TREATED?**

On a day-to-day basis, treat them normally. You and your employees should learn about AIDS, and when dealing with their problem, use compassion and understanding.

Above all, remember...

**AIDS IS HARD TO CATCH.**

This information is based upon data from the U.S. Public Health Service. For more information, call your local health department, the Public Health Service Hotline (1-800-342-AIDS) or your local Red Cross Chapter.

Or, if you’re interested in an educational program about AIDS for your company, call your local health department or your local Red Cross Chapter.

**WE WANT YOU TO KNOW AS MUCH ABOUT AIDS AS WE DO.**

American Red Cross
LETTERS TO THE EDITOR

continued from page 211

Bob Gray, ATC
Sports Medicine Centre
5800 Cooper Foster Park Road
Lorain, Ohio 44052

Sincerely,
Robert S. Gray, ATC
Chairman, Audio Visual Aids Committee

March 25, 1988

Dear Mr. Yates

Just recently, I had the opportunity to read a Journal article by Barker (1) that described the evaluation, treatment, and rehabilitation of selected ulnar neuropathies. After a close scrutiny of the material presented, I feel obligated to share some of my concerns regarding Ms. Barker’s publication.

My first concern addresses the fact that Ms. Barker’s article failed to document the prevalence of ulnar neuropathies in athletic populations. Although she did cite one study, I would have appreciated information relevant to the populations served by athletic trainers.

My second concern addresses the fact that Ms. Barker failed also to adequately research the potential consequences of cryotherapy use in neuropathy management. Both experience and research (2,3) have shown that the use of cryotherapy, specifically ice, for the treatment and/or management of neuropathies is contraindicated, and any use should be modified significantly in order to prevent further exacerbation of the problem. I hope these concerns are validated by other readers.

Respectfully submitted,
J. Terry Parker, MS, ATC - Examiner
140 Dorothy Drive
McKinney, Texas 75069

References


27 May 88

Re: Athletic Training, Volume 23, Number 2

Student Trainer Corner

In Mr. Widner’s article “Thoracic Injuries: Mechanisms, Characteristics, Management” in the aforementioned Journal, I’m curious to know if the charts on page 150 were intentionally incomplete. It didn’t prove very difficult to complete them, but inasmuch as the article was designed for students, it would appear that they would have been better served by having the author complete the charts.

Again, primarily because the article was intended for students, I would like to make one or two comments about the content of the article.

On page 149, in discussing Sternal Fractures, Mr. Widner mentions a “flail chest.” Although relatively uncommon in athletics, a flail chest is, in and of itself, a potentially life-threatening situation. In many cases, if not most, a flail chest can be recognized (visually, or at least tactilly) by the asymmetrical rise and fall of the chest. If a flail chest is evident, the quickest, safest, and most efficacious method of immediate care is the “laying on of hands” (manually stabilizing the flail segment). Although “... adhesive taping, light sand bags, or pillows ...” are all effective, they require acquisition, and application, time. The use of hands to stabilize the flail segment will buy you the time necessary for the application of these other methods of stabilization. This may appear to be a small point, but having worked as a primary care-giver in a community hospital Emergency Room for 7 years, I’ve been on the “receiving end” of more than one flail chest that was delayed in transit while people gathered and applied the equipment necessary for stabilization. A delay secondary to equipment is unacceptable. Until definitive care can be provided, in an appropriately equipped emergency facility, hypoxia will increase, arterial blood gasses will deteriorate, and the likelihood of pneumothorax, secondary to puncture, will remain a very real threat. These problems can be minimized by simply using a caregiver’s hands to stabilize the chest while others gather sandbags, which can then be applied, and fixed, in transit.

This next comment may appear to be “nit-picking” on my part; however, in discussing Rib Fracture, Mr. Widner indicates that the “... first type is the nondisplaced or greenstick fracture,...” Whether it’s supposed to read as it does, or not, the phrase implies that nondisplaced fractures are greenstick fractures. By definition, greenstick fractures are fractures in which cortical bone appears intact on, in most cases, the concave side of the fracture. Accordingly, greenstick fractures are nondisplaced fractures, but not all nondisplaced fractures are greenstick fractures. As I indicated, it may be a mute point for an Athletic Trainer, but I feel it’s important that students realize the difference. After all, the physician and the Athletic Trainer must be able to communicate, and that dictates a standard vocabulary. As an educator, I’m insistent that all students, regardless of their discipline (I work with Physician Assistant, Sports Medicine, Nursing and Physical Education students), “Say what they mean, mean what they say, and understand what they’ve said.”

I would hope that if Mr. Widner sees this letter he understands, I’m not taking issue with him. I feel strongly that the article was one that needed to be written and I feel that he did an admirable job. Nonetheless, I felt that, for the sake of the students, these comments were necessary.

Thank you for your time and cooperation in this matter.

Sincerely,

Brian P. Dean, PA-C
Alderson-Broaddus College
Health Sciences Division
Medical Science Department
Philippi, WV 26416
(304) 457-1700, x-283

TO: Steve Yates
FROM: Jerry Bell, Chair
Board of Athletic Trainers
Department of Professional Regulation
RE: ILLINOIS ATHLETIC TRAINERS
PRACTICE ACT

The requirements to practice athletic training in Illinois are:

1. NATA Certification
2. 800 hours of clinical training
3. Transcript providing documented coursework of:
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   B. Physiology
   C. Physiology of Exercise
   D. Applied Anatomy and Kinesiology
   E. Psychology (2 courses)
   F. First Aid and CPR or equivalent (Red Cross Standards)
   G. Nutrition
   H. Remedial Exercise or Therapeutic Exercises
   I. Personal, Community, School Health
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   K. Advanced Techniques of Athletic Training (modalities, administration).

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Department of Professional Regulation
320 West Washington, 3rd Floor
Springfield, IL 62786
(217) 785-0800

Visiting Team Athletic Trainers are excluded.

If you could please publish this in the Journal, it will help us a lot. Thanks.

Gerald Bell
UNIVERSITY OF ILLINOIS
Sports Injuries Research
216 Freer Hall
906 S. Goodwin
Urbana, IL 61801

---

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Camp Turtle Boot Protects Casts in Wet, Cold Weather

The Turtle Boot, an insulated boot designed to protect both plaster and synthetic casts, is now available from Camp International, Inc., of Jackson, Michigan. The Turtle Boot features high-density, neoprene rubber construction, covered with waterproof nylon to keep the patient’s foot warm and the cast dry in any weather. Elastic construction permits the patient to easily slip the boot on and off over almost any shape of cast without the use of laces, belts or straps.

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262 Athletic Training • Fall 1988
Association Activities

David G. Yeo, DPE, ATC

1988 NATA Awards and Scholarships

One of the most important features of the NATA National Convention is the recognition given to respective athletic trainers and physicians at the Annual Awards Banquet. It is extremely necessary that the Association extends proper thanks and congratulations to selected individuals for their significant achievements and valuable leadership over the years. Because so many individuals are worthy of these special awards, sincere thanks and praise go to George Sullivan, Chairman of the NATA Honor Awards Committee and the committee members, and the NATA Board of Directors for their extensive review and careful deliberation of the nominations for the awards.

1988 Scholarship Awards

The future leadership of the NATA clearly lies with the outstanding undergraduate and graduate students in our athletic training programs. The Association is pleased to recognize these exceptional students at the annual William E. Newell Student Trainer Awards Banquet with the presentation of specific grants and scholarships.

The difficult task of selecting the scholarship winners was accomplished through the diligent efforts of the NATA Grants and Scholarship Committee:

Frank George, Chairman, Brown University
Robert H. Gunn, Lamar Consolidated High School
Lindsay McLean, San Francisco 49'ers
Charles Moss, Boston Red Sox
Jerry Rhea, Atlanta Falcons

The Committee, and the entire NATA, acknowledge the excellence and achievements of the recipients of the scholarships, and in congratulating them encourage the students to maintain their high standards and hard work.

1988 Scholarship Awards

Eddie Wojecki 1988 Achievement Award
Daniel R. Souza, University of North Carolina at Chapel Hill

Undergraduate Scholarship Awards
Cynthia L. Keim, Boston University
John A. Vidrigh, Arizona State University
Ronald W. Courson, Medical College of Georgia
Cathy J. Heyde, University of Oklahoma
Patricia G. Krupka, Michigan State University
Lana R. Lykins, McMurry College

Robert H. Gunn Scholarship Award
Michael A. Chisar, California State University Fullerton

Sayers J. Miller, Jr. Scholarship Award
Paul A. Sheets, University of Nebraska-Lincoln

Chuck Cramer Scholarship Award
Anna M. Boll, Ohio University

William F.X. Linskey Scholarship Award
Lynnette Y. Schwartz, East Carolina University

William E. Newell Scholarship Award
Thomas Lange, Mankato State University

Otho Davis Postgraduate Scholarship Award
Robert W. McLeary, University of Northern Colorado

Del C. Humphrey Postgraduate Scholarship Award
William D. Gerhart, Lock Haven University

G. E. “Moose” Detty Postgraduate Scholarship Award
Jennifer Barnes, Brigham Young University

Protek Toe Products Postgraduate Scholarship Award
Laura A. Schmitt, West Chester University

Richard Ray, Jr., Hope College

Richard Vandervoort Memorial Scholarship Award
Catherine Ortega, Texas Women’s University

Edward Block Memorial Courage Postgraduate Scholarship Award
Jacqueline K. Wise, University of West Virginia

Postgraduate Scholarship Awards
Benjamin E. Reed, Marietta College
Fawn R. Gleckner, Ithaca College
Debra K. Crall, Central Michigan University
Patrick J. Gall, University of Montana
Scott T. Doberstein, University of Wisconsin-LaCrosse
Scott R. Sailor, California State University-Fresno

1988 Annual Student Writing Contest
Jennifer Carstens, Washington State University

Copies of articles from this publication are now available from the UMI Article Clearinghouse.

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300 North Zeeb Road, Box 91 Ann Arbor, MI 48106
District Scholarship Award Winners

Joseph Abraham Award
Julie Person, University of Lowell (MA)
David Smith, California University (PA)

Koko Rasabian-Arrowhead Athletics Scholarship Award
Peter Wheeler, Plymouth State University

Micro-Biomedics Scholarship Award
David Gerhart, Lock Haven University

Edward Block Curriculum Scholarship Award
Deidre Leaver, East Carolina University

A.C. “Whitey” Gwynne Internship Scholarship Award
Jeffrey A. Wood, Salisbury State University

Larry Sutton Memorial Postgraduate Scholarship
Memory E. Dossenbach, Appalachian State University

William E. “Pinky” Newell Living Memorial Scholarship
Richard Ray, Hope College

Great Lakes Athletic Trainers’ Association Undergraduate Living Memorial Scholarship
Debora Klinger, Western Michigan

Great Lakes Athletic Trainers’ Association Graduate Living Memorial Scholarship
Timothy Carver, Purdue University

NATA District 5 Memorial Scholarship
Rebecca Domeyer, Loras College
Cheryl Appleberry, Southwest Missouri State

Memorial Undergraduate Scholarship Award
Sara Iabee, University of Southern Mississippi

Memorial Graduate Scholarship Award
Gerald White, Northeast Louisiana University

Naseby Rhinehart Undergraduate Scholarship Award
David S. Meisner, Western Montana College

Bill Robertson Postgraduate Scholarship Award
Peter Harmer, University of Oregon

Swede-O Universal Scholarship Award
Beverly Blair, Connecticut State

Carl F. Krein Receives NATA Distinguished Athletic Training Educator Award

Carl F. Krein, Head Athletic Trainer at Central Connecticut State University, was presented the Sayers J. Miller, Jr. Distinguished Athletic Training Educator Award at the NATA Awards Banquet in Baltimore in June. Krein joins previous elite winners William E. “Pinky” Newell, Phil Donley, Joe Gieck, and Robert Behnke in receiving one of the Association’s most prestigious awards.

Krein received a Bachelor of Science degree in Physical Education from East Stroudsburg State University in 1963, a Physical Therapy Certificate from The Ohio State University in 1964, and Master of Arts degree in Physical Education from the University Connecticut in 1970. From 1964-66, Krein served as the Athletic Trainer and Physical Therapist for the State University of New York at Potsdam. Since 1969, Krein has been the Head Athletic Trainer and Physical Therapist for Central Connecticut State University, and a Home Care Physical Therapist for New Britain General Hospital.

Krein has an exemplary record as one of the Association’s leaders in athletic training education. He has been a subcommittee chairman of the NATA Board of Certification, Vice-President of the Eastern Athletic Trainers Association from 1982-84, President of the EATA from 1985-87, and Program Chairman for the

EATA in 1984 and 1985. He has served on the CCSU Drug and Alcohol Task Force, and has been Chairman of the CCSU Drug Education and Testing Committee. Krein is a member of the NATA Athletic Safeguards and Protective Equipment Committee, an active member of the Connecticut State Medical Society, and is a liaison for the Connecticut Athletic Trainers Association.

Carl Krein has distinguished himself as an outstanding educator for over 20 years. His numerous professional presentations as clinician and speaker include addresses at physical therapy association meetings, state athletic training and physical education conferences, coaches’ clinics, radio programs, and major college and university sports medicine conferences. His publications and extensive community service in athletic training endeavors add to the scope of his significant contributions.

Currently a full professor of Physical Education for the graduate and undergraduate faculty at CCSU, Krein’s internship program in athletic training consistently has produced students who become successful certified athletic trainers. The highest accolades for an individual receiving the NATA Distinguished Athletic Training Educator Award must come from the respective students of the award winner, and Krein’s students speak of him with exceptional praise. Carl Krein is known as a consummate professional in the classroom and lab setting, receiving acclaim in his knowledge, preparation, organization, and teaching skills. Perhaps most important is his reputation for caring for students and showing a sincere interest in their total education and university experience.

The NATA is very proud and privileged to present the 1988 Distinguished Athletic Training Educator Award to Carl F. Krein.
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In vitro studies reported in the literature have shown NONOXYNOL 9 to be active against the Human Immunodeficiency Virus (AIDS virus). It is recommended that, because of today's added health risks, the complete infection control procedures set forth by the Centers for Disease Control be closely followed.

1 LANCET, Dec. 21/28, 1422, 1985
2 Recommendations for Prevention of HIV Transmission in Health Care Settings. Centers for Disease Control. MMWR 36: (suppl. #2S), 1987

In vitro activity does not necessarily correlate with in vivo effectiveness, and the clinical significance of this in vitro activity is unknown. It must be remembered that by far the most common means of spread of this virus is by sexual intercourse, followed by parenteral exposure to contaminated blood or blood products, and prenatal transmission from infected mother to offspring. Therefore the significance of the role of antiseptics in the prevention of AIDS remains to be evaluated.

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1961 Charles Yocum
1986 William Tinsley Youmans, M.D.

District News

District 1

The Cramer “EATA Athletic Trainer of the Year” award was presented to Joe Camillone of Trenton (NJ) State College for his contributions to the EATA as Past President and former chair of the Scholarship Committee.

The Micro Bio-Medics Scholastic Athletic Trainer Award was presented to Robert Dukhardt, an athletic trainer at The Berkshire School in Sheffield, MA. Bob has served as an officer of the Athletic Trainers of Massachusetts, and has been active in his community’s anti-drug program.

District 4

Ohio Athletic Trainers Association “Trainers of the Year”:

High School - Bill Mohn, Solon High School
College/University - Billy Hill, The Ohio State University
Clinical/Professional - Gary Giffen, St. Elizabeth’s Medical Center

District 5

Lindenwood College in St. Charles, Missouri announced at its annual Commencement a gift of $600,000 from Dr. Harlen C. Hunter, an Advisory member. This second largest single gift in the school’s 160 year history is designated to improve the college’s athletic facilities and initiate a physical fitness room. As an expression of Lindenwood’s appreciation for Dr. Hunter’s generosity, the Board of Directors voted unanimously to name the college’s outdoor athletic facilities “The Harlen C. Hunter Sports Complex.”

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Volume 23 Number 3 • Athletic Training 269
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THE WHITE HOUSE
WASHINGTON
June 14, 1988

Dear Mr. Davis:

Nancy and I want to express our sincere thanks for the framed resolution which you and Jerry Rhea presented for us when you visited the White House. We are truly honored by this tribute as first honorary life fellows in your organization, and we are proud to have the handsome certificate for our collection of special memorabilia.

With our deep appreciation and best wishes to you and your colleagues,

Sincerely,

[Signature]

Mr. Otho Davis
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Cecil E. Donaho
December 26, 1904 - March 11, 1988

One of the pioneer athletic trainers of Texas passed away March 11, 1988 after being stricken with a heart attack at his home. “Coach” Donaho, as he was affectionately called, had been active as a coach and athletic trainer since graduating from Sam Houston State University in 1925. Cecil had served the athletes at Iola, Bessmay, Buna, Port Arthur, Dayton, Liberty and had spent the last twenty-five years at Beaumont South Park High School in Beaumont, Texas. From 1964, when he became the district’s first full time trainer, until the time of his retirement, he served in this capacity. Cecil was also responsible for starting a student trainer’s program for the Beaumont schools. Mr. Donaho was a member of both the Southwest Athletic Trainers Association and the National Athletic Trainers Association.

Mr. Donaho is survived by his wife of 58 years, Alma B. Donaho, two sons, Cecil E. Donaho, Jr. of California and John Donaho of Hamshire, Texas, one sister, one brother, five grandchildren and two great grandchildren. He will be missed by all who knew and respected him.
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In Memoriam

Bruce Melin
December 31, 1908 - March 29, 1988

A great athletic trainer, teacher and friend who touched the lives of so many individuals, passed away at the age of 79 while working in the training room.

A charter member of the NATA, Melin was inducted into the Hall of Fame in 1980. In 1949 he became faculty member and athletic trainer at Washington University in St. Louis, Missouri. From 1972 to 1976, Melin served as Washington University’s Coordinator of Physical Education and Athletes. He retired in 1977 but continued working as a part-time athletic trainer and instructor at Washington University.

Bruce served in numerous capacities with the NATA, including Parliamentarian and Membership Committee chair. He was inducted into the Greater St. Louis Athletic Association Hall of Fame in 1974, and the Missouri Athletic Trainers Association Sports Medicine Hall of Fame in 1984. In 1986 he received the Washington University Interfraternity Council Performance in Teaching award which recognizes superior teaching.

Bruce, a St. Paul, Minnesota native, earned his bachelor’s degree in physical education in 1944 and his master’s degree in 1948 from the University of Minnesota.

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In Memoriam

Bradley D. Parrott
October 14, 1966 - July 22, 1987

Brad Parrott, a student trainer at Northeast Louisiana University, was killed in a car accident during the 1987 summer break near his home in Mamou, Louisiana. He served for one year on the student trainer staff at Northeast in Monroe, but in that one year so endeared himself to his co-workers and the Northeast athletes that his passing will not be forgotten. A scholarship for athletic trainers is to be established in his memory by NLU. The I-AA National Champion football team presented an autographed game ball in his honor to the training room, which is displayed below his picture at the entrance to the training complex. Also, a portion of the 1987 football game program was dedicated to Parrott. A senior at Northeast in occupational therapy, he was one of twenty applicants accepted into NLU’s professional program of occupational therapy. A member of the Student Occupational Therapy Club as well as a member of NATA, Parrott had applied for admission to LSU Medical School and planned to pursue a career as a sports medicine doctor. He was a graduate of Sacred Heart High High School in the small south Louisiana town of Mamou.
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Victor "Vito" Recine
December 12, 1925 - March 22, 1988

After many years of dedicated service to athletic training and community, Victor "Vito" Recine passed from us on March 22, 1988. A physical therapist and athletic trainer, he began his career at New Brunswick High School working from 1948 to 1962. From 1962 until his retirement in 1985 he was the trainer at Sayreville High School. He was elected to the NATA Hall of Fame in 1976.

Mr. Recine was very active in the field. He represented the U.S. at the 1975 Pan American Games, was a trainer for the U.S. Boxing Federation. In addition, he worked with the U.S. Team Handball Association and the U.S. Bobsled Association and was a volunteer trainer at Rutgers University.

Mr. Recine was also active in the community. He served New Brunswick as a city commissioner in the 1970's and helped inspire legislation in New Jersey for the recognition of athletic trainers.

In addition to his wife, Mary, Vito is survived by two sons, Michael and Robert, two grandchildren, three brothers and four sisters. He will be long remembered for his many contributions to both athletic training and his community.
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Ralph Salvon, the senior trainer in the American League and an Orioles trainer for the past 23 years, died of complications from quadruple heart bypass surgery.

A western Massachusetts native, Salvon spent 36 years as a trainer in professional baseball. He had been with the Orioles since 1966 when he was appointed assistant to head trainer Eddie Weidner. Salvon became head trainer himself in 1968 and served in that capacity for 20 years.

Ralph Salvon worked through the ranks in professional baseball. He served as a trainer in A, AA, and AAA ball. His travels and positions had him working all over the country.

During the Florida Instructional League season of 1959, he was credited with saving the life of Cardinals player Jim Beauchamp. Beauchamp later played 10 years of major league ball and is now managing the Richmond Virginians.

Ralph was a graduate of the Springfield Trade School where he was a guard on the football team. Later he served in the U.S. Army during the Korean War.

Ralph is survived by his wife Jane, his mother Antoinette, three sisters and three brothers.

Contributions can be made to the Ralph Salvon Memorial Fund, c/o Save A Heart Foundation, 302 Reisterstown Road, Baltimore, MD 21208.
Abstracts

John Wells, PhD, PT, ATC


No examination of drug-using behavior in amateur and professional sports would be complete without discussing alcohol-the main “gateway” drug and a killer in its own right. Because full blown alcoholism usually takes years to develop, many athletes have been past active sports participation when signs of alcoholism could no longer be ignored. But drinking to excess has been observed in ever-younger groups, leading to a drop in the age at which alcoholism is diagnosed. Mark Gold, MD, director of research at Fair Oaks Hospital, Summit, NJ, has treated many athletes with substance abuse problems. He thinks there has been a change in attitude about drugs among athletes. “There used to be a cavalier feeling that the body could take whatever punishment was given, but now there is a recognition that you don’t get to perform for long at the level of a professional basketball player like Julius Erving with drugs on board. Professional athletes now recognize this very well.” Other evidence in the change in attitude: in 1982, the collective bargaining agreement between owners and players in the NFL identified alcohol as a drug and provided for treatment. Individual teams moved to make alcohol less available. Because of the current emphasis on testing and drug-free sports activities, and attendant publicity, some specialists in the field suggest that alcohol use among athletes in the younger age groups is diminishing and that athletes will lead the way in future efforts to reduce the damaging effects of alcohol abuse.

Brian W. Jansen
UNC Asheville


One hundred fifty-five patients with suspected acute or chronic tears of the menisci were selected for MRI scans during a 10 month interval by a single orthopaedic surgeon. MRI scans of the injured knee, including views of both menisci, were obtained in 155 patients (on 156 knees, one patient with bilateral scans) on the same high resolution 1.5 Tesla General Electric Signa Magnetic Resonance Scanner using the standard GE knee coil. The magnetic resonance images of the 155 patients were interpreted prior to arthroscopic examination by a single radiologist. The radiologist was unaware of the initial diagnosis other than that a meniscal or ligamentous injury was suspected. Of the 155 patients in whom MRI scans were obtained, 86 (87 knees) had subsequent arthroscopic surgery and make up the primary study group. The sensitivity, or percentage of patients with an arthroscopically confirmed pathology whose MRI scan was positive for that pathology, was 97.6%, 84.6%, and 100% for tears of the MM (medial meniscus), LM (lateral meniscus), and ACL (anterior cruciate ligament), respectively. The specificity, or percentage of patients without a specific lesion at arthroscopy who have an MRI scan negative for the lesion, was 98.1%, 98.7%, and 96.6% for evaluation of the MM, LM, and ACL respectively. The positive predictive value, or percentage of patients with a positive MRI scan who have an actual tear at arthroscopy was 88.9%, 91.7%, and 70% for tears of the MM, LM, and ACL, respectively. The negative predictive value, or percentage of patients with a negative MRI for a certain pathology who do not have that pathology as confirmed by arthroscopy was 97.6%, 97.3%, and 100% for the MM, LM, and ACL respectively. The accuracy, or percentage of patients correctly diagnosed by MRI, was 93.1%, 96.6% for evaluation of the MM, LM, and ACL, respectively, with an overall accuracy of 96.4%. The results of this study demonstrate that MRI is highly accurate in the diagnostic assessment of patients with suspected tears of the menisci and cruciate ligaments.

Dave England
University of Arkansas


Obesity is a familial disorder that is probably partly determined genetically. Many investigators who have studied the different components of energy expenditures in lean and obese persons have suggested that in the absence of a clear defect in energy expenditure in obese subjects, obesity is the result of excessive energy intake. However, only prospective studies can determine whether or not lower rates of energy expenditure contribute to the pathogenesis of human obesity. In the present longitudinal studies, we used the indirect calorimetric method to determine whether lower rates of energy expenditures at rest or over a twenty-four hour period are associated with an increased risk of subsequent gain in body weight. Our results showed that low rates of energy expenditures adjusted for fat-free body mass, age, and sex, were significant predictors of gains in body weight. The adjusted twenty-four hour energy expenditure was inversely related to the amount or rate of change in body weight.

Brian W. Jansen
UNC Asheville


Laboratory measures of flexibility and muscle strength have been proposed as indicators of ability to perform in a given sport or activity. These measures also help to discriminate between athletes of different sports and may indicate predisposition to athletic injuries. Sparse data, however, are available about the musculoskeletal fitness of soccer players. Although most soccer players have a definite foot preference for kicking the ball, it is uncertain whether or not this results in an asymmetry in the flexibility or strength of the lower extremities. This information may be important when attempting to rehabilitate the injured soccer athlete. After an injury, return to specific athletic training and subsequently competition is only advised upon restoration of normal function, including muscle strength and flexibility. This study was designed to determine whether symmetry in flexibility and strength are present in the legs of soccer players as well as to determine the average difference between the dominant and non-dominant leg in flexibility and strength. This study has examined selected anthropometric and musculoskeletal characteristics of 25 collegiate soccer players. It appears reasonable to assume that this profile reflects typical collegiate soccer
investigation showed that mean values for flexibility in similar aged sedentary men, and 20% to 25% lower than that in well-conditioned endurance athletes. This suggests that although all the players favored one foot in kicking and receiving the ball, this preference does not affect lower extremity flexibility or strength. This information may be helpful in the rehabilitation process of the injured soccer player.

Victor L. Rose
UNC Asheville


This paper presents the physiologic profile of 27 professional ice hockey players from a National Hockey League team. All physiologic testing was completed following a routine medical history and physical examination before the competitive season. Testing was performed to determine anthropometric characteristics, cardiorespiratory fitness, and musculoskeletal strength and flexibility. These players weighed an average of 85.6kg, of which only 9.2% was body fat, as measured by hydrostatic weighing. Consistent with their physical role during game conditions, the defensivemen were the heaviest and had the most body fat of the three group of players. Aerobic power was similar for all three player groups. The group averaged VO$_2$max of 53.4ml x kg$^{-1}$ x min$^{-1}$ is approximately 10% greater than that observed in similar aged sedentary men, and 20% to 25% lower than that in well-conditioned endurance athletes. This investigation showed that mean values for flexibility and strength measurements were symmetric. All strength measurements were found to be similar for goalies, forwards, and defensivemen.

Brian Jansen
UNC Asheville

THE USE OF HYPEROXIC GAS
continued from page 241


CALL FOR ABSTRACTS
FORT WORTH, JUNE 1989

Each year during our National Convention, members are continually sharing ideas, procedures, techniques, innovations in and for the profession of athletic training. Most of these conversations are among small groups of members and much of the information exchanged would be highly meaningful for the larger group. Many of these ideas have been developed through systematic data collection and observations made by the athletic trainers in the performance of their responsibilities. The accumulation of this information represents an important form of applied research.

With this in mind, the NATA Research and Injury Committee will offer a Free Communications Section and a Poster Presentation at our National Meeting in Fort Worth, June 1989. In order to provide organization to these sessions, the Committee is issuing a CALL FOR ABSTRACTS from the NATA membership. The titles of the projects to be presented will be available to members prior to the convention so that they will know which topics will be discussed and at what time during the session. All selected abstracts will be published in the Summer edition of Athletic Training.

REMEMBER: Your abstract should be of the informative type and should contain:
A. Sentence stating the specific objective of the project.
B. Brief statement of methods.
C. Summary of results/implementations.
D. Statement of Conclusion/recommendations.

All submitted abstracts are sent to a sub-committee consisting of members of the NATA Research and Injury Committee. Each member of this group will independently review and rank each abstract submitted without benefit of the author’s name or affiliation. Final selection of the abstracts for presentation are determined by the review committee’s order of merit and the amount of time allotted for Free Communication Sessions at the Annual Symposium. Each presenter will have fifteen minutes in which to deliver his/her topic. Notification will be made in plenty of time for the preparation of your topic.

The response to these sessions has been excellent. We encourage each member to participate in these information exchanges. So please submit your abstract soon and we look forward to seeing you in Fort Worth. ©

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1) Type title of paper or project in all capital letters, flush left.
2) Indent 3 spaces on a new line and type the name of all authors, with the author that will make the presentation listed first. Type last name then initials (without periods) followed by comma; continue with other authors, if any.
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pists must strive to look more introspectively at the area we influence most in the knee, the musculotendinous dynamic stabilizers, and develop newer more appropriate rehabilitation approaches.

References

Internal Medicine
Effects of Caffeine on Athletes

Athletes are constantly trying to enhance their performances and gain an edge on their opponents in any way possible. For some of them, unfortunately, the quickest and easiest way is the most preferred, even though it may not be the healthiest. Instead of getting enough sleep and relaxation, eating a proper diet, and maintaining good physical condition, the athletes choose to use stimulants to gain an edge. Athletes that use stimulants usually lose the battle with fatigue and in turn with their opponent. Stimulants are found everywhere today, with the most common being readily available in most homes. This culprit is caffeine. Caffeine is a plant alkaloid found in aqueous extracts. Over half of the world’s annual production of coffee is consumed in 98 percent of all American homes.

Caffeine is absorbed readily into the body, usually reaching peak serum levels within 30 to 60 minutes after ingestion. It can directly affect many of the areas of the body, including the gastric mucosa, myocardium, medulla, reticular-activating system, blood vessels, skeletal muscles, and renal tubercles. The effects of caffeine on these various areas are: 1) increased gastric acid, pepsin, and small intestine secretion, 2) increased heart rate, stroke volume, cardiac output, and blood pressure at rest, 3) tachyarrhythmias, both atrial and ventricular, 4) increasing lipolysis, 5) increased contractility of skeletal muscles, 6) increased oxygen consumption and metabolic rate, and 7) increased diureses.

Caffeine has been shown to enhance performance in endurance activities (1). Caffeine stimulates mobilization and may increase oxidation of free fatty acids (FFA), because an increase in circulating FFA is believed to spare muscle glycogen and delay exhaustion during prolonged exercise. Caffeine has been postulated to improve endurance. The higher plasma levels of FFA will be used as fuel and the muscle glycogen stores will not be depleted as rapidly. Caffeine seems to affect glycogenolysis and inhibit utilization of muscle glycogen stores (1). In a recent investigation to examine this, trained male runners were given doses of caffeinated coffee during work-outs. It was found that caffeine (400 mg) increased circulating resting FFA but did not alter respiratory exchange ratio during 45 minutes of treadmill running, indicating that FFA and carbohydrate utilization were unaffected. A possible explanation is that prolonged exercise at an intensity below anaerobic threshold, when carbohydrate sparing is critical, may minimize caffeine’s possible influence as an ergogenic aid (2). It was also suggested that caffeine may exert a placebo effect on performance.

In another study, it was investigated to determine if caffeine altered the rate of liver glycogen depletion during prolonged submaximal exercise. When the utilization of muscle glycogen and the uptake of glucose from the blood are decreased, this results in a reduction in the rate of liver glycogenolysis. In this study, no evidence was found that caffeine enhances lipolysis in excess of that caused by exercise alone. Caffeine failed to influence plasma FFA, blood glycerol, or the rate of glycerol utilization during exercise. Thus, the use of this drug as an effective ergogenic aid during prolonged bouts of running must be seriously questioned (3).

Like other xanthines, caffeine can increase alertness through its effects on the central nervous system (CNS). This stimulation, however, creates a decreased perception of fatigue that is similar to, but less pronounced than, the perception of fatigue experienced with the use of amphetamines.

One investigation on the influence of caffeine on the resting metabolic rate of exercise-trained and inactive subjects showed that high levels of endurance training reduced the thermogenic response to caffeine. Exercise training appears to have exerted a greater effect on resting metabolic rate response than caffeine consumption level. A strong stimulation such as endurance training may alter a thermogenic response to caffeine ingestion, resulting in a blunted response, as if a kind of energy-preserving mechanism were coming into play (4).

Caffeine has been shown to have a direct effect on skeletal muscle contractibility. It was found by Lopes, Jardin, and Aubier, that when athletes ingested caffeine during both fatigued and non-fatigued states they had significant increases in muscle tension. This may contribute to the enhanced performance idea associated with the use of caffeine (5). However, the enhancement is limited to endurance activities: caffeine doesn’t significantly improve performance during maximal short-term exercise bouts (6).

Some of the adverse effects found when using caffeine are tremors, nervousness, diuresis, and arrhythmias. Some of the more common effects are CNS-related and include restlessness, tremulousness, hyperactivity, irritability, dry-mouth, tinnitus, ocular dyskinesia, scotomata, insomnia, headaches, and depression. The effects on the myocardium are increases in sinus rate, ectopic beats, and force of contraction. Caffeine has also been associated with the exacerbation of migraine headaches (7,8,9,10).

Some people who consume large amounts of caffeine daily and then periodically abstain altogether experience a withdrawal syndrome that can include headaches, drowsiness, lethargy, rhinorrhea, irritability, nervousness, depression, and disinclination to work or perform. Caffeine can also have a diuretic effect which can be trouble for those who depend on maintaining hydration during long periods of activities (7,8,9,10).

Caffeine has been banned by the International Olympic Committee in amounts greater than 15 µg·ml⁻¹ in the urine (1).

This drug is mainly used by athletes participating in endurance events. It can increase FFA utilization, mask fatigue, and increase the force of contraction of skeletal muscle. For this, it is a very attractive drug for the endurance athlete. Due to its adverse effects, especially on the CNS and cardiovascular system, this drug would be very questionable for athletes attempting to enhance their performance. As with any drug, the adverse effects far outweigh any good that could possibly come from using them.

continued on page 300
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Book Reviews

Phil Callicutt, ATC, EdD

Athletic Training

Thomas D. Fahey, Ed.D.
Mayfield Publishing Co.
1240 Villa St.
Mountain View, CA 94041
1986
564 pages, Illustrated
Price: $34.00

This outstanding textbook has been in print for two years but it went unnoticed by this reviewer until the past summer. As I have stated in other reviews, new books concerning sports medicine cross my desk every month; most are good, some are outstanding. The ones that I usually consider outstanding are those written by a group of experts and then edited by a professional educator. This is true of the text being reviewed for this issue of the Journal.

Dr. Thomas Fahey called upon eighteen experts in the field of sports medicine to contribute to this undertaking. The contributing group consisted of athletic trainers, physicians, exercise physiologists, and physical therapists. Dr. Fahey in the preface states that the work is a compendium of practical information on preventing, evaluating, and treating injuries. This objective makes this text a wide ranging source of information for sports medicine professionals at all levels. The target population for the book was the student, but I found it to be interesting and concise in all aspects. All readers at all levels will enjoy and profit from the contents of this text. It has something for everyone and should not be thought of as primarily a student's text.

The organization of the text is divided into four parts. Part One introduces the reader to the responsibilities of the contemporary athletic trainer and to the equipment and facilities with which he or she works. Part Two devotes eleven chapters to the principles involved in the prevention and management of injuries. These chapters enable the reader to better understand the reasons behind injuries, treatments, and rehabilitation. In Part Three, a head-to-toe indepth presentation is given which looks into specific injuries and how they can be prevented and managed. The final part, Part Four, covers factors that can affect the athlete's performance, including disease, environmental stress, nutrition, body composition, and the use of drugs. Included in Part Four is a well written chapter on the problems associated with the child and older athlete.

Throughout the text the reader is greatly aided by a running glossary that defines each new term in the margin on the page where it first appears. Summaries of treatment protocols, called "Putting It Into Practice", appears frequently throughout the book so that the reader can effectively remember basic athletic training procedures. For convenience, a separate listing of these protocols appears in the table of contents.

I highly recommend this text for everyone who desires a well written document at a very reasonable price. ©
Current Literature

Brian Barry, MA, ATC


continued on page 300

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Certification

Schedule of Sites and Dates

All regional sites are subject to a minimum of six candidates per site and limited to a maximum of forty candidates. Completed applications must be received by the Certification Office within the prescribed deadline for the examination date chosen.

**January 22, 1989 — Deadline for the receipt of application is December 16, 1988 at 5:00 pm E.S.T.**

- Boston, MA
- Cheney, WA
- Chicago, IL
- Columbia, SC
- Costa Mesa, CA
- Fort Worth, TX
- Granville, OH
- Houston, TX
- Kansas City, MO
- Kent, WA
- Lexington, KY
- Minneapolis, MN
- Monclair, NJ
- Omaha, NE
- Portland, OR
- Santa Barbara, CA

**May 21, 1989 — Deadline for the receipt of application is April 14, 1989 at 5:00 pm E.D.T.**

- Albuquerque, NM
- Anderson, IN
- Chicago, IL
- Columbia, SC
- Costa Mesa, CA
- Denver, CO
- Fort Worth, TX
- Houston, TX
- Kansas City, MO
- Lexington, KY
- Mechanicsburg, PA
- Minneapolis, MN
- Monclair, NJ
- Omaha, NE
- Portland, OR
- Santa Clara, CA
- Seattle, WA

**July 9, 1989 — Deadline for the receipt of application is June 2, 1989 at 5:00 pm E.D.T.**

- Boston, MA
- Birmingham, AL
- Claymont, DE
- Costa Mesa, CA
- Dayton, OH
- Edinboro, PA
- Eugene, OR
- Greensboro, NC
- Madison, WI
- Mt. Pleasant, MI
- New Britain, CT
- Omaha, NE
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Volume 23 Number 3 • Athletic Training 291
Continuing Education

When filling out the CEU Report Form be sure to use your six digit membership number and not your hyphenated certification number, this makes processing faster and easier. These report forms can be found in the Winter Issue of the Journal.

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P.O. Box 319
Concord, NH 03301
603/225-3341 x 206

Angela Greer
District 2 Rep.
Bridgewater-Raritan High School-East
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201/231-8660 x 26

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District 3 Rep.
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803/781-1465

Tom O’Connell
District 4 Rep.
Glenbrook North High School
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Northbrook, IL 60062
312/272-6405

Joe Kroeber
District 5 Rep.
Jamestown High School
Jamestown, ND 58401
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Rex L. Hartwig
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San Antonio, TX 78212
512/735-9331

James C. Newberry
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Cibola High School
Albuquerque Public Schools
Albuquerque, NM 87124
505/897-0110

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619/726-5611 x 4125

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Head Athletic Trainer
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Wayne Cannon
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Placement

There are now two 24-hour hotline numbers. General Employment (919) 752-1266 and Graduate Assistant (919) 752-3603. If you would like to list a position on the hotline contact Leanne Butrum at the National Office. If you place an ad and fill it before the deadline, please contact her immediately.

Professional Education

Sayers "Bud" Miller
Distinguished Athletic Training Educator Award

Nominations are being received for the annual Distinguished Athletic Training Educator Award to be presented by the NATA Professional Education Committee in recognition of excellence in athletic training education:

I. Qualifications

To be nominated for the award, educators must have the following qualifications:

1. Current member of the National Athletic Trainers Association, Inc.
2. Member of a teaching faculty in the area of athletic training/sports medicine for at least ten (10) years.
3. Minimum of ten years of outstanding service in the area of athletic training education and research.
4. Recognized excellence in the field of athletic training education.
5. Outstanding service in district, state or national professional organizations concerned primarily with the field of athletic training.
6. Evidence of quality in publications and public speaking on topics in athletic training/sports medicine.

II. Nomination Procedures

1. The candidate’s current personal resume which includes:
   a. academic background
   b. employment background
   c. published research and other publications (journal articles, books, etc.)
   d. course work taught (during past five years)
   e. classroom teaching innovations
   f. course work/curriculums developed
   g. professional memberships
   h. positions on state, district, or national level of the National Athletic Trainers Association, Inc.
   i. positions on state, district, or national level or related sports medicine professional organizations
   j. consultant work
   k. speaking engagements on community, state, regional, and national levels
   l. community service
   m. college or university service (i.e. committee involvement, thesis advertising, etc.)
   n. any other pertinent materials

2. A minimum of three letters (additional letters may be submitted) from professional colleagues, administrators, or students providing detailed rationale in support of the candidate’s nomination.

Nominations including the above materials should be sent to the Professional Education Committee Project Director, Honors and Awards, and must be received by March 1, 1989. Presentation of the award will be made to the recipient at the 1989 NATA Annual Meeting and Clinical Symposium in Fort Worth, Texas. Send nominations to:

Ken Murray
Athletic Department
Texas Tech University
P.O. Box 4199
Lubbock, Texas 79409

Membership

As of August 1, 1988, the Student National dues will be $30. Please note that this fee does not include district dues which are also payable.
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Eleventh Annual N.A.T.A. 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. This contest is open to all undergraduate student 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 entry will receive a $100.00 cash prize and be published in Athletic Training with recognition as the winning entry in the Annual 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 "Guide to Contributors" section of this issue of Athletic Training. It is suggested that before starting students read: Knight KL: Writing articles for the journal. Athletic Training 13: 196-198, 1978. 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. Announcement of the winner will be made at the Annual Convention and Clinical Symposium in June:

7. The Writing Contest Committee reserves the right to make no awards if in their opinion none of the entries is of sufficient quality to merit recognition.

8. An original and two copies must be received at the following address by March 1, 1989.

NATA Student Writing Contest
Deloss Brubaker, ATC
Knollwood Center for Specialized Medicine
P.O. Box 9813
Mobile, AL 36691

Journal Deadlines/Designees

The Editorial Board will review papers submitted on an individual basis, work with the authors and prepare the papers for publication.

As stated in number 5 of the Guide to Contributors, this review process takes from 6 to 12 weeks. Send manuscripts, Case Reports, and Tips from the Field to:

Ken Knight, Editor
Physical Education Department
Indiana State University
Terre Haute, IN 47809

In order to avoid confusion and delays on other contributions to the Journal, the deadlines are provided below.

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<th>Journal</th>
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<td>Fall Issue</td>
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Send material for Announcements, Letters to the Editor and Committee Forum to:

Steve Yates, Editor-in-Chief
P.O. Box 7865 - Sports Medicine Unit
Wake Forest University
Winston-Salem, NC 27109

Information on upcoming events for the Calendar of Events section should be sent to:

Jeff Fair
Athletic Department
Oklahoma State University
Stillwater, OK 74074

New Products should be sent to:
Barrie Steele
Head Athletic Trainer
University of Idaho
Moscow, Idaho 83843

Items for the Student Athletic Trainer Forum should be sent to:
Deloss Brubaker
Knollwood Center for Specialized Medicine
P.O. Box 9813
Mobile, AL 36691

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Guide to Contributors

Athletic Training, the Journal of the National Athletic Trainers Association (NATA), Inc., welcomes the submission of manuscripts which may or may not be concerned with the progress of the athletic training profession. Manuscripts should conform to the following:

SUBMISSION POLICIES

1. Submit one original and three copies of the manuscript and artwork to the editor.

2. We accept manuscripts for review with the understanding that they are original, have not been submitted to any other publication. All manuscripts must be accompanied by a letter, signed by each author, containing the following statements. Manuscripts which are not accompanied by such a letter will not be reviewed.

3. Manuscripts may be taken from other sources, including text, illustrations, or tables. The author accepts responsibility for any major corrections of the manuscript as suggested by the editor. The initial review process usually takes from six to 12 weeks.

4. Published manuscripts and accompanying artwork, charts, graphs, tables, and photographs are the property of the National Athletic Trainers Association. For permission to reproduce an article or part thereof, published in Athletic Training, send request to the Editor-in-Chief.

5. Manuscripts are reviewed and edited to improve the effectiveness of communication between the author and the reader, and to assist the author in a presentation consistent with the accepted style of Athletic Training. The author accepts responsibility for any major corrections of the manuscript as suggested by the editor. The initial review process usually takes from six to 12 weeks.

STYList POLICIES

7. Personal pronouns (I, we) and the active voice are preferred. Use the third person for describing what happened, "I" or "we" (if more than one author) for describing what you did, and "you" or the imperative for instructions.

8. Each page must be typewritten on one side of 8 1/2 x 11 inch plain paper, double spaced, with one-half inch left margin and one inch margins elsewhere.

9. Manuscripts should contain the following information, organized in the order listed, with each section beginning on a separate page:
   a. Title page
   b. Biographical sketch
   c. 2nd Title
   d. Abstract
   e. Text (body of manuscript)
   f. References
   g. Acknowledgements
   h. Legend to illustrations
   i. Illustrations - each on a separate page
   j. Tables - each on a separate page
   k. Figures - each on a separate page

10. Titles should be brief within descriptive limits. 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, this should be in the title. Often both should appear. The title page should also include the names, titles, and affiliations of each author, and the name and address of the author with whom correspondence is to be directed. Both the title and biographical sketch pages should be numbered.

11. A brief biographical sketch of each author is requested.

12. A second title page which includes only the title and with no reference to the authors is text. Begin numbering the pages of your manuscript with this page as #1.

13. Abstracts of between 200 and 250 words must accompany the manuscript. This abstract should succinctly summarize the major intent of the manuscript, the major points of the body, and the author's summary and/or conclusions. The abstract should appear in the title and bio page.

14. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly stated. The abstract should appear before the main text. The title page should list the names of the authors associated with the article, and the name of the author who will be responsible for any major corrections.

15. The Reference page(s) accompanying a manuscript should list the authors, titles, and dates of publication, and will not be submitted as black and white line art, with a Rapidograph, a velox stat, or PMT overlay. Artwork cannot be returned if the manuscript is published. Please refrain from putting paper clips on any photographs.

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CURRENT LITERATURE

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MEDICAL UPDATE

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References


A defense against cancer can be cooked up in your kitchen.

There is evidence that diet and cancer are related. Follow these modifications in your daily diet to reduce chances of getting cancer:

1. Eat more high-fiber foods such as fruits and vegetables and whole-grain cereals.
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5. Cut down on total fat intake from animal sources and fats and oils.
6. Avoid obesity.
7. Be moderate in consumption of alcoholic beverages.

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