

# JOURNAL OF ATHLETIC TRAINING

*(Formerly Athletic Training,  
Journal of the National Athletic  
Trainers' Association,  
through Vol. 26, 1991)*



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VOLUME 27

NUMBER 1

1992

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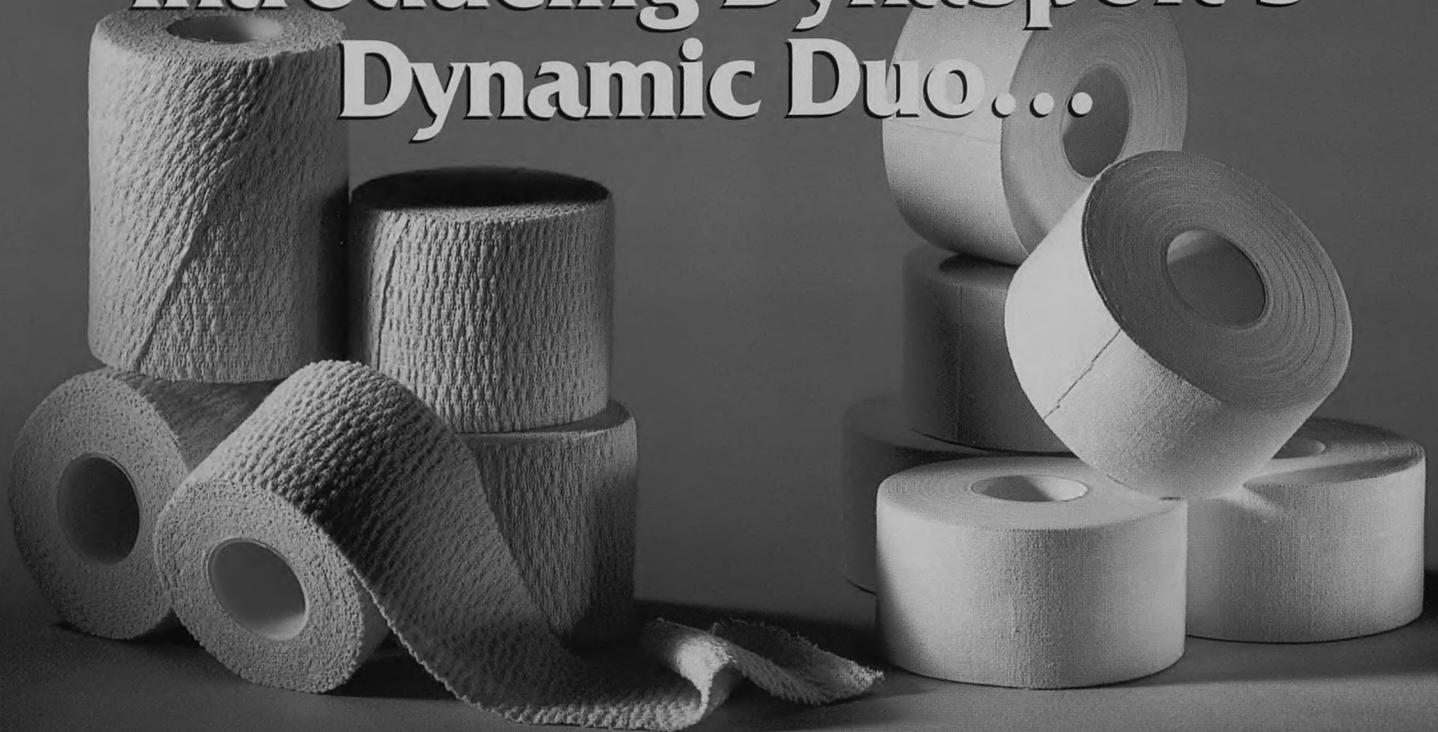
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<b>Consulting Editor</b> Steve Yates, MEd, ATC Sports Medicine Unit Bowman Gray School of Medicine Wake Forest University Winston-Salem, NC 27109	<b>Editorial Assistant</b> Janet Brown, MA Indiana State University Terre Haute, IN 47809	<b>Editorial Office</b> Indiana State University Arena C7 Terre Haute, IN 47809 (812) 237-2348 (812) 237-4338 Fax
<b>Managing Editor</b> Margaret Webb, PhD, MT, SBB Richmond, VA 23236	<b>Statistical Consultant</b> Richard Tandy, PhD University of Nevada at Las Vegas Las Vegas, NV 89154	<b>Business Office</b> 569 Southlake Boulevard Richmond, VA 23236 (800) 800-NATA (804) 379-0648 Fax

<b>Editorial Board</b> Marty Bradley, MS, ATC Old Dominion University Norfolk, VA 23529-0197	Rod A. Harter, PhD, ATC Oregon State University Corvallis, OR 97330	Kent Scriber, EdD, PT, ATC Ithaca College Ithaca, NY 14850
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The *Journal of Athletic Training* (ISSN 0 160 8320) is published quarterly (\$32 for one-year subscription, \$40 foreign) by the National Athletic Trainers' Association, Inc., 2952 Stemmons Freeway, Dallas, TX 75247. Second-class postage paid at Dallas, TX, and at additional mailing offices. POSTMASTER: Send address changes to: *Journal of Athletic Training* c/o NATA, 2952 Stemmons Freeway, Dallas, TX 75247. CHANGE OF ADDRESS: Request for address change must be received 30 days prior to date of issue with which it is to take effect. Duplicate copies cannot be sent to replace those undelivered as a result of failure to send advance notice. ADVERTISING: Although advertising is screened, acceptance of the advertisement does not imply NATA endorsement of the product or of the views expressed. Rates available upon request. The views and opinions in the *Journal of Athletic Training* are those of the authors and not necessarily of the National Athletic Trainers' Association, Inc. Copyright © 1992 by the National Athletic Trainers' Association, Inc. (ISSN 0 160 8320). All rights reserved. Printed by The William Byrd Press, Richmond, VA 23261. Produced by the Virginia Health Council, Inc., Richmond, VA 23236.

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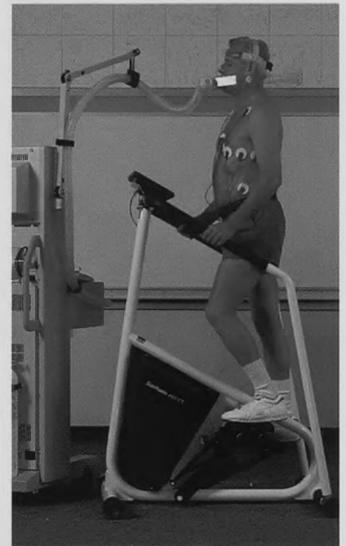
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## A Journal for Clinicians

The metamorphosis of *Athletic Training, the Journal of the National Athletic Trainers' Association* into the *Journal of Athletic Training* is now complete. With the new title comes a new cover and a "new look"; a new layout that we hope is easier to read.

Our content has changed also. In 1989, we published 396 pages, including 102 pages of editorial copy (articles) and 96 pages of association business. In 1991, we published 384 pages, of which 195 pages were editorial copy, and there was no association business. Thus, our editorial copy nearly doubled; increasing from 26% to 51%. And it is not just quantity that is increasing, the quality is increasing too. More about that later.

Our "child," the *NATA News*, is developing and maturing rapidly. When we proposed in 1987 that association business be moved from the *Journal* into a newsletter, we did not dream that anything so fine as the *NATA News* would result. Margaret Webb and her staff at the Virginia Health Council, Inc., are to be congratulated for their terrific work.

A dream that we had then, and continue to have, is that the *Journal of Athletic Training* become the premier publication of athletic injury prevention, care, and rehabilitation. We have made great strides in that area, but there is still much to do.

I have shared that dream with you in the past (1988; 23:212 and 1991; 26:104). I'd like to share it again—for it will only come true if you share in the dream and assist in achieving it.

As I was working on one of the articles in this issue, I needed some information from one of its authors, so I called him. After getting the needed information, I commented that I appreciated the work of the authors and was pleased that they had chosen to publish their work in

our journal. The author, a clinician, replied, "We chose [the *Journal of Athletic Training*] because we find ourselves turning to it more and more for practical ideas and helps. It seems more oriented to the clinician than many other journals in the field." That comment made my day, my week, my month, perhaps even my year. If every reader felt that way, and I know they don't, I would feel successful.

This is a clinician's journal. And, clinician is not restricted to those who work in predominantly physical therapy centers called "sports medicine clinics." An athletic training room is a clinic, staffed by clinicians. A clinic is, "a center for physical examination and treatment of ambulant patients who are not hospitalized," and "a place where preliminary diagnosis is made and treatment given..." (*Tabors Cyclopedic Medical Dictionary*, 1973, pC-80). Others have referred to the athletic trainer who applies his or her trade to athletes as "in the traditional setting" or "in the trenches." Allied health practitioners are "clinicians."

Our editorial goal is to publish an equal amount of research, literature reviews, and clinical techniques. Most of the research and literature reviews must be clinically relevant. They must contain ideas and information that are of practical value to the clinician—the athletic trainer who will be in the training room this afternoon preparing athletes for a practice or game, managing injuries and illness so the athletes can participate to their fullest potential.

Are we meeting our editorial goal? Not yet. In 1991, we published 38 full-length manuscripts and seven tips from the field. Only three of 38 were technique articles, 16 were research, and 20 were literature reviews. So, we do not have as many technique articles as we would like, although the seven tips were equal to the

two previous years combined. I remain convinced that there are hundreds of unique tips and techniques that have not yet been published. These could be used effectively by thousands of athletic trainers if they were shared. We need more of you to share your clinical techniques.

One thing that prevents many from writing is the lack of knowledge or experience in technical writing. We want to help you. In June, at our national convention in Denver, we will feature a writer's workshop with Robert Day, a world-renowned author, editor, and lecturer. Following Dr. Day's instructions, our editorial board will join him in working with authors and potential authors one-on-one. We encourage you to bring ideas, outlines, rough drafts, final drafts—even manuscripts that have been edited and need to be rewritten—to this workshop. We guarantee that you will walk away from this workshop with firm, tangible ideas of how to develop the manuscript for publication.

Another help for you is a style manual. We have adopted the *AMA Manual of Style* (Williams & Wilkins, 1988) as the official style manual of the journal. That forced us to change a few things, like our referencing style, and a few other odds and ends, which was kind of a hassle. But the advantage is that you can check out the manual from most libraries or purchase it for \$27. It has almost 300 pages of rules for writing—all you ever wanted to know and more. As you consult this before submitting your manuscript, you will have fewer mechanical or technical errors. Thus, our reviewers will concentrate more on content and give you more in-depth feedback, which will allow you to revise your manuscript to a higher level. So we all win. The process is easier for you and us, and the product is better for our readers.

## ■ CEU Credit Quiz ■

This CEU Quiz contains questions drawn from the following articles:

Sallade, Koch: *Training Errors in Long Distance Running*

Orteza, et al: *The Effect of Molded and Unmolded Orthotics on Balance and Pain While Jogging Following Inversion Ankle Sprain*

Beckett, et al: *Incidence of Hyperpronation in the ACL Injured Knee: A Clinical Perspective*

Moss, et al: *A Biomechanical Analysis of Patellofemoral Stress Syndrome*

The NATA Board of Certification accepts this continuing education offering for .3 hours of prescribed CEU credit in the program of the National Athletic Trainers' Association, Inc., provided that the test is used and completed as designed.

To participate in this program, read the material carefully, photocopy the test on the next page, and answer the test ques-

tions. Mark your answer by placing an X in the proper space. Then fill in your name, address, and other information and mail with \$12 for processing to the address on the next page. **FOR CREDIT, the form must reach Indiana State University by June 15, 1992.**

A passing score is 70%. We will notify the NATA Board of Certification of all

persons who score 70% or better, and the NATA will enter .3 CEU credit on those persons' records. Participation is confidential.

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- |      |      |      |      |       |
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### Instructions:

1. Photocopy this page and write on the copy.
2. Read the four articles listed on the previous page.
3. Answer the questions below.
4. Mail with \$12 fee (checks made payable to Indiana State University) prior to June 15, 1992 to:

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### CEU QUIZ

*Journal of Athletic Training*  
 Physical Education Department  
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### Questions

Questions	a	b	c	d	e
1. Factors linked to a predisposition for developing patellofemoral stress syndrome include: 1. leg strength    3. larger static Q-angle 2. weight    4. being female a. 1 only b. 1 and 3 only c. 3 only d. all except 4 e. 2, 3, and 4					
2. In the normal kinetics of gait: a. there are two phases: stance and swing. b. initial heel contact is on the lateral aspect of the calcaneus with the subtalar joint in a slightly supinated position. c. as the knee flexes during contact, the tibia internally rotates. d. excessive pronation transmits forces upward in the kinetic chain and produces knee stresses. e. all of the above					
3. Using a molded orthotic during rehabilitation of an inversion ankle sprain: a. may promote healing and speed return to activity. b. is insignificant because balance scores are not affected by ankle sprain. c. is probably effective because molded orthotics help decrease stress to the injured ligament(s). d. all of the above e. a and c					
4. Which of the following is not classified as a training error for runners? a. running on crowned roads b. running in brand new shoes without changing pace or routine c. increasing mileage or speed too quickly d. variety in training e. running only on soft surfaces, regardless of terrain					
5. Subtalar joint motion: a. is increased after lateral ankle sprain. b. has a direct effect on ankle injuries. c. needs to be controlled in individuals with ankle sprain in order to limit standing talar tilt. d. all of the above e. none of the above					

	a	b	c	d	e
6. Which of the following clinical tools can the clinician use to identify hyperpronation of the foot and ankle complex? a. gait analysis b. abnormal callus formations c. navicular drop test d. a and c e. all of the above					
7. Problems from running on hills can be decreased by: a. increasing the grade sharply. b. taking additional time for stretching. c. finishing work-outs on downhill grades, especially when fatigue is high. d. striking more on the mid-foot rather than the ball of the foot when running uphill. e. all of the above					
8. Navicular drop test scores in the ACL article: a. were significantly different between male and female. b. were statistically significant between right and left sides. c. were about the same in injured subjects as in uninjured subjects. d. were different between those injured during contact and non-contact. e. none of the above					
9. Of the three techniques used in the research of patellofemoral stress syndrome, which had the highest prediction ability and was least cumbersome to use, making it applicable in the clinical setting? a. anthropometric b. isokinetic c. biomechanical d. none of the above e. all were equally useful					
10. The navicular drop test, as described by Brody and cited in the ACL article: a. was used to objectively measure pronation. b. involves locating and marking the navicular tuberosity of the foot. c. requires that the subtalar joint be placed in the neutral position. d. all of the above e. b and c					

## ■ Letters to the Editor ■

I write this letter as "food for thought" in regard to the letters written by Robert Reese, Jr., ATC, and Bob Broxterman, MS, ATC, [*Athletic Training, JNATA*, Winter 1991] concerning changing the athletic trainer name. I am proud to be a physical therapist and an athletic trainer. These names define the areas in which I worked to be licensed or certified, and they provide the credentials to practice legally in the state of Tennessee.

I was reviewing *A History of the National Athletic Trainers' Association* (1980) given to the late Bob Brashear, MD (pioneer of sports medicine in the Knoxville, TN, area and orthopedic surgeon at Knoxville Orthopedic Clinic), by "Pinky" Newell. During the early days of athletic training, I am sure that there was not much emphasis on the name "athletic trainer," but rather on promoting the profession of athletic training by providing the best care possible at that time. I read on page 54 that Mickey O'Brien (past University of Tennessee head athletic trainer) received the Hall of Fame award. I was privileged to know him briefly as a University of Tennessee student athletic trainer from 1979 to 1983 under the direction of Tim Kerin, presently the head athletic trainer at the University of Tennessee. Mr. O'Brien often told us stories of how athletic trainers used to do things.

We have progressed a great deal over

the decades in our technology and various responsibilities, but I still feel "athletic trainer" is an appropriate name for our profession. The designation, ATC, denotes our certification. Through our education, patients and athletes will then know how our credentials separate us from the "non-certified athletic trainers" often referred to on the high school sidelines. Many parents don't know what a certified athletic trainer does at the high school level, because they are scarce in the state of Tennessee and nationally. The clinical and collegiate athletic trainers are often the only means to promote the profession through providing athletic training services.

Along with certified athletic trainers, licensed physical therapists come in contact with facilities (doctors' offices, chiropractic facilities, health club facilities, etc.) that have nonlicensed employees having the title "physical therapist" or state in their ads the service of physical therapy. Physical therapist assistants have to deal with "on-the-job trained aides" referring to themselves as PT assistants.

I strongly feel that the word "therapist" needs to be omitted entirely from consideration. I also believe that we need to concentrate our efforts on establishing our roles in providing athletic training in the clinical setting and preventing the PT profession from infringing on our turf in

the athletic fields. There is room for both professions to work together and assist each other with their similar but different areas of expertise.

We have the opportunity and responsibility to promote our profession within our realm of practice and outside our practice, through community education and an emphasis on service to athletes, particularly high school athletes. Parents, coaches, teachers, students, fans, legislators, businessmen, and businesswomen then will become familiar with what athletic trainers are doing, and we can educate them about our certification process and credentials. We must remember that these are the people who may work together to accept or reject certified athletic trainers in the school systems.

We are at the point where athletic trainers are recognized for their various skills and services, which creates diversity and a potential for employment and opportunities to promote the practice of athletic training. If the name "athletic trainer" was good enough for the founders of this profession, then it is good enough for us now and any time in the future.

Chip Ladd, PT, ATC  
Knoxville Orthopedic Clinic/  
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# Athletic Trainer Availability in Interscholastic Athletics in Michigan

Lynn M. Lindaman, MS, MD, ATC

**ABSTRACT:** *Between January and March 1989, I surveyed the athletic directors of the 711 high schools of the Michigan High School Athletic Association, in order to determine the level of medical care available for students who participate in various sports. The results were compared to previous studies done in Michigan and in other states, to determine if there had been any increase in the number of athletic trainers working in a high school setting or any improvement in their educational backgrounds. Certification by the National Athletic Trainers' Association (NATA) was the measurement used to determine improvement in educational background. With 57% of the 711 athletic directors responding, 41% reported that they had the services of an athletic trainer for at least one sport during the year. The percentage of athletic trainers varied directly with the size of the school. The more populous schools had the greatest percentage of athletic trainers. Seventy percent of the athletic trainers were reported to be certified by the NATA. These findings were compared to two earlier studies conducted in Michigan and to surveys in other states. It was determined that there was an increase in the availability of athletic trainers, particularly certified athletic trainers, at the post-secondary level.*

**S**tudies reporting the number of students who compete in interscholastic athletics and the frequency and severity of sports injuries leave little doubt about the need for adequate medical care for these

athletes (2,4,7,8,10). Yet, a serious question remains about the players' access to health care. Traditionally, medical care for athletes has meant the services of a team physician; however, numerous studies have demonstrated that only 40% to 80% of varsity football games have physicians in attendance (3,5,6,9, 12,13,14). These percentages drop dramatically to 6% to 13% for other sports (5,15). In addition, physicians almost never attend practices (5,14). In the past, this void in the provision of health care for athletes competing in interscholastic sports was filled by coaches (3,9,12,15). Unfortunately, coaches seldom have the ability and qualifications to provide this service (3,13).

The National Athletic Trainers' Association has worked to educate high school administrators and the public about the need for proper medical care for the high school athlete. There has been a strong effort to place athletic trainers, specifically certified athletic trainers, in high schools. This study was undertaken to assess the types of medical care available to students participating in interscholastic sports at each level of competition in Michigan. Then, these results were compared to results of previous surveys done in Michigan and in other states to determine if there had been any improvement in the availability of athletic trainers in general, and certified athletic trainers in particular.

## Materials and Methods

In January 1989, I mailed surveys to the 711 high school athletic directors in the state of Michigan. These athletic directors were affiliated with all of the public and private schools within the Michigan High School Athletic Association. In the survey, I requested demographic data to help group the results for further analysis.

The survey requested information from the athletic directors concerning the availability of student athletic trainers, athletic trainers, physicians, and other medical personnel (EMTs, paramedics, etc.) (Fig 1) for

each sport offered (Fig 2) and at each level of competition (Fig 3). They were to state what type of medical care was available at practices and at interscholastic competitions. Available was defined as, "present to render medical care for that team at either a practice or an interscholastic contest at least once during the season." A stamped, self-addressed envelope was provided with each survey.

## Results

Properly completed forms were returned by 57% (407/711) of the schools, somewhat evenly distributed among all classes of schools (52% to 60%) (Table 1). Forty-one percent of all responding schools reported having an athletic trainer available for at least one sport during the year. This ranged from 59% in Class A to 20% for Class D (Table 2). Of these athletic trainers, 70% were reported to be certified by the NATA. This varied from 82% to 25% among all classes of schools (Table 2). These figures did not include as "certified" those athletic trainers who were waiting to take the certification exam, awaiting the results of the examination, or completing their curriculum that semester.

The athletic directors were asked to report, as accurately as possible, the fees or salary paid to the athletic trainers. This was either the supplemental salary that the individual received or the fee that was paid to a hospital or sports medicine clinic for providing athletic trainers to the school district. These salaries represent the amount earned by an individual or corporation for that academic year for their athletic training services. No distinction was made about the amount of time that the athletic trainer worked or the number of teams that received medical care. Thirty-eight percent, ranging from 25% to 71%, of all athletic trainers were volunteers; that is, they received no reimbursement for their services (Table 2). Fifty-five percent of these volunteers were certified athletic trainers. Thirty percent of all certified athletic

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*Lynn Lindaman is a pediatric orthopaedic surgeon with the Iowa Orthopaedic Center in Des Moines, IA. This study was conducted while he was a senior resident with the Grand Rapids Orthopaedic Surgery Residency Program in Grand Rapids, MI.*

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### Medical Care for Interscholastic Athletes

School District: \_\_\_\_\_

Is your high school a 3-year (10-12) or 4-year (9-12) school? \_\_\_\_\_

What is your estimated enrollment ("Fourth Friday Count")? \_\_\_\_\_

Boys: \_\_\_\_\_ Girls: \_\_\_\_\_

What is the MHSAA classification of your school? \_\_\_\_\_

Please estimate the number of students out for at least one sport:

Boys: \_\_\_\_\_ Girls: \_\_\_\_\_ Total: \_\_\_\_\_

Does your high school have a person(s) in the position of student athletic trainer?

No \_\_\_\_\_ Yes \_\_\_\_\_ How many? \_\_\_\_\_

Does your high school have a person(s) in the position of athletic trainer?

No \_\_\_\_\_ Yes \_\_\_\_\_ How many? \_\_\_\_\_

If you do have a person(s) functioning in the capacity of athletic trainer:

Are they certified by the National Athletic Trainers' Association (NATA)?

No \_\_\_\_\_ Yes \_\_\_\_\_

How much are they paid for their work as an athletic trainer?

\$ \_\_\_\_\_

Does your high school have a person functioning in the capacity of team physician?

No \_\_\_\_\_ Yes \_\_\_\_\_

If you do have a team physician, what is his or her specialty?

Family/General Practice _____	Pediatrics _____
Internal Medicine _____	Ob/Gyn _____
Orthopaedics _____	Other _____
General Surgery _____	

How much are they paid for functioning as the team physician?

\$ \_\_\_\_\_ (\$0.00 = Volunteer)

Fig 1.—Survey Mailed to 711 Michigan High School Athletic Directors

Please indicate with a check mark which of the following sports are offered by your school district for interscholastic competition, and at which levels.				
Sport	Freshman	Sophomore	Jr. Varsity	Varsity
Football				
Boys Basketball				
Girls Basketball				
Volleyball				
Boys Soccer				
Girls Soccer				
Wrestling				
Gymnastics				
Boys Cross Country				
Girls Cross Country				
Baseball				
Softball				
Boys Track				
Girls Track				
Boys Golf				
Girls Golf				
Boys Tennis				
Girls Tennis				
Boys Swimming				
Girls Swimming				
Boys Skiing				
Girls Skiing				
Ice Hockey				

Fig 2.—Survey of High School Sports Offered in Michigan

trainers in this study worked as volunteers. The average salary for athletic trainers who received a salary was \$5,508 a year (Table 2).

The percentage of schools that have an athletic trainer available for each of their sports is listed in Table 3. The percentages are listed only for schools that offer competition in the sport (the number in parentheses), not the total number of schools responding to the survey. Athletic trainers most often were present for football. Looking at all of the varsity teams, only 22% of them had an athletic trainer available either for practice or competition during the year.

### Discussion

Forty-one percent of the schools responding had the services of an athletic trainer for at least one sport at least one time during the year. These percentages are markedly different from Redfean's (12) 1975 study, which reported that only 11% of the schools in Michigan had an athletic trainer. This 1975 survey disproportionately represented the larger schools (Table 1). Because larger schools are more likely to have athletic trainers, 11% may be an overestimate. The current study was more evenly distributed across all sizes of schools, which tends to enhance the difference between the two studies.

Similarly, Ray (11) in 1987 reported that only 15% (70/462) of the Michigan schools responding to his survey had athletic trainers. It would appear that the availability of athletic trainers has tripled in the three years since Ray's study; however, Ray never reported his definition of an athletic trainer and he did not clarify the distribution between the different classes of schools.

Comparisons with his study, therefore, need to be done with caution. Neither of these earlier studies mentioned the number of athletic trainers who were certified.

Unfortunately, the availability of athletic trainers is directly proportional to the size of the school. Schools with a small population, which are the least likely to have athletic trainers, are also the least likely to have access to a physician (3,5,13). At such schools, the responsibility of medical care falls solely upon the coaching staff.

Nationally, the situation is not much better, and may be worse, than in Michigan. In 1980, Porter (9) reported that 49% of the public schools surveyed in the Chicago area had athletic trainers. Again the

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Please indicate who is present at the practices and contests for the sports and levels of competition offered by your high school.

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AT = Athletic Trainer

MD = Medical Doctor  
OT = Other (paramedics, nurses, etc)

If none of the above are present at practices or contests, or your high school doesn't offer the sport or that level of competition, please leave those spaces blank. Otherwise use:

1 = Coverage at Practice only  
2 = Coverage at Contest only

3 = Coverage at Practice and Contests

Sport	Freshman				Sophomore				Jr. Varsity				Varsity			
	S T	A T	M D	O T	S T	A T	M D	O T	S T	A T	M D	O T	S T	A T	M D	O T
Medical Coverage																
Football																
Boys Basketball																
Girls Basketball																
Volleyball																
Boys Soccer																
Girls Soccer																
Wrestling																
Gymnastics																
Boys Cross Country																
Girls Cross Country																
Baseball																
Softball																
Boys Track																
Girls Track																
Boys Golf																
Girls Golf																
Boys Tennis																
Girls Tennis																
Boys Swimming																
Girls Swimming																
Boys Skiing																
Girls Skiing																
Ice Hockey																

Fig 3.—Survey of the Levels of Competition Offered in High School Sports in Michigan

Table 1.—Response to Survey of Michigan High School Athletic Directors

	Number Possible	Total Responding	Return Percentage	Redfearn(12)
Number of Schools	711	407	57%	55%
Number of Class A Schools	177	103	58%	61%
Number of Class B Schools	178	107	60%	63%
Number of Class C Schools	178	105	59%	49%
Number of Class D Schools	178	92	52%	27%

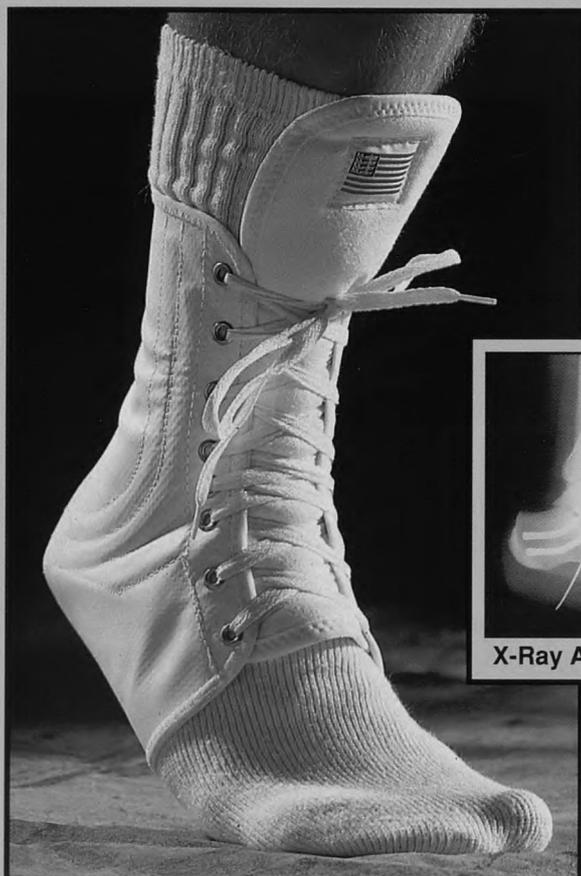
percentages were higher in the larger, wealthier, nonurban schools. She also reported that 23% of these schools had certified athletic trainers. Expanding the study to include the remainder of Illinois, Bell (1) found that 24% of all Illinois schools employed athletic trainers. Culpepper (3) reported that between 5% and 24% of Alabama schools had athletic trainers, varying directly with the size of the school. Wrenn (15) reported in 1980, that only 2% of Maryland schools employed athletic trainers. More recently, Powell (10) estimated that only 16% of all high schools in the nation had athletic trainers.

One of the factors influencing whether a school district provides athletic trainers for their athletes is the cost. The most visible, if not the major, cost for the school district is the salary for the individual. Over one-third of all the athletic trainers who worked in the responding high schools received no monetary compensation. Similarly, 30% of the certified athletic trainers were volunteers. This speaks well for the altruism and commitment of athletic trainers. Unfortunately, it does not speak well for the concern of school districts in providing medical care for their athletes. The adequacy of the reimbursement obviously depends upon the number of teams that the athletic trainer covers and the number of hours worked. Calculation of per-hour payment for athletic trainers was beyond the scope of this survey; however, the results do indicate the amount that most school districts are willing to spend to obtain an athletic trainer. It also demonstrates that being an athletic trainer for a high school probably would not be a sole means of financial support. It would serve only as a supplement to an income derived from teaching or working as an athletic trainer or physical therapist at another institution.

## Conclusion

Based on this study, I think that the availability of medical care at interscholastic athletic practices and competitions is not adequate. In an attempt to address this problem, there has been an increasing effort to place certified athletic trainers into the high schools. In Michigan, the number of schools responding to the survey that they either employ or have the services of an athletic trainer has increased substantially. More importantly, 70% of these athletic trainers are now certified by the National Athletic Trainers' Association, a

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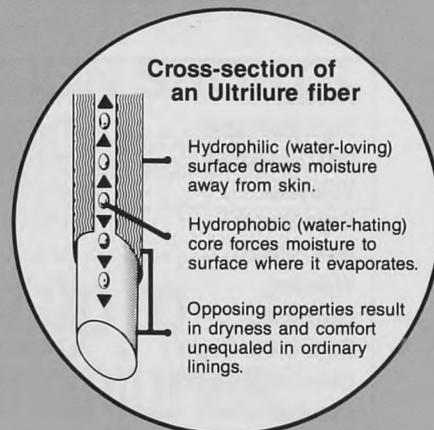
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Table 2.—High School Athletic Trainers in Michigan by Class of School

	Class A	Class B	Class C	Class D	Total
Schools responding that employ athletic trainers	59%(61/103)	48%(51/107)	34%(36/105)	20%(18/92)	41%(166/407)
Athletic trainers who are certified	75%(50/67)	82%(46/56)	75%(28/37)	25%(7/28)	70%(132/188)
Athletic trainers who are "volunteers"	25%(17/67)	36%(20/56)	38%(14/37)	71%(20/28)	38%(71/188)
Average salary of athletic trainers who receive a salary	\$6,671	\$6,863	\$2,798	\$4,225	\$5,508

\* Some schools employed more than one athletic trainer.

Table 3.—Percentage of Schools Providing Athletic Trainer Coverage in Varsity Sports (Number Offering Athletic Trainer Coverage/Number Offering Participation)

Sport	Total	Class A	Class B	Class C	Class D
Football	37%(137/370)	58%(59/101)	43%(46/106)	24%(24/102)	13%(8/61)
Boys Basketball	28%(111/402)	46%(46/101)	34%(36/106)	19%(20/105)	10%(9/90)
Girls Basketball	26%(105/398)	43%(43/100)	32%(34/106)	20%(21/105)	8%(7/87)
Volleyball	24%(88/371)	38%(37/98)	29%(30/104)	16%(16/99)	7%(5/70)
Boys Soccer	31%(47/152)	39%(30/76)	26%(12/46)	25%(3/12)	11%(2/18)
Girls Soccer	31%(30/98)	39%(24/62)	19%(5/26)	0%(0/5)	20%(1/5)
Wrestling	35%(95/272)	48%(45/93)	34%(32/94)	23%(16/69)	13%(2/16)
Gymnastics	48%(26/54)	57%(20/35)	38%(5/13)	0%(0/1)	20%(1/5)
Boys Cross Country	17%(55/325)	27%(27/99)	16%(16/102)	11%(9/85)	8%(3/39)
Girls Cross Country	17%(52/313)	27%(26/97)	16%(16/98)	10%(8/83)	6%(2/35)
Baseball	20%(77/376)	33%(33/100)	22%(23/105)	15%(15/99)	8%(6/72)
Softball	20%(73/366)	33%(33/99)	20%(21/104)	15%(14/96)	7%(5/67)
Boys Track	24%(89/378)	42%(42/101)	25%(27/107)	16%(16/100)	6%(4/70)
Girls Track	23%(87/376)	40%(40/100)	25%(27/107)	16%(16/100)	6%(4/69)
Boys Golf	4%(11/280)	5%(5/94)	4%(4/92)	3%(2/69)	0%(0/25)
Girls Golf	2%(2/120)	5%(2/44)	0%(0/35)	0%(0/29)	0%(0/12)
Boys Tennis	17%(37/217)	22%(21/94)	16%(12/73)	8%(3/36)	7%(1/14)
Girls Tennis	19%(38/203)	24%(22/92)	17%(12/69)	10%(3/30)	8%(1/12)
Boys Swimming	25%(34/138)	28%(23/82)	23%(10/44)	11%(1/9)	0%(0/3)
Girls Swimming	23%(31/135)	25%(20/81)	25%(10/40)	10%(1/10)	0%(0/4)
Boys Skiing	2%(1/48)	5%(1/21)	0%(0/9)	0%(0/11)	0%(0/7)
Girls Skiing	2%(1/47)	5%(1/21)	0%(0/8)	0%(0/11)	0%(0/7)
Ice Hockey	31%(17/55)	41%(14/34)	9%(1/11)	20%(1/5)	20%(1/5)

greater percentage than was reported by other states or in national surveys.

Unfortunately, even with this marked improvement, 78% of the varsity teams were without the services of an athletic trainer at any given time during the seasons. While 41% of the school districts that responded had an athletic trainer available, only 25% of them actually hired an athletic trainer.

The argument may be raised that more schools would hire athletic trainers if they were available; however, 39% of the schools with athletic trainers relied upon volunteers to provide this service. This substantiates the fact that the problem is not merely a lack of availability of athletic trainers for high schools. The problem is still a lack of concern and commitment by the school districts and athletic departments.

While there has been improvement in the levels of both the quality and quantity of athletic trainers for high school athletes, these levels are still inadequate. There needs to be an increase in the number of athletic trainers employed by school districts either as teachers/athletic trainers or contract workers from local sports medicine centers or physical therapy departments. Only 25% of the schools responding

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employed an athletic trainer. This demonstrates the need to educate the school districts about the importance of proper medical care for athletes participating in interscholastic sports. The best way to provide this care is with certified athletic trainers.

### Acknowledgements

Special thanks to John Roberts, executive director of the Michigan High School Athletic Association, who provided support for this survey. Also, thanks to Mary Dickerson of the Grand Rapids Orthopaedic Surgery Residency Program for her assistance in assembling, mailing, and collecting the surveys.

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### Comments

We often talk about the differences in approaches to sports medicine by coaches, physicians, and athletic trainers. Lindaman, author of the previous article, has been all three, so he has a unique view of sports medicine and high school athletics.

Dr. Lindaman was a student athletic trainer for four years at the University of Iowa. He was certified and returned to Iowa for an additional year as a graduate assistant athletic trainer. He taught high school for three years in Illinois and Iowa where he coached football, basketball, and track. He spent an additional three years as a graduate assistant track coach. He then went to medical school. For the past ten years, he has served as a high school team physician in Illinois, Michigan, Tennessee, and Iowa. So, he has spent considerable time (in the trenches) of all three professions.

In the process of working on this article with Dr. Lindaman and members of our Editorial Board (whose identities were unknown to each other), his unique background became apparent, as did some additional feelings of Dr. Lindaman concerning high school sports medicine. His comments follow.

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

I am appalled that the field of sports medicine has exploded over the last fifteen years, but has left medical care for the athlete who participates in high school interscholastic sports truly lagging behind. This has not been the result of any lack of effort on the part of the National Athletic Trainers' Association, however.

Most of the school boards in areas in which I have lived for the past fifteen years have been facing tremendous increases in costs. During this same time, the community has been voting down tax increases. Almost universally, the first part of the school district budget that is trimmed is the athletic department budget, and one of the first "sacrificial lambs" in the athletic department is usually any allocation for athletic trainers or for other forms of medical care. As athletic trainers, physicians, and parents attempt to improve the medical care for high school athletes, they are going to have to answer several questions from the athletic departments, the school boards,

and the taxpayers. Two of these questions are posed and answered below.

"Is there a need for medical care?" Absolutely. The articles cited in my introductory paragraph, along with the ongoing research by Powell and others, document that there is a significant injury rate in all sports in high school athletics.

"Is the level of medical care currently provided adequate?" It is not even close, from a physician's standpoint. (See my research on physicians that was published in *The American Journal of Sports Medicine*.) This study in Michigan, and those done in other states previously, have shown that the level of athletic trainer availability is not adequate, even with the improvement in the last fifteen years.

Some reviewers of this paper were offended by the fact that in my survey, I had counted as athletic trainers individuals who were not certified by the National Athletic Trainers' Association. My stand is that athletic trainer is a job description; Certified Athletic Trainer is a professional title. One reviewer appeared to be offended by this and responded, "According to your survey, anyone providing athletic training services is an athletic trainer," and "Anyone breathing who can semi-tape an ankle and attend practice could be considered an athletic trainer." I too am somewhat offended by this. Also, I am offended by the fact that any person who has gone through four years of medical school, who **cannot** tape an ankle, who does not know a sprain from a fracture, and who has a level of sports medicine knowledge that is far inferior to that of any athletic trainer, may walk onto an athletic field and call himself or herself a team physician. Unfortunately, that is the current status of the world of sports medicine. Until the states define athletic training and set licensure standards, such as certification by the National Athletic Trainers' Association, the reviewer's statement as to who may be considered an athletic trainer are very true.

If readers are offended by this, as they have a right to be, I would encourage them not to accept it and to work either at the local, state, or national level to come up with licensure standards for athletic training, to see that all schools have athletic trainers, and that they are certified.

Athletic trainers, whether they are certified or inept, and team physicians, whether specialists in sports medicine or inept, do serve a very vital role. Probably their most important function is to remove

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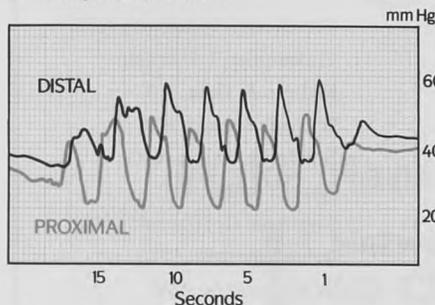
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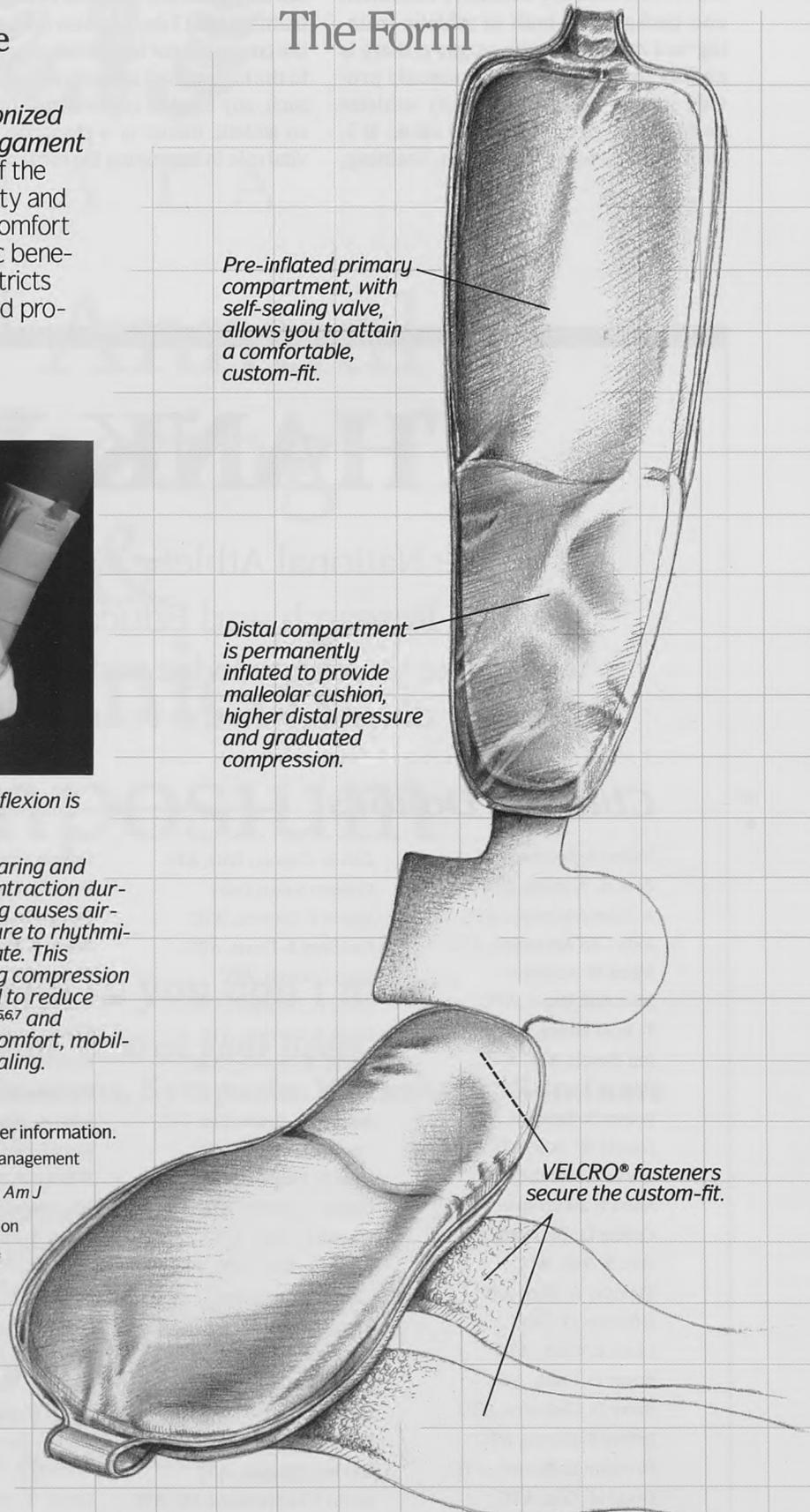
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the burden of providing medical care from the shoulders of the coach.

**If I were to return to coaching at this time, even with my extensive education and background both in athletic training and in orthopaedic surgery, there is no way that I could simultaneously provide proper coaching for my athletes and provide proper medical care. If I, with my extensive education, training,**

**and concern about the medical care for athletes cannot perform both functions, how dare we demand this of a coach who not only does not have the education and training that I do, but also does not have the commitment to provide medical care to the high school athletes as I would?** As such, any level of medical care offered by an athletic trainer or a physician serves a vital role in improving the medical care for

athletes who participate in interscholastic high school sports.

I hope that my research will provide impetus to improve the medical care for high school athletes, as well as provide background data to support those who are already involved in efforts to improve this medical care.

Lynn M. Lindaman, MD  
Des Moines, IA

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# Guidelines for Dispensing Medications

William R. Whitehill, MA, ATC  
Kenneth E. Wright, DA, ATC  
James B. Robinson, MD

**ABSTRACT:** Federal and state codes exist regarding administering and dispensing medications and there is variation between the two. Recognition of the differences is imperative for the athletic trainer, who has traditionally dispensed these agents in compliance with established legal and professional guidelines. Statutes that apply to classifying, documenting, prescribing, dispensing, labeling, and housing medications by athletic trainers are presented as a baseline for this article. State and local regulations should be consulted to clarify differences existing at various governmental levels. These guidelines are provided to assist athletic trainers in properly dispensing medications.

Over the past decade, a debate has grown over the use and abuse of drugs in the profession of athletic training (4,23). Legal proceedings have questioned the involvement of athletic trainers in dispensing both over-the-counter (OTC) and prescription drugs (9,13,14).

The role of the athletic trainer will depend on criteria such as the age of the athlete, state laws, and the type of drug (OTC or prescription). The athletic trainer should know the federal laws and his or her respective state codes regarding handling, dispensing, and documenting the use of all medications. Many athletic trainers work under the "Standard Operating Procedures" or "Standing Orders" concept. It would be prudent to contact legal counsel regarding the legality and extent of coverage of either or both of these concepts (5,6,10).

In 1982, the NATA and the Profes-

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*William Whitehill is assistant athletic trainer at The University of Alabama in Tuscaloosa, AL.*

*Kenneth Wright is curriculum director of athletic training at The University of Alabama.*

*James Robinson is team physician at The University of Alabama.*

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sional Examination Service studied the most appropriate content for the certification examination for entry-level athletic trainers (15). Of the 173 competencies included in the *Competencies in Athletic Training* (16), only one deals with pharmacology. It is Task #4, Rehabilitation and Reconditioning, Cognitive Domain #7—Role and function of commonly used pharmacological agents in the medical treatment of common athletic injuries/illnesses (16). There is much more to using pharmacological agents than this competency reflects. Therefore, athletic trainers are faced with the challenge of individually deciding their particular role in pharmacology and athletic training.

We present information concerning drug classification and requirements for handling various medications. Federal law will serve as the baseline for this information. However, state reference sources should be consulted because of the diversity of the federal and state laws. Whether to comply with the state law or the federal law is subject to debate. An accepted practice is to comply with the more stringent law or regulation (18).

## Definitions

Definitions of pharmacological terms are important in understanding regulations. For clarification, the following terms are defined:

**Administer** - to directly apply a controlled substance, whether by injection, inhalation, ingestion, or any other means, to the body of a patient or research subject by: a) a practitioner or, in his or her presence, an authorized agent; or b) the patient or research subject at the direction and in the presence of a practitioner (3)

**Dispense** - to deliver a controlled substance to an ultimate user or research subject by, or pursuant to, the lawful order of a practitioner, including prescribing, administering, packaging, labeling, or

compounding the substance for delivery (3); to sell, distribute, leave with, give away, dispose of, deliver, or supply (19)

**Drugs** - all medicinal substances, preparations, and devices recognized by the United States Pharmacopoeia and National Formulary, or any revision thereof, and all substances and preparations intended for external use in the cure, diagnosis, mitigation, treatment, or prevention of disease in humans or animals, including all substances and preparations other than food intended to affect the structure or function of the body (19)

**Legend Drug** - any drug, medicine, chemical, or poison labeled, "caution, federal law prohibits dispensing without prescription," or similar wording indicating that the drug, medicine, chemical, or poison may be sold or dispensed only with the prescription of a licensed medical practitioner (19)

**License** - the grant of authority by the State Board of Pharmacy to a person authorizing him or her to engage in the practice of pharmacy in that state (19)

**Medical Practitioner** - any physician, dentist, veterinarian, or other person authorized by law to treat, use, or prescribe medicine and drugs for sick and injured humans or animals in a particular state (19)

**Medicine** - any drug or combination of drugs that has the property of curing, diagnosing, preventing, treating, or mitigating diseases, or that which may be used for such purposes (19)

**Prescription** - any order for drugs or medical supplies, written, signed, or transmitted by word of mouth, telephone, telegraph, closed circuit, television, or other means of

communication by a legally competent practitioner, licensed by law to prescribe and administer drugs and medical supplies that are intended to be filled, compounded, or dispensed by a pharmacist (19)

## Drug Classifications and Registration

The federal government has divided drugs into three categories: legend (prescription) drugs, controlled substances, and over-the-counter (OTC) drugs. In addition to legend drugs, the Drug Enforcement Agency (DEA) has developed a controlled drug system for the classification of prescription drugs that are considered to have a potential for abuse. Those drugs are listed in Chapter 21 of the *Code of Federal Regulations*. All controlled substances are placed in one of five classes, based on the characteristics of that particular drug. The most strictly controlled drugs are placed in Schedule I, while those drugs that are the least controlled are placed in Schedule V (22).

The following list presents a brief overview of the five classifications, the criteria for each class, and examples of drugs in each schedule (3,18,22). Although the federal government has established a system for the classification of controlled substances, each athletic trainer should consult with his or her state and local regulations to insure compliance with all laws.

### Schedule I:

- 1) The substance has high potential for abuse.
- 2) The substance has no accepted medical use in treatment in the United States, or it lacks accepted safety for use in treatment under medical supervision.

Examples: heroin, lysergic acid diethylamide (LSD), and marijuana

### Schedule II:

- 1) The substance has a high potential for abuse.
- 2) The substance currently has accepted medical use in treatment in the United States or accepted medical use with severe restrictions.
- 3) The abuse of the substance may lead to severe psychic or physical dependence.

Examples: diphenoxylate, morphine,

and methadone

### Schedule III:

- 1) The substance has a potential for abuse less than the substances listed in Schedules I and II.
- 2) The substance currently has accepted medical use in treatment in the United States.
- 3) Abuse of the substance may lead to moderate or low physical dependence or high psychological dependence.

Examples: anabolic steroids, methylphenidate, and phencyclidine

### Schedule IV:

- 1) The substance has a low potential for abuse relative to substances in Schedule III.
- 2) The substance currently has accepted medical use in treatment in the United States.
- 3) Abuse of the substance may lead to limited physical or psychological dependence relative to the substances in Schedule III.

Examples: barbital, chloral hydrate, and phenobarbital

### Schedule V:

- 1) The substance has a low potential for abuse relative to the controlled substances listed in Schedule IV.
- 2) The substance currently has accepted medical use in treatment in the United States.
- 3) The substance may lead to limited physical or psychological dependence relative to the controlled substances listed in Schedule IV.

Examples: codeine and ethylmorphine

For a complete list of controlled substances, refer to the *Code of Federal Regulations* Title 21, Part 1308, 1991. All other legend medications that are not controlled in Schedules I through V require a prescription prior to dispensing. Examples of those substances are anti-inflammatory drugs (naproxen), muscle relaxants (methocarbamol), and antibiotics (penicillin).

The *Code of Federal Regulations* presents a generic statement for classifying controlled drugs (22). Individual states have more specific rules that often are more restrictive. You should know your state's specific guidelines.

Federal and state regulations require that all sites that dispense controlled substances have on file the proper registration forms for that location (1,21). This site documentation must be updated and completed properly on an annual basis. In addition to registration, facility administrators also must provide the following: security arrangements that are established to guard against theft; current, readily retrievable records of inventories; and a complete inventory of all stocks of controlled substances that is made every two years (21). Each controlled drug must have the following information on the inventory record: name, dosage form and unit strength, number of units or volume, and number of commercial containers of each substance (17).

## Record Documentation

The Food and Drug Administration (FDA) has developed a system of labeling any substance found in Schedules I through V. The following label information is the minimum required (11):

- a) The name of the patient to whom the controlled substance was dispensed
- b) The date that the controlled substance was dispensed
- c) The name and quantity of the controlled substance
- d) Instructions for taking or administering the controlled substance
- e) The name of the physician dispensing the controlled substance
- f) A statement explaining what the drug is intended to be used for

State law may require additional information (18), such as:

- g) The name and address of the pharmacy
- h) The serial number of the prescription
- i) The address of the patient
- j) The initials or name of the dispensing pharmacist
- k) The drug name, strength, and manufacturer's lot or control number
- l) The expiration date of the drug, if any
- m) The name of the manufacturer or distributor

Furthermore, over-the-counter (OTC) drugs must have certain information on the container label before the substance can be legally dispensed without a prescription.

The label must include: name of the product, name and address of the manufacturer, net contents of the package, name of all active ingredients, name of any habit-forming drug contained in the preparation, cautions and warnings, and adequate directions for safe and effective use (18). The label must be legible and attached to the container in which the drug is administered (8,12). Furthermore, the information must be written with "adequate directions for use," which means that the average person can safely use the medication for the purpose intended (11).

Another aspect in the control of medications is keeping accurate dispensing records. The minimum standards include (2,20):

- a) Date that the controlled substance was dispensed
- b) Name and quantity of the controlled substance dispensed
- c) Methods of administration of the controlled substance
- d) Name of the patient to whom the controlled substance was dispensed
- e) The diagnosis and the reason for the prescription for Schedule II amphetamines

Therefore, if controlled substances are located in and administered from either the traditional or non-traditional athletic training facility, it is recommended that accurate, systematic record keeping be a high priority (7). It should be noted that all medications, whether purchased from a licensed distributor or received in the form of sample packages, must be documented in the same fashion (17,18). Accountability remains constant in the issuance of all pharmacological substances (2,8).

### Recommendations

Athletic trainers who dispense medications of any kind should consider these recommendations:

- 1) Obtain a copy of your state's laws and regulations pertaining to ordering, prescribing, possessing, distributing, and dispensing all medications.
- 2) Review your credentials to insure that you meet the minimum standards that will allow you to be involved with handling legend drugs and controlled substances.
- 3) Contact your state board of pharmacy to assist you in establishing a written policy involving medications. Addresses and telephone numbers of State Boards of Pharmacy are listed in the *Pharmacy Law Digest* (18).
- 4) Discuss with legal counsel your involvement as it relates to medications and policies.
- 5) Clarify with legal counsel the judicial philosophy regarding the concept of "standing orders."
- 6) Use the university, college, or school health clinic for housing and distributing medications.
- 7) Maintain accurate, up-to-date records of all medications (prescription and over-the-counter) housed in your facility.
- 8) Establish appropriate labeling procedures to conform to legal standards for both controlled and non-prescription drugs.

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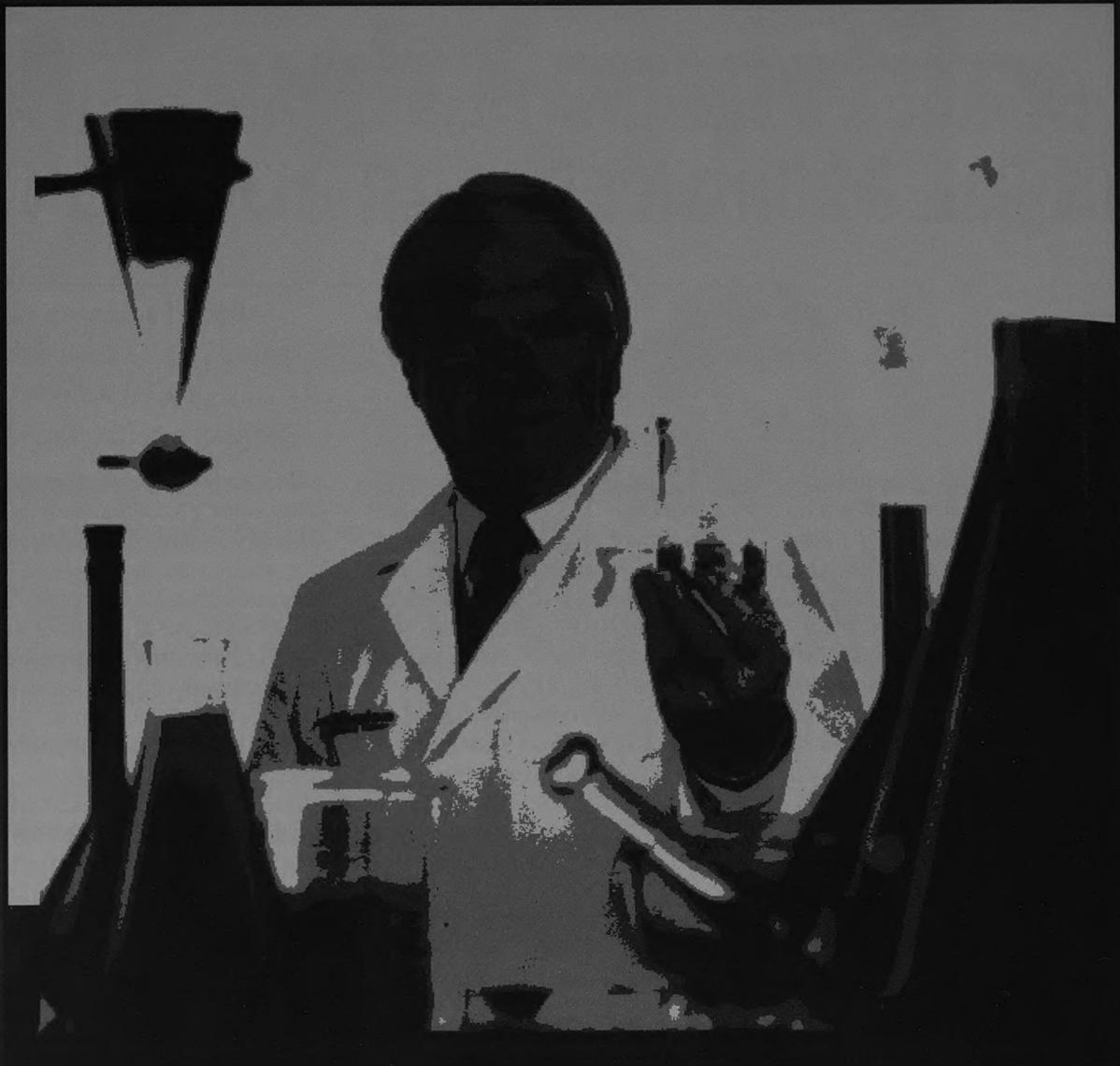
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# A Lisfranc's Fracture-Dislocation in a Collegiate Football Player

Robert J. Sauers, MEd, ATC  
Emil J. Dilorio, MD  
Carl B. Weiss, Jr., MD

**ABSTRACT:** *The Lisfranc's fracture-dislocation is an extremely serious injury that needs immediate recognition and treatment. In displaced fractures, swelling and deformity will be evident. But, often, because of spontaneous reduction, chronic midfoot pain and arthritis may result if the injury goes unrecognized. The tarsometatarsal joint, referred to as Lisfranc's joint, can be fractured and dislocated by direct or indirect forces. In football, one possible injury mechanism occurs when a foot that is planted on the ground receives an axial force applied to the heel as the forefoot is hyperextended. Using a classification system, the dislocation can be identified and treated in reference to the damage done. Treatment should consist of a thorough examination, including evaluation of the vascular supply. The athlete should be immobilized and transported properly, nonweight-bearing, for medical referral. Correct rehabilitation will allow the athlete to return to competition.*

The Lisfranc's fracture-dislocation is an injury that occurs when the tarsometatarsal joint is disrupted beyond ligamentous and bony stability (6). This injury rarely occurs, but it is one that requires immediate recognition by the athletic trainer (2,5,6). In a patient with a fracture-dislocation, deformity of the area helps with diagnosis. In a patient with any

foot injury, a physical examination is very important (7).

This report is provided so that the reader can gain an understanding of the mechanism of injury, treatment, and rehabilitation. Lisfranc's fracture-dislocation injuries are associated with a high potential for chronic disability (1).

A 19-year-old collegiate football full-back injured his left foot during practice. He was unable to walk and was assisted off the field in a nonweight-bearing manner. He was unable to describe how the injury happened, except to note that pain clearly was radiating from his foot.

We removed his shoe and sock, and deformity of the midfoot region was evident. The dorsalis pedis pulse from the artery lying dorsally between the first and second metatarsal was absent. Immediate reduction was performed by the athletic

trainer on the field, because disruption of these bones places the artery at risk. Reduction was done by applying steady anterior traction on the forefoot. The pulse returned immediately and the athlete felt relief.

Further examination revealed instability and crepitus, along with swelling and tenderness over the midfoot. An airsplint and ice were applied, and the athlete was transported to the team physician for treatment. Radiological examination revealed a Lisfranc's fracture-dislocation of the foot (Fig 1). The X-rays showed fractures of the second and third metatarsal heads, with an avulsion fracture at the base of the fifth metatarsal. The anteroposterior radiograph showed that the first metatarsal was displaced medially, and that the remaining four metatarsals were displaced laterally (Fig 2). This is known as a divergent



Fig 1.—Lisfranc's fracture-dislocation of the second and third metatarsal heads



Fig 2.—First metatarsal displaced medially; second through the fifth displaced laterally

Robert Sauers is clinical coordinator of Sports Medicine Lehigh Valley in Bethlehem, PA.

Emil Dilorio is medical director of Sports Medicine Lehigh Valley and team physician for Lehigh University in Bethlehem, PA.

Carl Weiss, Jr., is team orthopedic surgeon for Lafayette College in Easton, PA.

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fracture-dislocation (2).

The athlete was placed in a bi-valve cast and admitted to the hospital where closed reduction was performed by placing traction through the mid- and forefoot using Chinese finger traps, which were applied to the toes of the foot. Pressure was then applied downward via the heel as the fracture fragments were manipulated. Follow-up X-rays showed improved alignment of the second and third metatarsal head fractures, as well as the first through the fifth metatarsal cuneiform joints. Casting was recommended because the reduction was stable. If the reduction had been unstable, pin fixation would have been necessary (7).

Rehabilitation of the foot was initiated after the cast was removed. This included mobilization and exercise, with the emphasis on edema reduction. Gentle mobilization focused on increasing mobility of metatarso-phalangeal (MP) joints and the ankle mortise. Exercises included passive and active assisted range of motion activities such as towel stretching, wall stretching, alphabet formation, and clockwise/counterclockwise activities.

Electrical muscle stimulation was applied during each treatment to help reduce the edema and improve mobility of the foot and ankle. Pads were placed on the dorsum of the foot and around the malleoli to help encourage the pumping motion. Ice was applied and the extremity was elevated after each session. Ultrasound was applied during the first ten treatments to help scar tissue to form correctly.

Manual resistance, surgical tubing exercises, and an ankle strengthening machine were employed to develop muscle strength. The athlete's use of the pool, bicycle, rowing machine, and climber were important for cardiovascular training during the rehabilitative process. Aquatic therapy consisted of walking, running, and resistance work with swim fins and kick boards.

Manual stretching was performed on the gastrocnemius and soleus to improve plantar flexion. Toeing-off exercises and gait training were incorporated into the overall program.

Functional training was initiated using sport-specific drills. Cariocas, running circles, squares, cuts, and figure eights were used to help evaluate the athlete functionally. The athlete was able to play football one year later with the aid of a steel-plated shoe.

## Discussion

The tarsometatarsal (Lisfranc's) joint consists of five metatarsal bones, three cuneiforms, and the cuboid. The key to the stability of the tarsometatarsal joint lies in the structure of the second metatarsal base. Fractures to this area contribute to instability. In addition to these bones, ligaments also provide stability (3).

The forces that are responsible for the Lisfranc's fracture-dislocation are either direct or indirect (2,3). A direct force would result from a heavy weight being dropped on the foot. This athlete sustained an indirect force, which occurred when his forefoot was planted on the ground and a tackler from behind landed on his heel, applying an axial force. The forefoot was hyperextended as the force was applied to the tarsometatarsal joint causing disruption (Fig 3).



Fig 3.—Axial force applied to the heel with the foot in plantar flexion, causing a Lisfranc's fracture-dislocation

Using a classification system based on displacement, the injury is identified as total, partial, or divergent (2,3). Under Hardcastle's classification (2), this athlete sustained a divergent Lisfranc's dislocation when the first metatarsal displaced medially and the remaining four metatarsals displaced laterally (2,3).

Because the forefoot also was inverted during this injury, the fifth metatarsal sustained an avulsion fracture at the base. The hyperextended position of the toes caused the fractures of the second and third metatarsal heads.

The tarsometatarsal joint, also referred to as Lisfranc's joint, is relatively complex

and slightly mobile (4). Injuries to this area may be overlooked if the dislocation spontaneously reduces and is not properly evaluated. In a case of gross deformity, such as this, the diagnosis is evident. It is important to realize that spontaneous reduction may occur causing the diagnosis to be more difficult to make (3).

In addition to recognizing the swelling and deformity, the athletic trainer must check the dorsalis pedis pulse. The artery is at risk of damage in this type of injury, and a loss of blood flow can result in severe complications of the foot. Reported as a rare condition, tarsometatarsal joint injuries are occurring with increasing frequency in athletes. This may be the result of the change in footwear and/or the increase in the forces that athletes are exposed to on the playing field.

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# Effects of Varying Recovery Periods on Muscle Enzymes, Soreness, and Performance in Baseball Pitchers

Jeffrey A. Potteiger, PhD  
Daniel L. Blessing, PhD  
G. Dennis Wilson, EdD

**ABSTRACT:** In this study we examined the effects of varied recovery time on serum creatine kinase (CK), serum lactate dehydrogenase (LDH), muscle soreness, and pitch velocity in baseball pitchers. Ten males who had pitching experience participated in the study. After an 18-day training period, subjects pitched three simulated games. Game A and Game B were separated by four days of rest, while Game B and Game C were separated by two days of rest. CK, LDH, and muscle soreness were evaluated at the following times: before and immediately after exercise, and six, 24, 48, and 72 hours after exercise. Muscle performance was evaluated by measuring pitch velocity during the games. The CK level was elevated after each game (Game A - 249 U/l; Game B - 243 U/l; and Game C - 240 U/l); then it dropped toward baseline ( $p \leq 0.01$ ). CK post-exercise values were not different among games A, B, and C. LDH displayed a response similar to CK; however, there was a reduction over the span of the games ( $p \leq 0.05$ ). Muscle soreness was significantly elevated immediately after exercise ( $p \leq 0.01$ ) compared to all other measurement times. Pitch velocity was not different among games A,

B, and C. Results indicate that muscle damage, as evidenced by CK release, occurs in response to baseball pitching. However CK values, muscle soreness, and pitch velocity are not significantly affected by changes in the amount of recovery time typically scheduled between games.

The appearance of intramuscular enzymes in the blood following strenuous exercise provides evidence of skeletal muscle fiber damage (5,7,13,14,18). Creatine kinase (CK) and lactate dehydrogenase (LDH) are two physiological markers that have been used as indicators of skeletal muscle damage. The efflux of CK and LDH into the blood has been attributed to structural damage of the muscle fibers (1,4,8,9).

It has been reported that eccentric muscular contractions result in a greater CK and LDH efflux than concentric muscular contractions (11,15,16,18,20). The increased enzyme efflux is attributed to the generation of higher tensions by active muscle fibers during the eccentric contractions. The higher tension is thought to initiate some form of mechanical damage to the muscle that allows enzyme efflux into the blood.

The enzyme efflux that occurs after exercise may be modified by training (7,19) or repeated bouts of eccentric exercise (5,12). In these studies, previous training or eccentric exercise by the subjects reduced the amount of enzyme efflux during subsequent exercise bouts. Conversely, several studies show that a significant enzyme efflux still may occur following acute strenuous exercise, even when previous bouts of exercise have been performed (2,3,22).

The role of prior eccentric exercise on muscle enzyme release and performance is still unclear and deserves further study. The majority of past research has examined muscle enzyme release, muscle soreness, and performance in response to running, stepping, and isometric exercise bouts. The effect of other types of sport and exercise on these variables needs investigation. The purpose of this study was to examine the effects of varied recovery periods between games of baseball pitching on serum enzyme levels, muscle soreness, and performance.

## Methods

Ten males, who had prior experience as baseball pitchers, participated in the study. Age, height, and weight were (mean  $\pm$  SE) 22.6  $\pm$  1 yr, 173.0  $\pm$  2 cm, and 72.9  $\pm$  4 kg, respectively. As outlined by the American College of Sports Medicine, the experimental procedures were explained in detail, and the subjects signed an informed consent prior to participation in the study.

Subjects were required to report to the laboratory to participate in an 18-day training program. On alternating days, each subject threw a specified number of pitches at a predetermined percentage of their maximum velocity. The starting number of pitches for the training program was established at 55 and then increased by five pitches per workout until training was completed. By the end of the training program, subjects were throwing 100 pitches per workout. The beginning percentage of maximum velocity was 50% and was periodically increased to 100% for the last six days of the training program. During each training session, the subjects were given a warm-up similar to that employed before

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Jeffrey Potteiger is an assistant professor with the Department of Physical Education at Indiana State University in Terre Haute, IN.

Daniel Blessing is an associate professor with the Department of Health and Human Performance at Auburn University in Auburn, AL.

Dennis Wilson is a professor with the Department of Health and Human Performance at Auburn University.

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participation in a typical game situation. After warm-up, they threw 14 pitches per inning, with a six minute rest between innings, until they threw the predetermined number of pitches.

Subjects did not pitch for three days following training. They then pitched three simulated games with four days rest between Games A and B and two days rest between Games B and C (Table). The four-day recovery period was selected because it is an established routine for baseball

measures between games.

We attempted to establish a pitching protocol similar to a game situation. Subjects were allowed 45 warm-up pitches prior to the game and five warm-up pitches prior to each inning. Warm-up pitches were thrown at the rate of one pitch every 12 seconds. Subjects then threw 14 pitches per inning at a rate of one pitch every 20 seconds. At the end of 14 pitches (one inning), they rested six minutes and then threw during the next inning. Testing was

blood was allowed to clot and then was spun at 3000 rpm for 20 minutes in an IEC Centra-7R refrigerated centrifuge. A visual examination was performed to ensure that no hemolysis was present. The serum was divided into two separate storage tubes. The serum to be used for a CK level was frozen (-10 to -15° C) and analyzed within 72 hours. The serum for the LDH level was stored at room temperature (21° C) and analyzed within 72 hours. Creatine kinase was analyzed using Sigma procedure No. 16-UV and LDH was analyzed using Sigma procedure No. 47-UV (Sigma Diagnostics, St. Louis MO).

During each game, pitch velocity was monitored as a measure of performance. Each pitch was measured with a calibrated radar gun (RA-GUN G 1, Decatur Electronics, Decatur GA). On all pitches, subjects were instructed to maintain a velocity equal to or greater than 95% of their maximum velocity. Maintenance of near maximal pitching velocity was enforced to ensure that each subject was performing with a close to maximal effort on each pitch. Subjects were instructed to throw pitches eight, nine, and ten with their maximal effort, and these values were recorded as maximal pitch velocity.

Subjects were asked to rate their perception of soreness in the muscles of the pitching arm and muscles of the legs at all blood collection times. The Abraham (1) scale for muscle soreness was used to evaluate general soreness as follows: 0 - complete absence of soreness; 1 - light pain felt only by palpation; 2 - moderate soreness, some stiffness and/or weakness, especially during movement; and 3 - severe soreness, distressing pain that limits the range of motion.

A repeated measures analysis of variance (ANOVA) (treatment x time) was used to examine the results. Orthogonal polynomial comparison tests were employed to determine where the differences occurred. Significance was established at the  $p \leq 0.05$  level.

## Results

Creatine kinase response to the three pitching performances are shown in Fig 1. The response to each game was very similar; all three games elicited a significant increase in CK level ( $F(2,12)=23.61$ ,  $p=.0001$ ). Peak CK values occurred at 24 hours after exercise for Game A (249 U/l) and Game B (243 U/l), but at six hours after exercise for Game C (240 U/l). Following

Experimental Protocol

Pitching Assignment	Day	Blood Collection Before & after exercise
Game - A	1	Before, immediately after, 6 hr after
	2	24 hr after
	3	48 hr after
	4	72 hr after
	5	rest - no collection
Game - B	6	Before, immediately after, 6 hr after
	7	24 hr after
	8	48 hr after
Game - C	9	72 hr after, before, immediately after, 6 hr after*
	10	24 hr after
	11	48 hr after
	12	72 hr after

\* 72 hr after Game B and before exercise Game C are the same sample.

pitchers. The two-day recovery period was selected in an effort to reflect the unusual strategies used in post-season play and the recovery periods employed by relief pitchers. Randomization of the protocols within subjects did not occur because we felt that the two-day recovery period would have a carry over effect on the subsequent pitching performance.

During the time between the pitching performances, the subjects were instructed to refrain from participating in any physical activity. There were no instructions given regarding the use of any therapeutic

complete when the subjects finished seven innings of pitching. The total number of pitches thrown, excluding warm-ups, was 98. The protocol for the number of pitches and the between-inning rest was developed from previously recorded experimental data dealing with competitive collegiate games lasting seven innings.

Blood for CK and LDH was collected from the non-pitching arm via venipuncture. Six samples (5 ml each) were collected at the following times: (a) before exercise; (b) immediately after exercise; and (c) six, 24, 48, 72 hours after exercise (Table). The

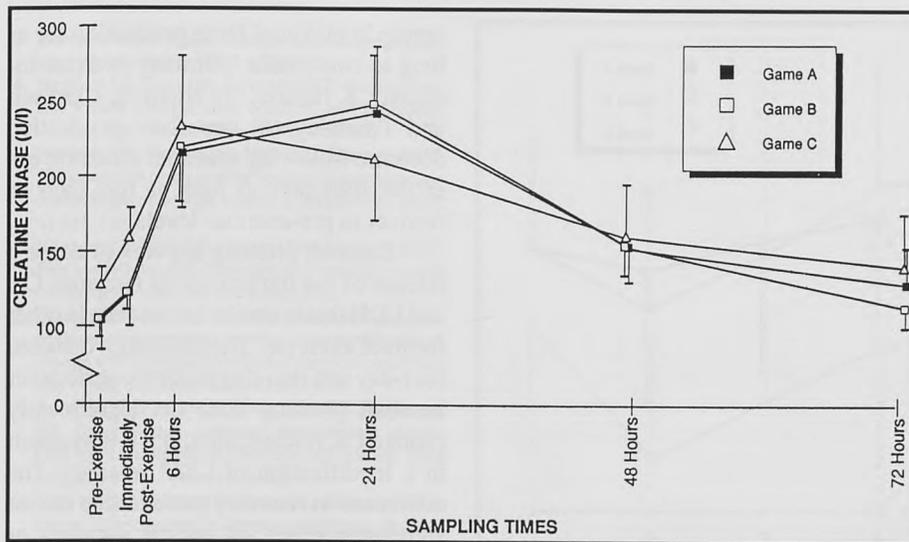


Fig 1.—Creatine kinase response prior to and following a game (mean  $\pm$  SE); \* Significant quadratic effect within games A, B, and C ( $p \leq 0.01$ )

each game, the enzyme levels then decreased, approaching baseline values at 72 hours after exercise. There were no significant differences between the three games at any of the sampling times ( $F(2, 12)=0.52$ ,  $p=.87$ ).

Fig 2 shows the LDH response to the games. As with CK, the LDH profile exhibited a significant LDH increase after each game ( $F(2, 12)=17.29$ ,  $p=.0001$ ). Peak values for LDH occurred at six hours after exercise in each case. There appeared to be a change in the response of LDH to the repeated games. In general, the LDH values for Game B ( $F(2, 12)=3.87$ ,  $p=.05$ ) and Game C ( $F(2, 12)=10.99$ ,  $p=.002$ ) were lower than for Game A ( $p \leq .05$ ).

Data for muscle soreness in the pitching arm are exhibited in Fig 3. In each protocol, the subjects reported the greatest

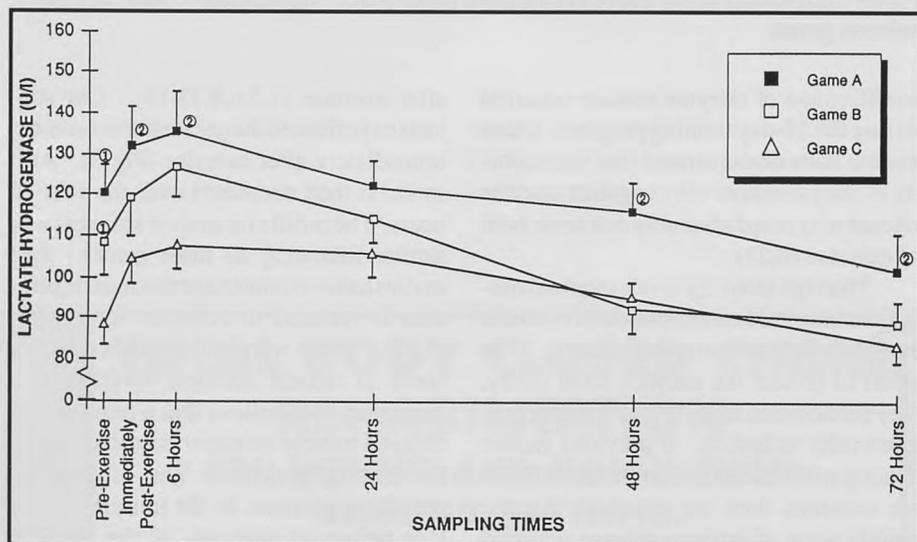


Fig 2.—Lactate dehydrogenase response prior to and following a game (mean  $\pm$  SE); 1-pre-exercise games A and B different from game C ( $p \leq 0.05$ ); 2-game A different from games B and C ( $p \leq 0.05$ ); \* Significant quadratic effect within games A, B, and C ( $p \leq 0.01$ )

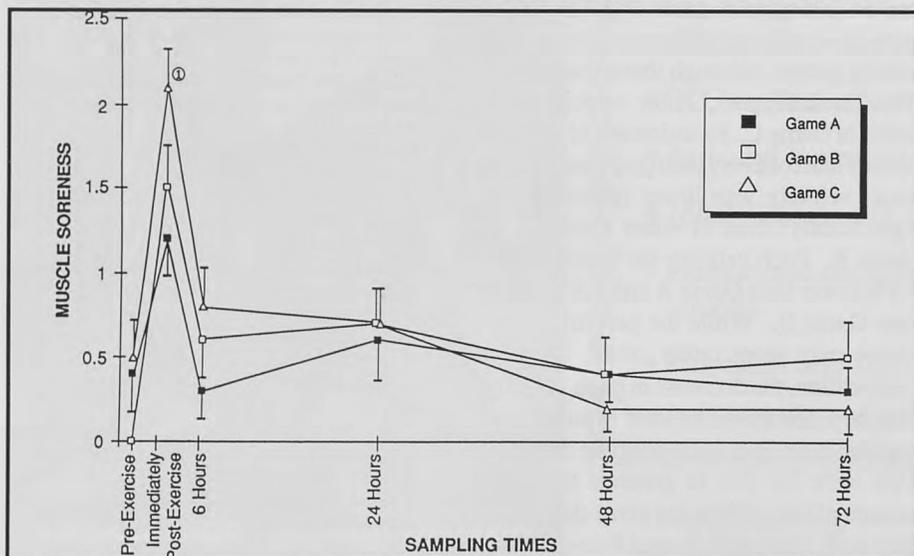


Fig 3.—Muscle soreness in the arm prior to and following a game (mean  $\pm$  SE); 1-immediate post-exercise different from all other values within games A, B, and C ( $p \leq 0.01$ )

soreness immediately after exercise, and this value was significantly different from all other values ( $F(2, 12)=21.00$ ,  $p=.0001$ ). Subjects reported no muscle soreness in the legs in response to any of the pitching performances.

The effects of the varied recovery periods did not significantly change the pitching velocity among games (Fig 4), although there was a slight trend toward decreased velocity in Game C ( $F(2, 21)=2.65$ ,  $p=.11$ ). Subjects were able to maintain their pitching velocity throughout the entire game, and there were no significant differences within games for any inning ( $F(2, 29)=0.34$ ,  $p=.70$ ).

## Discussion

It is commonly believed that the appearance of intramuscular enzymes in the blood is an indicator of skeletal muscle damage (5,7,13,14,18). It has been shown that enzyme efflux occurs in response to unaccustomed eccentric work or long duration strenuous exercise (11,15,16,18,20); however, previous training or prior participation in exercise may modify or provide a protective effect to subsequent enzyme release (5,7,10,17,21).

The CK and LDH post-exercise profiles for the individual pitching performances are similar to those reported in other studies using trained subjects (5,7). There was no significant modification of CK release among the pitching performances in our study. We believe that the

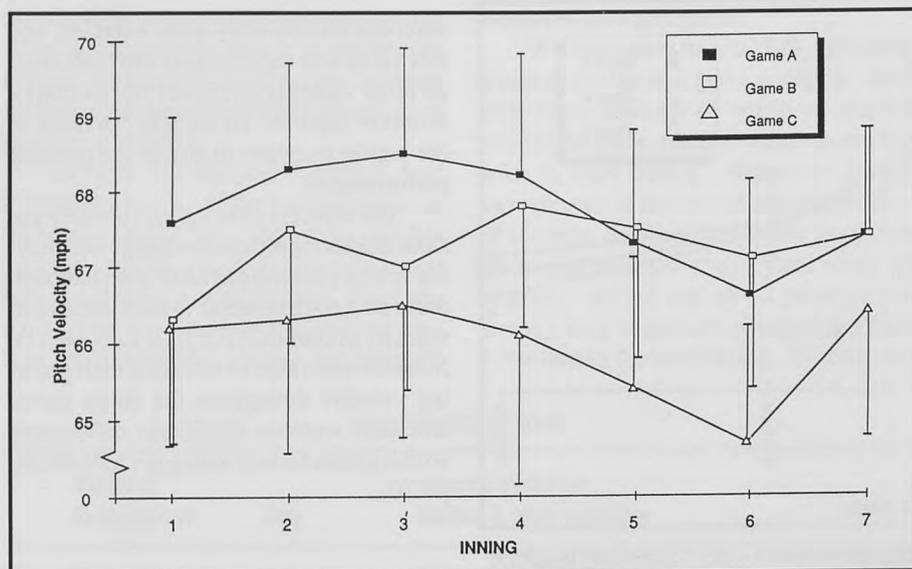


Fig 4.—Pitch velocity during a seven inning game (mean  $\pm$  SE); \* No significant difference within or between games

modification of enzyme release occurred during the 18-day training program. Other studies have demonstrated that the majority of the protective effect against enzyme release may occur after only one acute bout of exercise (6,21).

The high intensity levels required during pitching made it impossible to examine enzyme levels without prior training. In an effort to protect our subjects from injury, they participated in an 18-day training program prior to testing. If previous studies dealing with trained and untrained subjects are accurate, then we conclude that the modification of enzyme release occurred during the training program. Therefore, it appears that the CK and LDH response shown in this study is a normal occurrence in trained pitchers and is not significantly affected by either four days or two days of recovery.

While there was an increase in muscle enzyme efflux following pitching, the measurement of enzymes in the general circulation does not allow conclusions to be made about which muscle groups are involved with enzyme release and possible muscle damage. If determination of enzyme release from specific muscle groups can be made, then there exists the possibility of using enzyme levels following pitching as a clinical marker of arm overuse or arm injuries. Future research in this area is needed in an effort to make these determinations.

The majority of studies examining muscle soreness have found peak soreness levels to occur between 24 and 48 hours

after exercise (1,5,6,8,13,18). Our subjects experienced the greatest arm soreness immediately after exercise (Fig 3). Arm soreness then decreased over the next 72 hours. The profile for muscle soreness was similar following all three games. Past studies have demonstrated that muscle soreness is reduced in response to training (5,12). There were no significant differences in muscle soreness levels among games, and we believe that a reduction in delayed muscle soreness occurred during the training program. The subjects reported no soreness in the muscles of the legs before or after any of the pitching performances.

Maximal pitching velocity was recorded as a measure of muscle performance during each game (Fig 4). There were no significant differences in velocity among games, although there was a trend ( $F(2,21)=2.65$ ,  $p=0.11$ ) for velocity to be lower in Game C. Examination of the data reveals that for every inning of Game C, the mean velocity was lower (although not significantly) than in either Game A or Game B. Pitch velocity for Game C was 2.7% lower than Game A and 1.9% lower than Game B. While the percentage decrease may seem rather small, in game competition, the decrease in pitch velocity may be a determining factor in successful performance. It is quite possible that subjects were not able to generate the same amount of force following a two-day rest as they did following a normal four-day rest. These observations are supported by Newham et al. (12) who observed a de-

crease in maximal force production for as long as two weeks following exercise-induced CK release. In addition, Clarkson and Tremblay (6) saw force production decrease following maximal eccentric exercise, then take as long as five days to recover to pre-exercise levels.

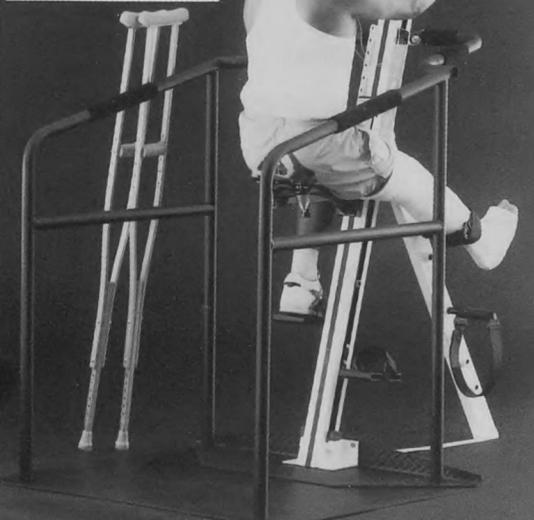
Baseball pitching appears to cause a release of the intramuscular enzymes CK and LDH that is similar to that seen in other forms of exercise. The difference between four-day and two-day recovery periods for baseball pitching does not significantly change CK release, although it may result in a modification of LDH release. The difference in recovery periods also has no significant effect on muscle soreness or pitch velocity, although it is interesting to note the trend for pitch velocity to be slightly lower following the two-day recovery period. We believe that elevated CK levels may indicate muscle damage, which could compromise pitching performance. It appears that further research is needed in an effort to determine if monitoring CK release from muscle tissue following pitching is related to subsequent baseball pitching performance.

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# Building an Adjustable Slide Board

Frank A. Trenney

**T**oday, closed kinetic chain rehabilitation for the lower extremities is the trend (1). Slide board activities are very beneficial in developing cardiovascular fitness, muscular strength and endurance, proprioceptive awareness, and functional activities (2), and have proven to be effective for closed kinetic chain rehabilitation.

With prices ranging from \$80 to \$375 for commercially manufactured slide boards, a less expensive slide board would be of value to those athletic trainers who are limited by budget constraints. This article is designed to assist any athletic trainer who could benefit from an adjustable slide board that can be constructed for approximately \$40 and in about three hours (not including a 24-hour drying period) using standard materials (Table 1) and tools (Table 2).

The slide board adjusts from six feet to eight feet in length to accommodate workload changes.

## Method of Construction

The first step in constructing an adjustable slide board is preparing the base. After all of the materials are acquired, begin by attaching the two eight-foot 2" x 4"s (Table 1, item M2) to the 2' x 8' sheet of ½" plywood (M3) with the deck screws (M1). To complete the base, glue and screw the five 17" 2" x 4"s (M4) to the plywood. Two of these will be placed at the ends of the base and the remaining two are placed between the center brace and the two side braces (Fig 1).

The second step is mounting the Marlite (M5) to the base by using the

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*Frank Trenney is a student athletic trainer at Indiana University of Pennsylvania in Indiana, PA.*

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Table 1.—Materials for Constructing a Slide Board

Item Number*	Quantity	Size	Description	Source
M1	25	1¾"	deck screws	Lumber Yard
M2	2	8'	2" x 4"	Lumber Yard
M3	1	2' x 8'	½" plywood	Lumber Yard
M4	5	17"	2" x 4"	Lumber Yard
M5	1	2' x 8'	¼" Marlite	Lumber Yard
M6	1	tube	Liquid Nail	Lumber Yard
M7	2	3'	4" x 4"	Lumber Yard
M8	2	4" x 3'	½" high density foam	Sports Med. Clinic
M9	2	16" x 3'	vinyl or equivalent	Discount Store
M10	5	4"	nails	Lumber Yard
M11	2	4"	¾" pipe (galvanized)	Lumber Yard
M12	1	can	car wax	Discount Store

\*Refers to reference in text

Table 2.—Equipment/Tools for Constructing a Slide Board

Tape measure	Screwdriver
Staple gun and ½" staples	Pencil
Electric drill	Hammer
¾" drill bit	Caulking gun
1" drill bit	Electric circular saw



Fig 1.—The completed base

Liquid Nail (M6). The cement is spread in a zig-zag manner on the top of the base (Fig 2), then the Marlite is placed on top of the base. After the Marlite is in place, determine the front and back edges of the board. Measure 2" from both the right and left sides along the back edge and mark with a pencil. Using a straightedge, draw a line from the front corners to these 2" marks (Fig 3). Cut along these lines with the electric saw. After this is completed, place a bed sheet and weights on top of the Marlite surface and allow the cement to dry for 24 hours to ensure a good bond.

The third step of construction is preparing the bumpers. After allowing the base to dry for 24 hours, take the two 4" x



Fig 2.—The application of the contact cement to the base

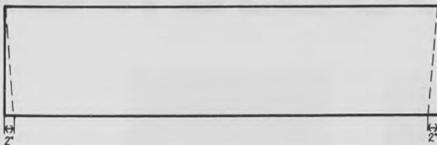


Fig 3.—Diagram depicting the cutting of the slide board. Notice that the front of the board is wider than the back in order to accommodate foot position at impact and push-off.

4"s (M7) and place them on top of and flush with the top right and left sides of the base. Mark the front and rear edges and cut the 4" x 4"s to fit. Glue (M6) and staple the ½" high density foam (M8) to the inside face of each bumper (Fig 4). Cover the entire bumper with the vinyl (M9). The vinyl should be attached snugly to the bumper with staples, then trimmed for neatness.

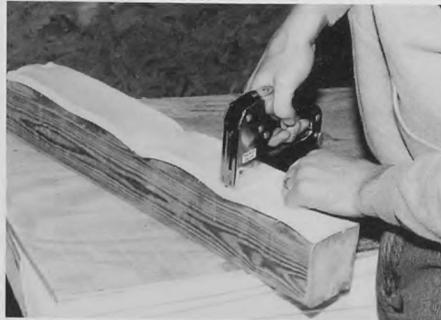


Fig 4.—The stapling of high density foam to the inside face of the bumper

The fourth step is mounting the bumpers onto the base. Because one of the bumpers will be fixed permanently to the board, it can be cemented and nailed to the base, using the five 4" nails (M10).

Because the second bumper is to be adjustable, two ¾" holes will be drilled into the bottom of the bumper. Each hole should be drilled 1½" from the outside edge of the bumper, 2" deep. Glue the two pieces of ¾" pipe (M11) into the holes. Then, drill 1" holes 2" deep into the base, using the bumper as your guide (Fig 5).



Fig 5.—The completed adjustable bumper. Notice the vinyl covering and the pegs with the corresponding holes in the slide board.

When the slide board is complete (Fig 6), wax (M12) and polish the Marlite surface. The board is ready for a workout after it has been prepared with the wax coating and the athlete has covered his or her shoes with a sock or some type of casting stockinette. For proper maintenance,

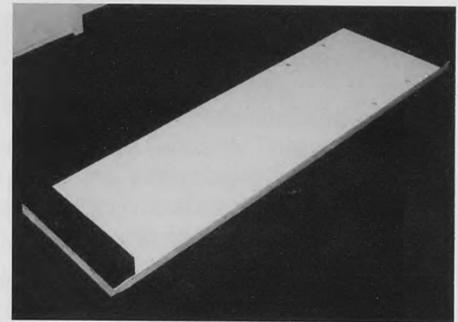


Fig 6.—The completed adjustable slide board

nance, the board should be waxed two or three times a week.

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# Improved Technique for Fabricating an RTV-11 Silicone Cast

John W. Robinson, MS, ATC, EMT

**R**TV-11 silicone rubber casting is an accepted procedure for protecting and stabilizing the upper extremity. Nondisplaced scaphoid fractures have been successfully managed with RTV-11 casting since 1973 (5), and I have used it as a protective playing cast since 1983.

RTV-11 is especially useful in contact sports because it protects the opponent as well as the injured athlete from injury. The fact that RTV-11 is not rigid in its final form makes it acceptable for use under both National Federation of State High School Athletics and National Collegiate Athletic Association guidelines (1,4).

Until now, the disadvantage of RTV-11 casting was the amount of time involved in fabricating the cast and waiting for it to dry. Drying time, in particular, could take as long as two to four hours (1,3). It also has been reported that the cast was not functional until 24 hours after fabrication (2).

The step-by-step process outlined here demonstrates improvements in cast fabrication and a significant reduction in drying time. The use of stannous octoate (STO) as a curing agent for RTV-11 silicone rubber is the key to these improvements.

## Materials

- 1) One to two one-pound cans of RTV-11 silicone rubber
- 2) Stannous octoate (STO) catalyst
- 3) A mixing cup large enough to hold three to four ounces of material

*John Robinson is director of athletic training services at The Center for Sports Medicine and Fitness in Ypsilanti, MI.*

- 4) A 60-cc syringe to measure silicone rubber (optional)
- 5) A one-cc medicine dropper for stannous octoate
- 6) A cast stand for forearm support
- 7) Several rolls of 2" or 3" cling gauze
- 8) 20 inches of 3" stockinette
- 9) One veterinary length rubber glove
- 10) Two regular disposable rubber gloves
- 11) A 1/8" thick piece of Aquaplast or Orthoplast
- 12) Tape scissors and cast-cutting scissors
- 13) Paper towels
- 14) Tongue depressors

## Preparing the Athlete

Apply a veterinary-length rubber glove to the appropriate hand or forearm.

Place a doubled 20" piece of stockinette, with a hole cut for the thumb, over the forearm and the rubber glove (Fig 1). Place the athlete's forearm in the cast stand with paper towels under it to catch any dripping RTV-11 (Fig 2).

## Preparing the Casting Material

Pour four to five ounces of RTV-11 silicone rubber into a mixing cup. Add one-tenth ml of STO catalyst to the RTV-11 (ten drops from a one-cc medicine dropper will produce one-tenth ml). Stir this mixture thoroughly with a tongue depressor until it thickens.

This amount of RTV-11 mixture is sufficient for one layer of the cast. Each layer should be prepared separately and applied as soon as it is mixed because of the rapid curing. The RTV-11 mixture begins to cure in three to five minutes.



Fig 1.—A stockinette is applied over a rubber glove.



Fig 2.—A casting stand is used to support the forearm.

## Fabricating the Cast

With the athlete's arm resting in the cast stand, pour the RTV-11 mixture directly onto the stockinette and spread the material evenly with a tongue depressor over the area to be protected (Fig 3). It is much easier to apply RTV-11 to the palmar surface of the hand and forearm if the patient will supinate during this step; this movement does not adversely affect the finished product. The stockinette should then be saturated completely with RTV-11.

After the first layer of RTV-11 has been applied, wrap the entire area with a single layer of 2" or 3" cling gauze (Fig 4).



Fig 3.—RTV-11 is spread directly onto the stockinette.



Fig 5.—Aquaplast is applied.



Fig 4.—Wrap the first layer of RTV-11 with cling gauze.



Fig 6.—A second layer of cling gauze is applied over the Aquaplast.

Determine the width of the gauze by the shape and size of the area to be covered. The objective is to cover the area smoothly and neatly. Be sure to apply the gauze before the first layer of RTV-11 begins to cure, so that it will bond with the RTV-11. Actually, any gauze can be used, but I prefer cling gauze. It adheres well to itself and is porous enough to allow for sufficient bonding between layers of RTV-11.

Prepare a second layer of RTV-11 and apply it according to the previous description. Again, note that the RTV-11 will begin to cure in three to five minutes and will become solid in approximately 10 minutes.

Additional support can be added to the cast with Aquaplast or Orthoplast. If additional support is to be used, cut the material to the appropriate size and shape prior to beginning the cast fabrication. After the second layer of RTV-11 has been applied, heat the Aquaplast or Orthoplast and place it on the area requiring additional support (Fig 5). Perform this before the second layer of RTV-11 has cured. Hold the support material in place with a second layer of cling gauze that covers the entire cast (Fig 6). Prepare and apply two more layers of RTV-11, placing gauze between them, for a total of

four layers. The final layer of RTV-11 will be sufficiently dry approximately ten minutes after its application.

Remove the cast using a pair of cast-cutting scissors. Make the cut along a line drawn on the cast between the fourth and fifth metacarpal. This allows the cast to cradle the fifth metacarpal and prevents the hand from slipping out of the cast during use. Removing the cast can be uncomfortable for the athlete, especially when cutting near the ulnar styloid. Cut the cast from both the distal and proximal ends to allow it to loosen before cutting near the ulnar styloid. Applying a small amount of Skin Lube to the tip of the scissors also will facilitate cast removal.

Once the cast is removed, pull the rubber veterinary glove from inside the cast. Trim the cast of all excess materials with a pair of tape scissors. The playing cast then can be reapplied to the limb and wrapped securely with a 2" or 3" elastic wrap secured with athletic tape.

This RTV-11 method allows the playing cast to be fabricated and ready for use in approximately 40 to 45 minutes. The key to this time frame is to use STO as the catalyst for the RTV-11 silicone rubber. RTV-11, a General Electric product, and STO can be purchased at most electrical supply companies.

## Acknowledgements

Technical input and pictorial assistance for the development of this article were provided by Robert E. Macek, MA, ATC, EMT, head athletic trainer at Saline High School, Saline, MI; Michael R. Marinucci, MS, ATC, EMT, head athletic trainer at Dexter High School, Dexter, MI; and Mark R. Stonerock, ATC, EMT, head athletic trainer at Pinckney High School, Pinckney, MI.

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# The Problem-Oriented Approach to Sports Injury Evaluations

A. John Gabriel, MA, ATC

**ABSTRACT:** *The problem-oriented approach to sports injury evaluations is used successfully throughout the United States by various health care providers, and can be used by certified athletic trainers to enhance the evaluation and management of sports injuries. The problem-oriented medical record is used successfully to provide effective communications and as a learning tool in health-related education. In this paper, I present a problem-oriented system for evaluating and keeping medical records on sports injuries. The process of collecting data through interviews and organizing that information is the focus.*

Certified athletic trainers often evaluate physical complaints and determine how to deal with these complaints. The problem-oriented system of evaluation and its counterpart, the problem-oriented medical record, are valuable tools that athletic trainers should use in evaluating sports injuries.

This article presents the problem-oriented system of evaluation and its implementation by certified athletic trainers. As a necessary complement to the problem-oriented system, I also discuss the problem-oriented medical record.

## Background Information on Evaluation

The concept of the problem-oriented system (POS) was first developed by Weed (9) at Case Western Reserve University in Cleveland in the late 1960s. The POS is

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*John Gabriel is an athletic trainer at Peru State College in Peru, NE. He has seventeen years of experience in college, high school, and clinical settings, as well as twelve years of experience as an emergency medical technician. Gabriel was formerly a program director for paramedic training in Sioux City, IA.*

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used as a logical system for recording medical information and presenting that information in a well-structured format. In 1976, Sherman and Fields (8) produced *Guide to Patient Evaluation: History-Taking, Physical Examination, and the Problem-Oriented Method*. That text outlines the problem-oriented system as a methodology for history-taking and examination techniques. Included was the problem-oriented medical record. The authors state that the problem-oriented medical record serves a valuable function in organizing the evaluation process by providing a framework for inserting information derived from the problem-oriented system. It is based on the acronym SOAP (subjective, objective, analysis, and procedure).

Current literature in sports medicine therapy shows a need for the POS and the problem-oriented medical record by certified athletic trainers. In a 1981 article, I presented an injury evaluation form based on the POS that began with history taking and included observations, palpation, manipulation (manual testing), clinical impressions, and a plan of action (5).

Booher and Thibodeau (3) outlined the use of a primary and secondary assessment for injury evaluation, represented by the acronym HOPS (history, observations, palpation, and stress). Fahey (4) identified a clinical evaluation of injuries organized in a systematic format that includes history, inspection, palpation, and functional testing. Fahey then separated the primary and secondary surveys for use in emergency situations that require rapid assessment and immediate first aid.

Arnheim (2) outlined a system of injury evaluation that begins with the primary assessment for on-site injury inspection followed by a secondary assessment. In his triad, Arnheim included the clinical evaluation for determining progress during a rehabilitation program.

Emergency medical care textbooks outline the primary and secondary assessments in the field, but do not elaborate on

a methodology for more extensive evaluations (1,6). The advanced emergency care textbook, *Basic Life Support Skills Manual*, by Phillips (7) outlines the POS and medical record for paramedics as part of a laboratory exercise on field evaluations, but it does not go into depth on the subject.

In reviewing the current materials about patient assessment that are available to athletic trainers, there appears to be some uniformity in the use of a primary and secondary assessment for injury evaluation; however, it differs from the primary and secondary assessment outlined in the United States Department of Transportation curriculum for emergency medical care training and in various emergency medical care textbooks (1,6,7). The primary and secondary assessments deal with a rapid review of bodily systems to determine life-threatening conditions first, then a quick examination of a victim for less critical injuries. The final objective of the primary and secondary assessment is to determine what injuries must be stabilized and how the patient is to be immobilized and transported. Fahey, and to a lesser degree Arnheim, have differentiated the assessment of injuries from evaluation, seeing the need for a more detailed investigation of medical problems in athletes.

## The Problem-Oriented System

As the first qualified health care provider to see most sports injuries, the certified athletic trainer plays an important role in the early detection and care of injuries. Consequently, the skill of the athletic trainer in collecting data on physical complaints and reaching an appropriate assessment affects the injury management process. The POS of evaluation is an investigative approach that can assist an athletic trainer in organizing the evaluation process into a logical framework and can have a positive effect on the injury management process.

The POS is based on the scientific method, and its primary purpose is to provide communications between health

care team members working with a patient. The problem-oriented medical record is a guide for the evaluator so that the POS can be applied consistently throughout the evaluation process.

Use of this system helps to organize an evaluation into a logical pattern, beginning with the patient history and concluding with a plan of management. The athletic trainer uses the problem-oriented medical record to assemble a base of information, appropriately called the data base. All information received from the athlete and collected by the athletic trainer during the course of the evaluation is added to the data base and analyzed to determine a course of action. Sherman and Fields (8), discussed the methodology of the POS for data collection and included four basic components. They are as follows:

1. Data Base - The record of the patient's history, physical examination, and laboratory reports

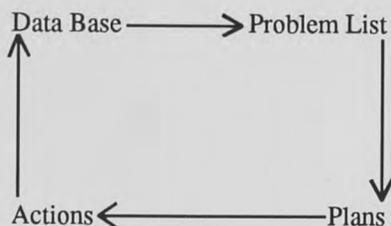
2. Problem List - A list of the identified patient's problems kept at the front of the medical record

3. Plans - A written plan for each major problem identified, including the evaluator's own assessment of the factors involved and processes occurring, with recommended further studies, treatment, and patient education

4. Action Plans - The records of implementation of plans and of the patient's progress. These include medical orders (diagnostic and therapeutic), consultations, records of additional information from history or further physical examination, and records of the monitoring of the patient's response to treatment.

As the evaluation proceeds from the identification of the problem to the analysis by the athletic trainer, numerous bits of information are added to the data base and create a closed loop.

The following diagram represents a pattern of logical thinking that theoretically never ends. Each time the athlete is treated for a problem, new information is received and a new assessment is made.



## The Problem-Oriented Medical Record

The problem-oriented medical record is used by a variety of health care professionals including physicians, nurses, therapists, and emergency medical technicians. It is the framework for using the problem-oriented system (Fig1). It aids the evaluator by defining a logical sequence that favors problem solving. The problem-oriented medical record is based on the acronym SOAP. The letters represent the following:

1. Subjective Information (S) - Consists of data base information given to the athletic trainer by the patient during the interview and history-taking phase

2. Objective Information (O) - Consists of the findings of formal tests and measurements performed by the athletic trainer

3. Analysis (or Assessment) (A) - The athletic trainer's analysis of the data collected and its implications

4. Plan of Action (or Procedure) (P) - An outline of the management of the problem; it often includes therapy plans and patient education

The advantages of using a simple format such as SOAP, is that it provides a guideline for evaluation, enhances data collection, and organizes that data into a consistent, standardized format. By organizing data collection into a specific format, the information collected can be reviewed, checked, and rechecked for accuracy during the evaluation.

Another advantage of using the problem-oriented medical record is that the evaluation skills of the writer can be reviewed and critiqued. The investigative logic and technical skills of the evaluator can be seen readily when

written into a standardized evaluation form. Subsequent evaluations of the same problem are compared to judge consistency and thoroughness in the evaluator's performance. For student athletic trainers, the preceptor (clinical instructor) can critique the student's injury evaluation report and readily discern whether the tests performed in the evaluation are appropriate for the problem identified by the athlete. In addition, the problem-oriented medical record will outline the effectiveness of the student's interviewing and history-taking skills.

## Subjective Information

The POS begins with the identification of the patient's complaint or problem during the interview and history taking. This is the first step in the evaluation process. It is the athletic trainer's most important evaluative tool, because a majority of problems can be analyzed successfully with the aid of a good patient history.

The subjective information recorded in the interview begins with the problem list, which Weed (9) called a "table of

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Fig 1.—Training room sports injury report form based on the problem-oriented approach to injury evaluation.

contents" of the patient's problems. In sports medicine, a problem is any significant deviation from the norm that has influenced, is influencing, or may influence the athlete's health or capacity to perform at the level of ability demanded by the sport.

It is important that an accurate list of problems be recorded. Without precisely determining what the problems are, there will be little precision in the management process. A good maxim to remember is: the patient has all the answers—so make sure that you ask the right questions. You can then use the problem list or symptoms that the patient presents to guide the remaining course of the evaluation. The major objectives of the subjective phase of the evaluation are to discover the problem, collect any history related to the problem, and identify the current history of that problem.

Additional sources of information for the history are the preparticipation physical examination and/or the preparticipation physical health-history survey. The objectives of the patient interview must be kept in mind constantly, and all information must be collected in a precise manner, as later data collection may become difficult.

### Interviewing

In the subjective phase of the evaluation, you establish a relationship between you and the athlete. Good rapport is important and is established by presenting a professional, but concerned, attitude. Positive rapport, established early in the interview enhances data collection and increases the probability of developing a constructive working relationship between the athlete and the trainer.

You should show concern and allow the athlete to talk freely. Give verbal support and educate the athlete about the significance of the evaluation findings. Through patient education, you give the athlete a plan of action that will help alleviate much of his or her apprehension and fear.

A useful interviewing technique is

"consensual validation." To employ this technique, periodically ask the patient what he or she means by a statement and confirm that the information being collected is correct. Consensual validation allows the patient to clarify and confirm what already has been said.

Finally, you must record the information as the interview progresses. This indicates to the patient that you feel both the person and the information are important. Recording data during the interview is central to the rationale behind the problem-oriented system and the problem-oriented medical record that stresses good record keeping for data collection and decision-making.

### Objective Information

Objective information is any data collected from formal tests and measurements (e.g., goniometry readings, Cybex testings, and laboratory reports). The data collected in the subjective phase will direct you to the areas of the body to evaluate and to the tests that will confirm the subjective complaints with "concrete" evidence.

Objective information includes observations made by the athletic trainer of the general condition of the injured area. Evidence of edema, hematoma, and obvious deformities are recorded in the objective part of the problem-oriented medical record. Your observations will include how the athlete is responding to an injury. These may include watching the gait pattern (lower extremity injury), observing the "splinting" of an injured area for protection (shoulder injury or dislocation), or looking for signs of dysfunction (atrophy or spasm).

You must record the findings of the examination in a precise and consistent form, using appropriate and acceptable medical nomenclature. Because the problem-oriented medical record is a tool for communication, information collected is of little value if it is incomplete, inaccurate, or illegible. It is important to decide in advance how the information is to be recorded (i.e., U.S. or metric measurements).

Establishing uniform recording guidelines will enable you to be consistent from evaluation to evaluation. Consistency also will ensure that any further tests or reevaluations are reliable measures for comparison.

### Assessment

At the completion of the objective examination, the extent of the problem must be determined. From recorded clinical impressions, you decide the need for medical or surgical intervention. If medical intervention is not indicated, you determine a diagnosis and proceed with therapeutic intervention.

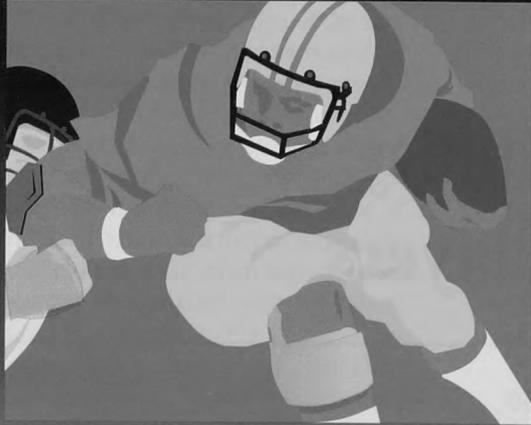
### Plan

With the assessment completed, a course of action and an outline can be planned for the athlete. Also, you may have received specific protocols from the team physician, which should be noted on the evaluation form. Any patient education or instructions also should be noted, as well as any orthopedic appliances or crutches that are to be used.

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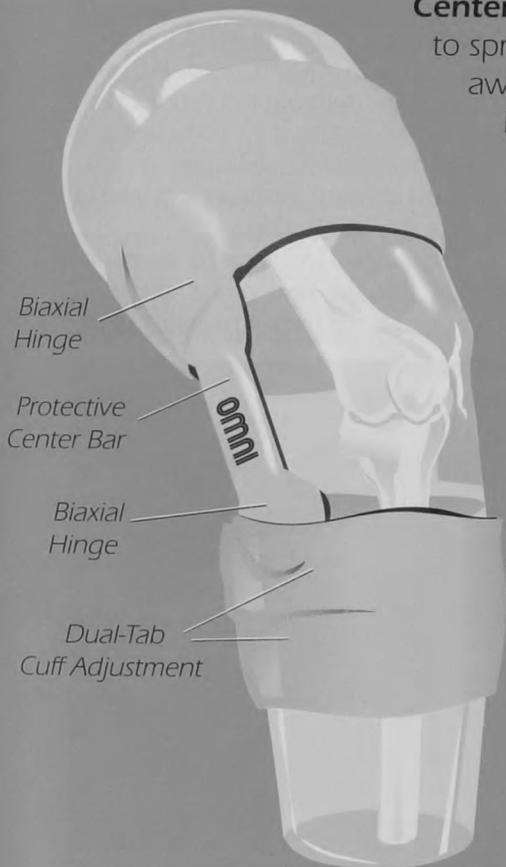


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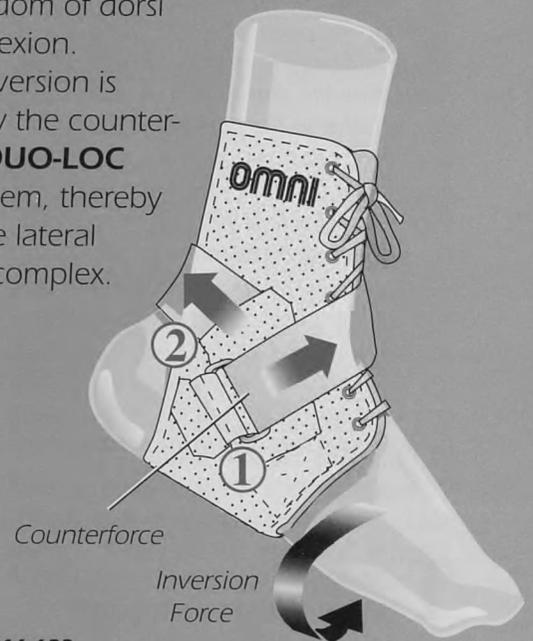


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# Patterns of Shoulder Flexibility Among College Baseball Players

Lisa Johnson

**ABSTRACT:** *In this study, I investigated and analyzed the various joint motions in the shoulders of college baseball players. Twenty-six players (age= 20.38±1.36 yr) from two colleges were examined for upper extremity range of motion (ROM), including shoulder flexion, extension, internal rotation at 90° abduction, and external rotation at 90° abduction. Joint motions were measured using a JAMAR®, six-inch, double-arm goniometer. Pitchers demonstrated 22° more shoulder flexion and 21° more external rotation at 90° abduction than infield position players, and 17° more shoulder flexion than outfield position players. There was no significant difference between the dominant arm flexibility of infield and outfield position players. When comparing the dominant to nondominant arm relative to the position, infield position players demonstrated 5° less shoulder flexion and 6° more external rotation on the dominant side at 90° abduction. Pitchers did not demonstrate any significant difference between the dominant and nondominant arm. There was, however, an indication that pitchers had a tendency to exhibit greater flexibility during flexion and external rotation at 90° abduction in the dominant side than in the nondominant side.*

The baseball player, as a throwing athlete, subjects the shoulder to various degrees of physical stress. From the time that the ball is taken from the glove to the point at which the follow-through ends,

*Lisa Johnson is a health science and athletic training major at James Madison University in Harrisonburg, VA.*

the shoulder is maneuvered through varying positions and placed under varying degrees of stress (3,4,6,9,10). The shoulder adapts to these demands by developing physical characteristics that lead to alterations in the range of motion (3,4,6,7).

There is a correlation between an athlete's shoulder joint mobility and the performance of a pitch (3,9,11). The act of throwing involves multiple muscle groups and the interaction of tendons, muscles, and bones (3). A flexible joint allows the muscles to work with each other, rather than against one another, which allows the ball to reach its destination with greater accuracy and speed (3,9,11). If flexibility is not emphasized and accomplished in a regular conditioning program, the pitch will be affected, and the athlete's risk of injury will be increased (1,3,10). If the typical range of motion (ROM) of the throwing shoulder is known, it can be used to help determine conditions that may predispose the athlete to injury or diminished performance.

In this study, we examined the ROM of the movements necessary to throw a baseball—shoulder flexion, extension, internal rotation at 90° abduction, and external rotation at 90° abduction.

## Methods

Thirty-two college baseball players from Eastern Mennonite College (EMC) and James Madison University (JMU),

both in Harrisonburg, VA, volunteered for upper extremity ROM testing. The flexibility exercises used by each team were similar (based on my observation). Athletes who indicated having current injuries or who played more than one position were excluded from this study. Thus, 26 healthy baseball players were chosen for testing (11 from EMC, 15 from JMU; age=20.4 ± 1.4 yr; ht=71.5 ± 2.2 in; wt=175.5 ± 17.5 lb; position: infield=8, outfield=9, pitchers=9; throwing arm: R=23, L=3; years involved in baseball=12.9 ± 1.4 yr).

Using the standard technique developed by Norkin and White (8), passive bilateral upper extremity ROM was measured with a JAMAR® (Clifton, NJ), six-inch, double arm goniometer during extension, internal rotation at 90° abduction, and external rotation at 90° abduction. A variation of the standard technique was used to measure shoulder flexion.

The standard technique for the evaluation of shoulder flexion was altered in order to study the functional ability of the

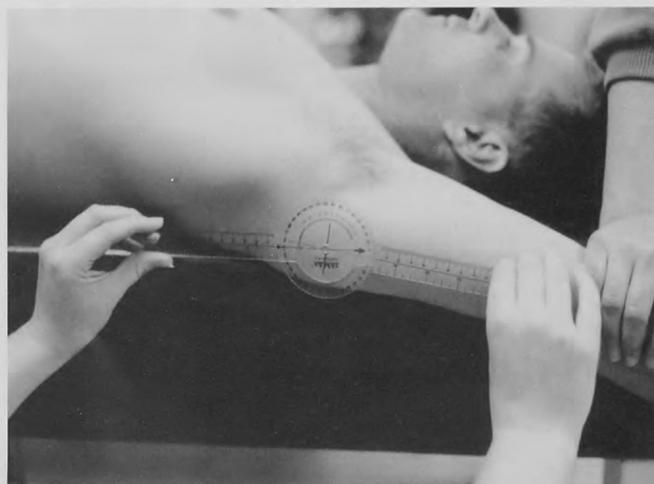


Fig 1.—Altered technique for measuring shoulder flexion range of motion

shoulder complex. The subject was placed in a supine position with the knees flexed and the shoulder over the edge of the supporting surface. This method increased the ROM allowing scapulothoracic, sternoclavicular, and acromioclavicular motion to occur with glenohumoral motion (8). The stationary arm of the goniometer then was aligned with the mid-axillary line of the thorax. The arm was moved through its range of motion, and the moving arm of the goniometer was aligned with the lateral midline of the humerus (Fig 1).

One-way analysis of variance (ANOVA) and Scheffé post hoc tests were used to compare differences between positions of the dominant arm measurements. Paired t-tests were used to compare differences between the measurements of the dominant arm and measurements of the nondominant arm of subjects within the given positions.

## Results

Means and standard deviations for total ROM in the various groups and arms (dominant and nondominant) are outlined in the Table. Infielders demonstrated 6° more external rotation at 90° abduction [ $t(8)=-1.95, p=.04$ ] and 5° more shoulder flexion [ $t(8)=2.90, p=.01$ ] on the dominant side than on the nondominant side.

Pitchers did not demonstrate any significant difference between the dominant and nondominant sides. There was, however, an indication that pitchers had a tendency to exhibit greater flexibility during flexion [ $t(9)=1.76, p=.06$ ] and during external rotation at 90° abduction [ $t(9)=1.67, p=.06$ ] on the dominant side than on the nondominant side. No significant differences were found between the dominant and nondominant arms of outfielders (internal rotation [ $t(9)=.02, p=.50$ ]; external rotation [ $t(9)=-1.11, p=.15$ ]; flexion [ $t(9)=1.12, p=.15$ ]; extension [ $t(9)=-0.09, p=.46$ ]).

Pitchers exhibited greater dominant arm ROM than infield and outfield position players. Pitchers demonstrated 22° more shoulder flexion [ $F(2,23)=12.65, p=.0004, \text{Scheffé } p=.001$ ] than infielders, and 17° more flexion [ $\text{Scheffé } p=.005$ ] than outfielders. Pitchers also demonstrated 21° more external rotation during abduction than infielders [ $F(2,23)=5.16, p=.02, \text{Scheffé } p=.02$ ] and 16° more than outfielders ( $\text{Scheffé } p=.069$ ). No other comparisons between positions were significant [ $\text{Scheffé} > .50 \text{ \& } F(2,23) < .54, p > .60$ ].

Dominant Versus Nondominant Shoulder Range of Motion (degrees; mean  $\pm$  SD)

	Flexion	Extension	Internal Rotation (90° Abduction)	External Rotation (90° Abduction)
<b>Pitcher</b>				
Dominant	209 $\pm$ 10.7 <sup>bc</sup>	96 $\pm$ 10.0	111 $\pm$ 15.2	136 $\pm$ 14.6 <sup>bd</sup>
Nondominant	202 $\pm$ 6.6	98 $\pm$ 12.2	116 $\pm$ 12.2	128 $\pm$ 12.9
<b>Infield Player</b>				
Dominant	187 $\pm$ 10.1 <sup>ab</sup>	92 $\pm$ 21.2	110 $\pm$ 11.8	115 $\pm$ 5.8 <sup>ab</sup>
Nondominant	192 $\pm$ 10.3 <sup>a</sup>	87 $\pm$ 16.6	114 $\pm$ 11.9	109 $\pm$ 7.8 <sup>a</sup>
<b>Outfield Player</b>				
Dominant	192 $\pm$ 7.2 <sup>c</sup>	90 $\pm$ 8.7	106 $\pm$ 12.8	120 $\pm$ 19.2 <sup>d</sup>
Nondominant	195 $\pm$ 6.5	90 $\pm$ 9.1	106 $\pm$ 10.6	114 $\pm$ 8.0

a. Dominant and nondominant arms difference ( $p < .05$ )

b. Pitchers' dominant arms greater than infield players' arms ( $p < .05$ )

c. Pitchers' dominant arms greater than outfield players' arms ( $p < .05$ )

d. Pitchers' dominant arms may be greater than outfield players' arms ( $p = .07$ )

## Discussion

### Dominant Versus Nondominant Arm

**External rotation of the shoulder at 90° abduction.** The examination of throwing mechanics may help explain the increase in external rotation found in the dominant arms of infield position players in this study. In the cocking phase of throwing, the shoulder is maximally externally rotated with the arm at 90° abduction (Fig 2) (3,10). Researchers who have stud-

ied the external rotation of the shoulder have found a significant difference between the dominant and nondominant arms of throwing athletes (3,4,10). During film analysis of 15 major league pitchers, a mean external rotation of 160° was measured (10). The exact contribution of the total amount of trunk extension and joint movement of the scapulothoracic and glenohumoral joints was not determined (10).

Other investigators, such as Brown, et al. (4), have studied the external rotation of the shoulder among major league players with the shoulder in two positions: 0° abduction and 90° abduction. These researchers found a significant difference between the dominant and nondominant arm when the arm was at 90° abduction, but not at 0° abduction (4). Because of the difference in the measurements at 0° and 90°, they assumed that the difference in external rotation at 90° abduction was an adaptation to throwing mechanics (4). This specific alteration of increased external rotation is believed to be a requirement for throwing a baseball successfully (11).

In this study, the absence of a difference in external rotation at 90° abduction between the dominant and nondominant arms of pitchers may be related to past injuries. Although the subjects were healthy, the physical histories of several individuals indicated that previous injuries had occurred to the arm and/or shoulder.



Fig 2.—Cocking phase of throwing (Note the external rotation of the arm.)

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These injuries could have altered the anatomy of the shoulder and arm, or the throwing mechanism itself, which may affect external rotation as indicated by Andrews and Gillogy (3).

In contrast, Brown, et al (4) found a significant difference in external rotation among pitchers, which indicated that pitchers had greater external rotation in the dominant arm. Although this study made an effort not to include athletes with current upper extremity injuries from the analysis, no notation was made about whether any previous pathological problems existed (4).

Brown et al (4) also found a significant difference in external rotation in position players. However, they did not define "position players," or the number of infielders and outfielders that they studied. Therefore, no assumption can be made about whether the differences between the present study and the study by Brown et al (4) are comparable.

**Shoulder Flexion.** Differences in shoulder flexion in the dominant side of infield position players could be attributed to incomplete use of full range of motion by the infield player, based on current research (4). In players who do not use their range of motion to their full extent, unilateral tightness of the pectoralis major and latissimus dorsi may be present, which adds to the significant decrease in motion (4). A specific example of this phenomenon can be found in infielders who throw short distances with little follow-through.

The tendency of pitchers to demonstrate greater flexion in the dominant arm compared to the nondominant arm conflicts with literature on the subject. Investigators, such as Brown et al (4) found that flexion in the dominant arm was much less than in the nondominant arm. Further research will be necessary to clarify the discrepancy between these studies.

The difference in results could be attributed to the mechanism of throwing and to the testing method used by the experimenter. A study of professional versus amateur pitchers indicated that amateur pitchers use all of the rotator cuff muscles of the shoulder; therefore, they use less lateral trunk flexion and more shoulder rotation (5). Reduced lateral trunk flexion is indicative of pitchers who throw side arm (10). The tendency toward greater shoulder flexion among pitchers in the present study may be an indication that

these pitchers use a different throwing technique, one in which the shoulder joint rotates through its full range of motion.

The measuring technique may have affected the results, also. The technique chosen by Brown et al. (4) was set by the American Academy of Orthopaedic Surgeons, which does not measure the functional ROM of the shoulder. The method used in this study allows full ROM, and may give a clearer indication about the functional ability of the throwing shoulder.

**Internal rotation of the shoulder at 90° abduction.** When measuring internal rotation, other investigators found a significant difference between the dominant and nondominant sides of major league pitchers (2,4,10). This was not true in the current study. This may be an indication of preexisting pathological conditions, which cause an alteration of the follow-through among some collegiate pitchers (3). Previous injuries may have led to anatomical differences or muscle selection during throwing (5).

#### **Dominant Arm: Pitchers Versus Infielders and Outfielders**

**Shoulder Flexion.** One would expect to find a greater difference in shoulder flexion between pitchers and other players because of repetitive throwing by pitchers, which produces alteration in shoulder ROM (3,4). The greater shoulder flexion among



Fig 3.—When throwing to first base, a shortstop uses less trunk flexion and more glenohumeral movement than a pitcher does when pitching to home plate.

pitchers when compared to infield and outfield position players in the current study can be explained by the mechanics of throwing and the degree of ball handling by the athlete.

In pitching, the athlete uses complex body movements to throw the ball across the plate. When the ball is released, the arm position relative to the head is determined by trunk flexion (6,10). If a pitcher's movement is compared to that of a shortstop making a play at first base, one would find that the infielder is using more glenohumeral movement than trunk flexion (Fig 3). This throw may not be as controlled as the pitcher's throw. Unlike the pitcher, an infielder may not begin and end his or her throw in the same manner every time (1).

The amount of ball handling also must be considered in order to assess the differences between a pitcher and infielder. Neither infield nor outfield position players were involved in repetitive throwing, therefore no differences were indicated between infield and outfield position players.

**External rotation of the shoulder at 90° abduction.** The greater external rotation at 90° abduction among pitchers when compared to that of infield position players may be attributed to the influences of repetitive throwing described previously. Also, other studies have indicated that pitchers possess greater flexibility in the dominant arm in comparison to other players, because the arm is fully cocked in order to impart the greatest force on the ball (4,10). One also may conclude that this action might contribute to the tendency toward greater external rotation at 90° abduction in pitchers than in outfielders.

#### **Conclusion**

The results of this study indicate that increases and decreases in ROM may occur in the shoulder complex as a result of throwing. Evidence suggests that alterations in the mechanism of throwing can lead to a difference in ROM between pitchers and other players. Because proper flexibility may enhance performance and minimize potential for injury, athletic trainers, coaches, and athletes can use this study as a baseline for preparticipation screening and as objective evidence of potential injury risk.

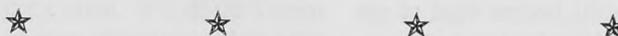
## Acknowledgements

Thanks to Craig Mackail, Herb Amato, Johanna Sowder, Wendy Crump, and Dr. Jean Dalton for their help and encouragement with this study. I also thank the coaching staff and players of the James Madison University and Eastern Mennonite College baseball teams for their participation in this study. A special thanks to Becky Salter, Susan Detwiler, and Heather Watts for their assistance with the photography and graphics.

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# Training Errors in Long Distance Running

John R. Sallade, PT, ATC  
Steve Koch, PT, ATC

**ABSTRACT:** Among the most common factors causing injury in long distance runners are training errors. Even the most elite runner may lose valuable workout time when training terrain, equipment, or the progression of workouts, is not appropriate. Through this article we hope to help athletic trainers identify specific errors in athletes' training and their related injuries. Additional suggestions are made that will aid the professional in workout modification in order to prevent injury or to expedite recovery.

Causes of running injuries generally can be classified into one of five categories:

1. Direct trauma (ankle sprains, falls producing contusions)
2. Inflexibility (tightness of heel cords, iliotibial bands, hamstrings, etc.)
3. Weakness (inadequate strength, endurance, or neuromuscular capability in key muscles, such as quadriceps, posterior tibialis, and peroneals)
4. Biomechanical instability (broadly described as over-pronation or over-supination)
5. Training errors (too much, too fast, on the wrong terrain, and with the wrong equipment)

While each of these causes is significant in its effect on runners, the scope of this article is limited to the identification and management of training errors that may lead even the most elite runner to

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*John Sallade and Steve Koch practice sports physical therapy with Reading-Berks Physical Therapy, PC (Reading, Fleetwood, Wyomissing, and Morgantown, PA). Both are avid runners.*

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injury and lost workout time. Those errors related to terrain or running surface are clearly the most common and, fortunately, the easiest to avoid.

## Ten Training Errors

We present ten of the most common training errors and treatment strategies that can help to prevent injury.

### 1. Running on crowned roads

Crowned roads are most often seen in rural, country areas where distance runners love to train. A crowned surface is high in the middle and slopes toward the berm. This road problem is compounded by the runner's practice of always facing traffic—which keeps the left leg in the “downhill” position and the right leg in the “uphill” position at all times. As can be seen in Fig 1, there is a “terrain-induced leg-length discrepancy,” as well as a tendency to oversupinate on the downhill leg and



Fig 1.—There is a tendency to overpronate on the uphill leg when running on crowned roads.

overpronate on the uphill leg (1). This will produce increased strain on the iliotibial band and peroneals of the downhill leg and on the pes anserine and posterior tibiales tendons of the uphill leg. The remedy is simple. Whenever safely possible, straddle the crown of the road, or at least, alternate the uphill and downhill leg.

### 2. Excessive hill running

While hill training is an important part of the competitive runner's workout schedule, excessive time on hills and an abrupt increase in hill time are injury risks. Uphill running puts increased demands on the triceps surae (Fig 2) in terms of both strength and flexibility, and may result in calf or Achilles' strains. In the presence of heel cord tightness, additional functional range of motion can be achieved by pronation (6, 7). If this pronation is excessive, it may produce strain on medial structures such as the posterior tibialis (which eccentrically



Fig 2.—There is an increased demand (stretch) on the triceps surae when running uphill.

controls pronation), and lateral structures such as the peroneus longus (which stabilizes the first ray during weight acceptance and into propulsion) (2, 6). A remedy to this is to increase hill time and grade gradually, stretch heel cords, and instruct the athlete to run on the balls of his or her feet (Fig 3). If the runner has persistent trouble with hills, additional time for stretching and calf strengthening should be allowed. Also, hill grade should be increased gradually and at a time when fatigue level is less pronounced. Downhill running is also stress-inducing, because it increases shock at heel strike and strain on quadriceps and anterior tibialis, because these muscle groups are forced to function eccentrically while "lowering" the body weight down an incline (Fig 4) (6). Remedies here are similar. Lean down the hill as much as possible (Fig 5), and strike more on the mid-foot.



Fig 3.—Running on the balls of the feet decreases stretch on the triceps surae.

Strengthening to the quadriceps and anterior tibialis, focusing on eccentrics, also will be beneficial. Attempting to strike the ground more softly and when under control will help also. Be sure that the runner is practicing a controlled foot strike, and avoids finishing a workout on a downhill grade at a time when his or her fatigue level is high.

### 3. Track work in predominately one direction

Running in the same direction around the turns of a track will force most feet to

over-pronate more on the inside leg (Fig 6), and supinate more on the outside leg (Fig 7). Excessive pronation, and the inward rotation of the tibia that follows, are common causes of injury, especially to the medial shin and knee. The solution is for the athlete to change running direction around the track often. If it doesn't seem feasible to change direction within each workout, change at least every other workout.



Fig 4.—Leaning back into the hill increases the eccentric strain on the anterior tibialis and quadriceps.



Fig 5.—Leaning down the hill decreases the strain on the anterior tibialis and quadriceps.

### 4. Running on excessively hard surfaces

Hard surfaces have traditionally taken a lot of blame for running injuries, as witnessed by the number of shoes on the market with shock-absorbing properties. Hard terrain tends to be more injury-inducing in high arched (forefoot valgus and cavus feet) and inflexible runners who have a poor ability to absorb shock anatomically (3). Running on somewhat softer surfaces



Fig 6.—There is a tendency toward increased pronation on the inside leg.



Fig 7.—There is a tendency toward increased supination on the outside leg.

and in shoes with better shock-absorbing properties may be helpful, but one should be careful not to blame hard surfaces too quickly and make the mistake of buying the wrong shoe or changing to an excessively soft, unstable surface. The solution is to have the athlete *systematically* experiment with different surfaces without changing to unstable terrain. Athletic trainers should assist an athlete in choosing the right shoes, keeping in mind that the manufacturer's specifications are designed primarily for effective marketing.

#### 5. Running on unstable terrain

A common belief is that soft surfaces are less stressful than hard surfaces. This assumption is not necessarily true. Soft surfaces, such as grassy fields, are often unstable, thus producing additional pronation in a "pronation-prone" foot, and lateral instability in the high arch "supination-prone" foot.

While shock certainly plays a role in certain injuries, a much larger percentage of injuries in persons with biomechanical abnormalities are related to instability or excessive motion for which soft surfaces often contribute. The solution is to recommend a shock-absorbing shoe with *appropriate* control properties, rather than to recommend running on soft surfaces. If a surface change seems in order, recommend one that is softer, but not uneven or mushy. Cinder and modern track surfaces are excellent. Grassy surfaces may be fine, but only if they are level and firm.

#### 6. Changing shoes

Today's runners have more shoes to choose from each year, if not each month. New materials, components, and strategies for injury prevention, as well as new colors for marketing, create both benefit and risk in training. Should the athlete find an appropriate shoe that allows pain- and injury-free function, additional pairs should be purchased before that model is taken off the market, because most shoes seem to be unavailable after a year.

Changing shoes without sound rationale or advice can be a costly proposition. Should a shoe change seem necessary, the athlete should seek qualified advice and be sure that the shoes are broken in gradually before the previous pair of shoes is in total disrepair. Some runners find ongoing rotation of a number of pairs of shoes helpful in this renewal process. In addition, while breaking in new shoes, the athlete should

not change other aspects of the training routine, so the source of a problem can be pinpointed, should one arise.

#### 7. Increasing mileage too quickly

Most runners risk increasing mileage too quickly. This problem frequently occurs in the spring, when the race season seems to arrive suddenly, forcing runners to increase their training in order to prepare for the first meet or race. It is natural to increase training as warm weather and longer days approach, but in order to prevent Achilles' tendinitis, plantar fasciitis, and other overuse injuries, this increase in training must be done gradually. In order for muscles and connective tissues to strengthen and meet the demands of the increased work load (4), it is safe to follow the 10% rule. That is, athletes should be instructed to increase their training mileage by no more than 10% each week. They should not expect to progress immediately from their winter schedule to the training regimen that they followed the previous fall. In order to prevent injury, they should progress safely, slowly, and systematically.

#### 8. Increasing training speed too quickly

Another danger that occurs in the spring, especially with the advent of racing season, is increasing the speed of running too rapidly. Again, as runners prepare for the first race of the year, they start thinking of speed. This is a time to be excited, yet cautious. Many runners have pressed hard in their initial stages of spring training, only to have their season postponed by a pulled hamstring. They must be aware of the prerequisites of running fast: a good training base, warm thoroughly stretched muscles, and strong joints and connective tissues.

Many of these suggestions are difficult to follow early in the season because of the limitations of cold weather and decreased training time. However, runners should play it safe and not expect a personal record in their first race of the year. To safely run fast in races, they must practice running fast in training; however, instruct them to precede their practice with an adequate warm-up and stretching of all lower extremity muscle groups.

Instruct the athletes and their coaches to allow their bodies to adjust to the change of pace. Performing gradual striders, following a normal training run, is a good way to introduce speed to their legs when they

have spent a winter training carefully and more slowly under winter conditions. They should increase the length of these striders at a comfortable pace, until they are able to do a quarter to half a mile. After this gradual increase, their legs will be prepared for the track and interval workouts needed to improve their speed.

#### 9. Not listening to body strain

Runners often train in a disciplined regimen, sometimes at their own expense. They frequently play the slave to their training logs. If Sunday calls for a fifteen-mile run, then that's what they do, feeling pressure to keep up their mileage. While a long distance base is a key ingredient to a carefully planned training program, runners sometimes become obsessed with the accumulation of mileage, and stop listening to the fatigue and strain that their body may be feeling (5). Instruct your athletes that, on a given day, if their legs are sore from the previous day's workout, and their body feels heavy and sluggish, they may wish to ride their exercise bike or swim in a pool. This relative rest may prove more beneficial to their training than the ten miles they "needed" in order to meet their weekly mileage total. High quality running can be more productive to their training than high quantity running. They will feel fresher and be better able to maintain a faster pace.

#### 10. Lack of variety in training

Running is the most important activity for a runner, especially for those concerned with improving race times. Too much of the same workout, however, can lead to trouble. Several days of hard running in succession may lead to overuse injuries and lost training time. Runners need to balance their training by alternating hard and easy days in their schedule (5). For instance, a hard workout day in which the athlete presses for time should be followed by an easier workout the next day, in order to allow muscles and joints to recover from the more vigorous workout or strain of a race.

#### Proceed with Caution

A final note of advice will be helpful in managing your athletes' regular training routines or periods of recuperation and rehabilitation. Instruct athletes and coaches not to change more than one aspect of their training at a time. If the runner has been nagged by a leg injury and attempts to

alleviate it by changing shoes and switching road surfaces, cutting out normal hill running, increasing stretching, using ice after running, and starting to ride a bike, then you will have no idea what, if anything, has been beneficial should the condition improve.

Conversely, if the athlete is running injury-free and simultaneously changes more than one aspect of the training program, you will never be able to pinpoint the source of a problem, should one occur. Naturally, if an injury develops, you will want to do everything possible to speed the healing process in order to get the athlete back to running as quickly as possible; however, changing numerous aspects of

the training routine may be more harmful than helpful. Once a runner is running relatively pain free again, different training methods, food, stretching techniques, shoes, and running surfaces may all be beneficial; however, you will need to experiment in each of these areas in a systematic way in order to find the winning formula.

Successful, injury-free running does not happen accidentally—it takes careful planning. Runners ask a lot of their bodies. Their athletic trainers need to do all that is possible to eliminate errors from their training in order to help them run more pain- and injury-free.

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# Effects of Isokinetic Velocity Spectrum Exercise on Average Power and Total Work

John E. Kovalski, PhD, ATC  
Robert J. Heitman, EdD  
Frederick M. Scaffidi, PhD  
Frank B. Fondren III, MD

**ABSTRACT:** *In this study we compared the influence that the order of the performance of different velocity exercise progressions has on average muscle power and total work production during a velocity spectrum isokinetic training session. Twenty-two college students were assigned randomly to four exercise trials, each containing an isokinetic exercise training session involving dominant knee extensors and flexors. Each exercise trial consisted of two sets of ten repetitions at speeds of 30°, 90°, 150°, and 210°/sec. The pretest, posttest, and experimental session muscle function measurements were assessed. Selected measurements of average power (joules/sec) and total work (joules) were used to make comparisons between the protocols. There was no training effect (change in peak torque) during the study for either extension or flexion at any of the four speeds. Total work was similar across the four protocols. There was a difference in average power for both extension and flexion among the protocols. We conclude that when performing velocity spectrum type training, performing faster speed sets*

*early in the exercise session will produce a greater average power.*

**I**sokinetic exercise is used to test and train functional characteristics of skeletal muscle. Isokinetic training studies have shown wide variations in intensity, frequency, duration, and effect on muscle strength (8,12,14,17), endurance (5), and power (3,4,11,18,20). These studies that examined velocity-specific effects during concentric exercise have produced conflicting results. In an early study, Moffroid and Whipple (12) reported that the effects of training at a specific velocity are limited to that velocity or to lower velocities, while more recent studies (3,11,18) using high velocity isokinetic training have reported that the overflow training effects reach higher velocities. In contrast, Vitti (20) concluded that increases in average leg power resulting from variable training speeds were not great enough to differentiate in favor of low, high, or low/high speed isokinetic training.

More recently, velocity spectrum training advocates have claimed that patients can recruit and train both type I and type II muscle fibers by varying the velocity of the movement over the course of the exercise session (2,3,9,10,19). This method of training is practiced to promote an optimal neuromuscular response and is supported by current theory concerning velocity-specific resistance training (9,13,15). Arthroscopic meniscectomy patients showed improved muscle function within three weeks using velocity spectrum isokinetic training (10,19).

Because isokinetic velocity spectrum training improves muscle function, we wondered if the order in which the velocity progression was performed would influence work and power production. A re-

view of the literature indicated an absence of information concerning velocity spectrum training and the influence of exercise progression order on a muscle's ability for work and power production. The purpose of this study was to compare the influence that the order of the performance of different velocity exercise progressions has on muscle average power and total work production during a velocity spectrum isokinetic training session.

## Methods

Twenty-two recreationally active college students volunteered and participated in this study (12 males, 10 females, age  $21.3 \pm 2.6$  yr; wt =  $157.7 \pm 28.7$  lb; ht =  $67.7 \pm 3.4$  in). We instructed each participant to refrain from participating in heavy resistance weight training or endurance training during the study. Usual recreational and daily living activities were permitted; however, each subject was instructed to refrain from physical activity for 24 hours prior to each exercise trial.

According to institutional guidelines, before they gave their signed consent to participate, we informed each subject of the nature, purpose, and possible risks involved in this study.

A repeated measures design was employed. A single independent variable (type of velocity spectrum training protocol) had four levels. Each subject participated in all protocols. The dependent variables were average power for knee flexion and extension, and total work. Data comparisons between protocols were first analyzed using a Doubly Multivariate (DM) analysis. Follow-up procedures consisted of separate multivariate analyses of variance (MANOVAs) run on each dependent variable with the Bonferroni adjustment. Then, the Scheffé post hoc test was used for univariate contrasts (16). A possible

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*John Kovalski is an assistant professor in the Department of Health, Physical Education, and Leisure Services (H, PE, & LS) and director of the South Alabama Sports Medicine Center at the University of South Alabama, Mobile, AL.*

*Robert Heitman is a professor in the Department of H, PE, & LS at the University of South Alabama.*

*Frederick Scaffidi is an associate professor and chairman of the Department of H, PE, & LS at the University of South Alabama.*

*Frank Fondren is a clinical assistant professor in the Department of Orthopedic Surgery at the University of South Alabama.*

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training effect was evaluated with dependent t-tests between pretest and posttest peak torque.

Each of the four exercise trials consisted of an isokinetic exercise training session involving the dominant knee extensors and flexors. One week prior to the first exercise trial, we read a definition of isokinetic exercise to each subject. He or she then observed and participated in an isokinetic exercise familiarization session. We made pretest and posttest strength comparisons (using dependent t-tests) three days prior to and following the exercise trials to assess whether a training effect occurred as a result of participation in the study. Each subject was randomly assigned to a group prior to performing the four protocols.

The exercise trials involved performing reciprocal knee extensions and flexions. A random order of velocity-specific exercise progressions with four different isokinetic exercise protocols was used (Table 1). Each exercise trial consisted of two sets of 10 repetitions at speeds of 30°, 90°, 150°, and 210°/sec. Measurements were made using two standard velocity spectrum training protocols (P1 and P2) and two modified velocity spectrum protocols (P3 and P4). In the modified protocols, the velocity of movement was not increased or decreased until all sets and repetitions were performed at the given speed. Once a week for four weeks, each subject performed one of the four proto-

cols. The isokinetic testing was performed through a range of 90°, where terminal extension was considered to be 0°. We encouraged each subject to exert a maximal effort at all times. Seven days separated each exercise trial.

The pretest, posttest, and experimental session muscle function measurements were assessed using the LIDO Active isokinetic dynamometer (Loredan Biomedical, West Sacramento, CA). The reliability and validity of this dynamometer have been reported previously (1). Selected measurements of muscle power and work were used to make comparisons between protocols. The data were sampled by a computer interfaced with the dynamometer so that angular position (degrees), velocity (degrees/sec), average power (joules/sec), and total work (joules) were recorded continually. While the actual testing range of motion (ROM) was 90°, an 80° ROM (between 5° and 85°) was analyzed to exclude measurements taken during acceleration and deceleration (6) and to standardize the ROM so that work values could be calculated.

Initial data reduction involved calculating the average power and total work for each set and the speed for each of the four protocols. Data analysis was performed on individual repetitions by adding the average power values (joules/sec) for each speed of the protocol and entering the mean value in the statistical analysis. Total work was analyzed by adding the work value (joules)

for each speed of the protocol and using the sum of the total work in the statistical analysis.

## Results

There was no training effect as a result of participation in this study. Pretest versus posttest comparisons of peak torque for flexion and extension at 30°, 90°, 150°, and 210°/sec were not significant ( $t(21) < 1.68; p > .108$ ).

The means and standard deviations for the four protocols for each dependent variable are presented in Table 2. The overall Doubly Multivariate analysis was significant ( $F(3,19) = 6.84; p = .001$ ). There was no difference in total work across the four protocols ( $F(3,19) = 2.60; p = .082$ ). Significant MANOVAs were found for the average power variable for both extension ( $F(3,19) = 17.32; p = .001$ ) and flexion ( $F(3,19) = 25.34; p = .001$ ). Protocol four produced greater average extension power than protocols one, two, and three (Scheffé,  $p < .05$ ). For average flexion power, protocols four and two produced greater power than protocols one and three.

## Discussion

The significant differences noted between protocol four (where the faster speeds were performed before progressing to the slower speeds) and the other protocols might be explained by the force-velocity and power-velocity curvilinear relationships reported in the physiological literature (7,9). That is, when exercising at faster speeds, the potential for producing power is greatest, and, when exercising at slower speeds, force production is greatest. Our results concur with the notion that when progressing from fast to slower speeds for both extension and flexion, performing the faster speeds early in the exercise trial, either in the velocity spectrum or the modified velocity spectrum protocols, generally produces a greater average power.

The enhancement of muscle power output by high-velocity training is supported by Coyle et al (3). Because the slower speeds are performed under greater resistance than the faster speeds, the muscle may fatigue more quickly (2). This may partially explain why the other three protocols generally produced less average power. The faster speed sets that are associated with greater power production were performed early in the exercise trials of protocols four and two, before fatigue may have become a factor.

Table 1.—Summary of the Four Isokinetic Protocols (P1-P4)

P1:	Speed (Deg/Sec)	:	30	90	150	210	210	150	90	30
	Reps	:	10	10	10	10	10	10	10	10
	Sets	:	1	1	1	1	1	1	1	1
	Rest	:	1 minute between each set							
P2:	Speed (Deg/Sec)	:	210	150	90	30	30	90	150	210
	Reps	:	10	10	10	10	10	10	10	10
	Sets	:	1	1	1	1	1	1	1	1
	Rest	:	1 minute between each set							
P3:	Speed (Deg/Sec)	:	30	90	150	210				
	Reps	:	10	10	10	10				
	Sets	:	2	2	2	2				
	Rest	:	1 minute between each set							
P4:	Speed (Deg/Sec)	:	210	150	90	30				
	Reps	:	10	10	10	10				
	Sets	:	2	2	2	2				
	Rest	:	1 minute between each set							

Table 2.—Summary of Average Power (Joules/Sec) and Total Work (Joules) for Knee Flexion and Extension Across Protocols (N=22; Mean±SD)

	Protocol 1	Protocol 2	Protocol 3	Protocol 4
Average Power Flexion	114.91 ± 28.75	125.80 ± 33.85	114.00 ± 27.34	133.35 ± 31.17
Average Power Extension	169.78 ± 39.00	174.17 ± 46.04	165.83 ± 34.94	187.25 ± 42.73
Total Work	15267.68 ± 3654.17	15700.49 ± 3638.12	15541.24 ± 3384.44	16084.33 ± 4267.75

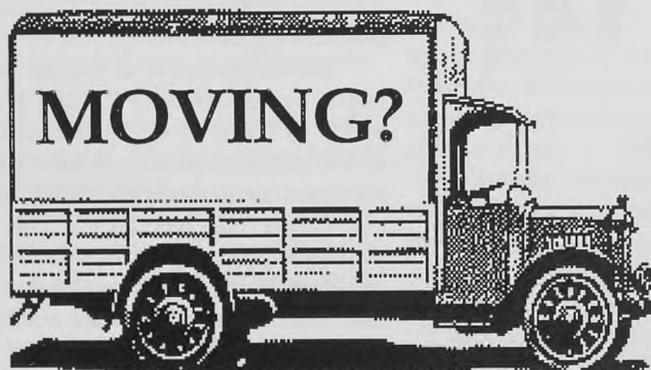
Muscle power production has not often been the focus of attention in determining specific velocities and progressions for velocity spectrum exercise. Because power is a product of force and velocity, it was used in this study as a measurement of work performed per unit of time. It appears that even though comparisons of the total work values between the four protocols revealed no differences, the ability of the muscle to produce force positively affected the average power produced in protocol four. Therefore, if an individual exercises isokinetically for rehabilitation or sport participation that requires muscular power, performance of fast speed training prior to progressing to slow speed training is recommended.

While we recommend caution in generalizing the results of this study to other populations (e.g., athletes, children, special populations) and other velocity spectrums, a basic practical implication might be made. When an individual exercises isokinetically, the velocity progression may be important to power production during that training/rehabilitation session even though total work may not be influenced. Future studies need to examine other fac-

tors such as training effects and different velocities, repetitions, and sets performed, as well as examining the interaction of fatigue and velocity spectrum training.

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# Incidence of Hyperpronation in the ACL Injured Knee: A Clinical Perspective

Mark E. Beckett, PT  
Denise L. Massie, MS, ATC  
K. Douglas Bowers, MD  
David A. Stoll, MD

**ABSTRACT:** *Assessing abnormal biomechanics when treating various lower extremity pathologies provides the athlete with comprehensive management and promotes injury prevention. However, there have been few previous investigations of abnormal biomechanical forces on ligamentous pathologies of the knee. During this clinical study we investigated the incidence of hyperpronation in subjects who have had an anterior cruciate ligament (ACL) injury. Fifty subjects with a past medical history of ACL rupture and 50 subjects without a history of lower extremity pathology participated in our study. Hyperpronation of the foot and ankle complex was measured with the navicular drop test. The ACL injured subjects had greater navicular drop test scores than non-injured subjects. This suggests that hyperpronation of the foot and ankle complex may increase the risk of injury to the ACL. There is a need for further investigation into possible pre-loading stresses on knee ligaments.*

**A**nterior cruciate ligament (ACL) injuries are considered common ligamentous injuries of the knee (2). The most effective treatment program for the ACL injured knee is controversial, however,

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*Mark Beckett is clinical director at Morgantown Physical Therapy Associates in Morgantown, WV.*

*Denise Massie is coordinator of education and research at the Sports Medicine Institute and athletic trainer at West Virginia University.*

*Douglas Bowers is a team physician at West Virginia University in Morgantown.*

*David Stoll is also a team physician at West Virginia University.*

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because of the use of various surgical procedures and rehabilitation protocols, and the proposed predisposing risk factors (1,2,13,15). Although there is a large volume of existing literature regarding ACL injuries, a clear understanding of this problem has not yet unfolded.

During gait, there appears to be a relationship between biomechanical abnormalities of the foot and ankle complex and knee pathologies (11,18,19,21,22). These abnormalities may relay stresses to any area proximal or distal to the lower extremity injury (9,22). The joints may function as a closed or open system based upon the weight bearing status of the lower extremity. During the gait cycle, the lower extremity functions in a closed chain manner (5). It is in this closed kinetic chain position that variable, yet important, influences of excessive pronation may be linked to various lower extremity pathologies.

The anterior cruciate ligament (ACL) originates at the posteromedial border of the lateral femoral condyle and courses distally to attach in front of and lateral to the anterior tibial spine (17). It consists of three distinct bundles and provides a vital check to prevent anterior displacement of the tibia on the femur, knee hyperextension, and excessive internal rotation of the tibia (1,6,8). The anteromedial bundle is tautest in flexion and provides anterolateral stability, while the posterolateral bundle is tautest in extension and provides posterolateral stability. The intermediate bundle assists in anterior and anteromedial stability (12,17).

While many have concluded that there is a relationship between abnormal biomechanics and lower extremity pathology, information on the effect of lower kinetic chain forces on knee ligament instabilities, specifically the anterior cruciate ligament, is limited. Therefore, the purpose of this study was to determine if a relationship

exists between hyperpronation and anterior cruciate ligament injuries.

## Materials and Methods

Fifty subjects with a history of ACL rupture participated in the ACL-injured group (11 females, 39 males, age =  $22.9 \pm 7.6$  yr; ht =  $177.8 \pm 10.3$  cm; wt =  $79.8 \pm 17.3$  kg). Of these subjects, 27 had sustained injury to the right extremity and 23 to the left extremity. Criteria for selection included arthroscopic examination of the ACL rupture and a corresponding written diagnosis from the orthopedic surgeon. Once the ACL rupture was identified, the involved ligament was either reconstructed or repaired, or the patient chose conservative non-operative management.

A random sample of 50 subjects without history of lower extremity pathology composed the ACL uninjured group. This group (18 females, 32 males, age =  $21.8 \pm 9.4$  yr; ht =  $173.7 \pm 9.0$  cm; wt =  $67.6 \pm 12.4$  kg) was composed of patients and clinical staff members.

The ACL-injured subjects completed a questionnaire regarding past medical history, mechanism of injury, and diagnosis. All subjects gave informed consent prior to investigation.

We performed the navicular drop test, as described by Brody (3), on each subject to objectively measure pronation. This test involves locating and marking the navicular tuberosity of the foot. With the subject seated and knees flexed at approximately  $90^\circ$ , the subtalar joint is placed in the neutral position. The subtalar joint is considered to be in the neutral position when the examiner, by passively inverting and everting the rearfoot, is able either to palpate the talus equally on both sides or not to palpate the talus at all (3). The talus is palpable by placing the thumb anteriorly and inferiorly to the medial malleolus at the talonavicular joint, and placing the index

finger anteriorly to the lateral malleolus.

With the subject seated and the subtalar joint in the neutral position, we placed an index card at the medial aspect of the rearfoot and placed a corresponding mark at the level of the navicular (Fig 1). The subject then assumed a full weight bearing position, allowing the foot to relax. The navicular level was noted on the index card (Fig 2). The difference between the two marks of navicular level was measured in millimeters. This procedure was performed bilaterally. Navicular drop values greater than 6 to 7 mm (7) and 10 mm (3) are considered hyperpronation.



Fig 1.—Place a dot with a felt tipped pen on the medial aspect of the navicular. With the subject seated, the foot on the floor, and the subtalar joint in a neutral position, place a 3x5 card next to the foot and mark the level of the navicular on the card with a dot.



Fig 2.—The subject then stands with full weight on the foot. The new level of the navicular is marked with a second mark on the 3x5 card. Then, the difference between the marks is measured.

The data were analyzed with a two-factor mixed model analysis of variance (ANOVA) with side (right;left) and group (ACL-injured; uninjured) as factors. The gender factor and mechanism of injury (contact versus non-contact) were compared with t-tests.

## Results

Navicular drop scores are summarized in the Table. There was no significant difference between male and female subjects on right ( $t(98)=.69, p=.49$ ) or left ( $t(98)=.25, p=.81$ ) navicular drop scores.

The difference between right and left sides was not statistically significant ( $F(1,196)=.13, p=.72$ ). There was no interaction between sides and group ( $F(1,196)=.06, p=.80$ ). There was no significant difference in navicular drop scores between those who were injured during

contact and non-contact ( $t(98)=-.37, p=.71$ ). However, the injured subjects had higher navicular drop scores than the uninjured group ( $F(1,196)=129.6, p=.001$ ).

## Discussion

In review of previous and current research, excessive pronation is considered to be a causative factor of various lower extremity pathologies. In a study of foot-related knee problems in the long distance runner, 77% (164/213) of knee injuries were related to an abnormal foot position, 43% (92/213) were identified as pronation-related, and 34% (72/213) were cavus-

related (4). The pronated foot has been viewed as "one possible structural and biomechanical problem that can cause low back pain, hip pain, knee pain, and foot pain" (9).

Abnormal pronation has a significant influence on specific areas of the closed kinetic chain. Before you can appreciate the effects of excessive pronation as it relates to the lower kinetic chain, however, you must have a working knowledge of the normal kinematics of gait.

## Normal Kinematics of Gait

Gait is divided into two phases: a stance

related (11). These pronation-related injuries fell into three categories: diffuse medial knee pain (57%), chondromalacia patella (28%), and medial joint pain (15%).

In a study of anatomical factors related to shin splints, hyperpronation of the foot was shown to be a significant etiological factor in the incidence of shin splints in

phase and a swing phase. The stance phase is further divided into three phases: contact, midstance, and propulsion. The contact phase begins with heel strike and ends with forefoot loading or foot flat. The midstance phase is that period from foot flat to heel lift. Propulsion begins with heel lift and extends to toe-off (16,21).

Navicular Drop Scores (Mean±SD)

Group	N	Foot	
		Right	Left
ACL uninjured	50	6.9±3.2	6.9±2.8
ACL injured	50	13.0±4.4	12.7±4.0*
Contact	23	12.7±4.8	12.6±4.4
Non-contact	27	13.2±4.1	12.7±3.7

\* Significant mean score difference between the right and left navicular, and ACL-injured and uninjured groups

During normal gait, initial heel contact is on the lateral aspect of the calcaneus with the subtalar joint in a slightly supinated position. During the contact phase of gait, the subtalar joint pronates. During midstance, when the foot is in full ground contact, the subtalar joint begins to supinate and continues this motion throughout the midstance and propulsive phases. In the closed kinetic chain, subtalar joint pronation consists of calcaneal eversion, talar adduction or medial rotation, and talar plantarflexion (5,16,21,22). This medial movement of the talar head results in a medial rotation of the body of the talus. Tiberio (21) explains that the articulation of the talus into the ankle joint mortise causes the lower extremity to internally rotate with subtalar joint pronation and externally rotate with subtalar joint supination. Therefore, the subtalar joint is viewed as a torque convertor, associating the medial and lateral rolling motion of the foot during gait with internal and external rotation of the lower extremity (5,16,19,21,22).

The motion of the knee joint itself is also an important component of the gait cycle. The knee is in full extension prior to heel strike and it flexes approximately 15° to 20° during the contact phase of gait. During midstance, knee extension is initiated with foot flat and continues until immediately prior to heel lift. In summary, as the knee flexes during the contact phase, the tibia internally rotates and, as the knee extends during the midstance phase, the tibia externally rotates (16,21). These previously described normal kinematics emphasize the role of excessive pronation in the transmission of forces upward in the kinetic chain.

Normally, subtalar joint pronation and tibial internal rotation occur only during the contact phase of gait. If pronation occurs beyond the contact phase, the tibia remains internally rotated, impeding the occurrence of subtalar joint supination and tibial external rotation, which normally occurs as the limb moves through the midstance phase of gait. This excessive internal tibial rotation transmits abnormal forces upward in the kinetic chain and produces medial knee stresses, force vector changes of the quadriceps mechanism, and lateral tracking of the patella (21).

The ACL tightens with tibial internal rotation, whereas during external rotation, the ACL becomes lax (1,8). An investigator of the biomechanics of the ACL found that internal rotation and varus movements

increase ACL strain (1). Inoue et al. (10) support the importance of the ACL in resisting the varus-valgus movement of the knee joint.

#### Effect of Pronation on the ACL

The exact mechanism and position of the lower extremity during injury to the ACL is difficult to define subjectively. However, injury usually results from an unsuspected fall or occurs during activity when an individual is performing a running, cutting, twisting, or decelerating movement (2,13). Typically, internal rotation of the tibia and knee hyperextension place increased stress on the ACL, specifically on the posterolateral bulk (2,17).

Because of the anatomical functions of the ACL, prolonged pronation of the foot and ankle complex produces excessive internal tibial rotation, and thus may produce a preloading effect on the ACL. This preloading concept may serve as a partial explanation for the high percentage of injuries to the ACL that occur during a non-contact moment of sport activity (3,14). A non-contact mechanism was responsible for 71% (355/500) of the injuries found in one study (unpublished observations of KDB) and for 78% (80/103) in another (14).

The effects of hyperpronation may be even more profound in the ACL deficient knee with loss of one or more menisci and injury to the secondary restraints. The quadriceps mechanism at heel strike exerts an anterior translatory force on the tibia, while the limb speed is decelerated by the hamstrings. The ACL prevents excessive internal tibial rotation and stabilizes the knee in association with the menisci and other secondary restraints. The menisci are important in controlling rotational motion of the knee (23). All of the 19 subjects with anterolateral rotatory instability had lost one or both menisci. If abnormal pronation of the foot and ankle complex exists with resultant prolonged internal rotation of the tibia, minimal restraint is available to check the anterior translatory forces of the tibia.

A similar scenario of events is directly related to the lateral pivot-shift phenomenon in association with ACL insufficiency during the normal gait cycle (20). Following heel strike, the quadriceps, in association with limb inertia, produce a force that results in anterior tibial displacement and internal rotatory torque. The ACL, hamstrings, and menisci act to resist this anterior and rotatory displacement. Once the

integrity of the ACL is compromised, these forces meet less resistance and actual subluxation occurs (20).

Increased knee rotation with anterolateral instability at 5° flexion, which correlates with the lateral pivot shift phenomenon, has been noted (22). During gait, the lateral pivot-shift phenomenon in the ACL-deficient knee is further compounded clinically by hyperpronation. Excessive pronation, in addition to hamstring and heel cord tightness, will lead to increased knee flexion during gait. As stated earlier, normal gait requires 15° to 20° of knee flexion. Because the pivot shift usually occurs from 20° to 45° of flexion (20), the relationship exists such that excessive pronation will increase the chance for a pivot shift to occur during gait.

The navicular drop test is not the only clinical tool available to identify hyperpronation of the foot and ankle complex. Gait analysis, abnormal callus formations, and a thorough lower quarter biomechanical evaluation also will provide the clinician with significant information to determine if excessive pronation occurs during gait. One study does not fully elucidate the relationship between hyperpronation and injury to the ACL. However, the results of this study suggest that a relationship does exist between hyperpronation and injuries of the ACL.

Additional research is indicated to focus on lower kinetic chain forces and ligament instabilities of the knee. Further knowledge of lower kinetic chain biomechanics will enhance our comprehensive management of knee ligament injuries.

#### Acknowledgement

We wish to thank Dr. Dana Brooks, assistant dean of physical education at West Virginia University, for his statistical assistance, and our clinical colleagues for their support.

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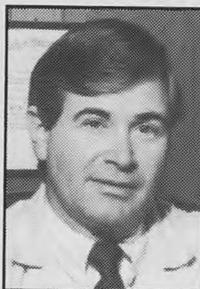
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# A Biomechanical Analysis of Patellofemoral Stress Syndrome

Robert I. Moss, PhD, ATC  
Paul DeVita, PhD  
Mary L. Dawson, PhD

**ABSTRACT:** This study was conducted in order to: a) investigate the relationship of selected anthropometric, strength, and kinematic variables to the incidence of patellofemoral stress syndrome in high school female athletes; and b) develop a predictive equation to screen individuals who may be predisposed to patellofemoral stress syndrome. Twenty-nine subjects were analyzed across nine dependent variables: two anthropometric measures, one strength measure, and six kinematic measures. Heavy subjects and those with a larger static quadriceps angle (Q-angle) were more likely to have patellofemoral stress syndrome. Leg strength did not seem to be a factor. Also, a variable of gait, the time from foot contact to the time when the minimum dynamic Q-angle occurred, was significantly slower in the subjects with patellofemoral stress syndrome. Furthermore, a predictive equation, which we created using discriminant analysis, was 89% accurate in predicting which subjects would or would not have patellofemoral stress syndrome. The equation uses an individual's weight, pelvic width, and static Q-angle. We conclude that, through proper

screening, individuals susceptible to patellofemoral stress syndrome may be identified prior to their becoming symptomatic, and that, through identifying causal variables, corrective procedures may be introduced in order to prevent patellofemoral stress syndrome from hindering an individual's physical activity.

There are many orthopedic problems that require anthropometric and biomechanical scrutiny in order to determine specific causes of pathology. Patellofemoral stress syndrome serves as a prime example, because it is a source of pain and discomfort to many who participate in physical activity. Anterior knee pain occurs most commonly in adolescent females (7,8,24).

Researchers of the etiology of this problem have agreed that there are many potential causes of patellofemoral stress syndrome (10,14,17,20). Past studies (15,26,27,33) have used expensive, noninvasive roentgenographic techniques, as well as invasive surgical procedures, to look at the relationship between the patella and femur. Most of these studies have involved static analysis (5,10,22), internal scrutiny of structural components (25,27), passive dynamic analysis with cadaveric knees (2,16), and clinical observation (3,13,23). From these studies, factors hypothesized to be linked with patellofemoral stress syndrome are: weak vastus medialis obliquus (VMO), large quadriceps angle (Q-angle), increased pronation, shallow femoral sulcus, abnormally shaped patella, hypoplastic lateral femoral condyle, tight lateral retinaculum, variable length and width of the patellar tendon, and tight hamstrings.

For this study we performed functional, dynamic research that would corroborate hypotheses based upon past clinical, static, and passive dynamic studies.

The conditions surrounding the biomechanical testing setting were intended to closely approximate the actual circumstances of injury. Observing the resultant movements and using biomechanical techniques, in particular cinematography, allowed us to quantify the variables in question.

## Materials and Methods

For the investigation, we selected 44 high school female athletes (age = 16.1 ± 1.3 yr). We divided them into three unequally sized groups. Subjects for Group I, the symptomatic subjects, met the following criteria: (a) no health problems except patellofemoral stress syndrome as diagnosed by a physician, and (b) participation in a high school sport that requires running. Fourteen of the subjects were diagnosed as having either unilateral or bilateral patellofemoral stress syndrome, providing us with 21 symptomatic knees for analysis. Subjects in Group II, the asymptomatic subjects, were healthy high school athletes. This group contained 15 subjects, therefore 30 asymptomatic knees. Group III, the verification subject group was composed of 15 subjects, eight with patellofemoral stress syndrome. They provided us with 14 asymptomatic knees and ten symptomatic knees. Note that the six asymptomatic knees that had contralateral symptomatic knees were not included in the division of this asymptomatic group. Group III was used exclusively for verifying the predictive equations created from Groups I and II.

Based on previous research and for the purpose of the investigation, we identified nine variables (Table 1) related to or descriptive of an individual with patellofemoral stress syndrome. We selected two anthropometric variables, weight and static Q-angle.

We obtained strength data from a Cybex II dynamometer and dual channel

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Robert Moss is assistant professor and program director of the graduate athletic training curriculum in the Department of Health, Physical Education and Recreation at Western Michigan University, Kalamazoo, MI.

Paul DeVita is assistant professor and director of the Biomechanics Laboratory in the Department of Physical Education at Southern Illinois University, Carbondale, IL.

Mary Dawson is professor and director of the Biomechanics Laboratory in the Department of Health, Physical Education and Recreation at Western Michigan University.

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Table 1.—Means, Standard Deviations, and Statistical Comparisons for All Variables

Variable	Asymptomatic Mean (SD)	Symptomatic Mean (SD)	df	t Value	p Value
Weight (N)	515(63)	612(69)	44	4.97	0.001*
Static Q-angle (degrees)	15.2(2.3)	17.1(2.7)	44	2.71	0.01*
Maximum quadriceps strength (Nm/kg)**	2.55(.37)	2.45(.40)	44	.83	0.21
Maximum pronation (degrees)	12.0(3.4)	12.3(3.5)	44	.40	0.39
Time to maximum pronation (s)	0.094(.021)	0.106(.021)	44	1.78	0.04
Velocity at maximum pronation (degrees/sec)	166.1(46.5)	134.8(49.5)	44	2.21	0.02
Minimum dynamic Q-angle (degrees)	9.5(4.2)	7.1(4.3)	44	1.78	0.04
Time to minimum dynamic Q-angle (a)	0.099(.02)	0.127(.025)	44	4.03	0.001*
Q-angle at maximum pronation (degrees)	10.9(3.9)	8.5(3.9)	44	2.01	0.025

\*Significant at 0.01 level  
 \*\*Strength as a ratio of peak torque to body weight

recorder. We recorded concentric knee extension and flexion torques for each individual performing at 60° per second throughout the full range of motion. We normalized the strength data by dividing the torque by the subject's body mass in kilograms resulting in Nm/kg. For the testing procedure, we gave standardized instructions and tested subjects using the protocol as presented in the Cybex II test manual (19). We evaluated peak torque values representing maximum quadriceps strength for each subject in Groups I and II.

Using two electronically driven Photo Sonic DI-PL, 16mm cameras while the subjects ran on a Quinton Model 18-60 treadmill, we collected cinematographic data. Cameras were placed 6.10m directly in front of and 6.10m directly behind the subjects. The cameras filmed active, dynamic Q-angle anteriorly, and rearfoot motion posteriorly. A nominal film speed of 100 Hz was used. It was calibrated at 99.8 Hz using the number of pulses generated by an internal LED timing light. Both cameras were equipped with Angenieux

12 to 120mm zoom lenses, shutter factors of 90/360, and f/stops of 1.8. We calibrated the treadmill for accurate speed prior to filming, and ran it at a 3.5 m/sec pace for all subjects.

Once on the treadmill, subjects walked at a 1.2 m/sec pace for a short acclimation period, approximately 30 seconds, then the speed was increased in five equal increments of 0.46 m/sec until the subjects reached the test speed. The speed was increased after subjects told us that they were comfortable on the treadmill. Total time on the treadmill for each subject averaged seven minutes. After subjects were comfortable at the test speed, we filmed five right and five left consecutive footfalls.

We used a NAC Analysis Projector DF 16C to view and mark the frames to be studied. The two film records were synchronized using the frames of foot contact. All trials that were analyzed had equal numbers of frames in both anterior and posterior film records indicating identical film speeds in both cameras.

The following body points were digitized with a Vanguard M-16C projector motion analyzer and a SAC Graf/Pen GP-8 sonic digitizer: (a) a mark on the running shorts representing the anterior superior iliac spine, the midpoint of the patella, and the tibial tubercle for the front view, and (b) two points on a line segment bisecting the lower leg and two points on a line bisecting the calcaneus (Fig 1, Fig 2) for the rear view. Three footfalls for both lower extremities were digitized for each subject. Selection of footfalls was based upon ease of recognition of landmarks for digitizing. Each point was digitized three times, visually checked for outlying values, and averaged to provide greater reliability. Each trial was digitized from the frame before

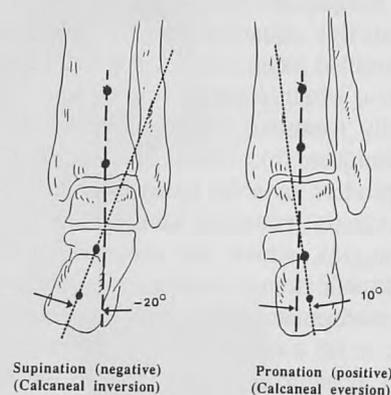


Fig 1.—Rearfoot markings (right leg); pronation and supination

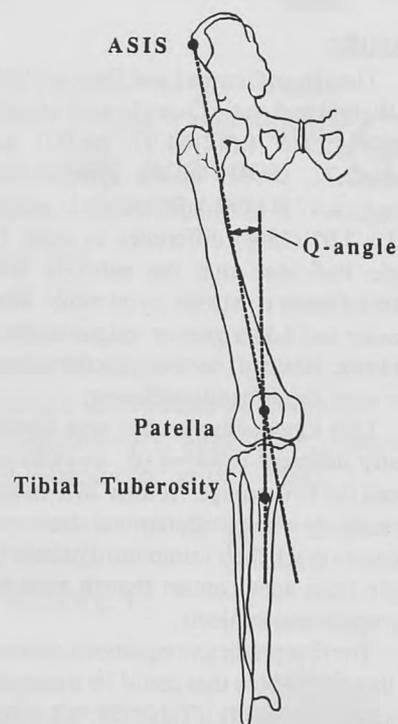


Fig 2.—Quadriceps angle (Q-angle) markings

heel strike to the frame of toe off. The resultant data were smoothed with an interactive routine (35).

We calculated the Q-angle, pronation angle, and angular velocities from the film data. Also, six variables describing Q-angle and pronation were calculated from the film: (a) maximum angle of pronation, (b) time to maximum pronation, (c) average velocity of pronation from rearfoot contact to maximum pronation, (d) minimum dynamic Q-angle, (e) time to minimum dynamic Q-angle, and (f) dynamic Q-angle at the time of maximum pronation.

We used student t-tests with Bonferroni comparisons ( $p < 0.01$ ) to compare the mean values for the variables between Groups I and II. Using discriminant analysis techniques (30), we formulated three predictive equations on: (a) practically quantified independent variables (weight, pelvic width, static Q-angle), which are easily measured using simple hands-on techniques; (b) technically quantified independent variables (quadriceps strength, maximum pronation, minimum dynamic Q-angle), which are measured using isokinetic strength testing equipment, high speed cinematography, and computer analysis; or (c) a combination of the practical and technical variables used in the two previously mentioned equations. The discriminant analysis was performed on Groups I and II, and verified with an independent group, Group III.

## Results

Data from Groups I and II are in Table 1. Weight and static Q-angle were significantly greater ( $t(44)=4.97$ ,  $p=.001$  and  $t(44)=2.71$ ,  $p=.01$ ) in the symptomatic group. A 97 N (19%) difference in weight and a 1.9° (12%) difference in static Q-angle indicated that the subjects with patellofemoral stress syndrome were heavier and had a greater valgus angle at the knee. None of the strength characteristics were significantly different.

One kinematic variable was significantly different ( $t(44)=4.03$ ,  $p=.001$ ) between the two groups. It took 28% longer for subjects with patellofemoral stress syndrome to reach their minimum dynamic Q-angle from foot contact than it took for asymptomatic subjects.

The first predictive equation consisted of three variables that could be measured quickly and easily (Table 2). It could predict 89% of the time whether a subject would or would not have patellofemoral

stress syndrome. The second equation used three variables that had to be measured by Cybex dynamometry, high speed cinematography, and computer analysis. This equation did not perform as well. It correctly predicted 71% of those who were not symptomatic and 56% of those who were symptomatic. The third equation consisted of all six variables from the two previously mentioned equations. It correctly predicted

ship between ground reaction forces and joint reaction forces and moments (34). Therefore, the heavier symptomatic subjects in this study probably had larger forces and moments about the knee. In order to control these large forces, the quadriceps must contract eccentrically, exerting a large force so that a controlled, smooth running gait can occur. Because the patella acts as a fulcrum for, and is embedded in, the

Table 2.—Discriminant Analyses

Function	Actual Group	Predicted Group		Overall Predictability
		Asymp	Symp	
Practical Variables*	Asymp = 28 Symp = 18	25 (89%) 2 (11%)	3 (11%) 16 (89%)	89%
Technical Variables**	Asymp = 28 Symp = 18	20 (71%) 8 (44%)	8 (29%) 10 (56%)	65%
Combined Variables†	Asymp = 28 Symp = 18	26 (93%) 5 (28%)	2 (7%) 13 (72%)	85%
Verification Variables††	Asymp = 14 Symp = 10	10 (71%) 1 (10%)	4 (29%) 9 (90%)	79%

\* Practical variables function is  $0.124 \text{ static Q-angle} - 64.2 \text{ pelvic width} + 0.026 \text{ weight} + 3.3$ .

\*\* Technical variables function is  $0.23 \text{ minimum dynamic Q-angle} - 2.01$ . The values for maximum pronation and maximum quadriceps strength did not meet the entry criteria for use in this equation.

† Combined variables function is  $0.16 \text{ static Q-angle} - 64.8 \text{ pelvic width} + 0.025 \text{ weight} - 0.11 \text{ minimum dynamic Q-angle} + 4.24$ .

†† Verification variables function uses the practical variables function with data from the verification group.

93% of those who did not have patellofemoral stress syndrome and 72% of those who did. A verification group consisting of 15 subjects was used to determine the predictability of the best discriminant equation. The first equation was deemed the best, because it had an overall higher predictive ability than the other equations, and obtaining values for the equation's variables was simple.

## Discussion

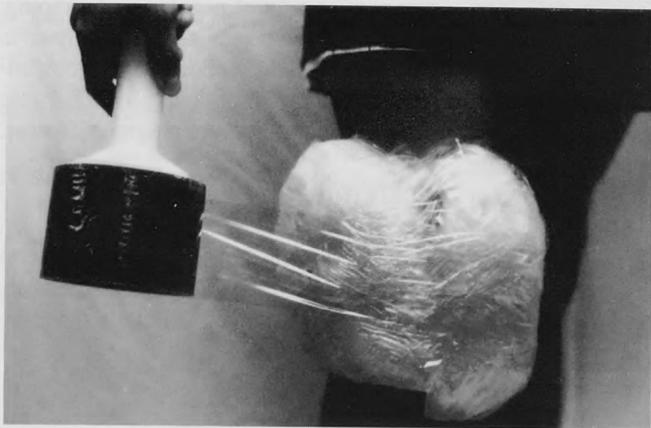
Anthropometric variables that were significant in this study correspond to those reported in previous research. Heavier runners produce larger ground reaction forces (12), and there is a direct relation-

ship between ground reaction forces and joint reaction forces and moments (34). Therefore, the heavier symptomatic subjects in this study probably had larger forces and moments about the knee. In order to control these large forces, the quadriceps must contract eccentrically, exerting a large force so that a controlled, smooth running gait can occur. Because the patella acts as a fulcrum for, and is embedded in, the

quadriceps mechanism, it also will undergo large forces that will predispose it to injury (9). The larger value for static Q-angle observed in the symptomatic knees agrees with that of Aglietti et al. (1), who reported that static Q-angles greater than 17° are associated with patellofemoral stress syndrome and that asymptomatic knees have smaller static Q-angles of 15°. The difference of 1.8° between groups appears to be small, but must be considered in the context of chronic, or overuse, injury development. Namely, running and jump training involve numerous repetitions of knee flexions and extensions and ground contact phases.

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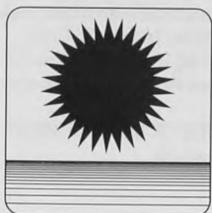
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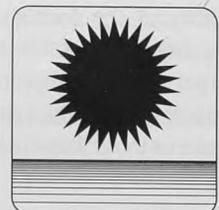
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Over the course of several months, small differences between single steps may have a cumulative effect. This effect holds true for small impact forces repetitively applied to animal legs (28). Joint degeneration and changes in substance of subchondral bone and articular cartilage were observed. The critical variable alluded to by the data in this study seems to be the Q-angle. This idea is supported by those subjects who displayed symptoms in one knee. The weight was the same over both knees, but the knee with the larger Q-angle was more likely to have patellofemoral stress syndrome. For example, subject ten was asymptomatic in the right knee and had a static Q-angle of 12° on that side. The contralateral, symptomatic knee had an angle of 16°.

The strength variables were not significantly different. This result does not substantiate the prevailing thought that quadriceps weakness, particularly in the vastus medialis obliquus is largely the responsible component of patellofemoral stress syndrome (11,24). We believe that our strength measures were not significant, because they were concentric measurements. The main function of the quadriceps, when running or landing from a jump, is to decelerate the fall of the body's center of mass, an eccentric action (17). Recommendations for further study include eccentric strength analyses of the quadriceps, which may show differences between Groups I and II.

Kinematic variables that we analyzed reflected pronation and Q-angle movements. Elapsed time to reach minimum Q-angle was significantly smaller in the asymptomatic group. This follows the pattern of a nonpathological closed kinetic chain whereby, when maximum pronation is reached more quickly, concurrent dynamic Q-angle should respond similarly. Many (6,31,32) consider patellofemoral stress syndrome to be primarily the result of an asynchronous closed kinetic chain, particularly in the relationship of rearfoot pronation to quadriceps angle.

Elements of pronation deemed critical by physicians and biomechanists (5,18,21,29) are the total degrees pronation and the time during which pronation takes place. These areas influence the shock-absorbing ability of the foot and leg. Velocity at maximum pronation was not significantly larger in the asymptomatic group, but the slower value in the symptomatic group did make us think that it may have been a factor

in the development of patellofemoral stress syndrome. Because pronation is crucial to decreasing the forces at foot contact, if the velocity at which pronation occurs is high enough, the dissipation factors may not be able to accommodate the vertical ground reaction forces of the movement; hence, trauma occurs to structures not normally responsible for absorbing such forces.

The value of the dynamic Q-angle which coincided with maximum pronation is interesting. Tiberio (32) alluded to the closed kinetic chain relationship between pronation and Q-angle, and stated that as the foot pronates, the tibia internally rotates, which effectively causes the Q-angle to become smaller. Theoretically, the point during footfall when maximum pronation occurs should be where the minimum Q-angle occurs. When the foot begins supination, the tibia should respond by externally rotating, resulting in progressively larger Q-angles, as dictated by normal kinematics (4,31). If these events do not occur simultaneously, rotational moments in opposite directions will result at the subtalar joint and at the articulations of the tibia, femur, and patella. The resultant counterrotational torques will manifest themselves somewhere along the kinetic chain, with a probable site being the knee. It should be noted that dynamic Q-angles were measured in two dimensions in this study and that other rotational components may affect these measurements. This is a limitation of the study.

We believe the first discriminant equation was best because it used variables that were less cumbersome and less costly to measure, and it was a better predictor than the others. Also, athletic trainers and others who see athletes prior to competitive seasons can easily advise the athletes based on the outcome of these simple variable measurements. Including weight as a variable was the major factor in producing a good predictor. The mean values of weight for the asymptomatic group and symptomatic group differed substantially. It should be noted that the practical variables were equally adept predictors for the asymptomatic group (89%) and for the symptomatic group (89%). The verification subjects displayed a different trend, with symptomatic subjects being predicted correctly at a higher rate than nonsymptomatic subjects (90% to 71%).

Prevention of athletic trauma via appropriate screening activities is imperative. Our research takes an important step

in that direction using anthropometric, isokinetic, and biomechanical techniques. It is interesting that the practical variable equation using only anthropometric variables had the highest prediction ability and was the least cumbersome to use, making it applicable in the clinical setting. As obvious as it seems, those individuals who are heavier should probably be encouraged to lose weight prior to engaging in athletics that require a lot of running and jumping. Or, they should be advised to participate in activities such as walking, biking, swimming, and low impact aerobics, because these do not require vertical ground forces.

## Acknowledgements

We thank Dr. Quinter Burnett and Dr. Terry Nelson of the Southwestern Michigan Sports Medicine Clinic in Kalamazoo, MI, for their assistance in obtaining volunteers for this study.

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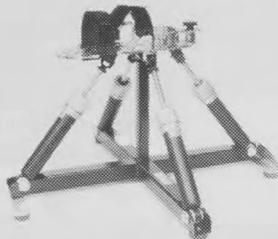
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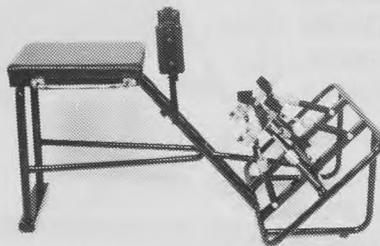
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# Plantar Fasciitis—Heel Pain in Athletes

Jeffery A. Middleton, MS, ATC  
Eric L. Kolodin, DPM

**ABSTRACT:** Plantar fasciitis is the most frequent hind foot problem that affects runners. It occurs when repetitive stress is placed on the heel from a chronic or acute condition. Athletes with biomechanical imbalances are most susceptible to this condition. They exhibit pain in the morning upon weight bearing and, frequently, in the acute stage, have discoloration of the injured area. Management includes preventive and therapeutic exercise, physical therapy, strengthening routines, taping, and the use of orthotics and non-steroidal anti-inflammatory drugs (NSAIDs). Although injections and NSAIDs bring relief, their effects are often only temporary. This condition is best treated with therapeutic exercises and orthotics in order to correct the athlete's biomechanical faults. This article presents principles and techniques that can be used to effectively prevent and treat plantar fasciitis.

**P**lantar fasciitis is an overuse injury that involves an inflammatory reaction of the plantar fascia at its origin on the calcaneus. It is most prevalent in runners, but can occur in any athlete who plays on hard surfaces and in heavier individuals. A review of the literature indicates that the signs and symptoms of this condition are uniform among athletes, and that it is the most frequent hind foot problem in runners (1,2,10). Many sources describe etiology and treatment protocols (3,5,7,8,13). The focus of this article is to describe a systematic approach to the management of plantar

*Jeffery Middleton is the athletic trainer at South Plainfield High School in South Plainfield, NJ. He is the past president of the Athletic Trainers' Society of New Jersey and sits on the NJ Board of Medical Examiner's Athletic Training Advisory Committee.*

*Eric Kolodin is a podiatric consultant to South Plainfield High School and is in private practice in Edison, NJ.*

fasciitis that is based on anatomy, recognition, treatment techniques, and preventive and therapeutic exercises.

## Anatomy

The plantar fascia is divided into three slips: medial, central, and lateral. The central portion is the thickest and originates at the medial process of the calcaneal tuberosity. It then divides into five slips. These blend into the distal plantar aspect of the digits. The medial and lateral portions blend with the central portion as the course becomes more distal (4) (Fig 1).

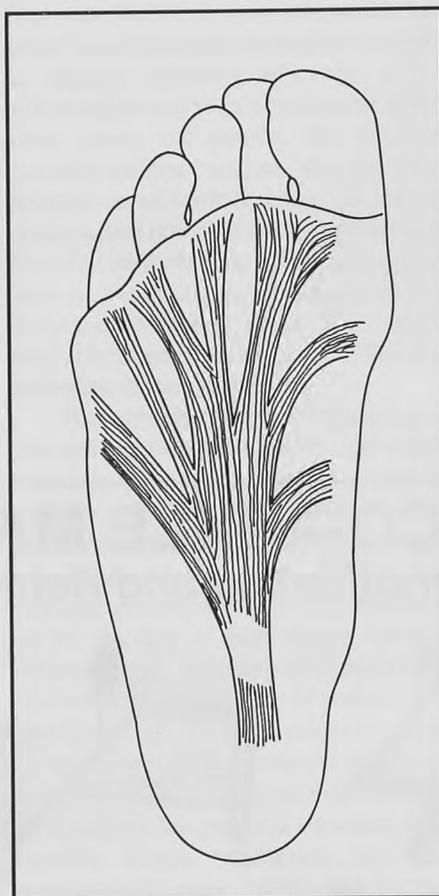


Fig 1.—Plantar fascia and its three slips

## Mechanism of Injury

Plantar fasciitis occurs when repetitive stress is placed on the heel because of a chronic and/or acute condition (13). This stress may be attributed to running or jump-

ing on hard surfaces, accompanied with constant pounding to the heel. Road racing and race walking, basketball, track, and sports played on unyielding surfaces are examples of activities that predispose athletes to this injury. The constant pull on the origin of the fascia causes microtears and inflammation in the heel area resulting in pain. In chronic cases, a bone spur may develop. The spur, in these instances, does not cause the athlete's pain, rather, the presence of fascial fibers around the spur result in an inflammatory process as they are pulled off the calcaneus (13).

## Signs and Symptoms

Certain biomechanical factors may lead to plantar fasciitis. An individual with a high forefoot varus deformity may compensate with a significant pronatory force, placing the plantar fascia under stress. Forefoot varus is a congenital fixed deformity in which the plantar plane of the forefoot is inverted to the plantar plane of the rearfoot with the subtalar joint in the neutral position (14). Those who present with more than 4° of forefoot deformity will compensate for this fixed deformity, which increases the stress on the origin of the fascia by pulling it off the calcaneus. This subsequently creates inflammation, pain, spasm, and bone spur formation. Athletes with a high or low arched foot also are likely to develop this condition. The high arched foot creates heel pain through the pull of the plantar fascia resulting from the hammering and contracting of the lesser digits. Frequently, there is swelling and discoloration over the plantar-medial aspect of the heel. A palpable defect in the fascia at its origin on the calcaneus may be evident. This requires immediate support or immobilization to lessen the extent of the tear (8).

The classic symptom of this condition is pain when first taking a step out of bed in the morning or after any prolonged rest period (12). Usually, pain is present in the plantar-medial aspect of the calcaneus and may be bilateral or unilateral. The pain and stiffness when bearing weight is related to

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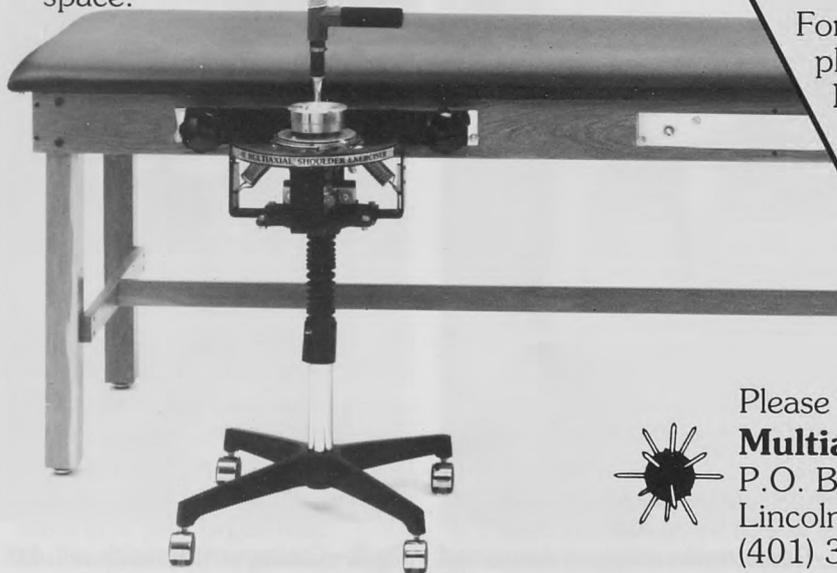
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muscle spasm and splinting of the fascia secondary to the inflammation. When this occurs, a normal muscle length is not attained easily, thus additional irritation and pain result.

### Management of Plantar Fasciitis

Management of plantar fasciitis is accomplished by addressing six specific areas: 1) Prevention, including stretching, warm-up, and proper shoe selection; 2) Use of therapeutic modalities; 3) Strengthening exercises; 4) Adhesive taping; 5) Orthotics; and 6) NSAIDs and cortisone injections.

### Prevention

The prevention of plantar fasciitis requires relatively simple procedures that take minimal time from the athlete's workout. Incorporated with a sound strengthening program, these preventive measures reduce the chance of injury and time loss.

**Warm-up and stretching.** We encourage all athletes to precede any workout with a warm-up that produces a good sweat. A perspiring athlete's soft tissues will be supple and receptive to the stretching exercises. A warm-up requires light jogging, walking, calisthenics, or bike riding for five to ten minutes. Proper stretching form is always emphasized, because improper technique can lead to soft tissue injury and an actual decrease in flexibility (2).

We strongly emphasize stretching exercises, because they effectively decrease the probability of musculotendinous injuries to the foot and help reduce soreness of the plantar fascia. It is essential to perform stretching exercises several times each day, but especially when the athlete arises, before and after practice, and before bedtime. We insist that all stretches be done statically and that the initial hold position is 15 seconds. The stretch times increase by five seconds each day until a stretch time of one minute for each is attained. The prolonged stretching is required to overcome the stretch reflex (2).

Fig 2 illustrates the classic wall lean stretch for the gastrocnemius muscle. An ankle that can easily dorsiflex  $10^{\circ}$  to  $15^{\circ}$  or more is essential for injury prevention (2). Perform the stretch with the foot straight ahead, abducted, and adducted for up to one minute (Fig 3, Fig 4, Fig 5).

The stretch in Fig 6 isolates the soleus. Lower the hips slightly as you bend the

knee, keeping the heel of the back leg on the floor. Hold each of these stretches for up to one minute.

The golf ball stretch (Fig 7) is repeated for up to five minutes for both feet. While seated, place a golf ball underneath the foot and slowly roll it up and down the arch, making sure not to use bruising pressure. Do not roll the ball on the center of the heel itself, or wherever there is point tenderness (8).

Also, the plantar fascia can be stretched using hand resistance by applying a force

causing dorsiflexion of the great toe (Fig 8). Hold for up to one minute, repeat two or three times before running.

Finally, with your thumb, massage the longitudinal arch of the foot up and down (Fig 9). Circular motions with firm pressure help loosen tight fascial tissues. Repeat three or four times each day, especially after running and at bedtime.

**Shoe selection.** Proper shoe selection is critical for preventing plantar fasciitis in athletes. An ill-fitting shoe can cause or



Fig 2.—Wall lean stretch



Fig 4.—Gastrocnemius stretch with foot abducted



Fig 3.—Gastrocnemius stretch with foot pointed straight



Fig 5.—Gastrocnemius stretch with foot adducted



Fig 6.—Alternate wall lean stretch

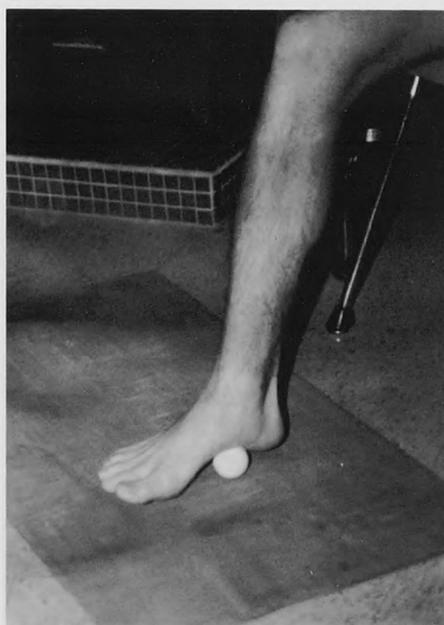


Fig 7.—Golf ball stretch



Fig 8.—Dorsiflexion of toe stretch



Fig 9.—Deep friction massage

aggravate numerous problems, whereas shoes that are the proper size may prevent injuries from occurring (Fig 10).

An athlete should remember these guidelines when selecting athletic shoes (9):

- 1) Shoes must be comfortable. Only you can tell if they fit. If the shoes are not comfortable, don't buy them!
- 2) Because feet are not necessarily symmetrical, have your feet measured each time you purchase shoes. Always buy shoes to fit your largest foot.
- 3) Feet swell to their largest size late in

the day; therefore, you should buy shoes in the afternoon.

- 4) All shoe sizes are not the same. Size depends on shoe make and style.
- 5) The toe box should be roomy enough to allow you to wiggle all of your toes.
- 6) Athletic shoes must have a flexible sole. The shoe should bend where

your foot bends, at the ball of the foot.

- 7) The instep should not gape and the heel should fit snugly.
- 8) The shoe must have sufficient longitudinal support and a stiff heel counter.
- 9) There should be a padded extension around the heel and adequate insole cushioning.

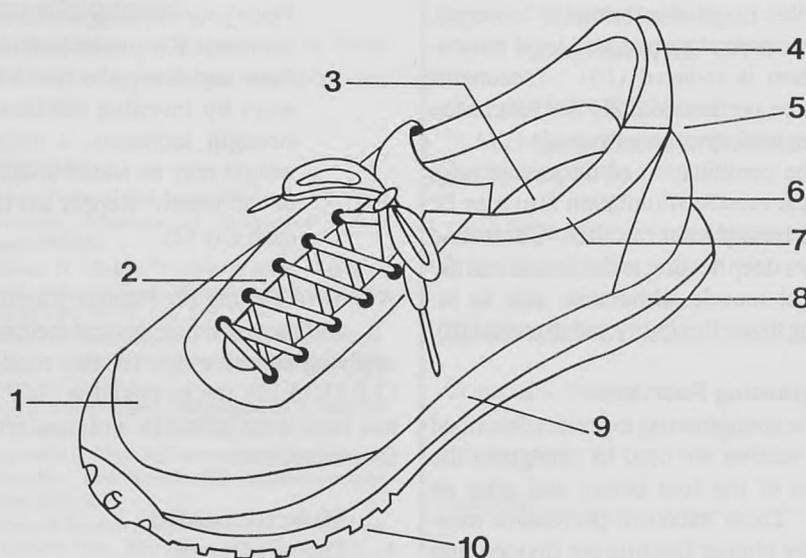


Fig 10.—Checklist for running shoes

1. Toebox allows room for all toes to wiggle.
2. Instep does not gape.
3. Adequate insole cushioning
4. Padded extension around Achilles' tendon
5. Heel fits snugly.
6. Stiff heel counter
7. Padded ankle opening
8. Outflared heel for stability
9. Sufficient longitudinal arch support
10. Flexible sole

- 10) The heel should be slightly flared for added stability.

### Therapeutic Modalities

To treat plantar fasciitis, the modalities that we have used with the greatest success are ice, ultrasound, deep friction massage, and electrical muscle stimulation. If the injury appears to be responding to a particular modality, we keep using it until the athlete is asymptomatic.

In acute phases of this condition, cold applications in the form of ice massage or ice bags are applied for at least 20 minutes, but no longer than 30 minutes, three or four times per day. The ice controls the swelling and relieves the discomfort of the inflammatory process of the injury.

Continuous ultrasound (.5-1.0 W/cm) for five minutes daily may be used in the post acute phase of the injury. The effects of ultrasound (i.e., pain reduction, increased blood flow, increased metabolism, and reduction of muscle spasm) (10) help in treating plantar fasciitis, and ultrasound has been a successful treatment for our athletes.

The direct effects of deep friction massage are also indicated in treating this condition. The deep massage (small circular movements over the affected area) affects skeletal structures to provide therapeutic movement over a small area. Scar tissue that may have formed is loosened, local edema is absorbed, and local muscular spasm is reduced (10). Treatments should be performed daily for five to ten minutes until symptoms subside.

The combination of ultrasound with electrical muscle stimulation also may be used to treat plantar fasciitis. Ultrasound provides deep heating to the tissues and the electrical muscle stimulation aids in increasing tissue flexibility and strength (10).

### Strengthening Exercises

The strengthening exercises described in this section are used to strengthen the muscles of the foot before and after an injury. These excellent preventive measures for plantar fasciitis are divided into two categories: weight bearing and non-weight bearing. The non-weight bearing exercises would be specifically indicated for post acute injury situations.

#### 1) Non-weight bearing exercises

- a. *Alphabet*—With the toes pointed straight ahead, write the complete alphabet in the air with the

toes, three times.

- b. *Toe squeeze*—Sit with both legs extended. Squeeze all five toes together and hold for five seconds. Relax and then spread the toes in a fanned position. Repeat ten times, with both feet, three times per day.
  - c. *Marble pick*—Use the toes to pick up small objects, such as marbles, and place them in a container. Repeat five times per day.
  - d. *Ankle circle*—Circumduct the ankle in both directions using as much of the full range of motion as possible. Repeat three times each day.
- 2) **Weight bearing exercises**

- a. *Step squeeze*—Stand on a stairstep with your toes lapping over the edge. Contract the toes against the edge of the step and hold for a count of five. Relax. Repeat ten times.
- b. *Towel grab*—Sit in a chair with a towel laid on the floor in front of you. Gather the towel with your toes. Repeat ten times, three times each day.
- c. *Towel scoop*—Place a folded towel on the floor next to you and perpendicular to the direction in which you are facing while seated. Place your forefoot on the end of the towel. Keep your heel on the floor and scoop the towel sideways by inverting the foot. As strength increases, a resistive weight may be added to the end of the towel. Repeat ten times each day (2).

### Adhesive Taping for Plantar Fasciitis

Although there are several methods of applying adhesive tape for this condition (2,6,11,15,16), the method described here has been most effective and comfortable for our athletes.

#### Materials needed

1. Taping adherent
2. Moleskin plantar fascia strap 2" to 3" wide (Fig 11)
3. Adhesive tape - 1 1/2" or 2" wide, depending on foot size
4. Elastic tape - 2" wide

#### Procedure

1. Seat athlete with the ankle flexed at 90°.

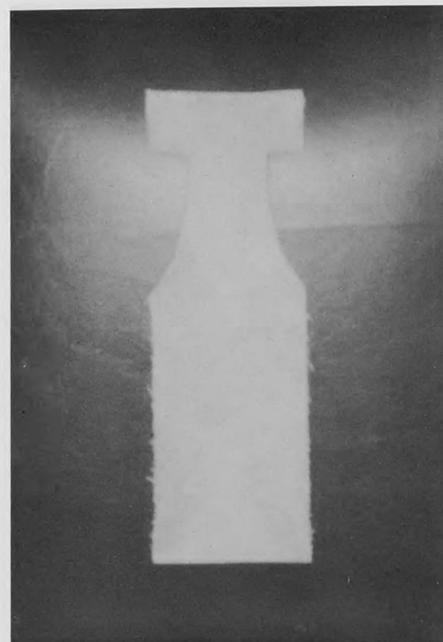


Fig 11.—Plantar fascia strap

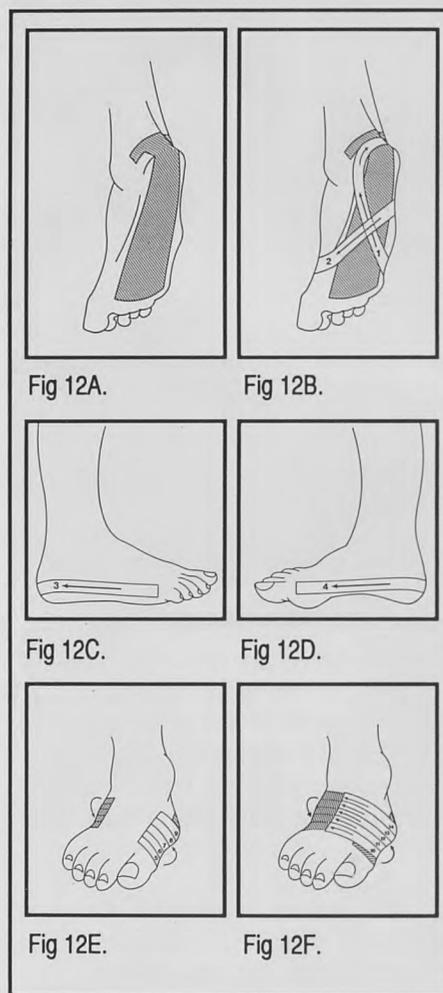


Fig 12.—Adhesive taping for plantar fasciitis

2. Prepare the skin with adherent.
3. Place the moleskin strap over the metatarsal heads. Attach the other end of the strap over the back of the calcaneus (Fig 12,A).
4. Using 2" wide elastic tape, begin a figure 8 pattern by attaching the beginning end of the tape at the base of the fifth metatarsal (Fig 12,B). Move at an angle that allows circling of the calcaneus; then, cross at the longitudi-

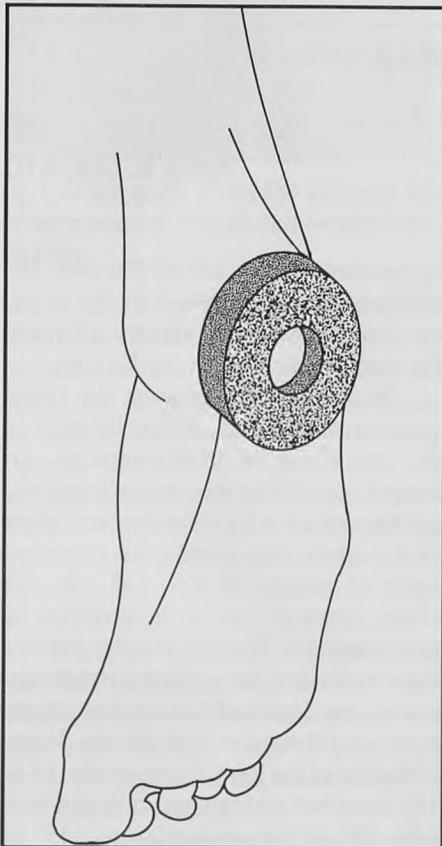


Fig 13.—Heel doughnut

nal arch at mid-foot. Finish at the first metatarsal head.

5. Using 1 1/2" or 2" wide tape, place a strip at the lateral side of the fifth metatarsal (Fig 12,C). Move the tape parallel to the foot, around the heel, and finish at the medial side of the first metatarsal (Fig 12,D).
6. Cover the tape and plantar fascia strap with adhesive tape strips, starting on the lateral side, encircling the heel, and ending on the medial side.
7. Repeat step 5.
8. Complete the taping technique by applying circular 1 1/2" strips of tape around the foot, beginning on the lateral side and finishing on the medial side (Figs 12,E and 12,F).

In addition to applying adhesive tape, a heel doughnut may relieve some of the irritation of the plantar fascia. This should be accompanied by a heel lift of 1/2" to 3/4" high, placed in the heel of each shoe (Fig 13).

#### Orthotics

Acute heel pain is best treated with the aforementioned modalities, shock absorbant devices, and taping techniques that take the stress off the plantar fascia. A chronic case responds well to a functional orthotic device. Orthotics assist in balancing the foot and relieving pressure placed on the heels. Polypropylene metatarsal length orthotics work well with walkers. Athletes who place more weight on the ball of the foot, however, generally will do well in a full length orthotic to control biomechanical abnormalities in the forefoot, such as forefoot varus or valgus deformities (8).

#### Nonsteroidal Anti-inflammatory Drugs (NSAIDs) and Injections

Long- and short-acting cortisone injections and/or NSAIDs may be necessary to bring relief. This may be temporary, however, if a biomechanical imbalance is present. However, we believe it is more successful to focus on the athlete's biomechanical faults by using orthotic devices.

#### Acknowledgement

Appreciation is expressed to Sean Brooks for posing for the photographs used in this article.

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# Rehabilitation of Myositis Ossificans in the Brachialis Muscle

Mark S. De Carlo, MS, PT, SCS, ATC  
 Kimberly R. Carrell, ATC  
 Gary W. Misamore, MD  
 Kecia E. Sell, ATC

**ABSTRACT:** Theories on the etiology and management of myositis ossificans vary greatly. In this article, possible causative factors and treatment options are reviewed. We present a successful treatment regimen for myositis ossificans of the brachialis muscle in a 15-year-old football player. The treatment program emphasizes using joint mobilization and eccentric strengthening early in rehabilitation. The patient regained full elbow range of motion after nine weeks of this rehabilitation program. Follow-up at nine months revealed nearly complete maturation of the heterotopic bone formation, full pain-free range of motion, normal strength, and a safe return to athletic competition.

**M** yositis ossificans traumatica is heterotopic bone formation (4,14) that generally results from trauma to muscle tissue (7,10). The highest incidence of myositis ossificans traumatica occurs in

the quadriceps muscle, while the next highest occurs in the brachialis muscle (1,3,4,14,15). The literature on myositis ossificans contains a variety of opinions regarding the pathogenesis of the disorder, the best means of diagnosis, a proper management and treatment regimen, and indications for surgical intervention. The initial emphasis of injury management is to prevent the formation of myositis ossificans (4). If myositis ossificans occurs, decreased range of motion and limited functional use result. The emphasis then changes to restoring normal function and reabsorbing the heterotopic bone. Our purpose is to introduce a unique treatment protocol for those having myositis ossificans formation by presenting a case report of a patient seen at Methodist Sports Medicine Center in Indianapolis, IN.

## Case Report

A 15-year-old football player presented at the clinic with a seven-week history of right arm pain and resultant disuse. The patient sustained a direct blow to the humerus just proximal to the elbow joint and, despite experiencing difficulty, continued to participate in football with padding over the area. He initially used a heating pad and warm whirlpool treatment, as well as range of motion exercises. Three weeks after the initial injury, he suffered another blow to the same area. At this time he noticed an almost immediate onset of swelling, tightness, and restricted range of motion at the elbow joint. He continued to experience pain in the area of the brachialis muscle radiating into the forearm. These symptoms were

aggravated by any use of the arm. His ability to extend his arm from the elbow continued to decrease, prompting the need for medical attention at our facility.

Physical examination at the initial visit revealed a firm, immobile mass in the area of the brachialis muscle. Attempts to mobilize this mass elicited minor discomfort. A fixed flexion contracture of the elbow was noted with decreased range of motion of 0-65-125. (At this clinic, range of motion is described by three numbers. The first number denotes hyperextension, the second number represents any degree of flexion contracture, and the third number indicates the degree of flexion of the joint. For example, 10-0-145 describes a ginglymus or hinge joint with 10° of hyperextension to 145° of flexion or 155° of total range of motion, while 0-65-125 denotes a 65° flexion contracture to 125° of flexion or 60° of total flexion.) Passive range of motion evaluation elicited pain and reflexive spasm in the flexor muscle mass. Joint mobilization techniques used to assess the integrity of the capsular structures at the elbow revealed definite capsular restriction. Radiographic evaluation revealed a large area of myositic ossification approximately 9 cm long and 3 cm wide in the region of the brachialis muscle (Fig 1).

The patient was placed on a rehabilitation program that included ice massage, gentle passive range of motion, eccentric strengthening, and mobilization of the elbow joint three times a week. Because of the formation of myositis ossificans, the patient experienced pain, muscle spasm, and a resultant disuse of his elbow. Sec-

*Mark De Carlo is the director of physical therapy at Methodist Sports Medicine Center in Indianapolis, IN.*

*Kimberly Carrell is the assistant athletic trainer at Lafayette College in Easton, PA.*

*Gary Misamore is a physician at Methodist Sports Medicine Center in Indianapolis, IN.*

*Kecia Sell is a physical therapy student at The University of Indianapolis Krannert Graduate School of Physical Therapy in Indianapolis, IN.*



Fig 1.—Radiograph of myositis ossificans formation in brachialis muscle, seven weeks following injury

ondary to this disuse, capsular soft tissue restriction resulted, which in turn led to further disability and disuse. Therefore, during the early phase of rehabilitation, the primary emphasis was on regaining capsular mobility and joint accessory motions through joint mobilization techniques. The following three techniques were used to restore these accessory motions and thus regain physiological range of motion at the elbow joint (3,11,12).

1. Dorsal-ventral glide of the radial head was performed with the elbow extended and the forearm supinated to the end of the available range (Fig 2). This technique facilitated the return of elbow flexion and extension (11).

2. Humero-ulnar distraction occurred with the elbow at approximately 70° of flexion, stressing the anterior part of the capsular ligament and allowing increased extension (12) (Fig 3).

3) A medial glide of the humerus



Fig 2.—Dorsal-ventral glide of the radial head is performed with the elbow extended and the forearm supinated.

with the forearm fixed served to increase flexion and extension (11) (Fig 4).

In addition, gentle passive motion was performed through a pain-free range, and eccentric strengthening of the biceps and brachialis was initiated with five pounds of resistance. The weight was increased in increments of 2½ pounds as strength and range of motion improved. Isolated lengthening motion of eccentric contraction allows early strengthening with minimal risk of further insult to the muscle tissue (5). During this phase of rehabilitation, the patient was restricted from contact sports, but was allowed to continue light activities, which included running and shooting a basketball to prepare for the winter athletic season.

After three weeks of this rehabilitation program, the patient's range of motion improved to 0-25-145. He subjectively noted less pain, tightness, and muscle spasm. A pad of Temperfoam with an Orthoplast outer shell was placed over the area of ossifica-



Fig 3.—In the humero-ulnar distraction, the elbow is in approximately 70° of flexion and the forearm is supinated. The shoulder harness around the axilla is used for additional stabilization of the humerus.



Fig 4.—During the medial glide of the humerus on a fixed forearm, the elbow is nearly extended and the forearm is supinated. The shoulder harness around the axilla is used for additional stabilization of the humerus.

tion. He was permitted to start practicing basketball with this protective device.

At five weeks following the initial visit, his range of motion was 0-15-145. Strength of the biceps was graded as good with resisted manual muscle testing. He no longer complained of pain upon passive range of motion. Radiographic evaluation revealed some degree of maturation of the soft tissue ossification. Maturation occurs following formation, reabsorption, and resolution of the now-stable ossified area.

After nine weeks of rehabilitation, or 16 weeks following the initial injury, the patient exhibited full elbow range of motion and was participating in basketball without restrictions. Routine physical

therapy was discontinued. He continued to perform strengthening exercises, changing from eccentric to concentric work. The protective pad was worn throughout the remainder of the basketball season.

The patient presented for follow-up nine months after his initial visit. He had no complaints of pain or problems, and he was participating in athletic endeavors without difficulty. Elbow range of motion was 0-0-150. Isokinetic strength evaluation for elbow flexion and extension at speeds of 60°/second, 180°/second, and 240°/second revealed torque values greater than 100 percent at all speeds when compared to the uninvolved extremity. Nearly complete maturation and stability of the heterotopic bone formation was evident on radiographs (Fig 5). For participation in contact sports, the patient was fitted with a protective bicep pad with an outer shell.

## Discussion

There is disagreement in the literature regarding the pathogenesis of myositis ossificans traumatica, and the degree to which it is preventable. The progression of this disorder originates with trauma resulting in a deep muscle contusion. A



Fig 5.—Radiograph of nearly complete maturation of the myositis ossificans formation in brachialis muscle, eleven months following injury

hematoma is formed that stimulates bone growth into the muscle tissue, which results in myositis ossificans (4,10). Some authors feel that the post-traumatic course of deep muscle contusions is significantly determined by the treatment administered in the acute inflammatory phase of wound healing. They contest that failure to pro-

vide immediate immobilization, rest, ice, and elevation may contribute to the formation of myositis ossificans (2,4,14,15). Other authors propose that improper management of the resultant hematoma and forced stretching of the muscle in the acute phase lead to the disorder (7,10). Another view is that the management of the trauma has no bearing on the development of myositis ossificans. Rather, the nature and/or extent of the initial trauma determine the result (6,9,12), or some other uncontrollable factor, such as body composition or chemistry, affects the ultimate outcome (9).

The rehabilitation is controversial in regard to the use of forced passive stretching, passive range of motion, and joint mobilization in the management of deep muscle contusions and myositis ossificans. Use of forced passive stretching to regain muscle length and range of motion is generally contraindicated in both contusions and mature heterotopic bone formation. This may cause muscle tissue tears (12,14) or contribute to actual bone growth (8,13). Cyriax (6) and T.A. Brady, M.D. (conversation, August 1988) contradict these claims, citing cases where myositis ossificans did not develop after forced manipulation of anesthetized patients. Passive range of motion is generally believed to be contraindicated in the management of muscle contusions and myositis ossificans (4,14,15) because of the risk of tearing muscle tissue. However, the literature is inconclusive regarding its contribution to heterotopic bone growth (13). The use of joint mobilization following the formation of myositis ossificans is not discussed extensively in the literature. However, Kessler et al (12) advocate the use of joint capsular mobilization without passive or forceful manipulation of the surrounding muscle. Others feel that any form of mobilization or massage, especially in the early acute phases, should be avoided (2,15).

The use of modalities such as ultrasound, ice, and moist heat remains a subject of debate (4,9,15). Some authors report that modalities have helped the condition, while others adamantly maintain that the use of modalities is contraindicated, because they may contribute to further ossification in the early stages following injury (15).

Ideally, when an athlete presents with a deep muscle contusion, attempts are made to prevent the growth of heterotopic

bone. These preventive measures include immediate ice, compression, elevation, and rest, followed by gentle, pain-free attempts to restore range of motion in the later stages of healing (3,4,9,15). However, even when the most careful measures are taken to protect the initial trauma from further injury, myositis ossificans may develop. Also, as described in the case study of this paper, patients may present with a formation of heterotopic ossification several weeks following the initial insult.

It has been our experience in these cases that patients not only present with fixed flexion contracture, but because of the trauma and immobilization, they may have decreased accessory movement at the involved joint. In these instances, our focus is placed on restoring physiological range of motion through mobilization techniques. Joint mobilization, as previously described, is carried out and has been shown to be very successful in returning patients to their previous functional level. Contrary to the beliefs of other authors, we feel that patients with myositis ossificans, as well as those with severe biceps or brachialis contusions, are best served through the use of joint mobilization. Muscle spasm, pain, and connective tissue tightness are relieved with mobilization, allowing improvement in active range of motion without forceful stretching of the muscles in the arm (12). Long-term follow-up of these patients has revealed natural reabsorption of any soft tissue ossification and no evidence of compromise to the natural healing process of the body. This demonstrates that a rehabilitation program incorporating joint mobilization techniques will allow patients with myositis ossificans of the arm to return quickly and safely to full participation in athletics.

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# The Effect of Molded and Unmolded Orthotics on Balance and Pain While Jogging Following Inversion Ankle Sprain

Linda Combs Orteza MS, PT, ATC  
W. Daniel Vogelbach, PT, ATC  
Craig R. Denegar, PhD, ATC

**ABSTRACT:** During this study, we examined the effects of using molded orthotics on persons who had suffered an inversion ankle sprain. We assessed standing balance with a digital balance evaluator for a group of 15 subjects who had no history of ankle sprains and for a group of nine subjects with acute ankle sprains. Then, we assessed the subjective pain experienced by ten subjects with acute ankle sprains while they jogged. During each part of the study, we tested the subjects while they were using a molded orthotic, an unmolded orthotic, and no orthotic in their shoes. We alternated the order of these treatments with each consecutive subject. The results indicate that subjects with a history of recent inversion ankle sprains had poorer balance than uninjured subjects. Molded orthotics had no effect on balance scores in the uninjured group, but their use improved balance scores in the ankle sprain group. Unmolded orthotics did not improve balance scores. Molded orthotics helped to decrease ankle pain during jogging for those with an ankle sprain, but unmolded orthotics did not. These findings suggest that molded orthotics may play a role in the treatment of inversion ankle sprains.

Linda Orteza is director of rehabilitation at SportsMedicine Grant in Columbus, OH.

Daniel Vogelbach is area manager of operations at Health South Rehabilitation Corporate, Orlando, FL.

Craig Denegar is an associate professor at Slippery Rock University, School of Physical Therapy, Slippery Rock, PA.

A sprained ankle is one of the most common injuries in competitive and recreational sports. Without adequate treatment, this injury can result in chronic instability (2). The majority of treatment protocols for ankle sprains call for inflammation control, early motion, gradual strengthening, proprioceptive training, functional progression, and some type of supportive device to protect the talocrural joint (4,12). The subtalar joint is seldom addressed in the treatment protocol, even though subtalar joint motion increases after lateral ankle sprains (9) and subtalar joint motions have a direct effect on ankle injuries (7). Standing talar tilt, which occurs with ankle sprains, can be limited by a neutral orthotic designed to control the subtalar joint, rather than the talocrural joint (14). Clinically, we have observed that such an orthotic decreases pain and permits an earlier return to normal activity following ankle sprains.

The reasons for conducting this study were to determine if: 1) recent inversion ankle sprains affect time out of balance as measured with a digital balance evaluator; 2) molded and unmolded orthotics affect balance measurements; and 3) molded and unmolded orthotics affect perceived pain during jogging following a lateral ankle sprain.

## Materials and Methods

This study consisted of two parts: 1) assessment of standing balance with the digital balance evaluator in a group of 15 subjects (6 males, 9 females,  $22.0 \pm 2.3$  yr) who had no history of ankle sprains, and in a group of nine subjects (5 males, 6 females,  $17.0 \pm 3.4$  yr) who had acute ankle sprains; and 2) subjective assessment of pain experienced while jogging by 10 injured subjects (7 males, 3 females,  $17.0 \pm 3.1$

yr) who had acute ankle sprains. For this study, "acute" was defined as an ankle sprain that had occurred within six weeks of testing. All patients with inversion ankle sprains, who received physical therapy at Morgantown Physical Therapy Associates between June 19 and August 13, 1987 or between April 18 and June 30, 1988, were asked to participate in the study. Those who gave their consent were tested. The uninjured group consisted of volunteers from Morgantown Physical Therapy Associates and the surrounding community who had no history of an ankle sprain. All subjects were full weight-bearing at the time of testing. The subjects in this portion of the study were not the same as the injured subjects who were evaluated on the digital balance evaluator, because the testing was not conducted during the same time period.

The digital balance evaluator is a single axis board that allows inversion and eversion of the foot (Fig 1). The board makes electrical contact at  $4^\circ$ , which defines a loss of balance. The amount of time that the loss of balance is maintained is recorded in seconds and is referred to as time out of balance. These two readings accumulate for a 30-second trial period. Time out of balance was analyzed in an effort to measure balance ability. The digital balance evaluator provides reliable measures of the number of touches and time out of balance (6,15).

Molded orthotics were made from  $1/8$ -inch solid Aquaplast™, which is a semi-rigid material. The Aquaplast was molded to the neutral subtalar joint position while the subject lay prone on an examining table. The examiner palpated the talonavicular joint for congruency and loaded the fifth ray. The neutral position for the subtalar joint is defined as the



1891, Dr. J. Naismith invents basketball.



1893, women begin to play.



1900, dribbling two-handed, first allowed.



1930's, underhand shot is common.

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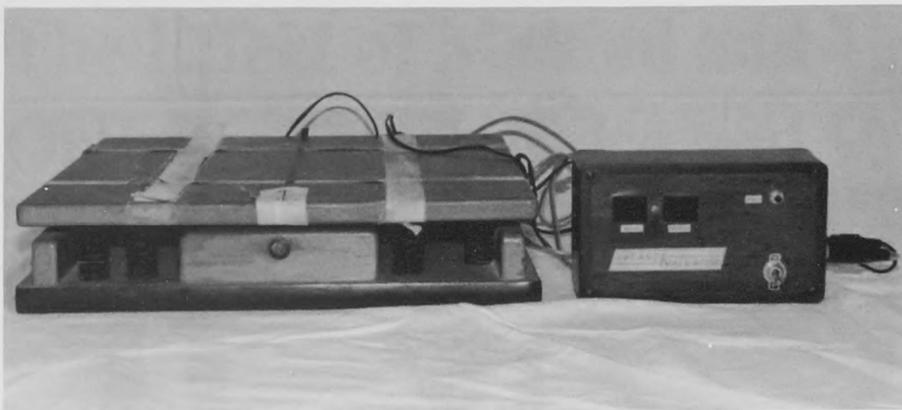


Fig 1.—The digital balance evaluator is a single axis device that assesses time out of balance and the number of times that balance is lost.

position of the foot during which the talonavicular joint is congruent and the forefoot is fully pronated against the rearfoot (1).

The Aquaplast then was ground smoothly to the length of the metatarsal heads, and extrinsic forefoot posting was added to those individuals who, upon examination, were found to have a forefoot varus deformity. Rearfoot varus was corrected by grinding the orthotic more laterally than medially. The Aquaplast then was covered with  $\frac{1}{8}$ -inch Plastazote® to form a full-length orthotic. No forefoot or rearfoot valgus deformities were found in any subjects.

Unmolded orthotics consisted of a  $\frac{1}{8}$ -inch Plastazote full-length orthotic. The orthotic was cut to the length of the individual's foot and then was inserted in his or her shoe without heating or molding.

All subjects performed under three separate conditions: 1) wearing a molded orthotic, 2) wearing an unmolded orthotic, and 3) wearing no orthotic in their shoes. Six treatment orders were established with two 3x3 Balanced Latin Squares. Subjects were assigned randomly to one of the treatment orders.

During the first phase, injured (n=19) and uninjured (n=15) subjects were tested on the digital balance evaluator. In order to become acquainted with the digital balance evaluator, the subjects practiced for three minutes. If the practice session caused any discomfort to the subjects who had ankle sprains, the testing was discontinued until it could be performed without pain. Subjects who were pain-free completed three 30-second trials, one under each of the treatment conditions, resting one to two minutes between trials.

The treated foot was placed on the board in the same position for each subject

and trial. Subjects were instructed to fix their eyes on a designated distant object, because eye tracking has been shown to have a negative effect on balance (13). Subjects were instructed to cross their arms over their chest and not allow their opposite foot to touch the board or the floor (Fig 2).

In the second phase of the study, 10 injured subjects were asked to jog 20 yards without an orthotic, 20 yards with an unmolded orthotic, and 20 yards with a molded orthotic. After jogging, the subjects were asked to assess their perceived pain level in the injured ankle during gait, as follows: grade four for severe pain, grade three for significant pain, grade two for moderate pain, grade one for minor pain, and grade zero for no pain.

### Data Analysis

An analysis of variance (ANOVA) with repeated measures on one factor (treatment condition) was conducted on the digital balance evaluator data. Follow-up analysis was performed in three steps. First, the digital balance evaluator data for time out of balance of the injured and uninjured subjects without orthotic devices was compared using a one factor ANOVA. Repeated measures ANOVAs were conducted separately on the digital balance evaluator data collected from the injured subjects for the molded orthotic, unmolded orthotic, and no orthotic conditions. Then, a repeated measures ANOVA was conducted on the reported pain during running data for each of the trials. Planned comparisons were performed with repeated measures ANOVAs to identify sources of variance. A Bonferroni correction was used to maintain a  $p=.05$  alpha level for the balance and pain data from injured subjects. Finally, the digital balance evaluator data of the



Fig 2.—Subjects were instructed to stand with their arms crossed in front of the chest and to focus on a designated distant object.

uninjured group without orthotics was compared to that of the injured subjects with molded orthotics.

### Results

The mixed model ANOVA revealed a significant main effect for the treatment condition ( $F(2,48)=4.75, p=.013$ ) and a group by treatment condition interaction that approached significance ( $F(2,48)=2.56, p=.088$ ). Because the descriptive data suggests that the significant main effect was primarily the result of the use of orthotics with ankle-injured subjects and that the interaction approached significance, follow-up tests were conducted. Injured subjects were out of balance more than uninjured subjects ( $F(1,24)=4.95, p=.036$ ). (See the Table for time out of balance means and SDs for injured and uninjured subjects.) For injured subjects, a difference between the three treatments on the digital balance evaluator was found ( $F(2,20)=5.03, p=.026$ ).

Planned comparisons identified significant differences between trials with molded orthotics and no orthotics ( $F(1,10)=3.68, p<.01$ ), but no significant differences between unmolded orthotics and molded orthotics ( $F(1,10)=1.03, p>.335$ ) or between no orthotics and unmolded orthotics ( $F(1,10)=3.75, p=.082$ ). No significant differences ( $F(2,28)=.42, p=.661$ ) in digital balance evaluator scores were found among uninjured subjects using no orthotic, unmolded orthotics, and

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Time Out of Balance Values of Uninjured and Injured Subjects in Seconds ( $\bar{x} \pm SD$ )

	No Orthotic	Unmolded Orthotic	Molded Orthotic
Injured	7.5±5.2	5.9±4.7	4.7±4.9
Uninjured	4.0±2.8	4.0±3.6	3.5±3.5

molded orthotics. The repeated measures ANOVA on the reported pain during jogging under the three conditions revealed a significant difference between trials ( $F(2,18)=13.87, p<.01$ ), molded orthotic= $.9 \pm .9$ , unmolded orthotic= $1.7 \pm .8$ , no orthotic= $1.8 \pm .6$ ). Planned comparisons revealed that subjects reported significantly less pain ( $p<.01$ ) when wearing a molded orthotic while jogging than when wearing the unmolded orthotic or no orthotic. No differences were found between those subjects using the unmolded orthotic and those not using an orthotic device. Finally, the digital balance evaluator data from the uninjured subjects who did not use orthotics was compared to the molded orthotics trial for the injured group. The difference between those trials was not significant ( $F(1,24)=.23, p>.05$ ).

## Discussion

Subjects with ankle sprains had significantly higher time out of balance scores. This concurs with Freeman's findings of a decrease in proprioception following an ankle sprain (2,3,4). The molded orthotic did have a significant effect on improving time out of balance scores after an ankle sprain. If the molded orthotic had been effective in both the uninjured and injured groups, one could speculate that the molded orthotic was effective in improving digital balance evaluator scores solely as a result of increased structural support (medially and laterally), thus preventing or retarding inversion and eversion. Because the orthotic did not affect time out of balance scores in the uninjured group, it is unlikely that structural support is the reason for effectiveness in the injured group. In fact, the descriptive data and the final statistical comparison between uninjured subjects without orthotics and injured subjects wearing molded orthotics suggests that molded orthotics restore much of the balance performance deficit created by the ankle injury.

The most common ankle injury is an inversion ankle sprain that usually occurs

in plantarflexion (5,7). The anterior talofibular ligament is the most commonly sprained ligament associated with an inversion injury. The anterior talofibular ligament spans the lateral malleolus and the neck of the talus, and functions to limit anterior drawer of the talus and to limit adduction (internal rotation) of the talus (10). Closed chain pronation of the subtalar joint involves plantar flexion/adduction of the talus (11). Excessive pronation may result in undue stress to the injured anterior talofibular ligament. Thus, control of the subtalar joint may decrease ligamentous stress, resulting in decreased pain and improved function.

Joint mechanoreceptors located in the joint capsule and ligaments contribute to joint kinesthetic and proprioceptive feedback and postural movements (8,16). Although there are four types of joint mechanoreceptors (16), distinctions between the different types of mechanoreceptors are not addressed in this study. These mechanoreceptors usually are damaged with ligamentous injury, which results in a decrease in kinesthetic/proprioceptive feedback and functional instability (2,3,4).

Maintaining the foot in a more neutral position may decrease the stress on the injured ligament(s) and enhance the function of the injured joint.

No distinction was made between foot types in this study. Individual biomechanical and foot structure differences may affect the response to neutral orthotics post ankle sprain. The excessively pronated foot may benefit from greater support and control than the excessively supinated foot.

Within the limits of this study, our results suggest that neutral orthotics can play a role in the treatment of ankle sprains. Although the mechanism has not been fully identified, orthotics improve balance skills and decrease pain. Improved joint congruency and decreased stress to the soft and/or bony structures provide a plausible explanation and suggest that the orthotics may promote healing and speed return to activity. More investigation is warranted in

order to fully understand the function of the subtalar joint in ankle sprains.

## Acknowledgements

This study fulfilled a requirement for master's degree in physical therapy at the University of Indianapolis, Indianapolis, IN, and was made possible with a grant from Morgantown Physical Therapy Associates, Morgantown, WV. We would like to acknowledge the advisors to this study—Sam Keggerreis, MS, PT, ATC, associate professor at the University of Indianapolis; John C. Spiker, MS, PT, ATC, president of Morgantown Physical Therapy Associates; and Jessica Danda, ATC—for assistance in manuscript preparation.

The testing for this study was conducted at Morgantown Physical Therapy Associates, Morgantown, WV. The photographs were provided by Elizabeth Domholt.

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# Taping for Excessive Pronation: Reverse 8-Stirrup

Crayton L. Moss, EdD, ATC

The reverse 8-stirrup taping technique originally was designed for the care and prevention of eversion ankle sprains (4). Recent investigations have shown that this taping technique significantly decreases the amount of maximum pronation and the degrees of total rearfoot movement when compared to using no support in the training shoe (5). Also, there was no significant difference between a prescribed semi-rigid orthotic and the reverse 8-stirrup for the treatment of excessive pronation (5). Our data indicate that the reverse 8-stirrup is a possible treatment for excessive pronation in runners (5). Clinical observation indicates that athletes with excessive pronation can participate pain-free when using this taping technique. Therefore, the following detailed procedure is presented as an acceptable technique for treating the various symptoms associated with excessive pronation.

## Materials

1. 16cm wooden block
2. Goniometer
3. 1½-inch adhesive tape
4. Heel and lace pads
5. Pre-taping underwrap (optional)
6. Tape adherent

## Pronation Evaluation

Have the athlete stand with both feet along each side of a 16cm wide wooden block (2). Remove the block and observe

the athlete from the rear (Fig 1). Instruct the athlete to supinate both of his or her feet until the Achilles' tendons appear to be in straight lines from the gastrocnemius to calcaneus. Then, mark with a magic marker (Fig 2). Have the athlete relax his or her arches and observe the angle of the Achilles' tendons deviations (Fig 3). Using a straight edge, connect the dots and measure the angles with a goniometer (Fig 4). The severity of excessive

pronation can be graded as mild ( $4^{\circ}$  to  $6^{\circ}$ ), moderate ( $6^{\circ}$  to  $10^{\circ}$ ), or severe ( $10^{\circ}$  to  $12^{\circ}$ ) (3). If excessive pronation is observed, whatever the severity, the reverse 8-stirrup is recommended.

## Athlete's Position

During the taping procedure, the athlete sits on a table with the leg extended and the foot at a  $90^{\circ}$  angle, with the subtalar joint in a neutral position as



Fig 1.—Stance from the rear with feet positioned 16cm apart



Fig 3.—Observed deviation of Achilles' tendon markings in a relaxed position



Fig 2.—Achilles' tendon markings in a straight line from gastrocnemius to calcaneus

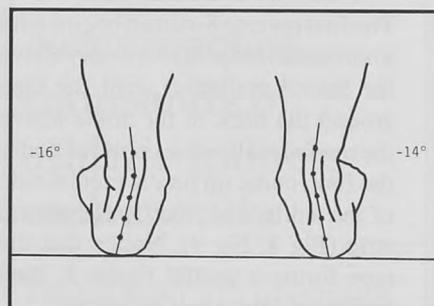


Fig 4.—Degrees measurement of Achilles' tendon deviation angle

*Crayton Moss is assistant professor with the School of Health, Physical Education, and Recreation at Bowling Green State University, Bowling Green, OH.*

described by Vogelbach and Combs (6).

“Grasp the fourth and fifth metatarsal heads while the index finger and thumb palpate the talus. The talus is best palpated by placing the thumb just anterior and inferior to the medial malleolus at the talonavicular joint, and the index finger just in front of the anterior aspect of the fibula (Fig 5). By inverting and everting the rearfoot, the examiner will find a position in which either the talus is felt equally on both sides or is not felt at all. This is considered the neutral position.”

Throughout the following procedures, do not place the ankle in an inversion position when the tape is applied. Keep the foot in a 90° dorsiflexion and subtalar neutral position, or the reverse 8-stirrup technique will not be effective.

### Taping Procedure

1. It is recommended that the athlete have a clean-shaven ankle and lower leg. First, apply tape adherent, heel and lace pads, and pretaping underwrap (optional). Next, apply an anchor strip at the musculotendinous junction of the gastrocnemius (Fig 6).
2. Apply a stirrup. Start on the top lateral aspect of the anchor strip and run it under the foot parallel to the Achilles' tendon, bisecting both the lateral and medial malleoli. Attach it to the anchor strip (Fig 7).
3. The first reverse 8-stirrup begins with a horizontal strip. Start directly above the lateral malleolus, pull the tape around the back of the ankle above the medial malleolus, continue under the foot, come up on the medial side of the ankle, and overlap the stirrup strip (Fig 8, Fig 9). Notice that the tape forms a partial figure 8, then continues into a medial stirrup.

**Note:** Do not force the foot into inversion, but maintain a neutral position throughout the taping technique. The most common error in using the reverse 8-stirrup is to allow the medial stirrup portion to position the

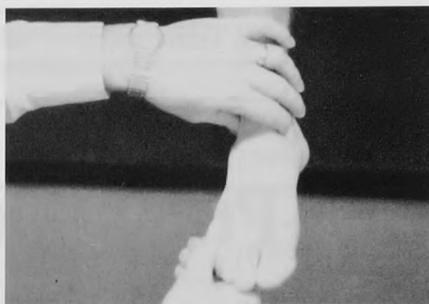


Fig 5.—The talar method of finding the neutral position of the subtalar joint

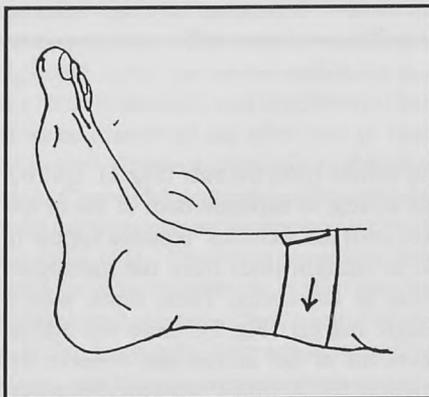


Fig 6.—Anchor strip

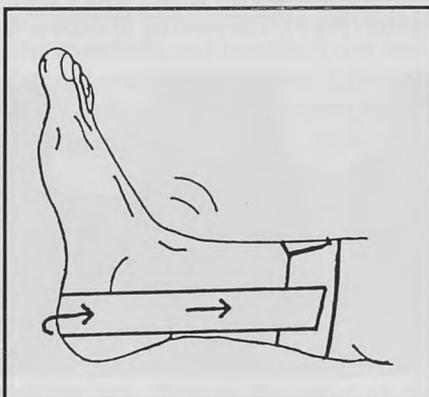


Fig 7.—Traditional stirrup for eversion ankle sprains

subtalar joint into a supinated rather than a neutral position.

4. Overlapping at least one-half, apply a second reverse 8-stirrup following the same procedure as Step 3. Two to four reverse 8-stirrups may be used, according to ankle/foot size. The third and/or fourth reverse 8-stirrup must be applied directly over the navicular bone (Fig 10, Fig 11).

**Note:** Some individuals prefer 2" elastic tape rather than 1 1/2" adhesive white tape. When elastic tape is used, the medial stirrup portion of the reverse

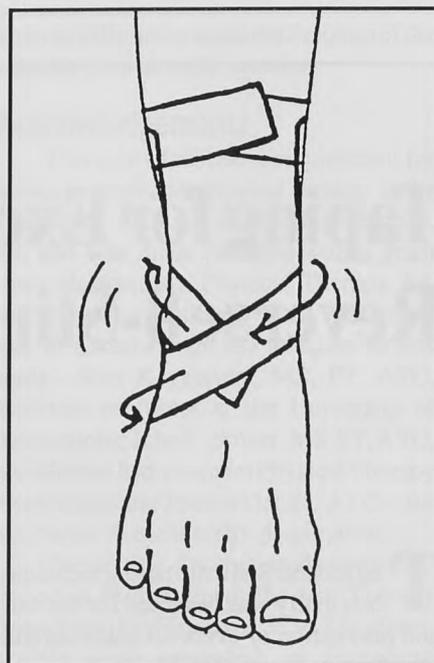


Fig 8.—The first reverse 8-stirrup begins with a horizontal strip above the lateral malleolus.

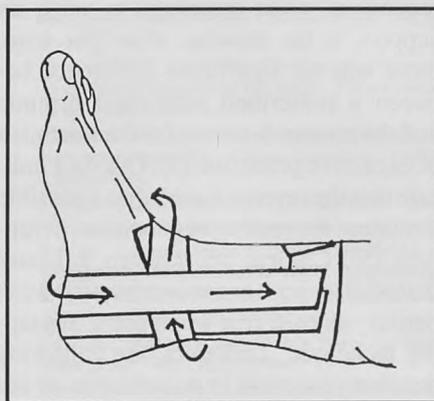


Fig 9.—The first reverse 8-stirrup continues from a partial figure 8 into a medial stirrup.

8-stirrup should be stretched to its optimal length before it is anchored.

5. Next, apply anchor strips. Start from the bottom and work upward. The last strip should cover all of the ends of the tape (Fig 12).
6. A heel lock gives the final support, as described by Arnheim (1). Apply the lateral heel lock by starting high on the instep. Bring the tape along the ankle at a slight angle, hooking the heel, leading under the arch, coming up on the opposite side, and finishing at the starting point. Apply the

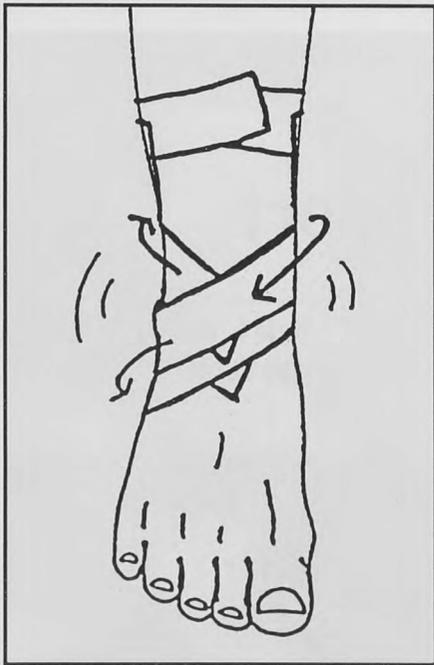


Fig 10.—The second reverse 8-stirrup overlaps at least one-half of the preceding reverse 8-stirrup.

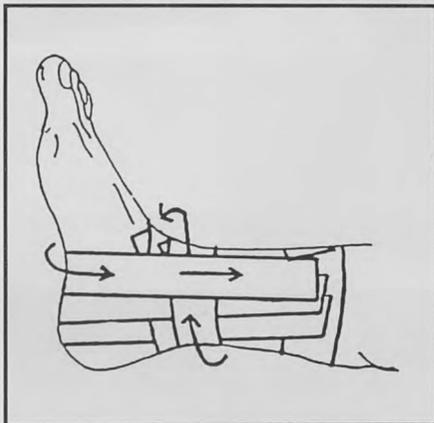


Fig 11.—The second reverse 8-stirrup is continued. Two to four reverse 8-stirrups may be used to insure that the final reverse 8-stirrup runs directly over the navicular.

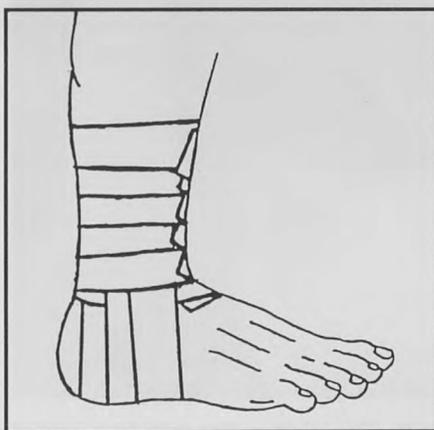


Fig 12.—Anchor strips; anchor distal to proximal

medial heel lock in a similar manner to the lateral heel lock, except on the opposite side of the ankle (Fig 13, Fig 14).

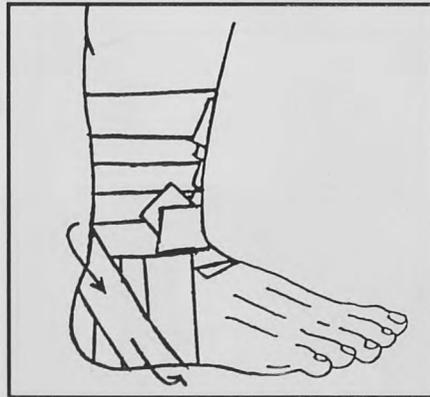


Fig 13.—Lateral heel lock

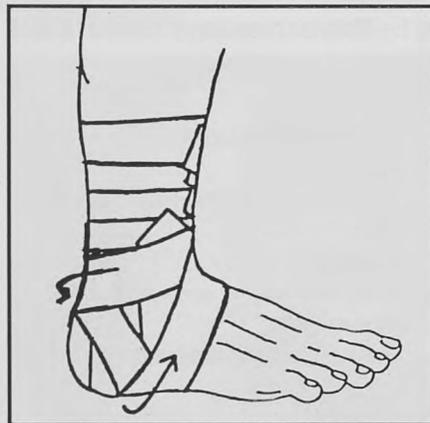


Fig 14.—Medial heel lock



Fig 15.—Evaluation of Achilles' tendon deviation with reverse 8-stirrup taping

## Reverse 8-Stirrup Evaluation

After completing the reverse 8-stirrup taping technique, re-evaluate the amount of pronation using the 16cm wooden block as described earlier. Measure the amount of pronation and retape if excessive pronation persists (Fig 15).

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# Upper Extremity Semi-Rigid Support

Kyle L. Farley, MA, ATC  
Jean Blagbrough Sublette, OTR, CHT

**S**plinting of upper extremity injuries presents a challenge for the athletic trainer and occupational therapist (1,2,3). Proper protection of stable injuries must be achieved without limiting an athlete's participation. Because of restrictions against using hard and non-yielding materials distal to the elbow, few materials are currently available to athletic trainers and occupational therapists. RTV-11 (General Electric Silicone) has been an acceptable material for splinting, but the fabrication process is time-consuming and requires one to three hours for curing. Scotchrap (3M) semi-rigid casting material reinforced with moleskin provides a time- and cost-effective alternative to other available materials.

We used these materials to construct a semi-rigid support for a high school football player who suffered multiple lacerations to the volar aspect of his left wrist, fingers, and thumb when his forearm was forced through a glass door. Following three surgeries to repair numerous structures and extensive therapy, he was released to play football provided that he avoided wrist and finger hyperextension. The support that we developed (Fig 1) enabled him to avoid hyperextension while playing football.

## Materials

The following materials were used:

1. Two rolls of 3M Scotchrap 2" semi-rigid support wrap (casting material)

*Kyle Farley is director of the sports medicine division of Pinnacle Rehabilitation of Missouri in North Kansas City, MO.*

*Jean Sublette is director of occupational therapy at Pinnacle Rehabilitation of Missouri.*

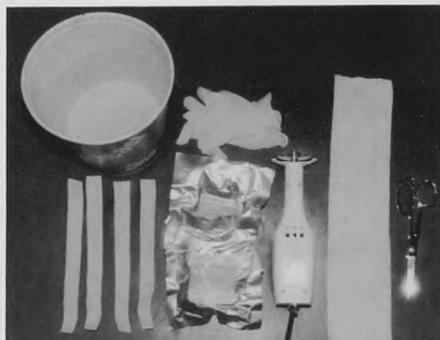


Fig 1.—Materials necessary to construct a semi-rigid support

2. Three-inch stockinette—fifteen inches long
3. Four 1" x 10" strips of adhesive moleskin
4. Latex gloves
5. Cast saw and/or scissors
6. Warm water
7. Two-inch elastic wrap and/or Elasticon

## Procedure

1. Place the patient's forearm, wrist, and fingers in appropriate position (wrist 30° flexion; metacarpals 50° flexion).
2. Cover all surfaces with a stockinette (Fig 2).
3. Wearing gloves, place the casting material in warm water, then squeeze out any excess water.
4. Apply the first roll of 3M Scotchrap, beginning at the hand (incorporate thumb, if desired) and maintaining the proper position (Fig 3).

**\* Allow the Scotchrap to begin setting-up (three to five minutes).**

5. Place two strips of moleskin lengthwise along the dorsal (Fig 4) and volar (Fig 5) aspects of the wrist and forearm.
6. Repeat steps four and five with a second roll of 3M Scotchrap. Allow



Fig 2.—The area to be protected must be covered with a stockinette.



Fig 3.—Semi-rigid casting material is applied over the stockinette and given time to set-up.



Fig 4.—Moleskin is placed on the dorsal surface for reinforcement.

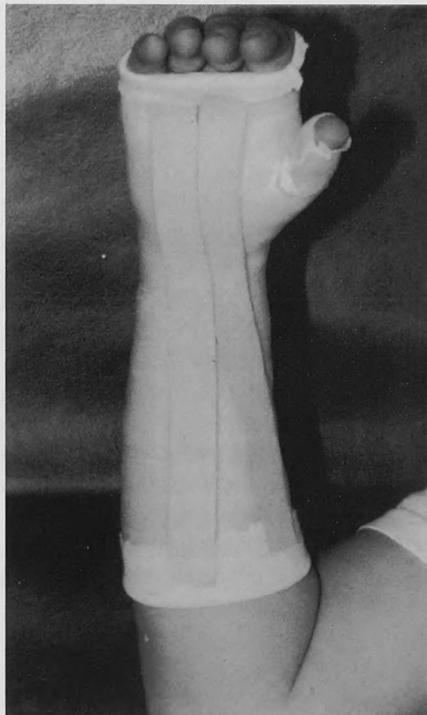


Fig 5.—Moleskin is placed on the volar surface for reinforcement.



Fig 6.—A second roll of semi-rigid casting material is applied and given time to set-up.



Fig 7.—Use a cast saw to cut the semi-rigid support along the ulnar border.

7. Cut a uni-valve along the ulnar border using a cast saw and/or scissors (Fig 7).
8. Use elastic wrap and/or Elasticon to hold the material in place (Fig 8).

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Fig 8.—An elastic wrap is applied to maintain the position of the semi-rigid support.

## ■ Abstracts ■

Clint Thompson, MS, ATC

**Dugas R, D'Ambrosia R. Causes and treatment of common overuse injuries in runners. *J Musculoskeletal Medicine*. 1991; 8(3):107-116.**

In the first part of a two-part article, Dugas and D'Ambrosia discuss three common problems of the knee that occur as a result of overuse—anterior knee pain, iliotibial tract syndrome, and popliteus tendinitis. The authors discuss the two primary causes of these problems and suggest that a careful analysis be made of the athlete's mechanics and training program as part of the total evaluation.

Running biomechanics is discussed, emphasizing the relationship of the foot and the knee, and the subsequent weight-bearing forces involved. A complete history, as well as observation of the patient's walking and running gait, is critical for the successful examination. Conservative measures including the use of orthotics, stretching, vigorous quadriceps exercise, and nonsteroidal antiinflammatory drugs (NSAIDs) were suggested for anterior patellofemoral pain. Very few patients are candidates for surgery, even after conservative management.

Treatment for iliotibial tract friction syndrome is directed at decreasing the inflammation and stretching the tract. This treatment includes six to eight weeks of rest, dexamethasone injections, and ice or heat. Popliteus tendinitis is indicated by lateral knee pain aggravated by weight bearing and downhill running. A decrease in mileage and the avoidance of downhill running, along with oral NSAIDs and ice for two weeks are recommended. If symptoms persist, a tear of the lateral meniscus should be considered.

Gary Ball

Kean College of New Jersey  
Union, NJ

**Dugas R, D'Ambrosia R. Causes and treatment of common overuse injuries in runners. *J Musculoskeletal Med*. 1991; 8(5):57-70.**

In the second part of this two-part article, overuse injuries to the back, hip, leg, and foot are addressed. Approximately 30% of the injuries seen in runners

who are between ages 30 to 50 are back injuries. These injuries include erector spine strain (the most frequent injury), herniated lumbar disc, spondylolisthesis, and degenerative arthritis. Differential diagnoses include thigh strain, bursitis, stress fracture, and avulsion injury. A conservative approach with the cessation of running for various periods is recommended pending a reduction in symptoms. An MRI and a CT scan are suggested if symptoms persist.

Injuries to the lower leg include exertion-induced compartment syndrome, shin splints or medial tibial stress syndrome, and tibial and fibular stress fractures. These injuries can be caused by increasing running miles too quickly. Therefore, a reduction in mileage is a primary treatment for these injuries.

The most common ankle and foot injuries seen in runners include Achilles' tendon injury, posterior tibialis and peroneal tendinitis, plantar fasciitis, and metatarsal stress fractures. Orthotic devices are suggested as a primary solution to these injuries provided that the etiology is biomechanical in nature. The authors advise against the use of steroid injections for tendinitis because of the possibility of rupture. With injuries to the lower leg, cross training is suggested in order to maintain the fitness level of the athlete, assuming that the athlete is asymptomatic when engaging in the activity.

Gary Ball

Kean College of New Jersey  
Union, NJ

**Wilkerson GB. Comparative biomechanical effects of the standard method of ankle taping and a taping method designed to enhance subtalar stability. *Am J Sports Med*. 1991; 19:588-595.**

Despite numerous scientific investigations, the effectiveness of ankle taping has not been clearly established or refuted, and the subject remains highly controversial. Restriction of forced passive ankle motion provided by the standard method of ankle taping was compared with that provided by a modified version

of the standard method, which incorporates the subtalar sling. The subjects for this study were 30 NCAA Division III college football players who were randomly selected from a group of 60 volunteers. Both ankles of each subject were involved in the study in order to provide 30 matched pairs of observations. Adhesive tape was applied to each subject's ankles for one practice session (two to three hours). One ankle was taped using the standard method of tape application and the other was taped using the modified method. All taping was done by the investigator in order to ensure that the taping was consistent for all subjects. The instrument used to induce and quantify ankle motion consists of a footplate that rotates around two perpendicular horizontal axes, both of which incorporate a goniometer. The data were analyzed by a 2x4x2 multivariate analysis of variance (MANOVA). The results indicated that a significant difference exists in the amount of ankle motion permitted by the two taping methods and in the maximal range of the four ankle motions. There is a significant differential effect of the two taping methods on the four ankle motions.

To further examine the differential effect of the two taping methods, a separate 2x3 repeated measures ANOVA was performed for each ankle motion. Then, the Neuman-Keuls method of multiple comparisons was used to determine which cell means were significantly different. The modified taping method provided significantly more initial restriction and residual restriction to both supination and inversion than that provided by the standard taping method. The findings of this study suggest that incorporation of the subtalar sling significantly enhances protection against an inversion sprain, but at the expense of a slightly greater restriction of plantar flexion.

Mike Sullivan

The Center for Hip and Knee Surgery  
Mooreville, IN

**Guillen-Garcia P. Arthroscopic laser surgery in treating the knee injuries of leading professional athletes. *Am J Arthroscopy*. 1991; 9:15-18.**

Arthroscopic surgery with a TwoPointOne Holmium Laser Prototype from Coherent was performed on the knees (57) of professional athletes in Spain. Fifty had meniscal pathology, two had synovitis, three had chondroplastic lesions, and two had anterior cruciate ligament (ACL) lesions. Both persons with synovitis showed excellent recovery. In the three chondroplastic knees, smoothing of the cartilage was easily achieved, and the base of the cartilage was left extremely firm. All 50 menisci evolved without hemarthrosis, except one case of an old peripheral disinsertion that required two hemarthrotic evacuations.

For the 57 knees, the use of portals or access routes did not lead to complications, primarily because the laser system requires very small openings. The mean period of time required before the athletes could return to practice was three to four weeks, and one of the patients was able to play soccer 13 days after a partial medial meniscectomy. The mean hospital stay was ten to 12 hours, and all of the patients were able to walk out of the hospital. Each patient was seen on the third day following the surgery and started running on the eighth day.

No infection, thrombosis, or any other complication such as internal or external burns or cartilage necrosis inherent to laser use was observed. A disadvantage of the laser prototype was that activation of the system was controlled with a foot switch and not with a handpiece. All cases were treated by the same surgical team, thus the technique was standardized. The Holmium Laser System represents a major breakthrough in arthroscopic knee surgery. Its use helps to obtain better results than arthroscopic surgery with mechanical instrumentation, because fewer complications may occur and a bevelled

pattern is obtained with meniscal trimming.

Mike Sullivan

The Center for Hip and Knee Surgery  
Mooresville, IN

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**Bennett JT, Urmson L, Binder AJ, Brunet ME, Thomas KA. Survey of health care available to child athletes. *Orthop Rev*. 1991; 20:983-988.**

Most musculoskeletal injuries of children and adolescents are the result of sports and recreational activities, but sports medicine education about youth injuries is practically nonexistent.

In order to determine the nature and extent of treatment delivered to the young athlete, a questionnaire was developed for use in determining the availability and characteristics of sports medicine clinics that have been designed for the prevention, diagnosis, and treatment of injuries of the child athlete. For this survey a child athlete was defined as one between ages four and 12. Centers that had a sports medicine clinic for children were sent the questionnaire in order to determine basis for formation, the length of operation, number of visits (categorized by age and by complaint), number and type of staff, population base, clinic schedule, types of services, referral sources, and profitability. Information about the number and nature of sports medicine clinics and their methods of health care delivery to child athletes was determined.

Mike Sullivan

The Center for Hip and Knee Surgery  
Mooresville, IN

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**Clay NR, Dias JJ, Costiga PS, Gregg PF, Barton NC. Need the thumb be immobilized in scaphoid fractures? *J Bone Joint Surg Am*. 1991; 73:828-832.**

Fractures of the waist of the scaphoid are common and are of considerable social and economic significance. Different authors have recommended the use of above elbow or below elbow plaster casts in a variety of different configurations in relation to the forearm, wrist, thumb, and fingers. In view of the lack of evidence for the need to enclose the thumb, a randomized trial was used to compare the scaphoid cast with a forearm gauntlet (Colles) cast for the treatment of fresh fractures of the scaphoid. Either a Colles cast or a scaphoid cast with the thumb enclosed to the interphalangeal joint was applied to 392 patients. In both cases the wrist was held in 30° of dorsiflexion. In the scaphoid casts, the thumb was positioned to allow pinch grip.

Patients who were involved in this study were reviewed at two weeks and at four weeks to check the integrity of their casts and to assess any functional problems. After eight weeks, their casts were removed and their progress was assessed clinically and radiologically. Of the 392 patients, 292 (mean age of 29.7 yr) were monitored for six months. At final review, six months after injury, a radiographic examination was repeated. The mean total time in the plaster cast for the scaphoid and the Colles cast was 9.6 and 9.0 weeks, respectively. The outcomes in terms of nonunion were similar for the two types of treatment. Both types of casts were equally well tolerated, and rehabilitation did not appear to be adversely affected by immobilization of the thumb. However, the scaphoid cast was more inconvenient for the patient and had the further disadvantage of being more costly to apply in terms of time and material. For fresh, nondisplaced fractures of the waist of the scaphoid, the simpler Colles plaster cast appears to be effective, convenient, and less costly.

Mike Sullivan

The Center for Hip and Knee Surgery  
Mooresville, IN

## ■ New Products ■

Barrie Steele, MS, ATC

### If You Need to Ice It, You Need CONTOUR PAK

Alice M. Mayn, inventor and co-owner of CONTOUR PAK, announces that her cold compress therapy is available for national distribution. CONTOUR PAK is a lightweight, convenient, and comfortable ice pack, which was invented by Mayn for a friend who had undergone breast surgery. There was no single ice therapy product available that conformed to the shape of the breast or other difficult-to-ice areas. CONTOUR PAK is an ideal cold compress therapy for the treatment of post surgical trauma, sprains, swelling, and sports-related injuries.

CONTOUR PAK is a reusable ice



pack that is manufactured in one size and fits adults as well as children. It is unique, because it is a single product that con-

forms to the different parts of the body making it unnecessary to have one ice pack for the knee, another one for the shoulder, and another one for the ankle. CONTOUR PAK fits them all.

CONTOUR PAK is covered in a soft fabric that is comfortable against the skin (eliminating the need to wrap the pack in a towel), guards against freeze burn, and is Velcro-compatible, allowing the pack to be strapped in place, if necessary, with the accompanying elastic/Velcro strap.

For more information on CONTOUR PAK, call (303) 926-2470.

### Latex Stretch Cord System Introduced

PHYSIO TONER is a moderately-priced latex stretch cord system for shoulder, back, knee, and ankle rehabilitation programs. It has been introduced to help bridge the gap between low cost, disposable bands and higher-priced latex equipment.

In clinical and home applications, PHYSIO TONER has been tested by athletes and physical therapists. It has proven to be user friendly, safe, cost effective, and extremely durable. PHYSIO TONER is made of 100% soft rubber, which benefits the user because it significantly reduces the risk of serious injury from accidental impact.

PHYSIO TONER's three resistance



levels are designed for shoulder, hip, knee, and ankle rehabilitation programs. Foam handles increase the user's comfort while they protect the cord from nicks and tears that may reduce the life span of other

latex cords. Each PHYSIO TONER kit comes with an easy to follow laminated exercise chart and a door hook for increased versatility. A Shoulder Rehabilitation Kit also is available for complete home range of motion and strengthening programs.

PHYSIO TONER allows athletic trainers and physical therapists to provide their patients with an affordable, professional product that is easy to use and will last for years.

For more information, contact Louis Stack, Fitter International, Inc., 4515 1st S.E. Calgary, Alberta T2G 2L2, (403) 243-6830, Fax (402) 229-1230.

## POLAR Announces FAVOR Heart Rate Monitor and POLAR EDGE Models

Priced to increase market share by overcoming a major obstacle to purchase, POLAR USA, America's leading manufacturer and distributor of wireless heart rate monitors (HRM) for exercise enthusiasts, elite athletes, and cardio-rehab exercisers, announces the February 1992 introduction of a new industry price leader, the POLAR FAVOR HRM. Designed for health-oriented exercisers who want simplicity and ease of operation combined with the highest degree of accuracy, the water-resistant POLAR FAVOR will retail for \$119.

The POLAR FAVOR appeals to the first-time owner of a heart rate monitor whose interest centers on the continuous tracking of heart rate in exercise regimens aimed at improving aerobic and cardiovascular fitness, weight loss, or athletic performance. Along with the electrocardiogram (ECG) accuracy of all POLAR models, the POLAR FAVOR features an instant-on control (no buttons to press) and a new style for the ultra-light transmitter belt, and a sleek, flat, half-dollar



sized wristwatch-like receiver. To activate the monitor, the user brings the arm wearing the receiver to within two inches of the transmitter. In seconds, the heart rate appears on the monitor face in large, easy-to-read digital numbers.

Concurrently, POLAR is introducing the new, more advanced POLAR EDGE model, aimed at recreational athletes who require a variety of technical features. The water-resistant POLAR EDGE has an upper and lower "target zone" setting capability so that exercisers can work out

at the appropriate intensity, regardless of whether they are running, biking, swimming, or using indoor stationary equipment. A beeper signals when the user strays above or below his target zone.

The POLAR EDGE also has a training-time feedback function that displays a bar graph of the time spent above the lower heart rate limit. The unit also operates as a watch and alarm, and it has elapsed-time stopwatch capability. The POLAR EDGE retails for \$189.

The transmitters, electrodes, and batteries of both the POLAR FAVOR and POLAR EDGE are totally enclosed within the chest strap, allowing improved electrical conductivity and greater dependability. The display modules rotate for right- and left-hand users, and detach from their wrist straps. An attachable bicycle mount is available also.

All POLAR heart rate monitors are wireless, ECG-accurate, and used by leading athletes, coaches, athletic trainers, physical therapists, sports physiologists, and physicians.

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## ■ Book Review ■

Phil Callicutt, EdD, ATC

### *Getting Back On Your Feet*

Sally R. Pryor, EMT  
Chelsea Green Publishing Co.  
PO Box 130, Route 113  
Post Mills, VT 05058-0130  
1991  
207 pages, Illustrated

A few months ago I received a telephone call from Sally Pryor concerning a new text that she had just completed. The title itself piqued my interest as a book reviewer. As I began reading, I immediately realized that this was a unique and worthwhile addition to the ever-growing number of sports medicine books being published.

*Getting Back On Your Feet* is a handbook of recovery for the approximately two million Americans each year who have injuries or surgery involving knees, ankles, feet, hips, and legs. It is intended to help them: to learn to manage crutches or other mobility aids, to speed their recovery through approved exercise,

to increase their knowledge of fitness maintenance so that further injury is prevented, and to return to the performance of everyday activities quickly.

A large proportion of Americans are actively involved in sports that may result in injury. The number of high-tech joint reconstructions and replacements increases every year and accidents, as always, are producing their share of injury and surgery. More and more individuals are finding themselves having to cope quickly and successfully with temporary walking impairment and are being thrust suddenly from an active and unrestricted lifestyle, into one where the most normal taken-for-granted activity becomes immensely difficult, time consuming, and psychologically defeating. Only those who have experienced it can understand the shock of losing the freedom to move easily and to do whatever is desired.

This text is about regaining your mobility as quickly as possible, while adapting to the restrictions caused by an

injury and/or surgery. It provides essential information, word-to-the-wise recommendations, subtle tips, categorical precautions, and explicit techniques from basic to advanced. The material has been reviewed and refined by people who have been injured and learned the best methods for recovery through trial and error.

All this worthwhile and valuable information is presented in 19 clear and concise chapters, including: Positive Imaging in Dealing with Injury, Recovery, and Rehabilitation; Taking Control of Your Recovery; Recovering with Crutches; Sitting Down and Standing Up Made Easy; The Door Made Passable; and Resources. Each chapter is entirely self-contained so that the reader can refer to any section without reading in sequence.

This thorough and practical guide offers the kind of advice that athletic trainers, physical therapists, and physicians might not, but should, give to their patients.

## Certificate and Plaque Order Form for *NATA Certified Athletic Trainers*

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# ■ Authors' Guide ■

(Revised February 1992)

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

## SUBMISSION POLICIES

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

## STYLE POLICIES

7. The active voice is preferred. Use the third person for describing what happened, "T" or "we" (if more than one author) for describing what you did, and "you" or the imperative for instruction.
8. Each page must be typewritten on one side of 8 1/2 x 11 inch plain paper, double spaced, with one-inch margins. **Do not right justify pages.**
9. Manuscripts should contain the following, organized in the order listed below, with each section beginning on a separate page:
  - a. Title page
  - b. Acknowledgements
  - c. Abstract and key words (first numbered page)
  - d. Text (body of manuscript)
  - e. References
  - f. Tables - each on a separate page
  - g. Legends to illustrations
  - h. Illustrations
10. Begin numbering the pages of your manuscript with the abstract page as #1; then, consecutively number all successive pages.

11. Titles should be brief within descriptive limits (a 16-word maximum is recommended). The name of the disability treated should be included in the title if it is the relevant factor; if the technique or type of treatment used is the principle reason for the report, it should be in the title. Often both should appear.
12. The title page should include the names, titles, and affiliations of each author, and the name, address, phone number, and fax number of the author to whom correspondence is to be directed.
13. A comprehensive abstract of 75 to 200 words must accompany all manuscripts except **tips from the field**. Number this page one, type the complete title (but not the author's name(s)) on the top, skip two lines, and begin the abstract. It should be a single paragraph succinctly summarizing the major intent of the manuscript, the major points of the body, and the author's summary and/or conclusions. It is unacceptable to state in the abstract words to the effect that "the significance of the information is discussed in the article." Also, do not confuse the abstract with the introduction.
14. List three to six key words or phrases that can be used in a subject index to refer to your paper. These should be on the same page as, and following, your abstract. For **tips from the field**, the key words should follow immediately after the title on the first numbered page.
15. Begin the text of the manuscript with an introductory paragraph or two in which the purpose or hypothesis of the article is clearly developed and stated. Tell *why* the study needed to be done or the article written, and culminate with a statement of the problem (or controversy). Highlights of the most prominent works of others as related to your subject are often appropriate for the introduction, but a detailed review of the literature should be reserved for the discussion section. In the one to two paragraph review of the literature, identify and develop the magnitude and significance of the controversy, pointing out differences between others' results, conclusions, and/or opinions. The introduction is not the place for great detail; state the facts in *brief* specific statements and reference them. The detail belongs in the discussion. Also, an overview of the manuscript is part of the abstract, not the introduction.
16. The body or main part of the manuscript varies according to the type of article (examples follow); however, the body should include a discussion section in which the importance of the material presented is discussed and related to other pertinent literature. Liberal use of headings and subheadings, charts, graphs, and figures is recommended.
  - a. The body of an **experimental report** consists of a methodology section, a presentation of the results, and a discussion of the results. The methodology section should contain sufficient detail concerning the methods, procedures, and apparatus employed so that others can reproduce the results. The results should be summarized using descriptive and inferential statistics, and a few well-planned and carefully constructed illustrations.
  - b. The body of a **literature review** article should be organized into subsections in which related thoughts of others are presented, summarized, and referenced. Each subsection should have a heading and brief summary, possibly one sentence. Sections must be arranged so that they progressively focus on the problem or question posed in the introduction.
  - c. The body of a **case study** should include the following components: personal data (age, sex, race, marital status, and occupation when relevant - but not name), chief complaint, history of present complaint (including symptoms), results of physical examination (example: "Physical findings relevant to the rehabilitation program were . . ."), medical history (surgery,

laboratory results, exam, etc.), diagnosis, treatment, and clinical course (rehabilitation until and after return to competition) criteria for return to competition, and deviation from the expected (what makes this case unique). NOTE: It is mandatory that the *Journal of Athletic Training* receive, with the manuscript, a release form signed by the individual being discussed in the case study. Case studies cannot be reviewed if the release is not included.

- d. The body of a **technique article** should include both the *how* and *why* of the technique; a step-by-step explanation of how to perform the technique, supplemented by photographs or illustrations; and why the technique should be used. The discussion of *why* should review similar techniques, point out how the new technique differs, and explain the advantages and disadvantages of the technique in comparison to the other techniques.
  - e. A **tip from the field** is similar to a technique article but much shorter. The tip should be presented and its significance briefly discussed and related to other similar techniques.
17. The manuscript should not have a separate summary section - the abstract serves as a summary. It is appropriate, however, to tie the article together with a summary paragraph or list of conclusions at the end of the discussion section.
  18. Citations in the text of the manuscript take the form of a number in parentheses, which indicates the number assigned to the citation. It is placed directly after the reference or the name of the author being cited. References should be used liberally. It is unethical to present others' ideas as your own. Also, use references so that readers who desire further information on the topic can benefit from your scholarship.
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  20. Tables must be typed. Type legends to illustrations on a separate page.
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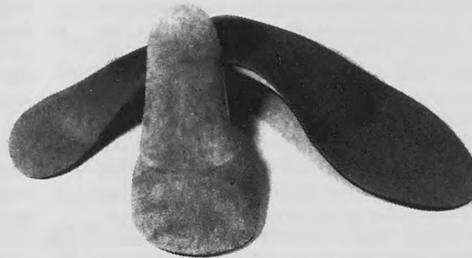
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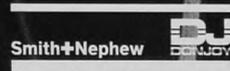


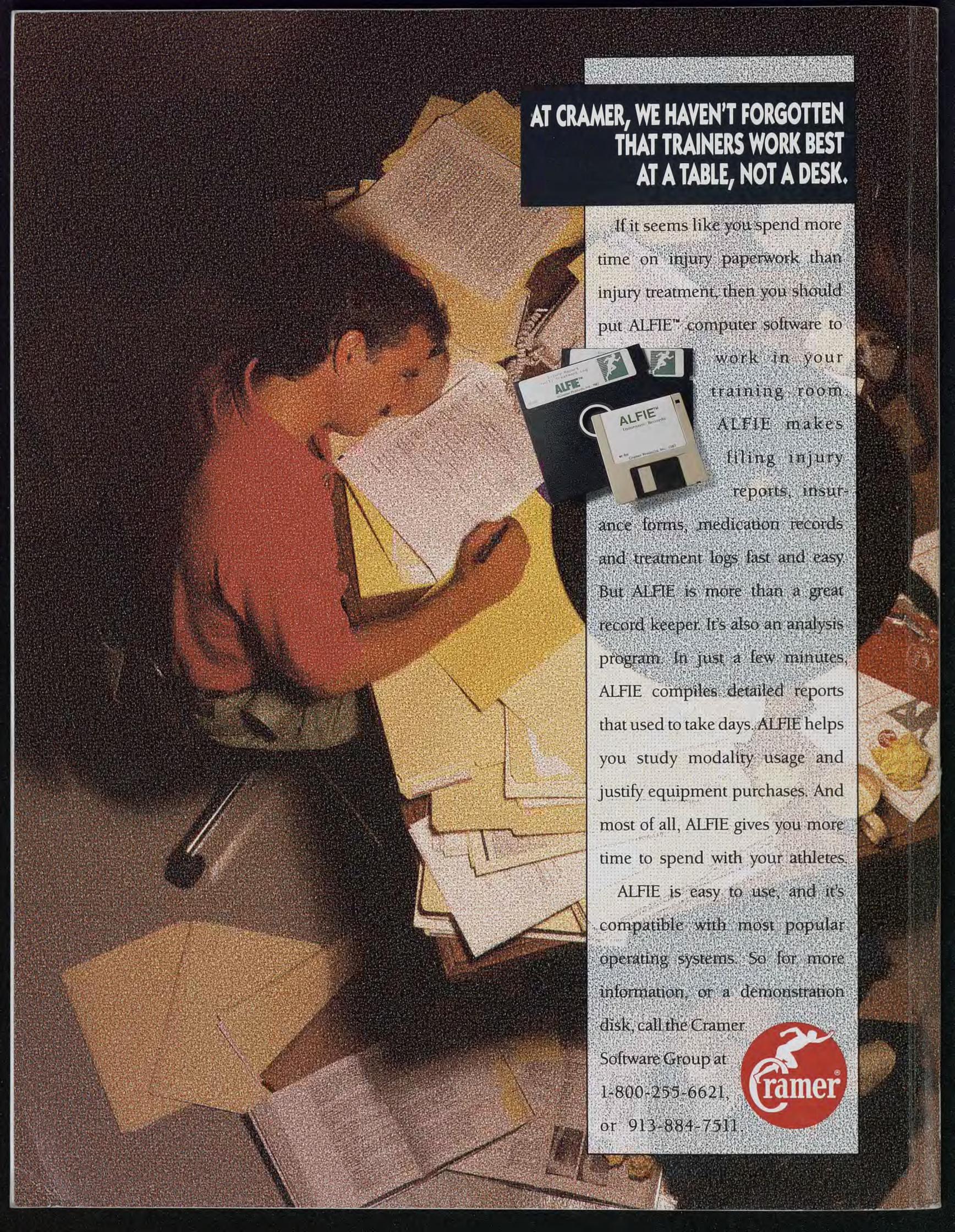
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