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Injuries to runners*

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Runners present a rather unique group of people to study. First of all, they comprise a very healthy segment of our population that most likely would not have any difficulty performing almost any other type of athletic endeavor except the one they have chosen. Second, contemporary runners are logging extremely high mileage, and this serves to magnify the deletorious effect of any basic anatomic variance that probably could be tolerated in most sporting events or activities. It is not unusual for a runner to complain only of a problem associated with distance running, whereas other activities such as tennis, squash, skiing, basketball, or hiking are tolerated well by the same individual. It is our opinion that this is the result of "accumulated impact loading" of the lower extremity encountered only in long distance running. The purpose of this paper is to describe a practical approach to treating runner's problems.

EXAMINATION

A thorough patient history is no less important here than in any other area of medicine. The examiner must be able to "speak the language" of runners. The single most important element in the history is the physician's ability to dissect the runner's training routine and to identify training errors. This is particularly important in view of the fact that about 60% of the problems are associated with a training error.

The physical examination must include a thorough assessment of the entire lower extremity from hip to toes. It should include evaluation of extremity alignment in the frontal and transverse planes, extremity length, knee function, ankle dorsiflexion with the knee extended and flexed, configuration of the weight-bearing foot, heel-leg alignment, heel-forefoot alignment, and an assessment of footwear and shoe wear. Gross abnormalities are not always present on examination nor should they be expected. Many of the anatomic factors that cause problems for runners are very subtle, and would not cause any difficulty were it not for the extreme stress that is applied to the extremity in long distance running.

Alignment variations were well exemplified by a group (Fig. 1) of individuals seen repeatedly with the complaint of knee pain associated with running. Examination revealed femoral neck anteversion, genu varum, squinting patellae, excessive Q angle, tibia varum, functional equinus, and pronated feet. Upon inquiring into their past history, it is not unusual to find that as children they wore corrective shoes and/or braces.

There are certain aspects of the lower extremity examination with which, perhaps, many physicians are not familiar but are nonetheless extremely important. These are the measurements associated with leg-heel and heel-forefoot alignments. These measurements are based upon three assumptions: (1) There is a position in which the foot will function most efficiently and with the least amount of stress being exerted on the joints, ligaments, and tendons. (2) With weight bearing, the foot should functionally be

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Fig. 1. *Teenage girl runner with anterior knee pain. Examination revealed femoral neck anteversion, genu varum, squinting patellae, increased Q angle, tibia varum, functional equinus, and mild foot pronation.*

positioned such that the vertical axis of the heel is parallel to the longitudinal axis of the distal one-third of the tibia and the plane of the metatarsal heads is perpendicular to the heel. (3) These relationships should exist with the subtalar joint in "neutral position."

Clinically, the subtalar joint is placed in a neutral position by having the patient lie prone on the examination table with the feet extending over the end.[1] The foot is grasped with the index finger and thumb by the 4th and 5th metatarsal heads and gently dorsiflexed until resistance is met. The foot is then moved through an arc of pronation and supination, and it will be noted that through this arc of motion, there is a point at which the foot seems to fall off to one side or the other more easily (Fig. 2). This "peak" is the neutral position of the subtalar joint. Another method is to place the patient supine and palpate the talar head with the other index finger and thumb as the foot is swung back and forth through its arc of motion (Fig. 3). With inversion, the talar head will be felt to bulge laterally and with eversion, to bulge medially. Position the foot such that the talar head does not seem to bulge to either side of the navicular. At this point, the talus is congruently positioned in the navicular and the subtalar joint is assumed to be in its neutral position. Even though this is not an extremely precise clinical maneuver, it does appear to be adequate for the purpose intended.

The first measurement is the *leg-heel alignment*. A mark is placed over the midline of the calcaneous at the Achilles insertion and another about 1 cm distal, again as near the midline of the calcaneous as can be estimated (Fig. 4). Two additional marks are placed over the midline of the distal one-third of the leg to represent the longitudinal axis of the tibia. The measurement is carried out by placing the subtalar joint in its

Fig. 2. *Placing the subtalar joint in neutral position with the patient lying prone.*

Fig. 3. *Placing the subtalar joint in neutral position with the patient lying supine. The talar head is palpated, noting when it is congruently positioned in relation to the navicular.*

neutral position, and then noting the alignment of the leg to the heel by the previously placed marks. Most unweighted heel-leg alignment measurements will reveal the heel to be parallel to the distal one-third of the leg or in a slight varus.

The *forefoot-heel alignment* is then estimated by noting the relationship of the plane of the forefoot at the metatarsal head level in relation to the vertical axis of the heel (Fig. 5). Normally, the plane of the forefoot at the metatarsal head level should be perpendicular to the vertical axis of the heel. If the plane is tilted such that the medial side of the foot rises above the neutral plane, the forefoot is supinated (varus) and if the medial side of the foot drops below the neutral plane, the forefoot is said to be pronated (valgus). The plane of the forefoot should be established in relation to the 2nd, 3rd, and 4th metatarsal heads rather than all five metatarsal heads. Forefoot pronation is actually not very common and must be distinguished from a plantar-flexed first ray. In this situation the 2nd, 3rd, and 4th metatarsal heads are in the neutral

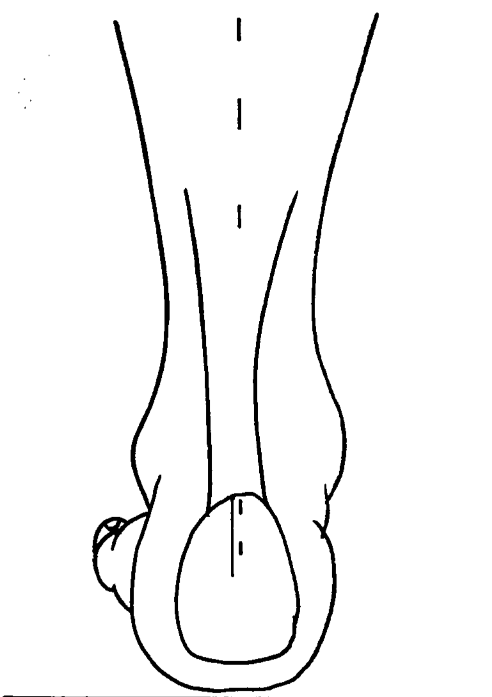

Fig. 4. *Normal leg-heel alignment. Skin marks placed over the distal leg are parallel to marks indicating the verticle axis of the heel with the foot in "neutral position."*

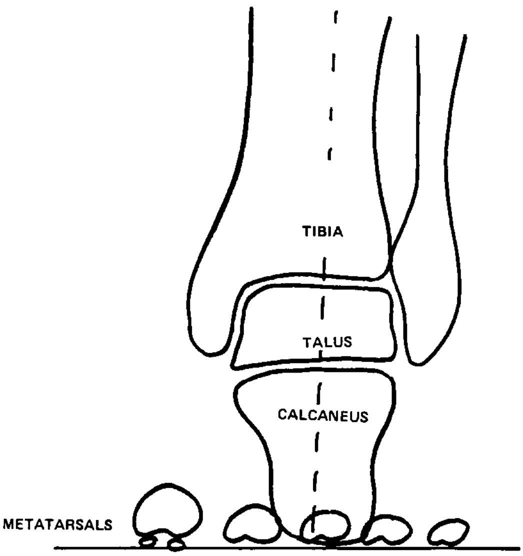

Fig. 5. *Normal heel-forefoot alignment. The plane of the metatarsal heads is perpendicular to the verticle axis of the calcaneus.*

plane in relation to the heel, but the 1st metatarsal is plantar flexed with the metatarsal head lying below the plane of the adjacent metatarsal heads. This condition is frequently associated with a cavus foot.

The weight-bearing foot is described as cavus, neutral, or pronated (planus). The term pronated is current jargon used for planus but more correctly refers to motion about the subtalar joint (eversion, abduction, and dorsiflexion). Some pronation is normal for the weight-bearing foot, but excessive pronation is a compensatory motion secondary to malalignment of the heel-foot or leg-foot alignment.

Examination of the training shoe can ve bery informative. The shoe may be deformed, reflecting adverse stresses upon the foot and may serve as a clue to the runner's problems. Anteroposterior and lateral x-rays are ordered and examined. The x-rays should be taken in the weight-bearing position.

BIOMECHANICS OF THE FOOT

The biomechanics of the foot is a very complex subject, and only certain relevant aspects of it will be discussed. As indicated in the previous section, much of the examination and assessment of foot function is in relation to motion and position of the subtalar joint. We have seen that the alignment of the leg, heel, and forefoot are evaluated based upon the assumption that the foot functions best with the subtalar joint at or near its neutral position. Two motions take place about the subtalar joint, pronation and supination. With pronation the foot is everted, abducted, and dorsiflexed and with supination it is inverted, adducted, and plantar flexed.

The total range of subtalar motion in 188 feet is shown in Table 1. These measurements were made by measuring the amount of eversion and inversion of the heel in relation to the leg with a goniometer. It is a very crude and inexact measurement, but our findings were basically in agreement with other investigators.[2]

Our studies have shown that just before foot strike, which is generally on the lateral side of the heel, the runner's foot assumes slight supination. Immediately after foot strike, there is a rapid period of pronation that continues for about 70%, with maximum pronation occurring at about 40% through the support phase which is approximately when the center of gravity passes over the weight-bearing foot. The midtarsal joint is unlocked during the period of pronation, and the foot becomes more flexible to adapt to the underlying surface. After maximum pronation, the subtalar joint gradually supinates, passing from pronation into supination at about 70% of the support phase. This stabilizes the midtarsal joint, creating a more rigid level for push-off.[3] Excessive or prolonged pronation during the support phase is associated with increased stresses being applied to the supporting structures of the foot, and it also requires additional effort by the intrinsic and extrinsic muscles.[4] Associated with pronation and supination of the subtalar joint is an obligatory tibial rotation. The tibia internally rotates with pronation and externally rotates during supination. Transverse plane rotations must occur at the knee, secondary to the obligatory tibial rotation during pronation and supination. If internal tibial rotation is increased and prolonged with excessive pronation, then more transverse rotation must be absorbed in the knee joint. The normal tibial-femoral rotation relationship at the knee is quite likely disturbed and may well account for much of the high incidence of knee problems in runners.[5]

TABLE 1
Subtalar joint motion

1. Total rom 31	*31* ± 7°	
2. Inversion 23	23 ± 6°	73%
3. Eversion 8	8 ± 4°	27%

MATERIAL

A review of 180 patients with 232 conditions was accomplished (Table 2). Sixty-five % of the injuries occurred among distance runners, 9% in sprint and middle distance runners, 24% in joggers, and 2% in hurdlers and decatheletes. Most of the injuries occurred among distance runners. The term distance runner refers not only to a competitive runner but also to a very dedicated noncompetitive runner logging high mileage on a nearly daily basis. The term jogger applies to low mileage runners seeking primarily recreational benefits and who run rather intermittently.

ETIOLOGY

The etiology of the various problems seen fell under three categories: (1) training errors, (2) anatomic factors, and (3) shoes and surfaces.

Training: Training errors were associated with 60% of the injuries, with *excessive mileage* accounting for 29% of training errors. The average weekly mileage for this group was 49 miles per week. Other significant training mistakes were: (1) *intense workouts* (primarily, interval type workouts on a hard surface track wearing a spiked shoe), (2) a *rapid change* in the training routine, and (3) running on *hills* and *hard surfaces*. The highest mileage recorded was 160 miles per week, and it is not uncommon for a competitive distance runner to average about 100 miles per week. At the present time there is a "mileage mania." Runners feel that the more mileage they log, the better they will be able to run, but unfortunately, this is not necessarily true. Granted, some individuals may benefit from high mileage but more runners encounter problems which, in essence, reduces their effec-

TABLE 2
Runners injuries

A. Number of patients—180			
B. Number of conditions—232			
C. Sex			
1. Male (152)		84%	
2. Female (28)		16%	
D. Age			
10–19		48%	81%
20–29		33%	
Range	7–54 yr		

tive training and hampers their progress. Each runner must determine the mileage that his body can tolerate and not attempt to emulate accomplished runners who thrive on high mileage. William Bowerman, former track coach at the University of Oregon and the 1972 Men's Olympic Team Coach, has coached more sub-4 min milers than any other coach in history. He has indicated that his milers generally never ran more than 70 miles per week, and does not feel that any additional mileage would have enhanced their performances. In fact, he quite strongly feels that additional mileage would have been deletorious.

The way in which mileage is accumulated is also extremely important. A good training program should allow for "hard-easy" days with the heavy mileage being accumulated on 3 or 4 days of the week with light workouts in between. The body must have time to rest and recover from intense efforts.

Anatomic Factors: Although many anatomic factors[6] must be considered as the possible etiology of the lower extremity problems in running, the configuration of the weight-bearing foot was studied particularly closely in this group of people. Fifty-eight % were found to be pronated, 20% had a cavus configuration, and 22% were neutral. Pronation of the foot seems to be a conpensatory mechanism for one or more of the following anatomic conditions: (1) tibial varum, (2) functional equinus with a tight triceps surae, (3) subtalar varus and/or, (4) forefoot supination.[1-5] Several diagnoses (Table 3) were associated with the pronated foot, but it is important to point out that no single anatomic variation correlated with any specific diagnosis in this study.

Sixteen patients had excessive pronation in 25 feet. Most of these feet had a normal subtalar joint range of motion (31° ± 7°), with two being less than normal, 19 within normal range, and only 4 greater than normal range of motion. All 25 feet demonstrated a forefoot supination. Fifty-six % had a subtalar varus. Subtalar supination or "varus," as it is more commonly referred to, indicates a ratio of subtalar range of motion with less eversion than normal, so that the heel assumes a varus position with the subtalar joint in the neutral position. Functional orthotics were used in 11 patients with excessively pronated feet, and it was found to be helpful for 8. The associated injury was resolved in 81% of these patients by the various modalities of treatment, which will be discussed later.

TABLE 3
Pronated feet (72 patients, 58%)

A.	Posterior tibial syndrome	(13) 15%
B.	Plantar fasciitis	(13) 15%
C.	Achilles tendinitis	(10) 12%
D.	Knee pain – no diagnois	(10) 12%
E.	Chondromalacia	(5) 6%

Twenty % of the total patients demonstrated a cavus foot. This involved 36 joints. The subtalar joint range of motion was reduced in 44% of the cases which would be expected, based upon previous clinical evidence. Actually more were anticipated to have a reduced range of motion but most of these subjects did not have a severe cavus foot. People with severe cavus feet usually do not tolerate distance running very well. Twelve % had increased subtalar motion and 44% normal range of motion. Sixty-six % had a subtalar varus and 50% a plantar-flexed first ray, which is quite typical for a cavus foot. Nineteen % had a supinated forefoot and 31% were considered neutral. As with the pronated feet, there was no single predominant diagnosis associated with the cavus foot. Functional orthotics were used in 10 patients, with positive results in 7 (70%). The associated problems with the cavus foot were resolved in 75% of the cases, but this group of patients proved to be the most intractible and difficult to manage. This was undoubtedly because the cavus foot is a relatively rigid, inflexible foot and not well adapted to the accumulated impact loading of distance running.

Other anatomic variances were also involved as etiologic factors, among which were femoral neck anteversion, muscle contractures (hamstring and calves), genu varus, tibial torsion, tibia varum, leg length discrepancies, etc. All must be considered in determining appropriate treatment.

CONDITIONS

Seventy-one % of the 232 conditions fell under 6 categories (Table 4). The term "posterior tibial syndrome" was used rather than "shin splints" which has come to indicate almost any type of leg pain. In this instance, the subjects had pain and tenderness typically along the posterior medial aspect of the tibia over the course of the posterior tibial muscle and tendon. Rather than refer to this with the nonspecific term shin splint, we used posterior tibial syndrome as a more specific designation. Certainly, other conditions as suggested by Slocum[7] must be considered.

Knee pain was the largest single complaint group, with 51 patients and 67 knees involved (Table 5).

Some explanation of the term "peripatellar pain" is in order. Too often anterior knee pain has been equated with chondromalacia and this is a fallacious assumption, unless there is clear-cut clinical evidence of chondromalacia characterized by retropatellar crepitation and definite facet tenderness. If not, the diagnosis of chondromalacia is somewhat doubtful and the term peripatellar pain perhaps is more appropriate. We feel that much of the discomfort about the anterior aspect of the knee in runners is associated with abnormal transverse plane rotation, rather than excessive wear on the articular surface of the patella and the pain in this case is probably caused by stress upon the soft tissues about the anterior aspect of the knee.

TREATMENT

Treatment must be individualized and several treatment modalities were utilized (Table 6).

Rest/Reduced Mileage: Total rest is undoubtedly the most unacceptable form of treatment for a serious runner. A dedicated runner will preferably give up anything other than training. Consequently, reducing mileage is a much more acceptable alternative. Our goal was to alter the training routine or in some way provide treatment that would allow the runner to continue training at a reduced level. At times, however, total rest was essential. The duration of rest depends upon the chronicity of the condition. As a rule of thumb, rest was required until the symptoms abated, but during this period of time, other modalities of treatment were utilized. Swimming is an excellent substitute to maintain cardiopulmonary conditioning during abstinence from running. Bike riding and cross-country skiing are other alternatives.

TABLE 4
Most common problems (232 total)

A.	Knee pain	67	29%
B.	Posterior tibial syndrome (shin splints)	30	13%
C.	Achilles tendinits	25	11%
D.	Plantar fasciitis	17	7%
E.	Stress fractures	14	6%
F.	Iliotibial tibial tract tendinitis	11	5%
		164	71%

TABLE 5
Knee problems (51 patients, 67 knees, 29%)

A.	Chondromalacia	17	25%
B.	Knee pain – no diagnosis	13	20%
C.	Iliotibial tract tendinitis	11	17%
D.	Peripatellar pain	10	15%
E.	Patellar tendinitis	5	7%
F.	Medial retinaculum	4	6%
G.	Miscellaneous	7	10%

TABLE 6
Treatment

A. Rest	47%
B. Orthotics	46%
C. Reduced mileage	26%
D. Shoe change/modification	19%
E. Steroid injection	17%
F. Anti-inflammatory	14%
G. Surgery	5%

A very common mistake made after a period of rest is returning to a vigorous training program only to have the injury, which has become asymptomatic, recur. A graduated schedule for returning to training should be outlined for each individual, particularly if the runner has been resting for a period of more than 3 to 4 weeks. As a rule of thumb, the runner is instructed to begin jogging 15 min a day the first week at about a $7^1/_2$ to 8 min per mile pace. Each subsequent week, 5 min are added to the daily time until an accumulated time of 40 min non-stop without discomfort is reached. This will require 6 weeks, and if, at the end of that time, an individual is progressing satisfactorily, return to a training regimen is allowed. The training program, however, must be scaled to an appropriate level for that particular individual's state of conditioning.

Stretching: Routine stretching is a significant element in the prophylaxis and treatment of injuries. There is a tendency for the hamstring and calf muscles to become very tight in distance runners. All runners should be placed on a continuous program of stretching. The impulse or ballistic type of stretching should be avoided. A slow sustained stretch very similar to those used in Yoga-type exercises should be utilized. Stretching cannot be emphasized enough.

Shoes: A different shoe and/or shoe modification was used frequently. Much long distance running is done on hard surfaces which provide little shock-absorbing capacity. Runners should be advised to run on a relatively soft surface such as a grassy area or on the soft shoulder of the road. Since this is not always possible, the next best alternative is for them to wear an adequately constructed shoe that will provide protection for the lower extremity. Unfortunately, none of the shoes currently on the market fulfill all of the essential characteristics for a good training shoe (Fig. 6). The heel counter should be very firm to control the hindfoot, and also have a well molded Achilles pad to prevent irritation. A heel that is flared and beveled provides heel stability and also allows the foot to be more easily plantar flexed immediately after heel strike. A soft cushion between the heel outsole and insole, with the heel elevated some 12 to 15 mm higher than the sole, gives additional shock absorption. A round toe with an adequately high box prevents crowding the toes. The tongue should be well padded to protect the instep from the laces. The shoe last should be straight rather than have an inflare of 6 to 8 degrees, which has been the standard for a number of years.[8] The normal foot does not have an adducted forefoot, and, therefore, there does not seem to be any logical reason for persisting with the inflare last. We have had an opportunity over the past 2 years to experiment with several straight last shoes on runners, and for the most part they have been found to be more comfortable than the standard lasted shoe.

The sole of the shoe under the forefoot should have a substantial midsole cushion, but be flexible under the metatarsal heads or have a tapered sole forward from the metatarsal heads to allow unhindered dorsiflexion of the metatarsal phalangeal joints during heel rise. The studded outsole designed by William Bowerman and called the "waffle sole" has been a significant advancement in outsole design.[9] The design is similar to the pattern on a waffle iron, and the small rubber studs provide additional cushion and traction. This type of outsole is currently being used on a number of different running shoes. Many runners have eliminated their problems simply by switching to a shoe with this type of sole or by having their shoes resoled with the waffle sole. This cannot be explained entirely by the design of the upper, since there is little difference among the various makes of shoes currently available. It appears most likely to be the result of the antitorsional tendency of the waffle sole in reducing torsional stresses transmitted from the ground to the extremity.

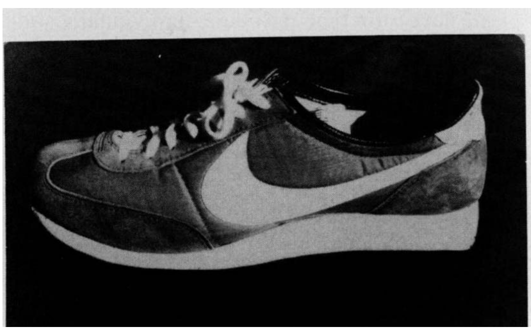

Fig. 6. *A prototype training shoe meeting the essential requirements to provide adequate foot protection.*

It is our contention that if an adequately designed shoe were available, many of the problems attendent to long distance running, short of training errors, could be prevented. Some individuals, however, would still require specific alterations.

Shoe modification[10] has proven quite gratifying. Broadening the flare on the heel for better heel stability was effective in treating Achilles tendinitis in many instances. Other modifications consisted of changing the contour of the heel to fit an individual's specific heel configuration, stiffening the heel counter, altering the height of the heel, and changing the midsole cushion under the forefoot and the heel. These alterations can usually be accomplished quite inexpensively at a shoe repair shop or by an orthotist.

Runners should be instructed to diligently maintain their shoes in good repair. A very common tendency is to allow the outer edge of the heel to wear down, creating an imbalance across the heel at foot strike. This can easily be corrected by replacing the heel periodically. Prophylactically, wear may be delayed by applying "shoe goo" to the outer edge of the heel which prolongs the life of the heel. Once a shoe becomes badly worn it should be replaced.

Orthotic Appliances: An orthotic appliance[1, 11] can be thought of as a type of "shim" placed between the foot and shoe to position the foot near its neutral position so it can function more efficiently. In this series, 83 pairs of orthotic appliances were prescribed, 39 rigid and 44 flexible, with 78% beneficial results. The softer, flexible type (Fig. 7) can be fabricated in the office as a temporary measure, or may be made of flexible material molded to a positive cast of the patient's foot by an orthotist. The longevity of the soft orthotic is quite limited, and control of the foot is less precise. Rigid orthotics made of plastic (Fig. 8) are more expensive, but much more durable and appear to give better foot control. The rigid orthotic is well tolerated by distance runners, while the flexible or softer orthotic are more applicable for shorter distances and competition. Orthotics are quite effective, particularly for compensatory foot pronation and those conditions associated with it. A rigid orthotic is custom fabricated for each individual from a cast of the foot taken with the subtalar joint placed in neutral position. Many runners only need an orthotic during the acute phase of their condition, and as soon as it is resolved, they can discontinue wearing the device. Others, however, find it more comfortable to continue running with an orthotic appliance and will be better served by a rigid orthotic that is more durable.

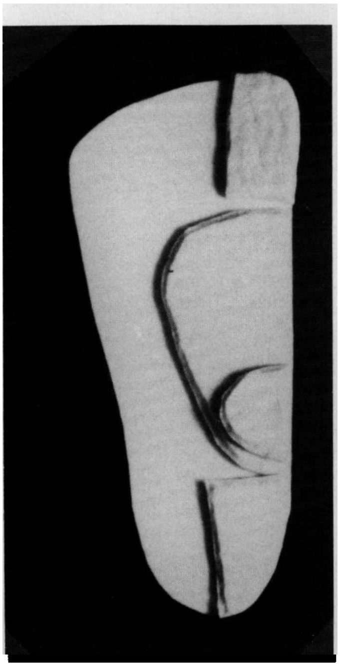

Fig. 7. *A soft orthotic fabricated in the office. Adhesive-backed $^{1}/_{4}$ inch felt pads are cut and placed on an insole material. This is a typical soft orthotic for excessive pronation.*

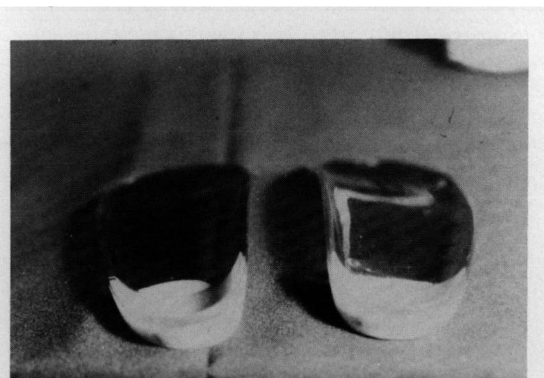

Fig. 8. *Rigid orthotics with a heel post.*

Common conditions associated with a pronated foot are tibia varum, subtalar joint varus, forefoot supination, and a functional equinus.[1] All of these conditions are *compensated* for by pronating the foot. The purpose of the orthotic is to *prevent or reduce compensatory* pronation which places additional stresses on the various foot structures. Tibia varum requires excessive pronation to place the foot in a plantigrade position on the surface. This can be corrected by an orthotic with a medial heel and forefoot "post" or wedge. Subtalar varus is neutralized by an orthotic with a medial heel post (Fig. 9), and

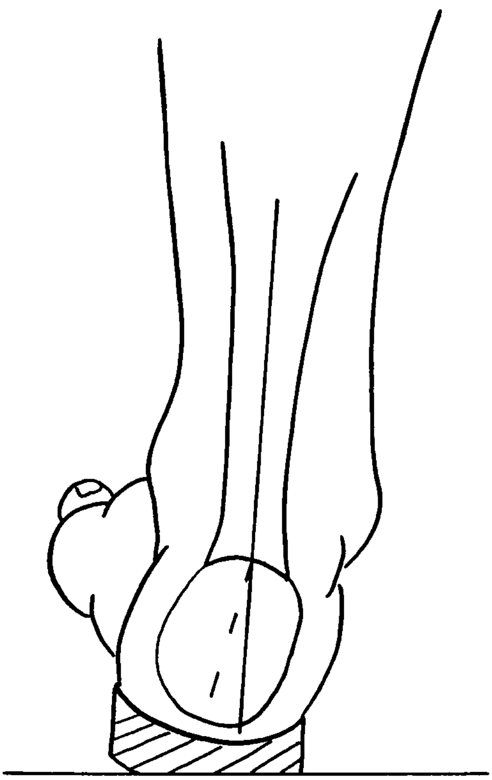

Fig. 9. *An orthotic with a medial heel post for subtalar varus.*

forefoot supination by an orthotic with a medial forefoot post (Fig. 10). Functional equinus requires subtalar pronation to compensate for the lack of ankle dorsiflexion. This condition, of course, would respond best to stretching the gastrosoleus group so that pronation is no longer required as a compensatory maneuver, but in the event that it cannot be corrected in this fashion, an orthotic with a medial heel and forefoot post will be helpful. However, pronation cannot be completely corrected without becoming extremely uncomfortable for the patient. This orthotic, therefore, must only partially correct the pronation. As a rule, slight undercorrection with an orthotic is better tolerated in runners than complete correction while overcorrection is usually intolerable. The cavus foot does not lend itself as readily to orthotic correction. It is usually associated with a high, rigid arch and a plantar-flexed first ray. This is compensated for by subtalar joint supination. Excess pressure is applied under the head of the 1st and 5th metatarsals, and the heel assumes a position of varus. Compensation can be reduced with this type of deformity by placing a lateral forefoot post on the orthotic (Fig. 11), and in some instances combining it with a medial heel post for subtalar varus. A soft or more flexible orthotic is better tolerated with a cavus foot.

Orthotics are not a panacea but have added a new horizon to our treatment armamentarium for the overuse syndrome. A good result is predicated upon correct analysis of leg-heel-forefoot alignment, proper casting technique,

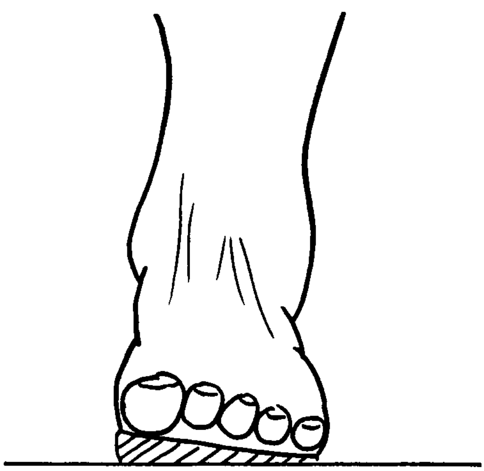

Fig. 10. *An orthotic with a medial forefoot post for forefoot supination (varus).*

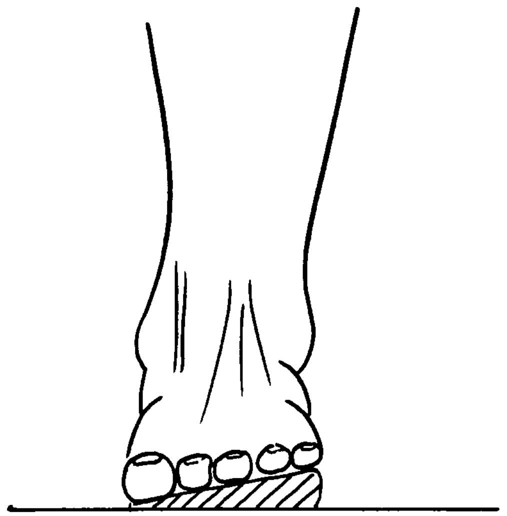

Fig. 11. *An orthotic with a lateral forefoot post for forefoot pronation (valgus or plantar-flexed first ray).*

and precise fabrication. There are a few podiatry laboratories specializing in orthotic appliances for athletics. It is no more logical to assume all orthotists or podiatry laboratories will make a satisfactory orthotic appliance for the athlete than it is to assume that all physicians treat athletic injuries equally well.

Steroids: Steroid injections should be used relatively sparingly. Intratendinous injections are to be avoided. Most steroid injections used for this group of patients were about the small joints of the foot, for iliotibial tract tendinitis at the knee, and occasionally for Achilles tendon tenosynovitis, where a peritendinous infiltration about the tandon was accomplished. Anti-inflammatory drugs such as phenylbutazone (Butazolidin), oxyphenbutazone (Tandearil), and aspirin were also used with varying degrees of success.

Surgery: There were 14 surgeries in 10 patients. Five Achilles tendon surgeries were done in two patients. One patient had bilateral Achilles tendon surgery for degeneration with fascial reconstruction. Another had three surgeries with a bilateral tenolysis of the Achilles tendon and an ostectomy of the calcaneus at the tendon insertion site. Both discontinued active competition but have continued as serious, recreational runners. A lateral retinacular release for anterior knee pain was performed six times in four patients, and three returned to light running. Patellar shaving for chondromalacia was done bilaterally in two patients and neither of them returned to running. An acute rupture of the patellar tendon was repaired in one patient who had a long history of anterior knee pain diagnosed as a patellar tendon tendinitis at the distal pole of the patella. Postoperatively, his knee became essentially asymptomatic and he returned to a very high level of competition.

CONCLUSIONS

(1) The vast majority of injuries among long distance runners are the results of improper training. (2) No specific anatomic factor correlates with any specific injury. (3) A wide variety of overuse syndromes or injuries may respond to one specific modality of treatment. (4) Most problems in distance runners can be resolved with adequate rest but may recur with resumption of running if the etiology has not been determined. (5) It is more acceptable to reduce mileage than to completely stop a runner from training, it it is at all feasible. (6) Present methods of applying foot and leg mechanics from a practical standpoint are inexact but nonetheless are often effective in diagnosis and treatment.

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EDITORIAL COMMENT

Dr. William G. Clancy, Jr: Dr. James is to be congratulated for this presentation. He has not "statisticed" us to death. He has not discussed rare or unusual problems that one may never see. He has educated us. He has presented material that all of us can sink our teeth into and use.

Most orthopaedists, even those interested in sports, hate to see a runner or jogger enter their office. Why? Because their injuries appear difficult to diagnose and even more difficult to treat. Often they find it difficult to communicate with the runner.

Runners are addicted. It is part of their life. The physician must remember this. If he appears indecisive, he will lose the runner's confidence, and even the correct treatment program will go unheeded.

Runners' injuries are subtle. If the physician does not dig into the training program, he may cure the injury only to have the athlete return again. I agree wholeheartedly with Dr. James' philosophy on mileage for distance training. At the high school level, I would consider 50 to 60 miles for a 7-day program as reasonable and for the collegiate athlete, 70 to 80 miles reasonable. Those who consistently average over 100 miles a week become an orthopaedist's nightmare.

Although we may control the quantity of running, one must also control the quality. I am a firm believer of Bill Bowerman and Bill Dillinger's "Oregon System" of alternate days of hard-easy workouts. I know of no data which show that the musculoskeletal structure fully recovers with 24 hr. Muscle biopsy studies tend to substantiate this philosophy.

Variation of normal anatomy is perhaps the most important factor in these overuse injuries. The physician, like the referee, will be "out of position" if he limits his examination to only the injured area. These variations may be subtle but a thorough examination will reveal them. Any variations of hip, knee, and foot alignment must be reflected in the weight-bearing foot.

Dr. James has presented an easy, and clinically objective method of examining the foot. I believe that he is on sound biomechanical footing in his approach with orthotic corrections for the various lower extremity malalignments. An example of this is a national caliber cross-country skier who for 3 years had chondromalacia during his summer distance running program. However, as soon as he started cross-country skiing his symptoms abated.

He had marked femoral anteversion and foot pronation. He was fitted with an orthotic. He resumed his running program without difficulty. It may be that the cross-country ski was stabilizing his foot and was acting like an orthotic, decreasing the stress on the knee.

Although there are no significant studies on the biomechanics of the running gait and orthotic correction is essentially empirical, clinical results have been extremely rewarding as indicated in this study. In a similar population of runners, we have had essentially the same results using orthotics as Dr. James.

In summary, Dr. James has provided us with a simple and effective way to exam the runner for foot and malalignment problems, has given us a rational way to compensate for malalignment problems utilizing orthotics, and has provided a reasonable rehabilitation running program.