HEEL PAIN IN THE RUNNING ATHLETE

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Introduction

Millions of Americans are running or are involved in some form of athletic activity and will suffer from some form of injury. Aside from the knee joint, the heel and its associated tendons and ligamentous attachments is the most frequent site for injuries to occur. The athlete stresses the body and specifically the foot and heel tissues to a far greater extent than more sedentary individuals. To appropriately assess and treat conditions of the heel in athletes, the podiatrist must possess a thorough knowledge of the function and anatomy of the heel and related structures. He must be able to translate that knowledge to the foot function involved in the activity such as running, baseball, football, ballet, or aerobics. The gait cycle and functional foot demands will vary markedly from sport to sport and activity to activity. The stress or demand must be understood in order to logically assess and treat conditions and complaints about the heel in athletes.

In the paragraphs that follow we will concentrate on the athlete and heel problems. Anatomy, function, and biomechanics of the athlete and in particular the runner will be reviewed. Gait cycles and tips on evaluation are included. Points of interest concerning history taking of sports related activity are reviewed. Recent advances in sports related research are included to highlight diagnosis and treatment approaches. An anatomical approach to the differential diagnosis of conditions of the heel is presented.

Biomechanics

Running is basically a series of coordinated hops from one foot to the other as a cycle of air-borne and support phases takes place. During running the foot contacts the ground 800-2000 times per mile at a force 2-4 times bodyweight (1). A range of possible strike patterns to absorb this force at the moment of foot to ground contact are possible. The foot strike of a runner varies depending on individual running style and class of runner. The heel is not necessarily the point of initial ground contact. Actual foot strike can occur by any of three means:

1. forefoot strike,
2. midfoot strike, and
3. heel strike.

Forefoot strike type ground contact during running is best exemplified by a sprinting runner for maximal short distance speed. Approximately 5-7% of all runners are forefoot strikers. They tend to stress heel tissues not by ground contact but by placing excessive stretch and stress on the Achilles tendon and plantar fascia as the ball of the foot accepts ground contact at impact. Likewise midfoot strikers fail to assume body weight through the heel pad exclusively. Ground force is assumed through the midfoot region as the entire foot contacts the ground from heel through forefoot. This best distributes the ground contact forces and minimizes their effects on any particular area of the foot.

Approximately 15-20% of runners are midfoot strikers. Heel strikers comprise the majority of runners nearly 75-80% (D. Milch — personal communication). The ground contact forces are assumed through the soft tissues and osseous structures of the heel and transferred proximally into the leg and distally into the forefoot. This type of running gait has many similarities and dissimilaritis to walking-type gait. The walking and running gait cycles are unique and yet related events.

The majority of runners utilize a heel contact much the same as a walking type gait cycle. The forces placed on the heel are much greater in running than walking. The practitioner should observe the activity or running of a particular patient to note the patient's running style. Once heel contact has occurred, motion at the subtalar joint aids in shock absorption much as in walking gait. The amount of compensatory subtalar motion, however, differs significantly from a running to walking type gait. Much more motion of pronation and supination occurs during running than walking. The base of gait or distance between malleoli at each step during the gait cycle is a major reason for this increased subtalar motion in the running type of gait.

Normally the base of gait is 2-3 inches in a walking type gait. This is narrowed to 0 inches or even a negative value during running. The negative value denotes a running style where the foot is placed on the opposite side of a central line of progression in a scissors type pattern. Careful frontal plane evaluation of running is needed to evaluate this occurrence. A side to side lurch may be observed in pathologically severe negative base of gait striding patterns. The zero or mildly negative base of gait of the average runner places the heel strike at a greater degree of varus than does a normal walking gait cycle.

This increased degree of varus demands a greater amount of subtalar joint pronation to achieve full forefoot loading during running. The increased varus heel attitude can also result in lateral ankle and tarsal stress and symptoms. The increased pronation can unlock the midfoot and lead to symptoms and complaints in the midtarsal joint and forefoot as well for the runner that would not be experienced during walking. Abnormal biomechanical conditions intrinsic to the foot and leg can exaggerate these phenomena. Environmental factors such as road surface cambor and shoe wedging and wear can also affect tarsal motion, function, and stress.

The late midstance to toe-off phase of running is quite similar to that of a walking type gait cycle. The major difference is the short duration of this event during running and its increased incidence or occurrence per minute.

The swing phase of running differs from that of walking in that an air-borne period exists. This represents a time when both feet are off the ground simultaneously in swing phase. The importance of the air-borne phase of running gait is that it markedly exaggerates the amount of force transmitted into the foot at ground contact. More force is applied through the foot at ground contact during running because of the air-borne period than during walking which conversely has a period of double foot contact.

Etiology

The etiology of painful heel complaints and running injuries is most often multifactorial. Training errors such as over zealous work-outs, using improper running surfaces, and choosing inadequate shoe gear combined with faulty biomechanics produce the majority of clinical symptomatology present in the athlete. Most frequently, injuries to runners occur when a training program begins or when progressing from one level to another. Beginners will many times run too much, too soon, and on inappropriate surfaces with inadequate shoe gear. The more experienced athlete can suffer injuries from increasing mileage too rapidly and overloading the musculoskeletal system. Probably the most common error, regardless of class, is an inadequate warm-up period.

Training on a proper running surface is extremely important. Various studies have attempted to quantify the shock sustained and transmitted at heel strike on different surfaces. A recent study compared asphalt, concrete, and grass in terms of shock absorption ability. Data was collected from seventeen male subjects who wore similar shoe gear and ran at near equal speeds. Shock was measured at the foot by using a Kistler Force Platform, while transmission to the heel was determined from an accelerometer mounted on a plexiglas bit bar. Results of the study were unexpected. The peak of the vertical force on concrete was found to be slightly lower than on the other two surfaces. The contact time was also increased on the concrete compared to grass and asphalt. The result was a vertical impulse being very similar in all three surfaces with no appreciable difference (2).

The contour of the running surface can play a substantial role in injuries to athletes. A grass surface is irregular and can subject the foot and ankle to unstable positions. These positions may result in twisting and turning type injuries. A sloped or banked surface will force the foot on the high side to pronate excessively and subsequently increase the stress absorbed by the soft tissues on the medial aspect of the foot and leg. Uphill running demands an increase in dorsiflexory motion and subsequently places additional strain on the Achilles tendon. Running downhill increases the impact at heel strike and puts strain on the anterior decelerating muscles. To best minimize the demands of running, the ideal training surface would be a flat, smooth path with moderate shock absorbing ability.

Many factors must then be considered when evaluating a runner with heel pain. Extrinsic factors such as shoe gear and running surface and contour should be noted. Intrinsic factors such as running style and biomechanics need to be thoroughly analyzed. Other factors such as distance, warm-up, experience and mileage levels should all be considered. All athletes vary in their ability to progress and improve. Individuality needs to be emphasized to the runner. Treatment approaches and recommendations must consider all these points.

Clinical Presentations

A variety of symptomatology and disorders in the athlete will be discussed. As a logical approach, disorders of the more superficial layers such as the skin will be covered initially continuing anatomically to the deeper soft tissue and osseous structures (Table 1).

Table 1: Anatomic Differential Diagnosis of Heel Pain

A. Skin
   1. Friction blisters
   2. Haglund's deformity
   3. Black heel

B. Tendons and Associated Structures
   1. Tendinitis
   2. Tendon rupture
   3. Synovitis or sheath disorders
   4. Retinacular weakness

C. Ligaments, Bursae, and Fascia
   1. Retrocalcaneal bursitis
   2. Plantar fasciitis
   3. Tarsal and ankle ligaments

D. Peripheral Nerves
   1. Sural nerve
   2. Posterior tibial nerve
      Medial calcaneal branch

E. Bone-Calcaneus
   1. Stress fracture
   2. Sever's disease
   3. Coincidental bony pathology

Skin

Friction blisters: The posterior aspect of the heel about the top of the shoe counter is a frequent area of friction blister formation. A friction blister is defined as an intradermal fluid collection secondary to irritation or rubbing. The presence of moisture is required to cause blistering. Extremes of dryness and wetness tend to decrease friction. Medium degrees of moisture at the rubbing surface tends to increase skin friction and promote blister formation. These blisters are most commonly noted on areas where the skin is thicker and tightly adhered to the underlying structures. The posterior aspect of the heel is one such area.

Haglund's deformity: This is a painful inflamed nodular swelling located at the posterolateral aspect of the calcaneus. The lesion can develop when a poorly supportive and padded shoe counter irritates the skin of the heel during activity. In more chronic cases, a painful symptomatic adventitious bursa may form over the area. A true Haglund's deformity with osseous enlargement may or may not be present. The stress of running and poor shoe counter or fit can mimic Haglund's deformity. This should not mislead the athlete or practitioner to consider osseous resection when shoe change or refitting may be all that is required.

Black heel: These lesions, also called calcaneal petechiae, are located plantarly at the posterior and posterolateral aspect of the heel. These grouped punctate hemorrhages are caused by a shearing or pinching stress resulting from abrupt contact of the foot hitting the ground. The black color associated with black heel is secondary to the pigment derived from the blood. This problem is seen almost exclusively in active young adults or adolescents engaged in sports, particularly in basketball and football. Important in the differential diagnosis here is verucca and the preulcerative changes noted in diabetic callous formation.

Tendons and Associated Structures

Ligamentous and tendon injuries occurring about the heel and ankle in the running athlete have been given separate consideration in other chapters of this text. When considering the differential diagnosis of heel pain, these structures must not be forgotten. Tendinitis and other afflictions to the Achilles tendon are some of the most common causes of heel pain in runners. Insult to the flexor digitorum longus, flexor hallucis longus, and tibialis posterior as well as the plantaris tendon can be a cause of medial and posterior medial heel pain and should not be overlooked during examination.

Ligaments, Bursae, and Fascial Structures

Retrocalcaneal bursitis: This bursa is located between the Achilles tendon and the posterior aspect of the calcaneus. It is a normal anatomic bursa that can become inflamed when the external force of a running shoe irritates the posterior aspect of the calcaneus. When present it must be differentiated from an Achilles tendinitis or os trigonom syndrome. Bursal tenderness can best be elicited by palpating anterior to the Achilles tendon proximal to its attachment to the calcaneus.

Plantar fascia: The most common cause of plantar heel pain in athletes is plantar fasciitis. The exact anatomic origin of the pain in this disorder is controversial and will not be discussed at this time. The term heel-spur syndrome has been used to describe this inflammatory reaction located at the insertion of the plantar aponeurosis into the tuberosity of the calcaneus. This terminology can be misleading. Pain in both presence and absence of a heel spur has been observed. Heel spurs can be noted clinically in asymptomatic patients as well.

The plantar fascia is a powerful contributor in stabilizing the foot as it passes from heel rise to toe off. This occurs as the fascia supinates the rearfoot and resists the pull of the Achilles tendon. During daily activities the foot may have difficulty in tolerating these forces. However, when excessive amounts of pronation occur, the fascia is subject to an abnormal amount of tension. This can be seen in the runner leading to fatigue and overuse symptomatology.

The pain associated with plantar fascial strain is characteristic. It is most severe upon arising from a resting position or upon first arising in the morning. The pain is rarely disabling and after several minutes of ambulation will usually decrease or resolve entirely. Upon palpation, pain is best elicited at the area of the medial tuberosity of the calcaneus. Pain may be noted distally along the fascia into the medial arch area plantarly. Dorsiflexion of the digits may recreate symptoms. There may be a mild to moderate increase in erythema and induration present in the area.

Several conditions should be considered in the differential diagnosis of plantar heel pain. Osseous differentials include calcaneal stress fractures and traction apophysitis. Other possibilities include Reiter's syndrome, gout, neoplasm, and osteomylitis which may occur coincidentally in runners, but have no direct relationship to their activity.

Peripheral Nerve

The sural and posterior tibial nerves or their branches may occasionally be the source of heel pain in athletes. A sural neuritis is a rare recalcitrant cause of lateral heel pain. It is most often caused by compression of the nerve by excessively tight shoe gear. This condition must be differentiated from peroneal tendinitis or chronic peroneal subluxation syndromes.

Medially, the posterior tibial nerve may become entrapped within the tarsal canal producing a tarsal tunnel syndrome. In the running athlete, entrapment occurring secondary to hyperpronatory conditions with adjacent tendonitis is an occasional source of medial heel pain. If the medial calcaneal branch of the tibial nerve is involved the pain may occur along the medial aspect of the sole of the heel.

Bone-Calcaneus

Calcaneal stress fracture: The calcaneus is one of the more common sites for stress fractures to occur in athletes. The pain associated with these fractures is usually severe and is exaggerated as long as weightbearing and ambulation continue. This is in direct contrast to heel-spur syndrome. Usually heel pain and plantar fasciitis is not severe and decreases with continued ambulation. The pain in stress fractures is easily elicited upon medial and lateral compression of the plantar aspect of the calcaneus. Depending on the severity of the injury, there may be an accompanying increase in soft tissue edema and erythema surrounding the fracture.

Sever's disease: A traction apophysitis of the calcaneus is a frequent cause of posterior heel pain in the younger athlete. Due to the vertically oriented position of the apophysis, it is subject to strong shearing stress by the pull of the triceps surae tendon and plantar fascia. Symptoms are aggravated by running and jumping activities. Pain can be elicited upon direct palpation of the posterior body of the calcaneus as well as with forced plantar flexion stress of the ankle. There is usually an increase in edema and erythema surrounding the Achilles tendon and posterior calcaneus. Symptoms can vary from disabling to nuisance.

Summary

Sports medicine is a challenging field of clinical practice. Application of basic knowledge and skills for the treatment of nonathletes translates poorly to athletes. An understanding of the demands of the particular athletic activity coupled with basic anatomical and functional concerns is needed by the practitioner. The heel is a highly specialized area of the foot. The runner and his heel must be carefully analyzed and understood to effect appropriate diagnosis and treatment.

References

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