CHAPTER 12

EVALUATION OF THE POSTERIOR HEEL: Clinical And Radiographic Anatomy

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Pain in the posterior aspect of the heel can occur with a variety of conditions secondary to a multitude of etiologies. The classic Haglund's deformity is the most common diagnosis for pain in the region of the Achilles tendon insertion, but further investigation has revealed a combination of etiologies for symptoms presenting in this region. The posterior heel is specialized in many respects, and includes specific skin, soft tissue and osseous variables that must be evaluated individually. This paper will discuss the historical perspective regarding this symptom complex, and provide the basis for clinical and radiographic evaluation for the differential diagnosis of posterior heel pathology.

HISTORICAL REVIEW

Retrocalcaneal bursitis has been renamed by many authors since being introduced into the literature by Albert and White in the early 1890s as an irritation and possible infection of metastatic origin in the region.[1,2] Haglund, in 1928, described the inflammation of the retrocalcaneal bursa and related it to a combination of stiff shoes and the osseous prominence at the posterosuperolateral aspect of the calcaneus, which was treated with bursal excision and resection of the prominent region.[3] Surgical correction and treatment was largely based on resection of the symptomatic region until Fowler and Phillip, in 1958, provided measurements of the calcaneal dimensions with a description of the constant retrocalcaneal bursa and the anatomic considerations of the Achilles tendon insertion in relation to the posterior superior aspect of the calcaneus.[4] Ruch combined the cadaveric measurements of Fowler and Phillip with an understanding of foot biomechanics relating the three foot types predisposed to retrocalcaneal pain, which include rearfoot varus, compensated forefoot valgus, and plantarflexed first ray.[5]

An expanded knowledge of foot pathomechanics and further study of the various presentations began to broaden the possible deformities presenting with posterior heel pain. Fiamengo discussed the retrocalcaneal step or exostosis with an increased incidence of painful calcifications of the Achilles tendon, which Black and Kanat expanded with an understanding of dystrophic calcifications.[6,7] Other authors discussed peritendinitis and the potential rheumatologic conditions resulting in inflammatory changes to the Achilles tendon insertion and the posterior calcaneus. The continued evaluation of pain at the posterior heel has provided and expanded the list of differential diagnosis for retrocalcaneal pain, and allowed a more complete understanding of the anatomic and biomechanical considerations of this entity.

ANATOMY OF THE POSTERIOR HEEL

Skin and Subcutaneous Tissues

Access to the posterior heel is affected by the soft tissue structures covering the calcaneus and Achilles tendon. The relaxed skin tension lines course transversely with hyperkeratotic tissue often appreciated overlying an eminence. As the plantar and posterior skin junction, the fascial strands securing the infracalcaneal fat pad to the deep fascia become more pronounced, decreasing the mobility of the overlying skin and subcutaneous tissue. The subcutaneous tissue is composed of a thin layer of normal areolar adipose tissue proximally with denser interdigitations of fibro-fatty tissue as the junction of the infracalcaneal fat pad occurs. The lesser saphenous vein and its tributaries are contained in this layer as they course with the sural nerve along the Achilles tendon laterally and inferiorly to a more midline relationship at the middle third of the leg. The sensory supply to the posterior heel is provided superiorly by the sural, and distally by the lateral calcaneal nerves branching from the sural nerve and the medial calcaneal nerves, branching from the tibial nerve prior to its bifurcation into the lateral and medial plantar nerves.

Vascular supply to the posterior aspect of the heel comes from various sources, and has been thoroughly evaluated in regard to the supply to the Achilles tendon. The vascular supply to the posterior calcaneus comes from an arterial network composed of the calcaneal anastomotic cascade from the posterior tibial artery, peroneal artery, lateral and medial calcaneal arteries and branches from the lateral and medial plantar arteries. These vessels are developed in early childhood, and supply the calcaneal apophysis and provide vascularity to the insertion of the Achilles tendon, plantaris and peritendinous structures.

The supply to the superior aspect of the Achilles tendon comes from the muscular branches to soleus and gastrocnemius and the surrounding peritendinous structures. A tenuous anastomosis of proximal and distal branches occurs in the "watershed" region 2 cm to 6 cm proximal to the insertion, resulting in an area of poor vascularity as described by Lagergren and Lindholm.[8] The vascularity of this region has been implicated in its weakening in both chronic and acute conditions, but was shown to be normal in cases of chronic Achilles tendinopathy by Astrom et al.[9] Their study did show a decrease in vascularity related to age, which is consistent with the literature in regard to increasing tendon pathology with increasing maturity. The vascularity of the posterior heel requires treating physicians to incorporate efforts to increase blood flow to this region, and is essential for a complete understanding of pathology of the posterior heel and leg.

Fascia

The fascial elements of the posterior heel form an additional stabilizer of the heel and assist the Achilles tendon in resisting dorsiflexion at the ankle joint. The superficial aponeurosis envelops the triceps surae and inserts into deep fascia specializations, the flexor and peroneal retinaculum, at the medial and lateral aspects of the leg and ankle. These are intricately attached to the calcaneus, as are the medial and lateral expansion of the Achilles tendon insertion, and provide resistance to dorsiflexion even in the absence of an intact Achilles tendon. The deeper aponeurotic fascia serves as a partial origin for the triceps surae, and encompasses the deep flexor musculature as well as the neurovascular structures contained within the flexor retinaculum. The two layers are separated by adipose tissue contained within Kager's triangle, which is bordered anteriorly by the deep fascia and by the deeper layer of the superficial aponeurosis at the posterior, medial and lateral borders. The fascia provides an essential strut which can become involved with inflammatory changes at its specialized insertion, resulting in pain in the region.

Myotendinous Complex

The triceps surae complex includes the muscles and tendon of the gastrocnemius, soleus and plantaris which provide a plantarflexory moment at the ankle and subtalar joint, as well as knee flexion due to the origin of the gastrocnemius from the femur. The Achilles tendon, formed from the gastrocnemius and soleus, courses distally, surrounded by paratenon to insert into the middle third of the posterior calcaneus, with expansions coursing anteriorly along the medial and lateral calcaneal borders. As the tendon courses distally, the fibers externally rotate with various patterns of rotation within the fibers, as described by Cummins.[10] Variable insertion patterns of the plantaris tendon have also been described at the anteromedial border of the Achilles tendon. The variable rotation of the fibers of the Achilles tendon can have an effect when dealing with the fulcrum of pull of the tendon over the prominence of the calcaneus. The lack of a true synovial sheath surrounding the Achilles tendon results in inflammatory changes localized to the vascular paratenon or the tendon itself, which may present with an acute or chronically painful posterior heel and leg.

The Achilles tendon withstands severe forces in gait, up to 900 kg of force with fast running. Changes in terrain, mechanics and shoes increase forces, potentially resulting in pathologic changes within the tendon. The posterior fibers of the Achilles tendon sustain more force due to an increased lever arm, which results in more dystrophy to these fibers. Pathologic forces result in inflammation and subsequent degeneration of the tendon with deposition of calcifications at the superficial fibers of the insertion. Intratendinous calcifications and tendon degeneration with inflammation can create pain in the insertional region of the calcaneus, as well as increase the rigidity of the tendon as it courses over the superior lateral aspect of the calcaneus, further inflaming the retrocalcaneal bursa.

Two bursa are intimately associated with the Achilles tendon which may provide a source of irritation and inflammation. The more constant of the two is the retrocalcaneal bursa, providing a smooth surface to the superior third of the posterior calcaneus as the Achilles tendon courses posterior to it until its insertion onto the middle third of the posterior surface (Fig. 1). This region has the potential to become inflamed secondary to irritation from the posterosuperior calcaneus on the Achilles tendon. A retro-Achilles bursa is present in approximately 50% of patients as an adventitious bursa, which is often formed and secondarily inflamed due to shoe irritation. The irritating forces effecting these bursa can only be evaluated when an understanding of the adjacent anatomic structures is appreciated.

Osseous Structures

The posterior aspect of the calcaneus has three major anatomic regions all with specific functions and potential sites of deformity. The inferior third is continuous with the plantar aspect of the calcaneus, and has the fibers of the plantar aponeurosis and continuing fibers from the Achilles tendon attached to it. This region and the entire circumference of the posterior heel has been involved with rheumatologic conditions and is susceptible to traumatically-induced symptoms.

The central third of the posterior calcaneus is trapezoidal in shape, and contains the insertion site of the Achilles tendon with multiple ridges and grooves noted. A ridge separates the inferior and middle thirds, as a retrocalcaneal exostosis or calcification is often present as a source of pain in this region. The most superficial fibers of the Achilles tendon insert in this region, allowing resection of the exostosis while leaving the majority of the tendon intact. The insertion extends anteriorly along the medial and lateral borders anastomosing with the deep fascia, as previously discussed.

The superior third of the posterior surface is a smooth triangularly-shaped facet with the apex superiorly and contouring anteriorly toward the superior surface of the calcaneus. The previously-mentioned retrocalcaneal bursa is present at this surface to prevent tendon damage against the bone. This aspect of the posterior surface is commonly the source of pain with Haglund's deformity, as the posterosuperior aspect of the calcaneus or bursal projection is impinged by the Achilles tendon with dorsiflexion.

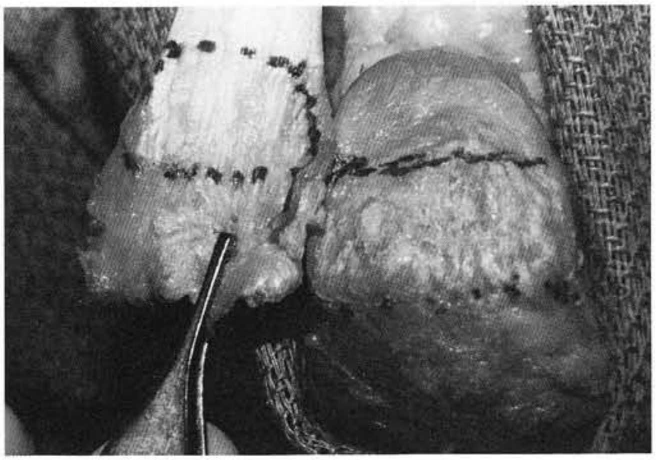

Figure 1.The anatomic relationship of the retrocalcaneal bursa, Achilles tendon with insertion and posterior calcaneus.

CLINICAL EXAMINATION

The clinical evaluation necessitates defining the area of deformity as well as the structures directly or indirectly impacting the posterior heel. Reviewing the patient's style of shoes and the onset, duration and presentation of retrocalcaneal pain narrows potential diagnosis, and can assist in evaluating for rheumatalogic conditions which can produce enthesiopathies. Inflammation of the skin or bursa overlying a prominence is frequently evident with paratendinous swelling commonly associated with tendon or bursa pathology. Pain is often elicited with direct palpation, as well as with dorsiflexion at the ankle joint. A sequential evaluation of the various anatomic regions is beneficial in the initial work-up. Mapping of the posterior heel as shown, assists the clinician in localizing the source of pathology and producing a list of differential diagnosis (Figs. 2,3).

A thorough evaluation of ankle equinus and the forefoot-to-rearfoot relationship in the sagittal and frontal planes provide the keys to the underlying etiology. Ruch described rearfoot varus, compensated forefoot valgus, and feet with a plantarflexed first ray as the common causes for Haglund's deformity, with equinus playing a large role in the development of insertional pathology.[5] Failure to determine the underlying pathology prevents the development of a treatment plan consistent with long-term success. An appreciation of the pathologic structures allows the establishment of multiple differential diagnosis before any adjunct examinations are performed.

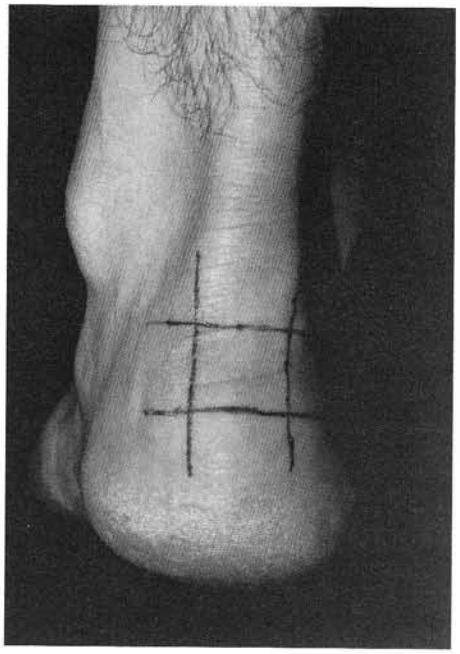

Figure 2. Clinical cross hatching of the posterior heel.

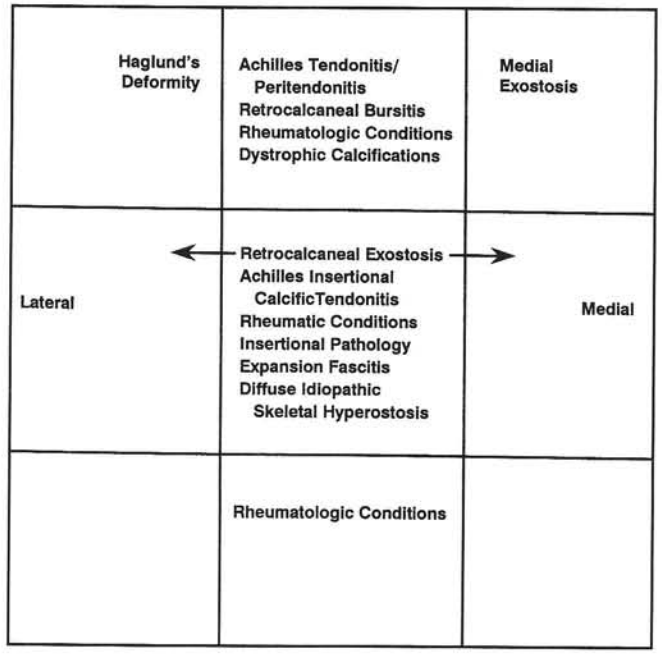

Figure 3. Schematic cross-hatching of the posterior heel with differential diagnosis based on regions.

RADIOGRAPHIC EVALUATION

Once the area of interest is narrowed on clinical exam, radiographic studies are helpful in further isolating and confirming the differential diagnosis. The lateral radiograph is most beneficial in evaluating posterior heel complaints, with additional views beneficial for specific presentations. The relationship of the posterior-superior prominence of the calcaneus to the remainder of the foot has been discussed by various authors attempting to describe quantitative measurements for pathology. These are often used more commonly in the academic setting, but can assist the physician in determining the specific site of pathology. The Fowler-Phillip angle is the relation of the inferior calcaneus to the posterior calcaneus. Normally it measures 44 to 69 degrees with values greater than 75 degrees designated by Fowler and Phillip to be abnormal (Fig. 4).[4] Ruch described the influence of the calcaneal inclination angle in combination with the Fowler-Phillip angle on retrocalcaneal pathology with Vega et al. correlating increased symptoms with values greater than 90 degrees.[5,11] The relationship of parallel pitch lines described by Pavlov indicates an increased prominence, if bone protrudes superior to a line parallel to the plantar calcaneus in line with the posterior portion of the posterior facet of the subtalar joint.[12]

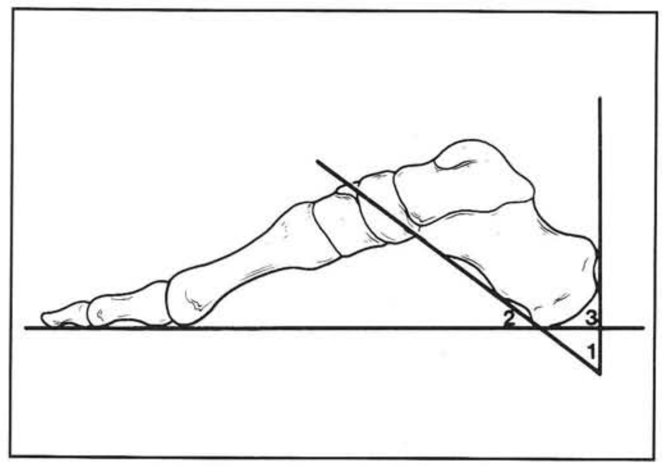

Figure 4. The relationship of (1) the Fowler-Phillip Angle, (2) calcaneal inclination angle, and (3) the total angle.

Christman established that a lateral radiograph allows visualization of the posterolateral aspect of the calcaneus, with pathology of the medial and midline posterior calcaneus hidden by the calcaneal overlap.[13] A calcaneal axial radiograph is used to determine frontal plane curvature within the body of the calcaneus. The evaluation of calcifications and exostosis are often evident on a lateral view, but the ability to determine their location on the posterior surface of the heel are best undertaken through the use of the modified

Figure 5. Positioning of the patient and X-ray beam for modified calcaneal axial radiograph.

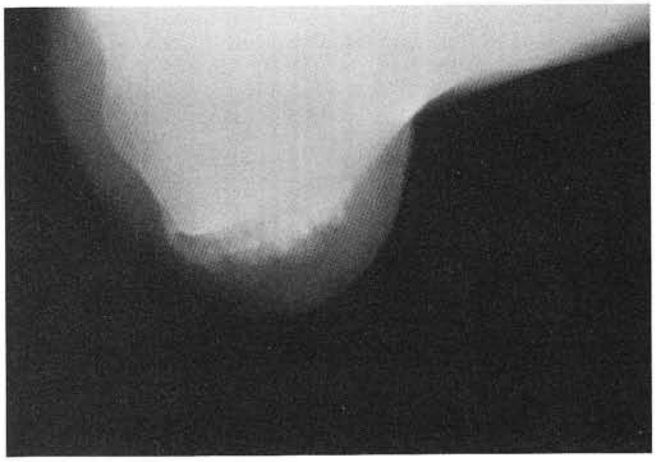

Figure 6. Modified calcaneal axial radiograph depicting retrocalcaneal exostosis.

calcaneal axial view (Figs. 5, 6).[14] This view is taken with the patient standing with the ankle dorsiflexed and the heel on the ground, with the tube 90 degrees to the plate and angled parallel with the posterior calcaneus. This view provides excellent visualization of the middle and superior thirds of the calcaneus for the evaluation of retrocalcaneal and intratendinous calcifications.

Further imaging modalities, including CT and MRI, can be beneficial for additional visualization of calcaneal and Achilles tendon pathology, but are often adjuncts to a complete initial clinical and radiographic evaluation. A lateral radiograph is the standard for determining the source of the deformity with additional views performed as necessary to provide an adjunct to the clinical evaluation.

SUMMARY

Retrocalcaneal pain can have many different etiologies which can be effectively evaluated through an understanding of the anatomy of the region and the mechanics of the foot in respect to this region. A comprehensive understanding of the clinical and radiographic anatomy of the posterior heel will assist the physician in making appropriate conservative and surgical decisions when managing patients with retrocalcaneal symptomatology.

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