CHRONIC HEEL PAIN

AN ESSAY

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Master Degree in Orthopedic Surgery

BY

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Abstract

A surprising long list of conditions can cause chronic heel pain. A detailed history and a careful physical examination should be performed to assess the area of maximum pain and tenderness. Studies in addition to routine radiographs include bone scans, CT, EMG and MRI. Treatment of chronic heel pain should proceed in a stepwise fashion, most of patients respond to conservative treatment and should be tried firstly, if this is failed surgical treatment is considered according to the cause of the pain.

Keywords

Chronic heel pain, posterior heel pain, plantar heel pain, diagnostic tools, management

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Anatomy and biomechanics of the ankle and hindfoot

1-SKIN

CUTANEOUS VASCULAR SUPPLY

The arterial supply to the skin of the foot is rich and is derived from branches of the three major arteries that supply the foot, namely the dorsalis pedis, posterior tibial and peroneal arteries.

Cutaneous venous drainage is via dorsal and plantar venous arches, which drain into medial and lateral marginal veins.

CUTANEOUS INNERVATION

The fourth and fifth lumbar and first sacral spinal nerve roots (L4, 5 and S1) supply sensation to the foot. Dorsal sensation is provided medially by the saphenous nerve, centrally by the superficial peroneal nerve and laterally by the sural nerve; the deep peroneal nerve supplies the dorsum of the first web space.

The plantar aspect of the foot is supplied by the medial and lateral plantar nerves, which arise as terminal branches of the tibial nerve. The medial plantar nerve supplies sensation to the plantar aspect of the hallux, the second, the third and the medial half of the fourth toes. The lateral plantar nerve supplies the remaining lateral aspect of the fourth and the entire fifth toe. The heel is innervated by calcaneal branches of the tibial nerve. Injury to any of these nerves can lead to painful neuromata and loss of protective sensation. The sural nerve is especially prone to neuroma formation. [1]

2-SOFT TISSUES

A-RETINACULA OF THE ANKLE JOINT

In the vicinity of the tibiotalar joint, the tendons of the muscles of the leg are bound down by localized thickenings of the deep fascia, forming retinacular bands that prevent bowstringing of the tendons. There are superior and inferior extensor, flexor and peroneal retinacula.

***Extensor retinacula:**

Superior extensor retinaculum

The superior extensor retinaculum binds down the tendons of tibialis anterior, extensor hallucis longus, extensor digitorum longus and peroneus tertius immediately above the anterior aspect of the tibiotalar joint. The anterior tibial vessels and deep peroneal nerve pass deep to the retinaculum. The superficial peroneal nerve passes superficially. The retinaculum is attached laterally to the distal end of the anterior border of the fibula and medially to the anterior border of the tibia. [(1)]

Inferior extensor retinaculum

The inferior extensor retinaculum is a Y-shaped band lying anterior to the tibiotalar joint.

*Flexor retinaculum

The flexor retinaculum is attached anteriorly to the tip of the medial malleolus, it continues posteriorly to the medial process of the calcaneus and the plantar aponeurosis.

The flexor retinaculum converts grooves on the tibia and calcaneus into canals for the tendons, and bridges over the posterior tibial vessels and tibial nerve. As these structures enter the sole they are, from medial to lateral, the tendons of tibialis posterior and flexor digitorum longus, the posterior tibial vessels, the tibial nerve and the tendon of flexor hallucis longus.

B-PLANTAR FASCIA

The plantar fascia, or plantar aponeurosis, consists of longitudinally arranged dense fibrous connective tissue bands that originate from the calcaneal tuberosity. [(2)]

After leaving the calcaneal tuberosity, these fibers course distally, fanning out over the sole, where they become thinner and broader. They divide and attach to the plantar fibrous digital sheaths of the lateral four toes and the sesamoids of the great toe. Vertical septa extend dorsally from the aponeurosis to divide the plantar aspect of the foot into three compartments: lateral, central, and medial (Fig. 1). [(3)]

This structure helps to support the foot's longitudinal arch, contributing as much as 25% to the stiffness of the foot and carrying as much as 14% of the total load imposed on the foot in weightbearing, Moreover, the plantar fascia functions to stabilize the toes during dynamic load bearing activities.[(4)]

Plantar fascia failure or surgical release can alter the previously discussed biomechanical behaviors of the talocrural and subtalar joints, significantly lengthening and lowering the medial longitudinal arch of the foot, as well as altering the forefoot loading response during the propulsion phases of gait.[(5)]

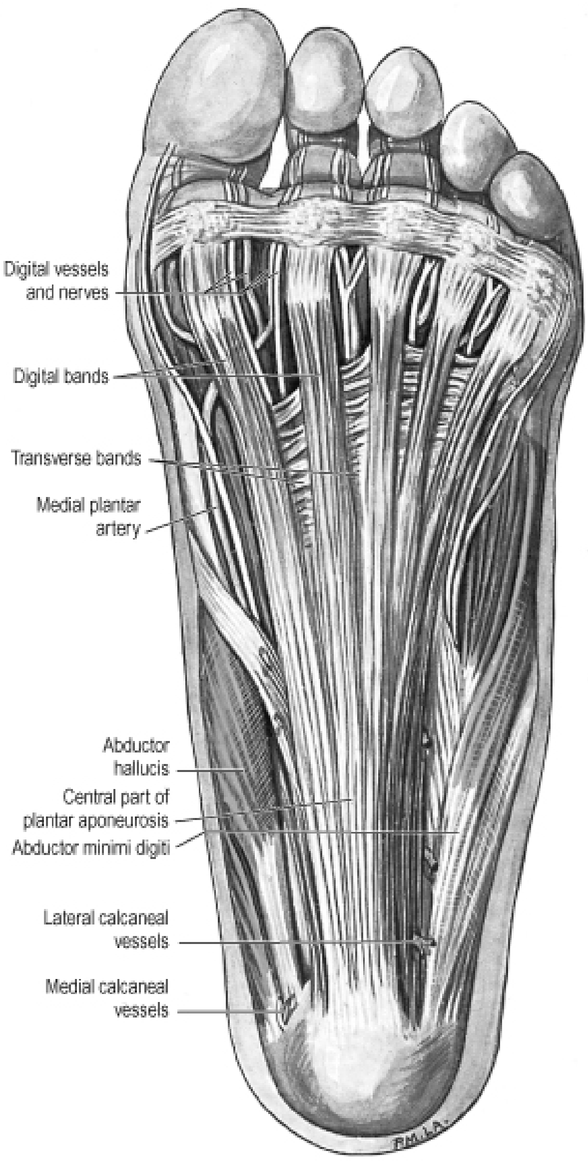

Fig.1 plantar fascia [1]

C-SPECIALIZED ADIPOSE TISSUE (HEEL PAD):

The heel pad is subject to repeated high impacts and is anatomically adapted to withstand these pressures. The average heel pad is 18 mm thick and the mean epidermal thickness is 0.64 mm (dorsal epidermal thickness averages 0.069 mm). The heel pad contains elastic adipose tissue organized as spiral fibrous septa anchored to each other, to the calcaneus and to the skin. The septa are U-shaped fat-filled columns designed to resist compressive loads and are reinforced internally with elastic diagonal and transverse fibers, which separate the fat into compartments. [1]

2-BONE

A-DISTAL TIBIA

B-DISTAL FIBULA (lateral malleolus)

C-TALUS

The talus is the link between the foot and leg, through the ankle joint and it consists of head, neck and body.

Head

Directed distally and somewhat inferomedially, the head has a distal surface which its long axis is inclined inferomedially to articulate with the proximal navicular surface (Fig. 2). The plantar surface of the head has three articular areas, separated by smooth ridges. The most posterior and largest rests on a shelf-like medial calcaneal projection, the sustentaculum tali. When the foot is inverted passively, the dorsolateral aspect of the head is visible and palpable 3 cm distal to the tibia; it is hidden by extensor tendons when the toes are dorsiflexed. (1)

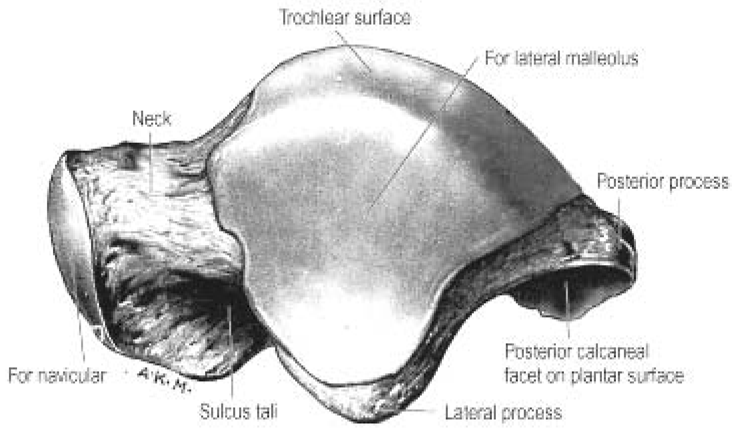

Fig.2 lateral aspect of talus. (1)

Neck

The neck is the narrow, medially inclined region between the head and body. Its rough surfaces are for ligaments (Fig. 3). The medial plantar surface has deep sulcus tali which, when the talus and calcaneus are articulated, form a roof to the sinus tarsi, which is occupied by interosseous talocalcaneal and cervical ligaments.(1)

Body

The body is covered dorsally by a trochlear surface articulating with the distal end of the tibia. The triangular lateral surface is smooth and vertically concave for articulation with the lateral malleolus. Superiorly, it is continuous with the trochlear surface; inferiorly its apex is a lateral process. Proximally, the medial surface is (posterosuperiorly) covered by a comma-shaped facet, which is deeper in front and articulates with the medial malleolus. Distally, this surface is rough and contains numerous vascular foramina. (1)

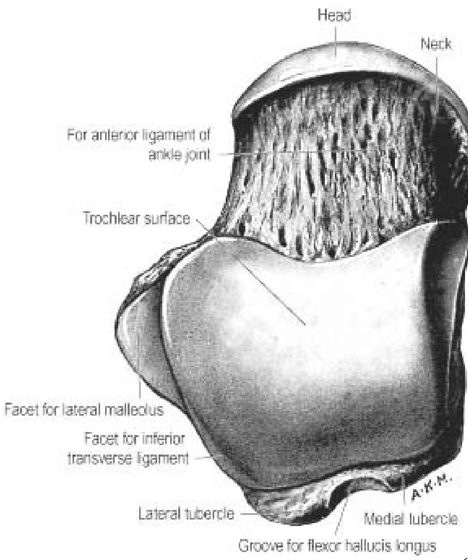

Fig.3 superior aspect of talus [1]

D-CALCANEUS

The calcaneus, the largest tarsal bone, projects posterior to the tibia and fibula as a short lever for muscles of the calf attached to its posterior surface. It is irregularly cuboidal, its long axis inclined distally upwards and laterally (Fig. 4).

It has the following surfaces:

The superior or proximal surface is divisible into three:

The posterior one-third which supports fibroadipose tissue (Kager's fat pad) between the calcaneal tendon and ankle joint.

The middle one-third carries the posterior talar facet,

The anterior one-third is partly articular; distal (anterior) to the posterior articular facet, a rough depression narrows into a groove on the medial side, the sulcus calcanei, which completes the sinus tarsi with the talus. [1]

The anterior surface is the smallest, and is an obliquely set articular facet for the cuboid.

The posterior surface is divided into three regions. These are a smooth proximal (superior) area separated from the calcaneal tendon by a bursa and adipose tissue, a middle area, the largest and a distal (inferior) area inclined downwards and forwards, vertically striated, which is the subcutaneous weight-bearing surface.

The plantar surface is rough, especially proximally as the calcaneal tuberosity. Further distally, an anterior tubercle marks the distal limit of the attachment of the long plantar ligament.

The lateral and **the medial surfaces** [1]

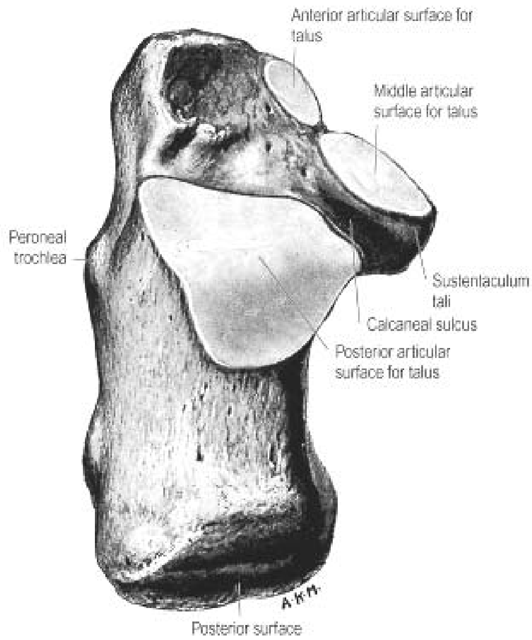

Fig.4 calcaneus.

4-JOINTS

A-ANKLE (TALOCRURAL) JOINT

The talocrural joint is approximately a uniaxial hinge. The lower end of the tibia and its medial malleolus, together with the lateral malleolus of the fibula and inferior transverse tibiofibular ligament, form a deep recess ('mortise') for the body of the talus. Although it appears to be a simple hinge, its axis of rotation is dynamic, shifting during dorsi-and plantar flexion.

Dorsiflexion is to 10° with the knee straight, and to 30° with knee flexion (because of relaxation of the calcaneal tendon).

Plantar flexion is to c.30°. Dorsiflexion is the 'close-packed' position, with maximal congruence and ligamentous tension; from this position, all major thrusting movements are exerted, in walking, running and jumping. [(1)]

Articulating surfaces

Articular surfaces are covered by hyaline cartilage. The talar trochlear surface is wider in front and articulates with the distal tibial articular surface.

The medial talar articular surface articulates with the medial malleolus while the larger lateral talar articular surface articulates with the lateral malleolus. The bones are connected by a fibrous capsule, medial (deltoid), anterior and posterior talofibular and calcaneofibular ligaments. [(1)]

Ligaments

*** The lateral ligament** which has discrete parts:
The anterior talofibular ligament and The posterior talofibular ligament (Fig. 5).

* **The medial ligament (deltoid collateral):** is a strong, triangular band, attached to the apex and the anterior and posterior borders of the medial malleolus.
The superficial fibers divide into the anterior (tibionavicular), intermediate (tibiocalcaneal) and posterior (posterior tibiotalar) fibers.
The deep fibers (anterior tibiotalar) pass from the tip of the medial malleolus to the non-articular part of the medial talar surface. (Fig. 6)
* **The calcaneofibular ligament**, a long cord, runs from the apex of the fibular malleolus to a tubercle on the lateral calcaneal surface. [(1)]

Factors maintaining stability

Passive stability is conferred upon the ankle mainly by the medial and lateral ligament complexes, the distal tibiofibular ligaments, the crossing and attached tendon tunnels, the bony contours and the capsular attachments.

Dynamic stability is conferred by gravity, muscle action and ground reaction forces. Stability requires the continuous action of soleus, and increases (often involving gastrocnemius) with leaning forward, and vice versa. If backward sway takes the projection of the centre of gravity ('weight line') posterior to the transverse axes of the ankle joints, the plantar flexors relax and the dorsiflexors contract. [(1)]

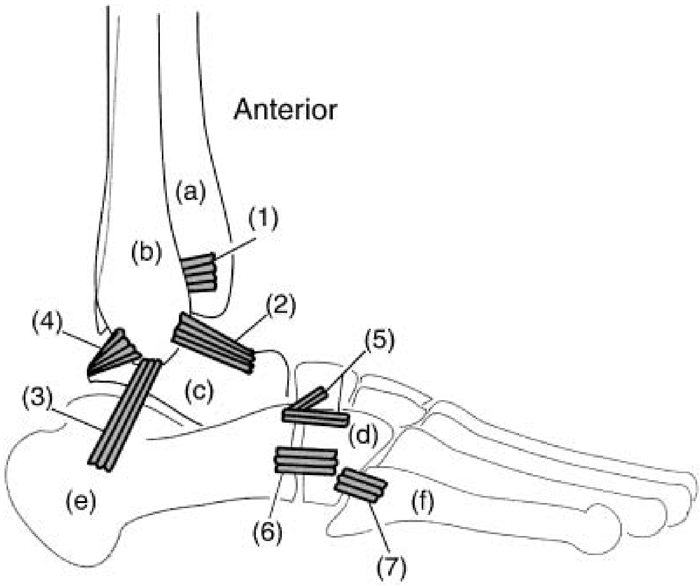

Fig.5 Lateral ligaments of the (R) ankle and foot. (a) Tibia; (b) Fibula; (c) Talus; (d) Cuboid; (e) Calcaneus; (f) 5th metatarsal; (1) Anterior tibiofibular ligament; (2) Anterior talofibular ligament; (3) Calcaneofibular ligament; (4) Posterior talofibular ligament; (5) Bifurcate ligament; (6) Calcaneocuboidal ligament; (7) Cubometarsal ligament. [(3)]

B-TALOCALCANEAL JOINT (Subtalar joint)

Anterior and posterior articulations between the calcaneus and talus form a functional unit often termed the 'subtalar joint'. The posterior articulation is referred to as the talocalcaneal joint and the anterior articulation is regarded as part of the talocalcaneonavicular joint.

The bones are connected by a fibrous capsule, and by lateral, medial, interosseous talocalcaneal and cervical ligaments. [(1)]

Articulating surfaces

The subtalar joint proper involves the concave posterior calcaneal facet on the posterior part of the inferior surface of the talus and the convex posterior facet on the superior surface of the calcaneus.

Ligaments

*** Lateral and medial talocalcaneal ligament**

*** Interosseous talocalcaneal ligament** descends obliquely and laterally from the sulcus tali to the calcaneal sulcus.

*** Cervical ligament** is attached to the superior calcaneal surface, from where it ascends medially to an inferolateral tubercle on the talar neck.

Factors maintaining stability

Stability is conferred by the bone contours of the hindfoot plus the above mentioned ligaments, although which ligaments provide the most stability is not known. An additional ligamentous restraint is provided by the calcaneofibular component of the lateral ligament complex. The tendons crossing the articulation aid stability. [(1)]

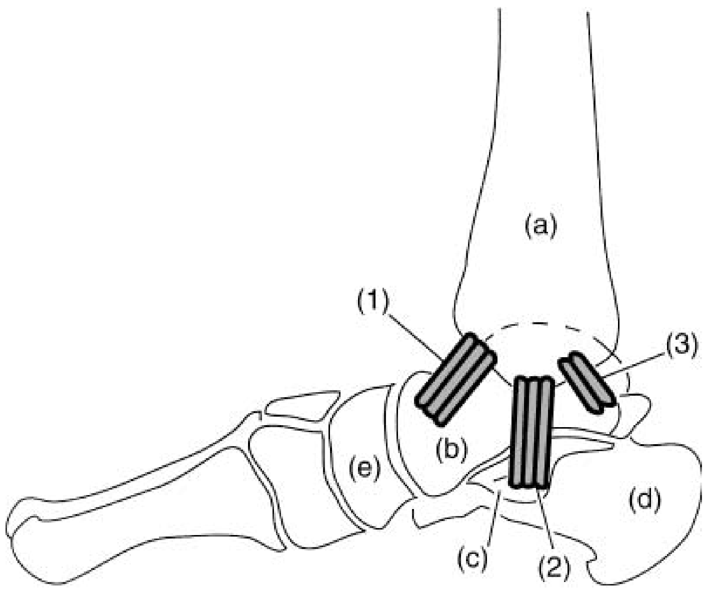

Fig.6 Medial ligaments of the (R) ankle and foot, (a) Tibia; (b) Talus; (c) Sustantaculum tali of the calcaneus; (d) Calcaneus; (e) Naviculum; (1) Anterior tibiotalar ligament; (2) Tibiocalcaneal ligament; (3) Posterior tibiotalar ligament. [(3)]

Biomechanical considerations of the ankle and subtalar joints

Planes of motion:

***Plantar flexion and dorsiflexion**: refer to movement in the sagittal plane and occur principally, but not exclusively, at the ankle, metatarsophalangeal and interphalangeal joints.

***Inversion and eversion**: inversion is tilting of the plantar surface of the foot towards the midline (25-30 degree), and eversion is tilting away from the midline (5-10 degree). This is motion takes place principally in the talocalcaneal and transverse tarsal joints.

***Adduction and abduction**: adduction is movement of the foot towards the midline in the transverse plane; abduction is movement away from the midline. This movement occurs at the transverse tarsal joints and, to a limited degree, the first tarsometatarsal joint and the metatarsophalangeal joints.

***Supination and pronation**: supination describes a three-dimensional movement and is a combination of adduction, inversion and plantar flexion. Pronation is the opposite motion, i.e. a combination of abduction, eversion and dorsiflexion. Pronation and supination are usually better terms than eversion and inversion, as the latter rarely occur in isolation and the former describe the 'compound' motion that usually occurs.

Movements at the ankle joint are almost entirely restricted to dorsi-and plantar flexion, but slight rotation may occur in plantar flexion. The ranges of movement at the talocalcaneonavicular and subtalar joint are greater: inversion and eversion mainly occur here. [(1)]

Muscles producing movement:

Heel inversion is controlled by tibialis anterior, tibialis posterior and the gastrocnemius-soleus complex via the calcaneal tendon; the flexors of the long toe also contribute. Heel eversion results from the pull of peroneus longus, brevis and tertius, in addition to the extensors of the long toe.

Hindfoot biomechanics

Hindfoot function involves eccentric loading of the subtalar joint and repetitive strain of the calcaneal soft tissues. Both are induced by the serial pattern of foot support.

The subtalar joint (Fig. 7) experiences rapid eversion following heel strike and subsequent inversion during terminal stance. Although these actions reduce the rotatory strain on the ankle joint, they also challenge the local soft tissues and controlling muscles. Compression and traction of the soft tissues about the heel are normal events during each walking cycle.

Loading the limb at the onset of stance causes heel pad compression. Conversely, the plantar fascia and tendo Achillis are subjected to significant