Expert Review Clinical Examination of the Foot and Ankle

Rohit Kotnis*, Parminder J Singh*, Christopher Bulstrode▲

Abstract Approximately 20 percent of all musculoskeletal complaints are related to the foot and ankle. This may be attributed to the functions of this part of the locomotor system. These include providing a stable base on which the body can stand; acting as a rigid lever to propel the body forward during walking and providing shock absorption for the force generated during walking and running (approximately two to six times an individual's body weight).

The diagnosis and treatment of foot and ankle injuries requires a knowledge of anatomy, gait, biomechanics and common disorders that afflict the system. These topics together with a system for clinical examination of the foot and ankle injuries are presented below. This paper suggests an examination routine in a logical order consistent with The Principles of Clinical Examination[1] on which more individualised examinations can be developed. Word Count: 2251.

Key words: Ankle, Foot, Examination, Achilles tendon, Pes Cavus

Address for correspondence: rkotnis@hotmail.com

Author affiliations: *Specialist Registrar, Trauma and Orthopaedics, Oxford. ▲Professor of Trauma and Orthopaedics, University of Oxford.

Introduction
The ankle or talocrural joint, is a synovial hinge joint that connects the distal ends of the tibia and fibula in the lower limb with the proximal end of the talus bone in the foot. The articulation between the tibia and the talus bears more weight than between the smaller fibula and the talus. The ankle joint is responsible for the majority of dorsiflexion (moving the toes up as when standing only on the heels) and plantar flexion of the foot (moving the toes down, as when standing on the toes).

The foot can be divided into three parts – hind foot (calcaneus, talus), mid foot (navicular, cuboids, cuneiforms) and the forefoot (metatarsals and phalanges).

Examination
Start your examination by introducing yourself and ask the patient to undress from their knees down. The socks and shoes must be removed. Be observant and look around the room for any walking aids, insoles or custom footwear. Remember to ask for consent from the patient and to wash your hands before performing the examination.

Look
Ask the patient to stand and assess overall limb alignment. Assess pelvic obliquity, limb length discrepancy (and its level), any valgus/varus deformities of the knee, and rotational alignment. Now focus your attention on the foot and ankle itself.

Shapes of the foot:
Assess the overall shape of the forefoot from the front. From the side, look for the normal medial arch. The hind foot is best appreciated from behind. Now, look at the vertical relationship between the achilles tendon and the calcaneum (normal heel valgus of 5°). Look from behind and count the number of toes that can be seen. The ‘too many toes’ sign demonstrates increased forefoot abduction (pes planus or flat foot) and a splayed forefoot.
Foot shapes you may encounter include: neutral foot (no overall deformity), skew foot (hind foot valgus and forefoot adduction), metatarsus adductus (neutral hind foot and adduction of the metatarsus), pes planus or flat foot [2] (collapse of the medial arch), pes cavus or high arch (increased medial arch). Causes of a flat foot are shown in Table 1 and a cavus foot in Table 2:

<table>
<thead>
<tr>
<th>Normal variant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperlaxity syndrome – e.g. Marfans</td>
</tr>
<tr>
<td>Tarsal Coalition[3] – rigid and painful flat foot (Figure 1)</td>
</tr>
<tr>
<td>Tibialis posterior dysfunction</td>
</tr>
</tbody>
</table>

Table 1 Causes of pes planus (flat foot).

<table>
<thead>
<tr>
<th>Spinal anomalies e.g. spina bifida</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hereditary sensorimotor neuropathies such as Charcot-Marie-Tooth disease[4].</td>
</tr>
<tr>
<td>Charcot foot (e.g. neuropathic foot)[5]</td>
</tr>
<tr>
<td>Post compartment syndrome (e.g. volkman ischaemic contracture)[6]</td>
</tr>
</tbody>
</table>

Table 2 Causes of pes cavus[3] (high arch foot).

Figure 1 Sagittal MRI scan of the foot illustrating a fibrous coalition between the calcaneum and navicular bones.

Figure 2 (a) Lateral view of the foot in a patient with pronounced pes cavus (raised medial longitudinal arch) (b) lateral radiograph of the foot illustrating pes cavus.

Skin: A bunion or red swelling on the medial aspect of the metatarso-phalangeal joint (MTPJ) is common. This is an area of inflamed skin with an underlying subcutaneous bursa and a prominent medial eminence. Systemic manifestations include gouty tophi and thin fat pads under the metatarsal heads as seen in Rheumatoid Arthritis. Remember to assess the appearance of the nails and their hygiene.

Soft tissues – swelling may indicate soft tissue or joint pathology. Muscle wasting is most commonly seen on the dorsum of the foot and in the clefts between the metatarsals. If present, a full neurological examination of the upper and lower limbs should be performed including the spine.

Bones – look for any bony prominences or exostoses. Common forefoot deformities are shown in Table 3.
Joint

<table>
<thead>
<tr>
<th>Joint</th>
<th>Metatarsophalangeal</th>
<th>Proximal interphalangeal</th>
<th>Distal interphalangeal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claw toe</td>
<td>Hyper-extension</td>
<td>Flexion</td>
<td>Flexion</td>
</tr>
<tr>
<td>Hammer toe</td>
<td>Normal or extension</td>
<td>Flexion</td>
<td>Normal</td>
</tr>
<tr>
<td>Mallet toe</td>
<td>Normal</td>
<td>Normal</td>
<td>Flexion</td>
</tr>
<tr>
<td>Hallux valgus or varus</td>
<td>Valgus or varus position</td>
<td>Normal</td>
<td>--</td>
</tr>
</tbody>
</table>

Table 3 Common forefoot deformities and their joint relationships[7].

Gait:

Ask the patient to walk up and down the room. Look for a high stepping gait (foot drop), painful (antalgic) gait (ankle and foot joint pain) and a short propulsive phase (forefoot pain or weak calf).

Footwear:

Inspect the footwear. This may reveal areas of abnormal weight bearing. With normal wear of the sole, a corner is typically worn off the postero-lateral aspect of the heel (heel strike). In addition, there may be a circular wear pattern under the ball of the big toe (toe-off phase). Look at the shoe:

External appearance – material used, metal supports, heel raise, depth and width.

Internal appearance – insoles, arch supports, heel cups

Feel

Skin – Reduced sensation in a glove and stocking distribution is seen with Diabetic neuropathy.

Soft tissues – the posterior tibial and the dorsal pedis pulses must be palpated. Palpate the tibialis anterior tendon and the long extensor tendons on the dorsum of the foot. From the back, palpate the Achilles tendon. From the lateral side, palpate the peroneal tendons and palpate the tibialis posterior tendon from the medial side. The sinus tarsi can be assessed. This is an anatomical space bounded by the talus and calcaneum and is recognizable as a soft tissue depression anterior to the lateral malleolus. This is filled with fat and the extensor digitorum brevis muscle. Sinus tarsi syndrome may occur[8] (See Box 1).

Box 1 Sinus Tarsi Syndrome

"Sinus tarsi syndrome" may be caused by injury to the interosseous talocalcaneal ligament or the subtalar joint. There is pain and tenderness over the sinus tarsi with subjective hind foot instability. The pain is characteristically relieved by local anaesthetic injection.

Bones - feel for deformity, bony prominences and tenderness.

Ankle joint – the medial and lateral malleoli, anterior and posterior joint line, lateral gutter and ligament complex, the syndesmosis (distal tibio-fibular joint), medial gutter and medial ligament complex.

Subtalar joint – palpate each facet, the posterior facet is felt on the lateral hindfoot and the middle facet on the medial hindfoot.

Mid-tarsal joints: the talonavicular and calcaneocuboid joints

Tarso-metatarsal joints (TMTJ) - Note that the second TMTJ is several millimetres proximal to the others. There is minimal movement in the second and third ray, moderate in the fourth and fifth rays and very variable in the first ray).

Specific structures to palpate:

Calcaneum (heel bone) - The commonest cause of pain is plantar fasciitis. This may present with numbness, burning and electric shock sensations worse in the morning which improve as the day goes on. Identify the exact point of tenderness.
Tendons – examine for tenderness of the Achilles tendon insertion, peroneal or tibialis posterior tendons.

Head of talus – invert and evert the patient’s foot.

Sustentaculum tali – palpate one fingerbreadth below the medial malleolus. This important structure serves as an attachment for the spring ligament.

Cuneiforms (medial, middle and lateral), MTP’s, webspaces and all the forefoot bones.

**Move**

The movements of the foot and ankle are linked via the ankle, subtalar and midfoot joints. Remember the acronyms PAED and SAPI:

- **PAED** – Pronation, Abduction, Eversion and Dorsiflexion
- **SAPI** – Supination, Adduction, Plantarflexion and Inversion

It is important to differentiate active vs passive movements of the Foot and Ankle

**Ankle (Figure 3)**

Dorsiflexion (DF) - ask the patient to lift their foot to their body (55°) with the heel in neutral (e.g., an anterior tibial osteophyte), joint contracture, tight Achilles tendon). Test dorsiflexion with the knee both flexed and extended. If restriction is greater with the knee extended than flexed, the contracture is principally in the gastrocnemius. Restriction which is equal in all knee positions is due to a contracture principally of the soleus or other causes (e.g., anterior impingement, capsular contracture/arthrofibrosis).

Plantarflexion (PF) – ask the patient to touch the floor with their foot (15°). Weakness suggests injury to the Achilles tendon or pathology affecting the S1 nerve root.

**Figure 3 (a) Ankle joint dorsiflexion (b) Ankle joint plantarflexion.**

Other active tests for ankle/foot:
- Lunge / “Skier” position = tests ankle DF
- Tip-toe stance = tests ankle PF + fixed vs flexible planus foot + Achilles/calf strength
- Ask the patient to stand on their heels = tests balance + ankle DF
- Stand on one foot = tests stability and pain

**Subtalar joint (Figure 4)**

Hold the talar neck and ask the patient to move their heel from side to side. Repeat using a hand on the heel to move the joint and apply a varus and valgus stress whilst feeling for movements of the talus. Holding the talus as opposed to the tibia isolates subtalar from ankle motion. (Normal = 5 degrees in each direction).

- **Inversion** – ask the patient to move their foot in towards them
- **Eversion** – ask the patient to move their foot out to the side
Figure 4  The position of the hands when testing for subtalar motion. Note the patient’s foot resting on the examiner’s forearm and the thumb palpating the talar neck to isolate subtalar joint motion.

Mid-tarsal joint
Hold the heel with one hand and move the forefoot medially (adduction = 20°) & laterally (abduction = 10°) with the other hand. Also pronate and supinate the forefoot whilst holding the heel in other hand.

Tarsometatarsal joint:
Active movement at the TMTJ’s is almost always zero for the 2nd and 3rd TMJ’s. Any movement is usually in the naviculo-cuneiform joint. Hold the midfoot and manipulate each metatarsal up and down to estimate passive range of movement.

Metatarsophalangeal joint:
Test extension (70 to 90°) by asking the patient to lift their toes to the ceiling and flexion (45°) by pointing their toes to the floor. Normal toe-off requires 35-40° of dorsiflexion.

Special Tests
Achilles Tendon
Feel the gastrocnemius and soleus bellies and the whole length of the tendon for gaps (rupture), tenderness or swelling. Also identify the postero-lateral (Haglund’s) prominence of the calcaneum and palpate the retro-Achilles bursa.

The best test for integrity of the tendon is the Thompson[9] or Simmonds test[10]. Do not me misled by the patient’s ability to stand on tiptoes - some people can do this using their long toe flexors alone. Lie the patient prone and allow the calves to rest on your forearms. Squeeze each calf in turn and watch for movement at the ankle joint. Lack of movement indicates a rupture, unless proven otherwise by imaging.

Subtalar joint flexibility (Figure 5)
Ask the patient to stand on their toes and observe the heel from behind, the heel moves normally from valgus to varus indicating flexibility. The Coleman block test[11] is used to assess flexibility of the subtalar joint. Ask the patient to stand on a 2cm block with the great toe over the medial edge, resting on the floor. Now look from behind. If the hind foot varus remains, the subtalar joint is fixed. If it corrects to valgus, the joint is mobile.

Figure 5  (A) The normal valgus position of the heels when viewed from behind with the patient standing.  (B) The patient is asked to stand on their tip toes. Note that the heels now swings into the varus position illustrating flexibility of the subtalar joints.
Flat Foot flexibility:
Use the Windlass and Jack’s test to distinguish a flexible from fixed flat foot.

Windlass test[12] - ask the patient to stand on their toes. Observe the arch of the foot on the medial aspect. As soon as the patient stands on their toes, the arch forms. Failure of this indicates a fixed flat foot. Causes include tarsal coalition and triple joint arthritis.

Jack’s test[13] – with the patient standing, lift up the great toe. The arch should form in the flexible flat foot. (Figure 6)

Figure 6  Lateral view of the foot illustrating formation of the medial longitudinal arch when the great toe is lifted. This test helps to differentiate a rigid from a flexible flat foot.

Ankle Stability[14]
Trauma to the ankle is a common cause of instability. Accurate assessment may be difficult in the acute setting because of pain.

Anterior draw test (Figure 7) - with the foot resting over the bed in slight plantar-flexion, hold the heel with one hand and the front of the tibia with the other. Move the heel forward on the fixed tibia. Compare with the other side. Instability of the syndesmosis may be palpable.

Squeeze test for distal tibia-fibular stability - compress the proximal calf. Pain at the ankle may indicate separation of the distal fibula from the tibia. Other tests for syndesmosis:

(a) Cotton test - push heel laterally from medial side, whilst resisting with opposite push from lateral side of leg

(b) Dorsi-flexion/eversion test - forced passive dorsiflexion and eversion causing pain in syndesmosis

Tilt test – hold the talus at the neck, rather than the heel so you can be sure that any tilt is in the ankle not the subtalar joint.

Figure 7  Anterior Draw test for anterior laxity of the tibio-talar joint. The tibia is fixed with one hand while the other hand is positioned to allow an anterior force to be applied to the heel on the tibia.

Tarsometatarsal Joint (TMTJ) stability:
Stability can be assessed by pushing each joint up and down. Standing lateral radiographs may be used in addition.

Tibialis Anterior:
Ask the patient to walk on their heels with their feet inverted. The tibialis anterior tendon can be seen. Now, with the patient’s feet resting over the edge of the couch, ask the patient to actively dorsiflex and invert their foot to reach your hand. Palpate the tibialis anterior muscle.

Tibialis posterior
Pathology of the tibialis posterior typically presents with postero-medial ankle pain, swelling and gradual onset of a flat foot. When assessing the tendon, look for swelling along its course, a flat foot with heel valgus, the ‘too many toes’ sign and prominence of the talus head. Palpate for tenderness, swelling or gaps in the tendon. To test integrity:
Ask the patient to perform a single foot tiptoe test on both sides. The inability to lift the affected heel off the ground is suggestive of a tibialis posterior tendon injury or insufficiency. Occasionally the patient may be able to lift their heel from the ground, but the heel fails to tilt into varus to the same degree as the contralateral leg. Pain is the important symptom here.

To test strength, position the foot in the plantar-flexed and inverted position. Ask the patient to hold this position while you push against their foot.

**Dorsiflexors**

Tendonitis of the long toe dorsiflexors usually presents in athletes. Pain affects gait in the early contact phase. Palpate for swelling, gaps or any tenderness. Ask the patient to move the foot into dorsiflexion and then asking them to hold this position whilst you push the foot down.

Inability to dorsiflex the foot is referred to as foot drop. Causes include: stroke, spinal injury, spinal stenosis or disc prolapse, peripheral nerve injury (e.g. sciatic, common and deep peroneal) or a peripheral neuropathy.

**Peroneals**

Peroneal tendon pathology presents with swelling and/or pain of the lateral hindfoot pain or midfoot. There may be a history of the ankle ‘giving way’. Presentations of peroneal tendon pathology include: “Peroneal spasm” may be seen in tarsal coalition. Here, the muscles are usually contracted secondary to the hindfoot valgus.

Peroneal tendon dislocation - attempt to dislocate the tendons by asking the patient to dorsiflex and evert their foot (active test). Peroneus longus may be palpated just before it crosses under the foot to insert onto the base of the 1st MT. Ask the patient to plantarflex the 1st metatarsal. Test strength and integrity by active and resisted eversion while you palpate the tendons for swelling, tenderness or gaps.

**Morton’s Neuroma**

This condition represents thickening of the tissue that surrounds the digital nerve leading to the toes as the nerve passes under the ligament connecting the metatarsals in the forefoot. Most frequent between the third and fourth toes. A neuroma presents with burning pain in the ball of the foot that radiates to the involved toes. The condition is difficult to diagnose and requires a high index of suspicion. Palpate in the web space between the symptomatic toes for a mass. Compression of the metatarsals may elicit a ‘click’ between the bones (Mulders click).

**References**


Conflicts of Interest
None declared