(vii) Clinical examination of the foot and ankle

Howard Davies
Chris Blundell

Abstract
Examination of the foot and ankle can appear to be highly complicated, but if broken down into the component parts of “look, feel and move” supplemented with some simple special tests then it is often possible to arrive at a sound clinical diagnosis. The foot is a dynamic structure, therefore weight bearing and in particular gait is an essential part of the examination, as is an assessment of lower limb neurology. Remember to pay particular attention to a patient's footwear and any orthoses they may use.

Keywords ankle; examination; foot

Introduction
The foot and ankle comprise a complex array of mobile and planar joints, ligaments and tendons that act synergistically to propel the body forwards whilst walking and to provide a stable weight bearing surface for standing. Whilst the number of joints within the foot can be challenging for the examiner, by following the basic tenets/principles of look, feel and move and by using a logical approach the diagnosis of pathology within the foot can be simple and rewarding. However, the foot and ankle are dynamic structures relying on both intrinsic and extrinsic muscles to stabilize joints and allow propulsion. For this reason it is vital that all patients walk at some point during the examination to assess their gait and foot function whilst the muscles are acting, to make the pathology apparent. It is also important to examine meticulously areas of the foot that are often overlooked such as the plantar aspect and between the toes, and to complete each examination by assessing the foot pulses and any neurological deficit. It is essential that both the examiner and patient are comfortable during the consultation and as such you require a spacious room with an area to walk in, a height adjustable couch comfortable during the consultation and as such you require a logical approach the diagnosis of pathology within the foot can be challenging for the examiner, by following the

General overview
Before the examination can take place the patient needs to expose both lower limbs to above the knee as a minimum, even higher if hip and spinal pathology are suspected from the history.

Before looking at the patient, take a moment to examine their footwear once it is removed as the wear pattern may give you an idea of any gait or rotational deformities the patient has and will give you a chance to look at any orthoses or insoles that may have been used. Also note the style of shoes; in particular, if they have been designed to accommodate a fixed deformity in the foot and ankle. Walking aids may also have been brought into the examination room and should be noted if present.

Look
Static inspection
Front: in the first instance, ask the patient to stand in front of you with legs together if possible, in order to get a good comparison. From the front note the general alignment, including rotational profile, and approximate leg lengths. In a logical order starting distally observe the shape of the foot, looking in particular for hallux valgus and deformities of the lesser toes (Table 1). Hallux valgus is defined as a deviation of the great toe of more than 10 degrees from the midline. It is commonly associated with a bunion, which is in fact a separate deformity and usually comprises part of the metatarsal head with its overlying bursa. It is often the bunion rather than the first metatarsophalangeal joint which is symptomatic due to pressure caused by ill-fitting footwear; overlying erythema and swelling should help to distinguish the cause. A bunion overlying the fifth metatarsal head is termed a bunionette and can make the foot very broad, resulting in difficulty fitting shoes. Claw toes can be as a result of abnormal neurology and this should be borne in mind for the remainder of the examination. At the toe level also note whether there is any under or overriding of adjacent toes, any ulceration or dorsal callosity over the joints or deformity of the nails and try to visualize how the deformity will affect shoe wear and function.

From the front one can also assess the state of the skin for scars, swelling, varicosities and erythema. In patients with a sensory neuropathy and intact skin a swollen, warm and red foot is much more likely to represent Charcot neuropathy than an infection and should be investigated urgently.

Side: next inspect the feet from the side. It is much easier if the examiner gets the patient to move rather than the other way around. Look carefully at the medial arch and make an assessment of whether it is flat (planus), high arched (cavus) or normal and whether both sides are symmetrical. In extreme planus deformities it may be possible to see the head of the talus push into the ground. Viewing from the side may help identify clawing or other deformities of the lesser toes.

Deformities of the lesser toes

<table>
<thead>
<tr>
<th>Name</th>
<th>Deformity</th>
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<tbody>
<tr>
<td>Mallet toe</td>
<td>Flexion Distal Interphalangeal Joint (DIPJ)</td>
</tr>
<tr>
<td>Hammer toe</td>
<td>Flexion Proximal Interphalangeal Joint (PIPJ)</td>
</tr>
<tr>
<td>Claw toe</td>
<td>Flexion both DIPJ and PIPJ</td>
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Table 1

Howard Davies MSc FRCS (TR & ORTH) Foot and Ankle Fellow, Sheffield Foot and Ankle Unit, Department of Trauma and Orthopaedics, Northern General Hospital, Sheffield, UK. Conflict of interest: none declared.

Chris Blundell MD FRCS (TR & ORTH) Consultant Trauma and Orthopaedic Surgeon, Sheffield Foot and Ankle Unit, Department of Trauma and Orthopaedics, Northern General Hospital, Sheffield, UK. Conflict of interest: none declared.

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Back: last, turn the patient to inspect the feet from behind. Subtle swelling of the ankle joint can manifest posteriorly by blurring the sharp outline of the Achilles tendon. Both sides should be compared. This is now an ideal opportunity to watch the patient walk in order to assess their gait pattern.

Dynamic inspection

Gait: ask the patient to walk directly away from you, turn around and walk directly back so that you can watch from both sides. Ensure the patient keeps their head up and looks forward as otherwise this will affect their walking pattern.

Gait analysis can be very demanding and complex so we recommend concentrating on a few important principles and features. First consider the cadence, rhythm and symmetry of the gait. Note whether it is antalgic or high stepping, and if there is evidence of a foot drop. In foot drop caused by weakness in the tibialis anterior muscle (e.g. peroneal nerve palsy) you may see recruitment of the extensor hallucis longus and extensor digitorum longus tendons in order to dorsiflex the ankle, but which leads to a simultaneous dynamic clawing of the toes. It may be possible to see a medial arch form during the swing phase of gait in a patient with a mobile flat foot.

Patients with stiff ankle joints often walk with external rotation of the foot as this way they can compensate for the lack of ankle dorsiflexion by rolling over the subtalar joint instead. Ankle stiffness can be further examined by stopping the patient and asking them to squat down whilst keeping their heels pressed into the ground. Any loss of dorsiflexion will lead to the heels rising as the patient descends. Causes include intrinsic ankle pathology and a tight Achilles tendon. This is a useful test as patients with a tight Achilles tendon and lack of dorsiflexion can present with metatarsalgia as the forefoot is overloaded during the walking cycle, yet the problem to be addressed is in the hindfoot.

Walk the patient as necessary, without causing undue discomfort, until you are sure you have identified most of the above points. Subtle gait abnormalities can be unmasked by asking the patient to walk faster. Remember to consider the knee, hip, spine and neurological causes for unusual gait patterns.

Tibialis posterior: in a standing position the heel normally adopts a slight valgus position (Figure 1). Both the position of the heel and the medial arch are intimately related to several structures, but in particular the tibialis posterior (tib post) tendon. If the tendon degenerates or ruptures the arch will collapse and the hindfoot will be pushed into valgus. The integrity of the tib post can be tested by asking the patient to perform a heel raise (stand on tip toes). The tib post is a powerful flexor and inverter of the hindfoot, so as the muscle activates to lift the heel the intact tendon will pull the hindfoot into varus. It is important to ask the patient to perform a single stance heel raise on the affected side only, as it is possible to mask a symptomatic leg by compensating with the opposite one. The test should also ideally be performed with the patient standing as close to a wall as possible. This will give them a chance to place their hands against the wall for stability whilst standing on one leg without being able to lean forward and do a “push up” on the wall to help the heel raise and give a false impression of an intact tib post. In subtle cases the flexor hallucis longus (FHL) and flexor digitorum longus (FDL) tendons may compensate for a weak tib post and the patient may be able to perform a single stance heel raise. However, the muscle bellies of FHL and FDL are relatively small and fatigue very quickly, so in this situation the patient is asked to perform multiple heel raises. As they tire the problem will be unmasked. There are many other reasons why a patient may not be able to perform a heel raise, including Achilles tendonopathy, motor weakness and pain or stiffness from arthritic joints in the foot and ankle, all these causes need to be considered before diagnosing tib post deficiency.

Too many toes: in long standing tib post insufficiency a flat foot deformity can occur, which causes the forefoot to adopt an abducted position. If you observe the patient from behind you will notice that you can see more toes lateral to the tibia than on the normal side. This is known as the ‘too many toes sign’ and whilst it is common in tib post insufficiency, be aware that it can also be a feature of external tibial rotation. It is normally reckoned that more than two toes protruding laterally is abnormal (thus “two toes is too many toes”) although in reality it is safer just to note a difference between the two sides.

Cavo-varus foot: if the heel is in varus rather than in valgus then not only will it be difficult for the patient to perform a single stance heel raise due to lateral instability, but the test will not elicit any useful information as the tib post has to be intact in order for the heel to attain this position. The varus heel will usually be accompanied by a midfoot cavus deformity because the foot naturally wants to adopt a plantigrade position and in order to do so it must form a tripod. As the heel moves medially the forefoot supinates correspondingly which elevates the first ray off the ground, therefore in order to reform the tripod the first ray must flex creating a high medial arch. In these situations we need to ask two questions which may affect further treatment. First, we need to ascertain whether the cavus deformity is driven by (primarily caused by) the plantar flexed first ray or the varus heel. Second, is the hindfoot deformity fixed or flexible? Both these questions can be answered by the Coleman block test.

Coleman block test: the idea behind the Coleman block test is simply that by standing with the heel on a high surface and allowing the first ray to drop into space without touching the
In order to perform the test, ask the patient to stand with the heel and the lateral border of their foot on a block or a thick book, the British National Formulary is perfect (Figure 2). With the first ray overhanging the block in space, ask the patient to try and touch the floor with the great toe. It is often helpful to get the patient to stand on a block with the other foot to keep them balanced and to demonstrate the test in front of them before they attempt it. Once the test is set up, stand behind the patient and look at the heel from the back. If the heel returns to a normal valgus position this tells us that the hindfoot is flexible and the deformity is being driven by a flexed first ray (which has now been eliminated). If the hindfoot remains in fixed varus it tells us that the deformity is driven by the hindfoot. The distinction between flexible and fixed hindfoot deformities is important for pre-operative planning as a cavus foot with a flexible hindfoot deformity may be corrected with a first ray osteotomy and tendon transfers alone, whereas a fixed hindfoot will require an additional calcaneal osteotomy or a subtalar fusion.

**Skin:** following the standing inspection, sit the patient on a high couch in a comfortable position with their affected foot unsupported by the examiner. Ensure that the patient’s hip is not excessively flexed and the plantar aspect of the foot is easy to see. Examine the plantar aspect of the foot looking particularly for calluses under the metatarsal heads and don’t forget to look for lesions between and on the tips of toes.

**Feel**

Now you have “looked” you can move onto the “feel” part of the examination. Palpation should be used to elicit areas of tenderness, tenosynovitis, swelling and warmth. It is important to palpate every part of the foot and ankle in a logical order and we recommend starting proximally and moving distally.

**Hindfoot**

Seat the patient with their leg supported on a stool and begin by firmly palpating the substance of the Achilles tendon for any swelling or tenderness that might represent a tendonopathy. Continue distally to the insertion of the tendon, where pain will represent an enthesopathy, a bursitis or a bony prominence that impinges between the posterior calcaneum and the Achilles, known as a Haglund deformity. The posterior part of the ankle joint can also be palpated for tenderness and it is possible to feel the joint line at this level.

Moving medially, palpate the tib post tendon from its origin behind the medial malleolus to its insertion at the navicular. From observation you will already have an idea whether the tendon is ruptured by the shape of the foot, or dysfunctional by the inability to heel raise, but pain on palpation will unmask a lesser degree of tendonopathy (grade I) that may be amenable to treatment with physiotherapy rather than surgery. Whilst on the medial aspect of the hindfoot, palpate the deltoid ligament, which runs from the tip of the medial malleolus to the talus. The deltoid ligament is unlikely to be damaged by degenerative processes but a traumatic rupture can lead to instability of the ankle joint.

The subtalar joint should be palpated from the lateral side. Orientate yourself by finding the sinus tarsi, which is a soft spot just anterior to the distal fibula. Once you have the correct level then you can easily identify the anterior and posterior processes of the subtalar joint. Pain on palpation may represent arthrosis within the joint, though deep palpation in the sinus is usually tender as this area is well endowed with nociceptors. In traumatic situations, ensure you examine the anterior talofibular and the calcaneofibular ligaments that lie anterior and distal to the fibula respectively and which confer stability to the ankle mortice. Swelling and tenderness over the ligaments may indicate a chronic rupture. The peroneal tendons lie posterior to the fibula, with peroneus brevis being closest to bone. The peroneal tendons can dislocate anteriorly if the retinaculum is disrupted and this may be felt as a click as the ankle joint is passively moved from plantar flexion with hindfoot inversion to dorsiflexion with hindfoot eversion. Follow the peroneus brevis tendon to its insertion at the base of the fifth metatarsal to palpate for tenosynovitis, which may represent intra-substance tears.

**Ankle**

Move to the anterior part of the ankle joint and palpate along the whole margin of the mortice. It is often possible to provoke painful symptoms in the arthritic ankle and may be possible to identify anterior margin osteophytes. Whilst moving across the ankle from medial to lateral there is an opportunity to palpate the tendons that overlie the ankle including tibialis anterior, extensor hallucis longus (EHL), extensor digitorum longus (EDL) and peroneus tertius. In each case, it may be possible to identify tenosynovitis.

**Midfoot**

The midfoot consists of the Chopart joints (talonavicular and calcaneocuboid) and the Lisfranc complex (tarsometatarsal joints). The key to examining these joints is to have an appreciation of their location within the foot, which is often more proximal than expected. The talonavicular joint is usually easy to find as the head of the talus can be found medially and can be exposed by inverting and evertting the midfoot. Once you have identified the level of the talonavicular joint, move laterally at the same level to palpate the calcaneocuboid joint and distally to palpate the
cuneiforms and the tarsometatarsal joints. Tenderness in any region is likely to be due to an underlying arthritic joint.

Forefoot
Palpation of the forefoot is mostly focused on the metatarsal heads and the adjacent joints. Examine each metatarsal head in turn, paying particular attention to any callus formation or tenderness that might represent overloading of the head, often secondary to a short first ray. The metatarsophalangeal joint (MTPJ) may also be thickened and tender due to synovitis, particularly in rheumatoid patients, and is often more apparent on the dorsal aspect of the joint. Acute swelling and significant pain associated with the MTPJ’s may be secondary to a plantar plate rupture and will cause hammering of the toe as a late sign.

Patients with deficient plantar plates often develop subluxation of the MTPJ’s, which may eventually lead to frank dislocation. In the early stages it can be possible to elicit a drawer sign of the lesser toes analogous to Lachman’s test in the knee. The significance of a positive result is that in a patient undergoing first ray surgery, a lesser metatarsal osteotomy may be required to relocate the unstable toe. Instability is diagnosed by firmly holding the base of the proximal phalanx with one hand and the corresponding metatarsal head with the other and translating the toe backwards and forwards such that the MTPJ subluxates and relocates. Ordinarily, there should be no translational movements at the joint. Be careful because this manoeuvre can be very painful in an acutely inflamed joint and there may be only one chance to try it.

Morton's neuroma
Morton’s neuromata are a common cause of pain in the forefoot and are often described by the patient as a severe burning with the symptoms being relieved when the shoes are removed. In order to examine for a neuroma, palpate firmly between each of the metatarsal heads in turn, ensuring that you distinguish between the space and the metatarsal head itself. In any webspaces that exhibit pain on palpation you should perform a Mulder’s click test to help clarify the diagnosis.³ The basis of the Mulder’s click is that a sizeable neuroma if pushed out from between the metatarsal heads will produce a palpable and occasionally audible click. Beware, however, that the test may be falsely positive for all masses between the metatarsal heads, including bursae. The test is performed by maximally dorsiflexing the foot and applying firm pressure between the metatarsal heads with the thumb of one hand. This manoeuvre ensures that the neuroma is situated between the metatarsal heads. Using the other hand, squeeze the first and fifth metatarsal heads together and feel for a click, which is a positive sign, as the swelling moves from a dorsal to a plantar position relative to the adjacent metatarsal heads (Figure 3). The test should be repeated for each webspace. As neuromata form on digital nerves they often alter sensation to the affected toes, so it is strongly recommended that one checks the sensation along the border of each toe in order to help confirm or refute the diagnosis.

Move
Passive movement
The final stage of the examination is movement, and again this should be done in a logical fashion starting proximally and working distally, usually with passive movements first followed by active. Given the large number of joints in the foot, the examination can be deceptive, as although it may appear that a particular joint is moving, it may be the adjacent joints that are masking stiffness. Therefore, in order to ensure each joint is examined correctly, it is important that the examiner stabilizes the adjacent joints with his or her other hand.

Ankle: the main movement of the ankle is plantar and dorsiflexion, usually with an arc of 65 degrees. It is very easy to mistake motion at the ankle for that in the midfoot, and indeed it can be difficult to tell if a patient has an ankle fusion by glancing at them as they walk due to the amount of compensation that can occur in the distal aspect of the foot. For this reason, as you examine the ankle, it is vital that you stabilize the midfoot. We recommend that you grip the heel with the palm of your hand and rest the sole of the foot on your forearm (Figure 4). This way, as the ankle moves you are blocking any motion at the midfoot and getting a true picture. The examination can be made more accurate by using your other hand to palpate the anterior aspect of the talar dome in the mortice to get an idea of how it is moving in comparison to the foot. Very little movement of the talus suggests movement is occurring through the distal joints.
A common mistake when examining the range of movement of the ankle is not to take into account the effect of a short Achilles tendon secondary to either a valgus or a varus hindfoot. As the calcaneum moves medially or laterally, the axis of pull of the Achilles moves from the midline and eventually acts as a secondary driver of the deformity. As this process progresses, the Achilles tendon gradually becomes shortened as the distance it needs to traverse is decreased. When you measure ankle movement in a patient with hindfoot deformity it can appear that they have a good range of movement; however, to assess it properly the hindfoot, if flexible, has to be brought into a neutral position. Only then will any shortening of the Achilles tendon become obvious as the foot will tend to plantar flex as the heel is brought into line. This is useful as it allows one to distinguish stiffness secondary to intrinsic ankle pathology and stiffness secondary to a tight Achilles tendon.

**Silverskiold test:** ankle dorsiflexion is commonly restricted by a tight Achilles tendon. The Silverskiold test can be used to differentiate between a tight gastrocnemius and a tight soleus muscle. It relies on the fact that the gastrocnemius muscle crosses both the knee and the ankle and therefore can be effectively lengthened by flexing the knee. Sit the patient down with the knee fully extended, then dorsiflex the ankle as much as possible and record the range. Now ask the patient to flex the knee and repeat the ankle dorsiflexion. If the two measurements are different and the ankle dorsiflexes further with the knee bent then the gastrocnemius is tight.

**Ankle stability:** as well as dorsiflexion and plantar flexion the ankle can be examined for stability in both the antero-posterior and coronal planes. For anterior stability you can perform the drawer test, which is analogous to the Lachman test. With the patient fully relaxed and the foot in a degree of gravity equinus, place one hand behind the calcaneum and the other hand on the anterior aspect of the tibia to support it. Pull the heel forwards and note the degree of anterior translation of the talus against the tibia; it often requires comparison between the two sides to record a pathological result. Remember to move the talus forward perpendicular to the inter-malleolar axis so that the more anteriorly positioned medial malleolus does not give a false negative anterior drawer test. The ankle can also be unstable in the coronal plane, usually secondary to calcaneal-fibular ligament deficiency. Medial and lateral movements are often mistaken for those at the subtalar joint. The key to differentiating between instability of the ankle and subtalar movement is to place a thumb over the upper lateral corner of the talus in the ankle mortice. Grasp the heel and make side to side movements, if the ankle is unstable then your should feel a definite tilt of the talus as it subluxates out of joint. If the ankle is stable then most coronal movement will occur at the subtalar joint, which has a range of approximately 30 degrees.

**Midfoot:** the talonavicular joint allows supination and pronation of the forefoot on the hindfoot. In order to examine this joint the hindfoot represented by the talus must be stabilized with the thumb from one hand on the talar neck whilst the forefoot is put through its range of motion by the other (Figure 5). Movement at this complex gives the opportunity to study how the forefoot aligns with the hindfoot and whether it is able to maintain a neutral position.

The Lisfranc complex is situated between the base of the metatarsals and the cuneiforms/cuboid. These are planar joints and so have little movement but can cause significant pain if they are arthritic. They can be examined on mass by stabilizing the cuneiforms with one hand and moving the metatarsals in the plane of motion, which is both dorso-plantar and mediolateral.

It is often useful to examine the first tarsometatarsal joint (1st TMTJ) in isolation from the other joints at the Lisfranc level. This can be done by firmly holding the lateral metatarsals whilst moving the first metatarsal shaft up and down with the other hand. In certain patients there can be a degree of hypermobility at the 1st TMTJ, and in these patients standard osteotomies for hallux valgus correction may have a higher recurrence rate.

Although it is difficult to quantify hypermobility at the 1st TMTJ, a difference in displacement of 2 cm compared to the lateral rays is usually taken as a positive result.

**Forefoot:** the first MTPJ is very susceptible to arthritic change and dorsal osteophytes are commonly present and often palpable. A careful examination here can be extremely valuable in determining appropriate surgery in suitable patients. Holding the first metatarsal for support, put the great toe through its full range of movement. Note the maximum dorsiflexion and plantar flexion and especially whether there is painful impingement of osteophytes against the proximal phalanx at the extremes of movement. Now apply axial pressure across the joint and grind it with small circular movements: pain and crepitus represent an arthritic joint. If the patient has pain only on the extremes of movement along with palpable osteophytes, they may benefit from a chellectomy, which would remove the obstruction and retain movement in the joint. If the pain is present in the mid-part of motion and on grinding the joint then a fusion or joint replacement would be more appropriate.

In hallux valgus, as well as dorsal and plantar flexion, make an attempt to reduce the deformity by squeezing the first and fifth metatarsals together and pulling the great toe medially. This manoeuvre will give you a feel for how easy it will be to surgically reduce the deformity and potentially how successful the outcome is likely to be. Patients with hallux valgus are often...
short in the first ray, which subsequently causes overloading of the adjacent ray, particularly the second. There will be a tendency for the overloaded second ray to try and shorten itself and this occurs in the form of a hammer toe deformity and instability at the MTPJ which can be assessed as described above. Whilst examining the great toe ensure the Interphalangeal joint is examined for range of movement, pain and osteophytes. Finally, assess the lesser toe MTP, PIP and DIP joints individually for pain, instability and deformities and note whether they are fixed or correctable.

Active movement
Assessing the active movements of the foot and ankle will give an idea of the muscle strength that drives them. One must be aware, however, that both pain and any stiffness will limit power across any joint. The main movements to assess are plantar flexion and dorsiflexion of the ankle, inversion and eversion of the hindfoot and flexion and extension of the toes. Both sides should be compared at each stage. The concept of inversion (tib ant and tib post) and eversion (peroneal tendons) can be difficult for some patients to grasp, so rather than asking a patient to perform them, it is easier to place the foot into the position of maximal deformity and ask them to push against the examining hand (Figure 6).

Whilst both tib ant and tib post are inverters of the hindfoot they can be examined in isolation by testing inversion with maximal plantar flexion (tib post) and inversion with dorsiflexion (tib ant). Both these manoeuvres should be accompanied by direct palpation of the appropriate tendon.

Neurovascular
The examination should be completed by assessing the foot pulses and capillary refill as well as performing a full sensory examination, including both dermatomes and individual nerve distributions. Any global sensory deficit should be investigated further with a 10 g Semmes Weinstein filament to test for protective sensation.

Conclusions
The descriptions given above are a guide as to how one can approach the task of formally and methodically examining the foot and ankle. However, it can only really be learnt through experience and through practice, from a platform of a sound understanding and appreciation of the anatomy and biomechanics of the foot and ankle. Furthermore, the examination of the foot and ankle can only be put into appropriate context with a good understanding of the potential pathologies that can exist. As one gains experience in the assessment of the foot and ankle, an approach to clinical examination will inevitably evolve. However, particularly for those in training, a step-by-step, didactic, methodical approach can help enormously in ensuring that the examination is thorough and that potential pathologies are not overlooked.

REFERENCES