Imaging of the foot and ankle

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Abstract

There are a number of imaging modalities available to assist in assessment of the foot and ankle. The variety of techniques will be described with emphasis on the particular advantages and limitations of each. Recent advances and variations relating to the individual modalities are reviewed together with specific clinical scenarios.

Keywords ankle; diagnostic imaging; foot

Introduction

Imaging of the foot and ankle is commonly undertaken and there is a wide range of modalities available for assessment of a variety of abnormalities. Radiography remains the mainstay of imaging but there are several more advanced techniques which can be usefully applied. An understanding of these is critical for a balanced approach to imaging.

Plain radiographs

The initial evaluation of many musculoskeletal conditions of the foot and ankle is with plain radiographs. These are produced through variations in the absorption of ionizing radiation by the body's tissues, resulting in excellent spatial resolution between soft tissue and bone due to their differing attenuation values.

Typically two views of a body part are taken, conventionally in the anteroposterior (AP) and lateral planes. Due to the complex anatomy within the ankle and foot this is frequently modified depending on clinical concern. The use of weight-bearing films, other than in trauma, allows for standardization of images and can reveal subtle but important changes in alignment (Figure 1).

A modified AP image with the foot and ankle in 15–20° of internal rotation, the mortise view, provides unobstructed assessment of the talar dome (Figure 1a), as a standard AP image can obscure pathology here. In the foot, due to the overlapping orientation of the tarsal arches, oblique images can provide valuable supplementary views but do not replace the standard radiological assessment.

Advantages

Radiographs are widely available and relatively inexpensive. For the diagnosis of bony abnormalities plain radiographs are particularly useful. The demonstration of a joint effusion or soft tissue swelling is useful in cases of radiographically occult injuries (Figure 2).[1]

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Disadvantages

The acquisition of plain radiographs involves ionizing radiation and whilst the dose to the extremity is minimal, the potential hazards of radiation should not be ignored. Whilst allowing a limited soft tissue evaluation as alluded to above, a detailed review of the soft tissues is not possible on radiographs due to the narrow range of attenuation values between them. It is important that additional imaging is performed if clinical concern persists.

Variations

Stress views: active or passive stress views may demonstrate indirect evidence of a ligamentous injury. The combination of the additional applied force and an underlying ligamentous disruption results in widening of the joint space. In the ankle, stress views can evaluate disruption of the lateral ligament complex (talar tilt), the medial ligament complex and the tibiofibular syndesmosis.

Fluoroscopy: fluoroscopic techniques are typically used in orthopaedic surgery and radiological services to guide fracture reduction or aid interventional procedures. Similar to standard radiography this modality utilizes a X-ray source but produces real time dynamic images and allows dynamic evaluation of the joint.

Arthrography: arthrography involves the injection of a radioopaque contrast agent into a joint, typically under fluoroscopic guidance, or alternatively with ultrasound. Indirect information pertaining to the soft tissues can be deduced from the pattern of distribution of the injected contrast medium. Both diagnostic and therapeutic joint injections are frequently combined with arthrographic procedures *via* injection of local anaesthetic or steroid agents respectively.

In the foot and ankle, arthrography is typically performed in conjunction with MRI or less frequently CT utilizing a suitable contrast agent.

Tomosynthesis: the conventional radiographic technique can be modified to acquire numerous low dose images of specific body part at differing focal depths. Digital tomosynthesis is established in breast imaging and in the evaluation of pulmonary nodules but has expanded into musculoskeletal imaging.[2] The radiation dose is greater than conventional radiography but is less than CT and this modality shows promise in the evaluation of postoperative patients with potential reduction in the extent of streak artefact. Studies have demonstrated the value of tomosynthesis in relation to wrist fractures but there is potential to investigate for occult bone injury in any area where complex anatomy or soft tissue overlay limits evaluation or where abnormalities are radiographically occult (Figure 3).[3]

Ultrasound (US)

US plays a key role in the diagnosis and management of musculoskeletal disease. For the evaluation of superficial musculoskeletal structures a high frequency probe is necessary, typically a linear array probe of at least 7 MHZ and ideally 10 MHz or greater. This enables greater spatial resolution at the expense of limited depth penetration. A small footprint probe if

Figure 1 Diabetic patient with distal neuropathy. (**a**) Weight-bearing mortise radiograph demonstrates talar tilt not appreciated on (**b**) reformatted coronal CT of the same patient.

available can be a usual adjunct particularly in the foot. Whilst evaluation of the bone is not possible with US the periosteum is well visualized and occult stress fractures of the ankle or metatarsals can be detected.[4]

Advantages

When compared to other imaging modalities, US offers the unique advantage of dynamic assessment. It is a high resolution, rapid real time examination which can be focused on the exact site of clinical symptoms and involves no radiation. Tendons and ligaments can be evaluated during active or passive movement. For example, dynamic US can elucidate peroneal subluxation not evident on static imaging.

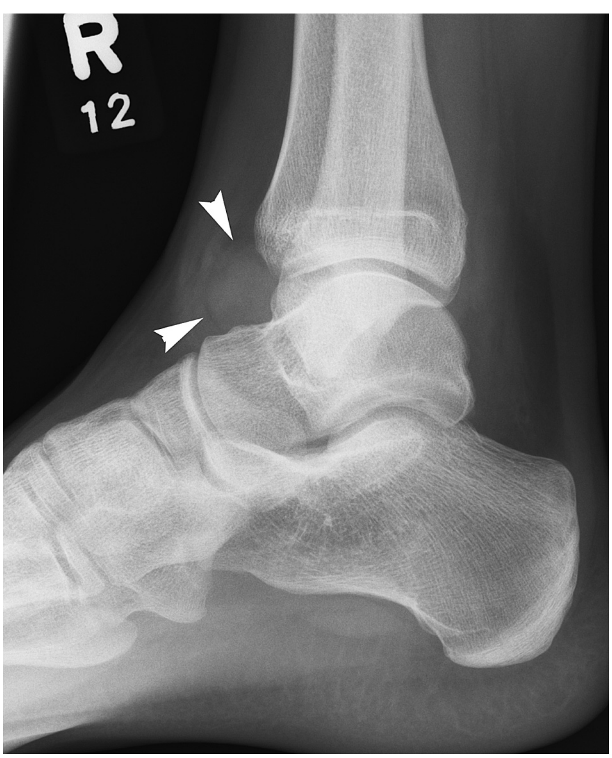

Figure 2 Lateral radiograph demonstrates an ankle joint effusion (arrowheads) but no fracture following trauma.

Figure 3 Digital tomosynthesis ankle mortise radiograph shows a minimally displaced lateral malleolus fracture (arrow) not evident on standard radiography.