A RADIOLOGICAL APPROACH TO THE SUBTALAR JOINT

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The subtalar joint is complex, and its radiological abnormalities are often overlooked because their demonstration presents technical difficulties.

Inversion and eversion are generally thought to be carried out at the transverse joint of the foot, but it is at the talo-calcaneo-navicular joint that most of these movements occur (Wood Jones 1949). Active movements at this level are usually combined with ankle movement. Hence inversion, adduction and flexion occur together as do eversion, abduction and extension.

"Movement of the calcaneum under the talus is essential to inversion and eversion and fixation of the calcaneum will for all practicable purposes prevent these movements." (Inkster 1938.) Abnormalities of this region, whether congenital or acquired, have therefore a considerable effect on the function and mobility of the foot.

The object of this paper is to suggest a radiographic approach to the demonstration of this region, illustrated by examples of the abnormalities exposed.

ANATOMY

The subtalar joint is formed by three separated sets of facets on the calcaneum and plantar surface of the talus. These may be termed the anterior, middle and posterior joints (Fig. 1). The anterior and middle joints are frequently separated by an inter-articular ligament (Smith 1894). The posterior joint has its long axis set obliquely at about 40 degrees to the mid-line of the foot. Its contour is complex but generally curved convexly upwards. The anterior and middle joint facets of the calcaneum have the same direction and relation to the axis of the foot, but their curvature tends to be concave.

Across the contiguous surfaces of the calcaneum and talus are grooves—the sulcus calcanei and sulcus tali—which complete the canalis tarsi. This tunnel opens at its anterior end into the wide bay of the sinus tarsi. The canal is occupied by fat and small vessels. The interosseous talo-calcaneal ligament occupies the sinus tarsi and represents a strong axis about which gliding movements may occur.

RADIOGRAPHY

To establish a logical radiographic approach to a joint of this complexity obviously involves multiple projections. Several projections have been suggested by previous authors, particularly for injuries of the calcaneum.

Palmer (1948) commented on the difficulties of demonstration and suggested an oblique lateral view from below and posteriorly to give a clear view of the posterior facet as it reaches the end of the sinus tarsi. Slomann (1926) and Holland (1928) had previously emphasised
the importance of an oblique lateral view in the diagnosis of calcaneo-navicular coalition. An oblique view is standard procedure in some centres (Chambers 1950).

Anthonsen (1943) described an oblique projection highly commended by Warrick and Bremner (1953) for its value in demonstrating the posterior and middle facets. The technique for this projection involves two tube tilts, 25 degrees caudally and 30 degrees dorsi-ventrally towards the toes, the central ray being directed to a point just below the medial malleolus with the dorsiflexed foot in the lateral position on the film. It has not been found possible to produce these tilts together on many x-ray tubes. The foot position can be adjusted to counter this, but it is felt that the double angulation together with foot positioning makes comparative reproduction difficult. The middle joint facet is also at its greatest distance from the film.

Several oblique medial and oblique lateral projections were suggested by Clark (1956) in an attempt to demonstrate the joint facets. She suggested that the limb be rotated medially...
45 degrees and the tube tilted 40 degrees, 30 degrees or 10 degrees. Alternatively, the limb may be rotated laterally 45 degrees with a tube tilt of 12 to 18 degrees.

In a busy orthopaedic department also undertaking accident work it is of value to have available a routine procedure that can be applied to both static and traumatic lesions arising at the subtalar joint. It should be a method applicable to immobilised patients and to painful stiff feet. It should also be a method which can be used with any x-ray tube and with as little wastage of time as possible. An attempt has been made to establish an economic method of demonstrating all sections of the subtalar joint.

A disarticulated skeleton foot with foam rubber between the talus and calcaneum to establish a resilient joint space was radiographed. Wire markers were fixed in turn to the oval periphery of all three facets of the calcaneum. The most advantageous method of viewing a joint is with its contiguous articular surfaces in profile. The central ray was therefore directed tangentially to each joint. The superimposition of the opposite margins of the oval marker on the film confirmed the profile projection of the joint. Since the posterior joint has a complex curved surface it is advantageous to obtain two views of it at right angles. Radiographs of the disarticulated foot with wire markers in position were also obtained in all the projections described by previous authors. By this experimental technique the following projections are put forward as an approach to the subtalar joint.

*Oblique dorso-plantar* (oblique lateral) to demonstrate the anterior joint (Fig. 2). The inner border of the foot is placed on the film and the sole inclined 45 degrees to the film. The tube is centred 1 inch below and 1 inch anterior to the lateral malleolus.

*Medial oblique axial* to demonstrate the middle joint and also to give a tangential view of the convexity of the posterior joint (Fig. 3). The foot is dorsiflexed and when possible inverted, the position being maintained by a broad bandage held by the seated patient. The limb is rotated medially 60 degrees and the foot rested on a 30 degrees wedge. The tube is directed axially, tilted 10 degrees towards the head and centred 1 inch below and 1 inch anterior to the lateral malleolus. Inversion, which completes the composite movement of inversion, adduction and flexion, can be maintained by an asymmetrical pull on the broad bandage. This projection gives an "end-on" view of the canalis tarsi as in Anthonsen's view but has the added advantages of placing the sustentaculum tali close to the film for bone detail and of being easily reproduced by a fixed angulation of the tube (see below).

*Lateral oblique axial* to demonstrate the posterior joint in profile (Fig. 4). The foot is dorsiflexed and when possible everted, the position again being maintained by asymmetrical pull on the broad bandage. The limb is laterally rotated 60 degrees, flexing the knee when necessary, and the foot rested on a 30 degrees wedge. The tube is directed axially, tilted 10 degrees towards the head and centred 1 inch below the medial malleolus. The tube direction and tilt may be fixed for both oblique axial views. The radiographic factors used are 60-65 kilovolts and 50 mAs, at 36 inches using Ilfex non-screen film. Standard views of the tarsus in lateral and axial projections may be necessary to demonstrate the tuber-joint angle or other features but it is suggested that when interest is directed to the subtalar joint the projections described above should be routine.

Multiplane tomography and stereoscopy have been investigated to a limited extent and have potentialities.

**ABNORMALITIES OF THE SUBTALAR JOINT**

The following abnormalities have been demonstrated by oblique views when standard projections were inadequate.

**Congenital abnormalities**—Two groups of structural anomalies which may produce a "peroneal spastic flat foot" have a direct relation to the subtalar joint.

*Talo-calcaneal bridge*—The bridge may be osseous, cartilaginous or fibrous, uniting the posterior aspect of the sustentaculum tali with the talus. Movement of the joint is impeded...
and inversion is impossible. Symptoms often do not occur until adolescence, but early diagnosis is valuable because late sequelae may be reduced. The bony bar may be demonstrated in the medial oblique axial view. Narrowing of the middle joint space is also usually present and may be the only feature when the fusion is cartilaginous (Fig. 5).

Calcaneo-navicular bridge—A similar type of fusion may occur due probably to similar developmental factors in the early differentiation of mesenchyme. A pseudarthrosis may develop. Symptoms of this coalition are often found earlier, because, it is thought, the mid-tarsal joint is more vulnerable to stress than the subtalar joint in childhood (Jack 1954). This fusion is best seen in the oblique lateral view (Fig. 6).

It has been suggested that many feet show some degree of valgus deformity and that the presence of these anomalies has been overlooked because of the difficulty of visualisation on
routine radiographs (Webster and Roberts 1951, Harris 1955). Spur formation on the dorso-lateral aspect of the head of the talus has been considered significant of the presence of congenital anomalies (Harris and Beath 1948). It has been described by some authorities including Jack (1954), however, as representing the effects of long standing valgus deformity at the midtarsal joint of whatever origin. It is to be emphasised therefore that this sign when

seen in a routine view of the foot is an indication for further investigation of the subtalar joint (Fig. 7).

Extra-articular arthrodesis of the subtalar joint by introducing bone grafts into the sinus tarsi has been employed in the correction of some cases of paralytic flat foot (Grice 1952). Maintenance of the graft in position post-operatively as an effective block to eversion is essential. The medial oblique axial view is valuable for confirming this and may be employed while the foot is still in plaster.
Traumatic lesions—Fractures of the calcaneum may be simple crack fractures (Figs. 8 and 9) or may involve the subtalar joint, particularly in the shearing compression type of fracture. Warrick and Bremner (1953) emphasised the importance of identifying the position of the lateral portion of the posterior articular facet which may be depressed into the main lateral fragment of the calcaneum by secondary compression when the fracture runs obliquely across the posterior facet. The facet may be depressed with the underlying bone or the depressed lateral portion may be continuous with the tuberosity which is split horizontally. These features can be demonstrated by the medial and lateral oblique axial views (Fig. 10).

Many fractures of the calcaneum with severe joint involvement may lead to bony ankylosis with varying functional disability. It seems to be of some importance prognostically,
however, to demonstrate any joint involvement because degenerative change may frequently be anticipated when the articular margins have been disrupted. Traumatic arthritis may be severe (Fig. 14).

Arthritis. Tuberculous arthritis (Fig. 11)—In tuberculous arthritis complete disorganisation may be produced but in the early stages the infection may be limited to part of the joint and be demonstrable by oblique views. Clinical differentiation at this stage may be difficult. Gout (Fig. 12)—Urate deposits in gout may be demonstrated in relation to the subtalar joint before any major arthritic change has developed. Rheumatoid arthritis (Fig. 13)—Although mainly involving the small joints distally, rheumatoid arthritis may produce a rigid valgus deformity by involvement of the subtalar joint. Standard views are usually confined to the
forefoot and early proximal changes may be overlooked. Erosions and joint space narrowing are demonstrable. Osteoarthritis (Fig. 14)—Osteoarthritis in the subtalar joint may be secondary to structural deformity or to trauma. It is capable of producing a stiff and painful foot. Early narrowing of the joint space is often confined to one or two compartments of the joint and will therefore be seen clearly only in oblique axial views.

**Fig. 14**
Gross osteoarthritis after injury. Several tarsal joints are involved, particularly the posterior compartment of the subtalar joint demonstrated in the lateral oblique axial projection.

**Fig. 15**
Osteitis deformans of the calcaneum. Secondary narrowing in the middle compartment of the subtalar joint, demonstrated in the medial oblique axial projection.

**Local bone disease**—Many other conditions, primarily affecting bone, may produce secondary change in the subtalar joint—for example, osteitis deformans (Fig. 15).

**SUMMARY**

The subtalar joint is not easy to visualise by standard radiographic methods. Several projections are described including medial and lateral oblique axial views to demonstrate the
three compartments of the joint. It is suggested that when visualisation of the subtalar joint is required these views should be routine.

Various conditions affecting the subtalar joint and their demonstration by these oblique axial views are discussed.

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REFERENCES


