The proximal extent of the ankle capsule and safety for the insertion of percutaneous fine wires


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We have assessed the proximal capsular extension of the ankle joint in 18 patients who had a contrast-enhanced MRI ankle arthrogram in order to delineate the capsular attachments.

We noted consistent proximal capsular extensions anterior to the distal tibia and in the tibiofibular recess. The mean capsular extension anterior to the distal tibia was 9.6 mm (4.9 to 27.0) proximal to the anteroinferior tibial margin and 3.8 mm (-2.1 to 9.3) proximal to the dome of the tibial plafond. In the tibiofibular recess, the mean capsular extension was 19.2 mm (12.7 to 38.0) proximal to the anteroinferior tibial margin and 13.4 mm (5.8 to 20.5) proximal to the dome of the tibial plafond.

These areas of proximal capsular extensions run the risk of being traversed during the insertion of finewires for the treatment of fractures of the distal tibia. Surgeons using these techniques should be aware of this anatomy in order to minimise the risk of septic arthritis.

The reduction of a low distal tibial fracture may be satisfactorily held by external fixation with finewires. This minimises surgical exposures for the use of large plates, which have been associated with high complication rates and unsatisfactory results especially in high-energy injuries.

External fixation has been associated with pin-track infection that may develop into deep infection. In the knee joint, the capsule extends distally below the level of the tibial plateau. Wires placed in the proximal tibial metaphysis may traverse the intracapsular space and risk septic arthritis. Exclusion. Patients whose ankle joint capsule may have been abnormally distorted were excluded from the study such as those with a history of recent ankle trauma, ankle fracture, previous ankle surgery and rheumatoid or other forms of inflammatory arthritis.

MRI arthrography. The ankle joint was slowly injected with 5 to 15 ml of 1 mM dimeglumine gadopentetate solution (Magnevist, Schering AG, Berlin, Germany) 15 to 30 minutes before MRI scanning. The anteromedial or anterolateral approach was chosen, depending on which was furthest away from the site of pain. The transition from mild to moderate ‘tightness’ felt by the patient within the joint during the slow injection indicated capsular ‘fullness’. At this point no further contrast was injected. Patients were encouraged to maintain active flexion/extension movements of the ankle joint before the MRI scan in an attempt to distribute the contrast medium evenly.

Selected sagittal, axial and coronal views were obtained with a 1.5 Tesla MRI system (GE Medical Systems, Milwaukee, Wisconsin). The following sequences were obtained: sagittal fat saturated (FS); T2-weighted fast spin echo (FSE); sagittal GE T2-weighted; axial dual echo spin echo (SE); coronal SE T1-weighted and coronal T1-weighted FSE FS.

Capsular measurements. The sites of the proximal extent of the capsular reflection were noted and their corresponding perpendicular heights were measured with reference to: the
anteroinferior margin of the distal tibia, which corresponds to the anterior tibiotalar joint line; the superior extent of the dome of the tibial plafond, and the tips of the medial and lateral malleoli (Fig. 1). These measurements were performed digitally using Advantage Windows v4.2 (GE Medical Systems). Where necessary, when the tip of the capsular extension lay between two consecutive axial cuts, we adopted the lesser value. We recorded the mean and range for each measurement.

Results
A unilateral contrast-enhanced MRI ankle arthrogram was carried out on 18 patients. The median age was 32.9 years (20.5 to 76.8). There were ten men and eight
women with seven right and 11 left ankles being investigated.

All contrast-enhanced MRIs of the ankle joint space were well defined.

Two sites of proximal capsular extensions were noted, one anterior to the distal tibia and the other in the tibiofibular recess (Figs 2 and 3).

The mean proximal capsular extension anterior to the distal tibia was 9.6 mm (4.9 to 27.0) proximal to the anteroinferior margin of the distal tibia and 3.8 mm (2.1 to 9.3) proximal to the dome of the tibial plafond. The mean proximal capsular attachment was 14.0 mm (8.8 to 21.4) and 29.4 mm (21.8 to 39.4) proximal to the tips of the medial and lateral malleoli, respectively.

The mean proximal capsular extension in the tibiofibular recess was 19.2 mm (12.7 to 38.0) proximal to the anteroinferior margin of the distal tibia and 13.4 mm (5.8 to 20.5) proximal to the dome of the tibial plafond. The mean proximal capsular extension was 23.6 mm (15.2 to 31.7) and 39.1 mm (28.9 to 43.3) proximal to the tips of the medial and lateral malleoli, respectively.

There was no evidence that the capsule had been ruptured because of the injection of excessive contrast media. Any escape of contrast medium would have been obvious on the T1 fat-saturated sequence.

Discussion

The position of fine-wires for fractures of the distal tibia requires precise anatomical knowledge of soft tissue and bony anatomy of the leg and foot. Safe corridors for insertion have been described by several authors. Although this knowledge may aid the surgeon in avoiding tendons and neurovascular structures during the insertion of wires, there is a risk of penetrating the ankle joint when they are used to treat fractures of the distal tibia.

The level of the proximal capsular extension of the ankle joint has not been previously formally assessed. Vives et al described an anteromedial capsular reflection of the ankle joint was anteromedial to the anterior joint line and that the proximal capsular reflection was 32 mm (by dissection) and 30 mm (by arthrogram) from the medial malleolus and 21 mm (by dissection) and 20 mm (by arthrogram) from the anterior joint line. However, their results were based on one cadaver dissection with a pre-dissection arthrogram. Our results have shown that proximal capsular extension occurred at two sites, anterior to the distal tibia and in the tibiofibular recess. In our study, the mean proximal capsular extension anterior to the distal tibia was 14 mm from the medial malleolus and 9.6 mm from the level of the anterior tibiotalar joint line. The discrepancy in results may be due to difficulties related to cadaver dissection and techniques of measurement.

The shape of the proximal capsular extension of the ankle joint has never been formally assessed. Boardman and Liu described an anterolateral extension of the ankle joint capsule. Vives et al described an anteromedial capsular extension. In our study, we noted that the proximal capsular extension anterior to the distal tibia spans across from the anteromedial to the anterolateral aspects of the distal tibia. This is contrary to the impression that there are two separate proximal capsular extensions anterior to the distal tibia, one being anteromedial and the other anterolateral.

In a meta-analysis by Hutson and Zych of 17 studies with peri-articular tibial fractures (ten proximal, seven distal) treated with tensioned wire fixators, the incidence of septic arthritis in the ankle was 0.5% (1 of 187) compared with 1.3% (5 of 381) in the knee. There were no comments as to how close to the ankle joint the wires were placed. One potential explanation for the lower incidence of septic arthritis in the ankle compared with the knee after peri-articular wire placement is the protective role of the fibula. Organisms travelling through skin, subcutaneous fat and fascia may be hindered by the fibula and its periosteal coverings. It may have a protective role in preventing infection reaching the tibiofibular recess. A wire placed mediolaterally in the distal tibia that is just anterior to the fibula (Fig. 4) and less than 39 mm from the fibular tip may traverse the joint capsule within the anterior portion of the tibiofibular recess that is not ‘shielded’ by the fibula.
The results of this study confirm the work by Tol and van Dijk,\(^\text{10}\) which showed that the anterior ankle joint capsule attaches proximal to the anterior tibial cartilage rim, the site where the anterior tibial osteophytic spur originates. The hypothesis of repetitive capsular traction as a cause for the formation of a talotibial osteophytic spur which leads to anterior ankle impingement syndrome, also known as footballer’s ankle, is thus less plausible than previously thought.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References