Foot and Ankle Surgery 25 (2019) 618–622

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas

# Access to the talar dome surface with different surgical approaches

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ARTICLE INFO

*Article history:*
Received 4 March 2018
Received in revised form 27 May 2018
Accepted 23 June 2018

*Keywords:*
Ankle
Talar dome
Anatomy
Surgical approach
Osteochondral lesion
Fracture

ABSTRACT

*Background:* Access to the talar dome for the treatment of osteochondral lesions (OCLs) can be achieved via several different approaches to the ankle joint. The recent description of an anatomical nine-grid scheme of the talus has proven useful to localise OCLs but no studies have demonstrated which approaches are indicated to access each of these zones. The aim of this study is to demonstrate the access afforded to each zone by each approach.
*Methods:* Four standard soft tissue ankle approaches were performed simultaneously in ten fresh-frozen cadavers (anterolateral — AL, anteromedial — AM, posterolateral — PL, posteromedial — PM). The area of the talus, which was accessible with an instrument perpendicular to the surface was documented for each of the approaches. Using ImageJ software the surface area exposed with each approach was calculated. The talar dome was then divided using a nine-grid scheme and exposure to each zone was documented.
*Results:* The AL, AM, PL and PM approaches allow for exposure of 24%, 25%, 5%, 7% of the talar dome respectively. The AL gives access to zones 3 (completely) and 2, 5, 6 (partially); the AM to zones 1 (completely) and 2, 4, 5 (partially); the PL to zones 9 and 8 (partially); and the PM to zones 7 and 8 (partially).
*Conclusions:* A large area of the talar dome cannot be easily accessed with the use of standard soft tissue approaches (39%). Minimal or no access is achieved for grid zones 4–6 and 8. In those instances careful preoperative planning is necessary and extended exposure can be achieved with the use of osteotomies, section of the ATFL or through modified approaches.


## 1. Introduction

Access to the talar dome is necessary for the surgical treatment of osteochondral lesions (OCLs) or the fixation of certain talar body fractures. In some cases (e.g. osteochondral grafting) perpendicular access to the affected area is required and the location and extent of the lesion is instrumental in choosing the most appropriate approach to the ankle joint. Osteotomy can provide more extensive exposure of the talar dome than arthrotomy alone, but carries increased potential for morbidity [1]. In line with these concerns, newer osteotomy techniques have been developed to minimise risks and avoid ligamentous disruption [2]. However, osteotomy carries a higher risk, and therefore remains a second choice surgical approach, to be used when arthrotomy alone is insufficient [1,2].

A previous study has investigated the extent of access to the talus with open surgical approaches. Muir et al. [1] demonstrated in a cadaveric study that a residual 15% of the central talar dome surface cannot be accessed perpendicularly for resurfacing procedures with any standard approach, even with the use of osteotomies. This study raised concern regarding the appropriate preoperative planning required to deal with these lesions. However their results were expressed in terms of percentages of the total talar dome surface, which limited their clinical usefulness.

To assist in preoperative planning, computerised tomography (CT) and magnetic resonance imaging (MRI) studies have been suggested as a useful adjunct to determine whether anterior or

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https://doi.org/10.1016/j.fas.2018.06.006
1268-7731/

posterior arthroscopy is more appropriate to access a particular talar OCL [3]. The recent description of an anatomical nine-grid scheme of the talus facilitates localisation of OCLs and has been popularised among foot and ankle surgeons and the research community [4–7]. It seems clear that the information provided by CT and MRI is beneficial in preoperative planning, both for location of the lesion and the selection of one technique over another, but it is less clear which surgical approaches will provide optimal exposure of a particular lesion located on a CT or MRI.

To date, no correlation has been established between the standard ankle approaches and the exposure of these talar grid areas, which are commonly used for localisation. The aim of this study is to demonstrate which approaches are indicated to access each of these zones. Our hypothesis is that the talar dome cannot be fully accessed with standard ankle approaches and that there is a correlation of the talar grid areas accessed with each approach.

## 2. Methods

Ten unpaired feet (five left and five right), from Caucasian fresh frozen voluntary donor specimens from the anatomy department of the University of Barcelona were used for this study. All feet were amputated at the level of the proximal tibia. Specimens were excluded if they presented any degree of deformity, hard end-point stiffness or surgical incisions from a history of foot or ankle surgery. The study was approved by the Institutional Review Board for Ethical standards (IRB00003099) and complied with the Declaration of Helsinki.

Four standard soft tissue ankle approaches were performed simultaneously in each specimen (anterolateral — AL, anteromedial — AM, posterolateral — PL, posteromedial — PM). To perform the approaches the textbook by Hoppenfeld et al. [8] was used as a guide and their descriptions were followed. In order to adhere to a standardised dissection, all the approaches were performed by the same foot and ankle surgeon. The AL approach used a 6-cm longitudinal incision, lateral to the peroneus tertius or, in its absence, the extensor digitorum longus (Fig. 1). The AM used a 6-cm longitudinal incision, between the tibialis anterior and the medial malleolus (Fig. 2). The PL approach involved a 6-cm longitudinal incision, between the tendo Achilles and the lateral malleolus; the intermuscular plane between the peronei tendons and the flexor hallucis longus muscle was developed (Fig. 3). The PM approach used a 6-cm slightly curved incision between the medial malleolus and tendo Achilles; after incising the retinaculum the intermuscular plane between the tibialis posterior and flexor digitorum longus (FDL) tendons was developed (Fig. 4). In all cases the capsule from the ankle joint was incised and elevated to expose the talar dome. Any peripheral nerves encountered during the procedures were protected.

The area of the talus, which was accessible with an instrument perpendicular to the surface (surgical blade) was documented for each of the approaches. The ankle was manipulated throughout the whole range of motion and the largest exposable surface was used for any given approach. For anterior approaches full plantarflexion provided the largest surface whereas for posterior approaches full dorsiflexion was performed. The talus was then disarticulated and examined as well as digitally photographed. Using ImageJ software [9] the surface area exposed with each approach was calculated. This programme from the National Institutes of Health has been utilised in numerous scientific and orthopaedic publications for data analysis [10–13]. Once calibrated for each talus specimen individually, the square area of exposed surface was calculated. The talar dome in each specimen was divided using a nine-grid scheme following the description of Elias et al. [4] and exposure to each zone was documented.

## 3. Results

The ten below-knee specimens comprised 5 men and 5 women with a median age of 72.5 (range 51–83 years).

The AL approach allowed for exposure of a mean 24% (range 19%–38%) of the talar dome surface, the AM approach gave access to a mean of 25% (range 21%–29%), the PL approach to a mean of 5% (range 3%–11%) and the PM approach to a mean of 7% (range 5%–8%). Whilst performing the PM approach, we noticed that when attempting to use the plane between the tibialis posterior tendon and the malleolus, instead of between TP and FDL, the accessible area was reduced in all cases, although this was not quantified (Fig. 5).

The talar grid zones accessible with each approach are represented in Table 1.

## 4. Discussion

We found that the clinically important zones 4 and 6 can only be partially accessed via an AM or AL approach respectively. Specifically, the AL approach gives access to zones 3 (completely) and 2, 5, 6 (partially); the AM to zones 1 (completely) and 2, 4, 5

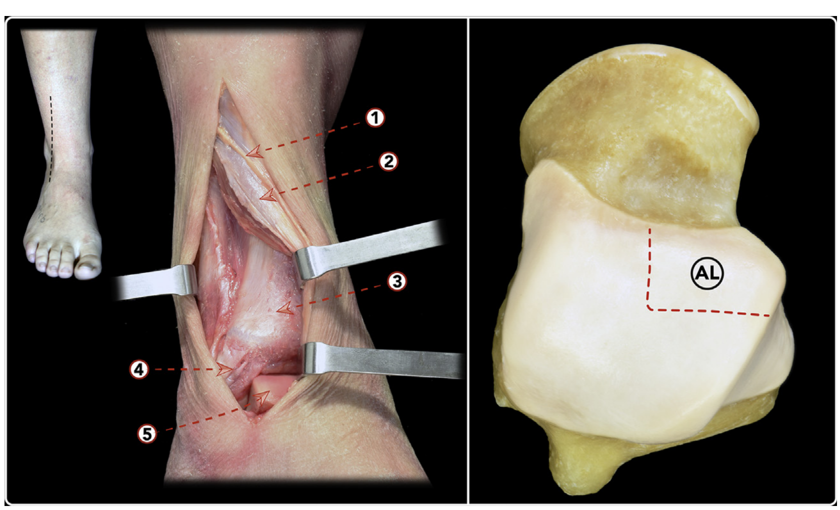


**Fig. 1.** ANTEROLATERAL approach. Cadaveric approach and representation of the accessible talar dome area with the anterolateral approach. (1) Superficial peroneal nerve, (2) incised leg fascia and retinaculum, (3) distal tibial metaphysis, (4) anterior tibiofibular ligament, (5) talar dome and articular surface.

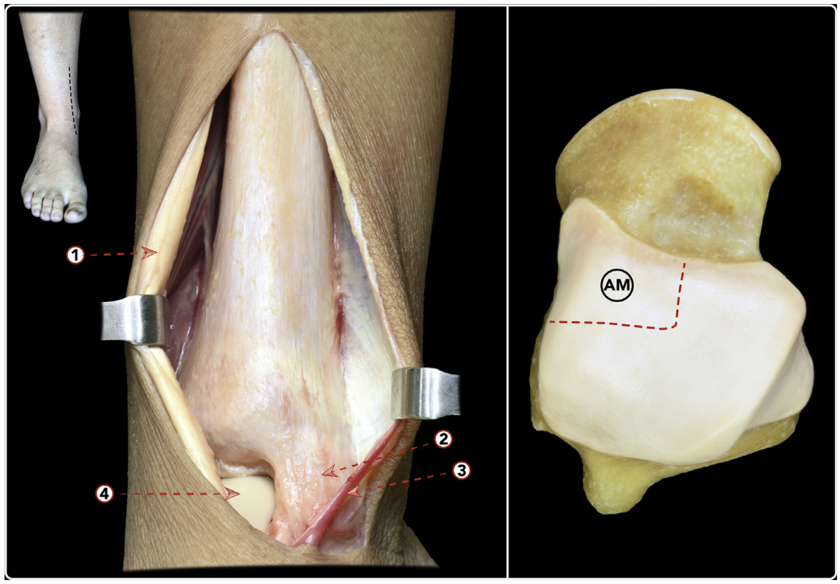


**Fig. 2.** ANTEROMEDIAL approach. Cadaveric approach and representation of the accessible area of the talar dome with the anteromedial approach. (1) Tibialis anterior tendon, (2) medial malleolus, (3) great saphenous vein, (4) talar dome and articular surface.

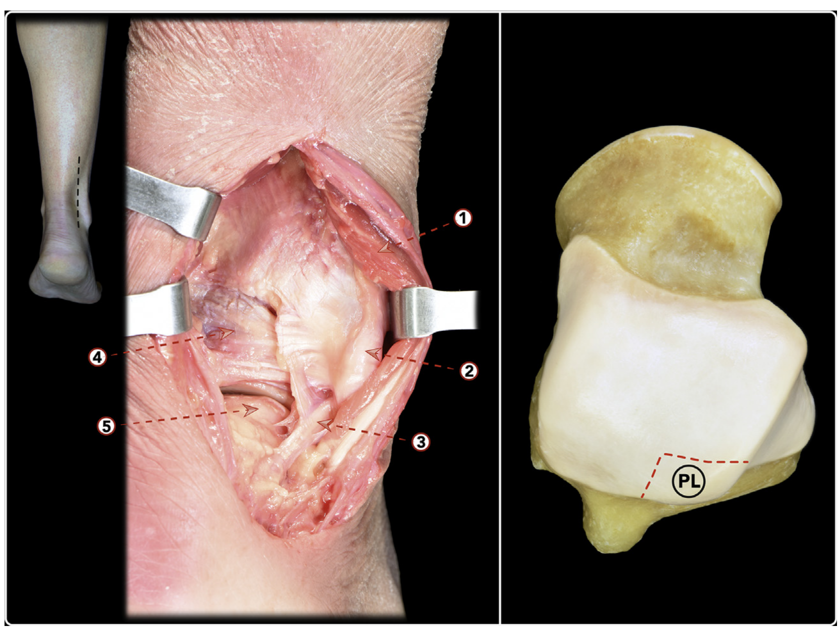


**Fig. 3.** POSTEROLATERAL approach. Cadaveric approach and representation of the accessible talar dome area with the posterolateral approach. (1) Flexor hallucis longus muscle fibers, (2) lateral malleolus, (3) posterior tibiofibular ligament, (4) posterior intermalleolar ligament, (5) talus.

(partially); the PL to zones 9 and 8 (partially); and the PM to zones 7 and 8 (partially). When a lesion falls within these partially accessible zones, it is therefore sensible to be prepared for other procedures, such as osteotomies (in the case of zone 4) or sectioning of the ATFL (in the case of zone 6) to improve access, and to discuss this with the patient during the pre-operative planning and consenting process.

Surgical management of OCLs requires detailed preoperative planning. The use of arthroscopy via anterior and/or posterior portals to treat OCLs allows for visualisation of most of the talar dome and distal tibia. Depending on the location of the lesion some portals will be more appropriate than others and, investigations such as CT or MRI are essential to guide the decision-making process [3]. However, those lesions that are accessible to arthroscopy may not be adequately exposed by the open approaches used for cartilage transplantation techniques. For a successful transplantation the whole surface of the lesion needs to be reached by instruments that are used perpendicularly to the talar dome, hence it must not be covered by the tibial plafond. The centromedial and posteromedial areas of the talar dome are covered by the tibial plafond throughout the whole range of motion and are difficult even to visualise [14]. A number of interventions have been described to assist in the management of OCLs that are not accessible by the standard soft tissue approaches. Osteotomies of the tibia or fibula are popular but not without risk of significant morbidity. Potential complications associated with osteotomies include the risk of nonunion or malunion, tendon injury and hardware-related problems, in addition to the necessity

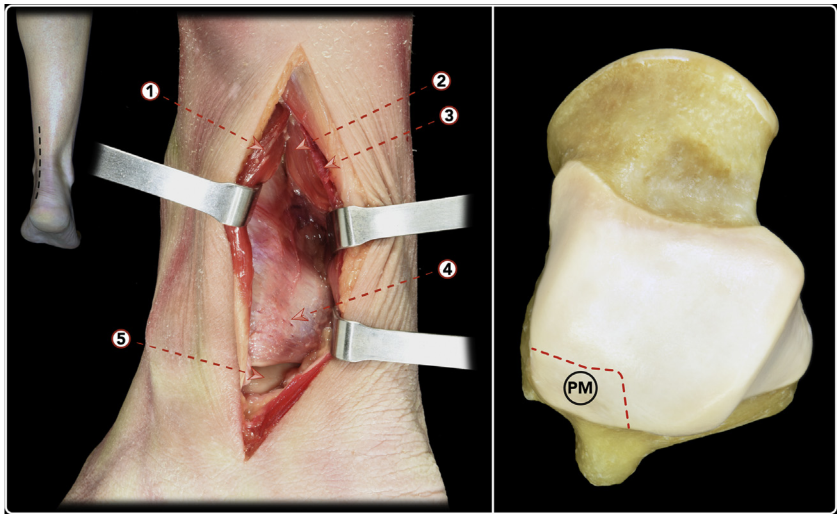


**Fig. 4.** POSTEROMEDIAL approach. Cadaveric approach and representation of the accessible talar dome area with the posteromedial approach. (1) Flexor digitorum longus muscle, (2) tibialis posterior muscle, (3) posterior tibial artery, (4) medial malleolus, (5) talar dome and articular surface.

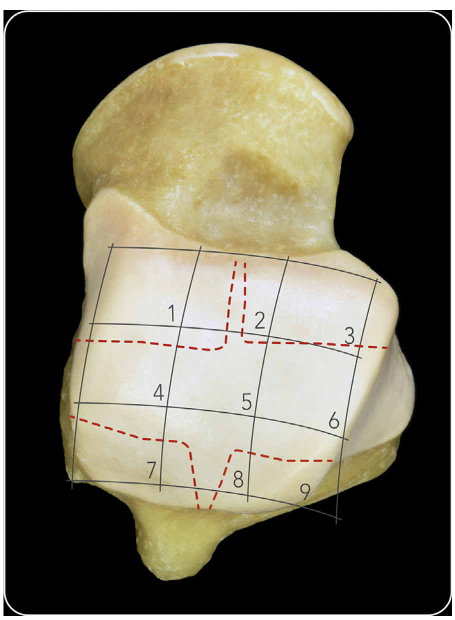


**Fig. 5.** Articular surface of the talus with superposition of the talus grid corresponding to the areas exposed. The AL gives access to zones 3 (completely) and 2, 5, 6 (partially); the AM to zones 1 (completely) and 2, 4, 5 (partially); the PL to zones 9 and 8 (partially); and the PM to zones 7 and 8 (partially).

for a period of non weight-bearing and immobilisation [15,16]. Other options include anterior talofibular ligament release and tendon-splitting approaches [17,18]. The surgeon and patient must strike the correct balance between the morbidity caused by the required exposure and the potential benefits of the treatment itself. It is therefore very important for both surgeon and patient that the necessity for performing an osteotomy in particular is anticipated pre-operatively.

In our study we specifically investigated the area, which was accessible with an instrument perpendicular to the articular surface. Our results are therefore valid for techniques used in revision surgery or for larger talar OCLs, such as matrix-induced autologous chondrocyte transplantation (MACI), osteochondral autograft transplantation (OATS), or resurfacing implants. In other cases, where the technique being used does not require such perpendicular access, the accessible area would be larger for each approach than that reported here. We found that lesions in particular areas of the talus are likely to require osteotomies or other interventions to carry out perpendicular access procedures.

Muir et al. investigated the access to the talar dome using soft-tissue as well as osteotomy approaches [1]. The authors measured the access achieved by a perpendicular K-wire on radiographs and by using a moulding process applied at the surface of the talus. They concluded that on average 17% and 20% of the medial and lateral talar dome respectively, could not be accessed without osteotomy. Furthermore a residual 15% of the central talar dome remained inaccessible even with osteotomies. The finding that 37% of the total talar surface is not perpendicularly accessible via soft tissue surgical approaches correlates very strongly with the findings in our study (39%). However, these results expressed simply in terms of percentages are of only limited clinical use.

Historically it was assumed that most OCLs were located in the anterolateral and posteromedial regions of the talus, although no clear parameters to locate these lesions had been established. In fact, this historical assumption was challenged when a recent MRI study described a nine-zone grid of the surface of the talar dome and determined that the most common locations for OCLs were in the centromedial and centrolateral regions (zones 4 and 6 respectively) [4]. This was confirmed clinically by a study, which used the same nine-zone grid to determine the most common locations of symptomatic, operatively-treated OCLs, and found that centromedial and centrolateral were the most common zones [5].

It seems clear then that the development of this grid system has proven useful in locating lesions both on imaging studies and during operative procedures. In our study we therefore sought to aid in the preoperative planning of open procedures used to treat difficult OCLs by using this reproducible nine-zone grid. We also brought greater accuracy to the measuring process by using digital software to calculate the surface area of each talar zone accessed by each surgical approach.

The current study has some limitations. Firstly, the cadaveric nature of the study and the freezing and thawing process may alter the elasticity of the soft tissues and therefore the area exposed by each approach. Similarly, no contralateral limbs were available for comparison of the range of motion with the dissected ankles. Therefore we cannot exclude the possibility of excessively stiff ankle specimens, which would also affect the exposure of the talar area. Finally, although the results obtained are a good guide for

**Table 1**
Representation of the talar grid zones accessible through each ankle approach using a perpendicular instrument.

| Area /Grid zone | | Anterolateral | Anteromedial | Posterolateral | Posteromedial | Exposure* | |
|---|---|---|---|---|---|---|---|
| | | | | | | F | P |
| Anterior | 1 | | | | | 10 | |
| | 2 | | | | | 8 | 2 |
| | 3 | | | | | 10 | |
| Central | 4 | | | | | | 5 |
| | 5 | | | | | | 2 |
| | 6 | | | | | | 2 |
| Posterior | 7 | | | | | 4 | 6 |
| | 8 | | | | | | 3 |
| | 9 | | | | | | 10 |

Dark shade = full exposure. Pale shade = partial exposure. White = no exposure.
*Number of specimens allowing exposure to each of the 9 zones of the grid (n = 10). F = full exposure. P = partial exposure.

surgical practice, no clinical correlation was performed and further studies in operated patients are warranted. These are all limitations inherent to cadaveric studies.

## 5. Conclusions

A large area of the talar dome cannot be perpendicularly accessed with the use of standard soft tissue approaches (39%). Minimal or no access is achieved for grid zones 4, 5, 6 and 8. Extended exposure can be achieved with the use of osteotomies, section of the ATFL or through modified approaches. Careful preoperative planning is necessary when attempting techniques that require full exposure of a particular area of the talar dome such as MACI, OATS or talar resurfacing implants.

## Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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