Access to talar dome surface with different ankle approaches

ABSTRACT

INTRODUCTION
Access to the talar dome for treatment of osteochondral lesions (OCLs) can be achieved by different approaches to the ankle joint. Osteotomies are used in cases where the area to treat is not fully accessible. The recent description of an anatomical nine-grid scheme of the talus has proven useful to localize OCLs but no studies have demonstrated what approaches are indicated to access each of these zones.

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 that 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 divided in 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, 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 like OATs, ACI, or MACI.

INTRODUCTION

Access to the talar dome is necessary for the surgical treatment of osteochondral lesions (OCLs) or fixation of certain talar body fractures. In some cases (i.e osteochondral grafting) perpendicular access to the affected area is required and the location and extent of the lesion is instrumental to choose the most appropriate approach to the ankle joint.

To assist in preoperative planning, computerized tomography (CT) and magnetic resonance imaging (MRI) studies have been suggested as a useful adjunct to determine whether a talar OCL is accessible via anterior arthroscopic portals or a posterior endoscopy would be more suitable (Van Bergen). This has proven very valuable for those lesions that are amenable to arthroscopy-only treatment. In a number of cases however, open procedures are required to treat OCLs and the extent of exposure obtained with various approaches to the ankle and talus dome becomes an important factor in preoperative planning. One previous study has investigated this issue. Muir et al (Muir) 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 to increase access to certain areas. This study raised concern regarding the appropriate preoperative planning required to deal with these lesions. Their results were expressed in the percentage of the total talar dome surface and despite the drawings included in the paper, it was difficult to reproduce or translate those percentages in the operative field.

Osteotomies can aid in exposing those lesions where the area to treat is not fully accessible although they carry potential morbidity and are effectively an iatrogenic procedure. Such a surgical gesture is used *in lieu* of a better technical option to accomplish the beneficial treatment although the osteotomy is not the intended goal but more of a required harm. Concerning side effects of osteotomies include the risk of nonunion or malunion, tendon injury, hardware-related problems and increased time of non-weighbearing and immobilization. (Alexander, REF) In line with these concerns, newer osteotomy techniques have been developed to minimize risks and avoid ligamentous disruptions. (Vaghela)

It seems clear that the information provided by diagnostic imaging modalities is beneficial to aid in preoperative planning, location of the lesion, and the selection of one technique over another. CT or MRI are widely used in the preoperative period of OCLs or traumatic injuries. It is not as clear though which surgical approaches will provide optimal exposure of a particular lesion located on a CT or MRI. The recent description of an anatomical nine-grid scheme of the talus facilitates localization of OCLs and has been popularized among foot and ankle surgeons and the research community (Elias, Orr, Lomax, Hembree).

To date, no correlation has been established between the standard ankle approaches and the exposure of these talar grid areas that are commonly used for

localization. The aim of this study is to demonstrate what approaches are indicated to access each of these zones.

METHODS

Ten unpaired feet (five left and five right), from Caucasian fresh frozen voluntary donor specimens were used for this study in the anatomy laboratory. All feet were amputated at the level of the proximal tibia. Specimens were excluded if they presented any degree of deformities, ulcers or surgical incisions from a history of foot or ankle surgery.

Four standard soft tissue ankle approaches were performed simultaneously in each specimen (anterolateral - AL, anteromedial - AM, posterolateral - PL, posteromedial - PM). **(FIGURE 1)** To perform the approaches the textbook by Hoppenfeld (REF?) was used as a guide and their descriptions were followed. In order to adhere to a standardized 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. The AM used a 6-cm longitudinal incision, between the tibialis anterior and the medial malleolus. The PL approach involved an 8-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. 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. 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 that was accessible with an instrument perpendicular to the surface 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. The talus was then disarticulated and examined as well as digitally photographed. Using ImageJ software (Rasband) the surface area exposed with each approach was calculated. This program from the National Institutes of Health has been utilized in numerous scientific and orthopaedic publications for data analysis (Fortin, Hammond, Myer, Nofsinger). Once calibrated for each talus specimen individually, the square area of exposed surface was calculated. The talar dome in each specimen was divided in a nine-grid scheme following the description of Elias et al. (Elias) and exposure to each zone was documented**. (FIGURE 2).**

RESULTS

The AL approach allowed for exposure of a mean 24% (range 19%-38%) of the talar dome surface. The AM gave access to a mean of 25% (range 21%-29%) of the talar dome surface. Via de PL approach, access was given to a mean of 5% (range 3%-11%) of the talar dome surface and via the PM a mean of 7% (range 5%-8%). When performing the PM approach, we noticed that when attempting to use the plane between the tibialis posterior tendon and the malleolus, instead of the FDL, the

accessible area was reduced in all cases, although this was not quantified. **(FIGURE 2)**

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

DISCUSSION

The most important finding of this study is that a large area of the talar dome accounting for 39% of its total surface cannot be easily accessed with the use of standard soft tissue approaches. We documented the area that was accessible with an instrument perpendicular to the surface as this is the requirement in most of the cartilage transplantation techniques used in OCLs. Particularly for large lesions, these techniques are commonly used surgical procedures, which include autologous chondrocyte transplantation (ACI), matrix-induced autologous chondrocyte transplantation (MACI), or osteochondral allograft transplantation (OAT).

Surgical management of OCLs requires detailed preoperative planning. The use of arthroscopy to treat OCLs allows for visualization of most of the talar dome and distal tibia through different portals. Depending on the location of the lesion some portals will be more adequate than others and to guide the decision making process, investigations such as CT or MRI are essential. (Van Bergen). 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 be uncovered from 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 even more difficult to visualize (Ross). Lesions located in those areas are accessed via osteotomies of the tibia or fibula to expose the working area. The necessity of adding an osteotomy to the surgical intervention is extremely important for both the surgeon and the patient and a gesture that should be anticipated. Our study has shown that lesions found in particular areas are likely to require osteotomies or other interventions to carry out the procedure.

Historically it was assumed that most of the 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). (Elias) This was confirmed clinically by a study that used the same nine-zone grid to determine that the most common locations of symptomatic, operatively treated OCLs were consistent with the centromedial and centrolateral regions of the talus. (Orr) It seems clear then that the development of this grid has proven useful to locate lesions both on image studies and during operative procedures. With the current study we sought to aid in the preoperative planning of OCLs using a reproducible method of location like the

nine-zone grid. These zones where OCLs present with higher incidence (i.e zone 4 and 6) can only be accessed partially via an AM and AL approach respectively.

To address this issue previous studies had been published prior to the development of the nine-zone grid and are therefore more difficult to interpret. Muir et al investigated the access to the talar dome using soft-tissue as well as osteotomy approaches. (Muir) They measured the access achieved by a perpendicular K-wire on radiographs and by using a molding process applied at the surface of the talus. They concluded that 17% and 20% on average of the medial and lateral talar dome, respectively, could not be accessed without osteotomy and a residual 15% of the central talar dome remains inaccessible even with osteotomies. We believe that with the use of newer technologies and the nine-zone talar grid, our study could bring better accuracy to the measuring process by using digital software. More importantly, the results expressed only in percentages are difficult to reproduce or translate into the operating field. With the information provided by our study the location of an OCL identified on MRI is easily transferrable to the surgical field and thus, facilitates the selection of the best optimal approach. Having said that, the area that we found inaccessible with soft-tissue approaches (39%) correlates with the results of Muir et al of 37% and we have showed that this area corresponds to zones …. When a lesion falls in these zones it is sensible to be prepared for osteotomies or other procedures to improve access and to inform the patient during the consent process.

A number of interventions have been described to assist in the management of OCLs that are not accessible through the standard soft tissue approaches. Osteotomies are popular but not exempt of morbidity. Other resources include the … lig and tendon-splitting approaches. (Easley… Patzkowski) The correct balance between the morbidity caused and the exposure required for treatment lies in the decision of the treating surgeon and the affected patient.

The current study has some limitations. First, 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 may not correlate with the patient. Second, no contralateral limbs were available for comparison of the range of motion of the ankle and therefore stiff ankles cannot be excluded. This would also affect the exposure of the talar area. Third, although the results obtained are a good guide for the surgical procedure, no clinical correlation was performed and further studies in operated patients are warranted.

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 like OATs, ACI, or MACI.

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