FOOT AND ANKLE

An evolution in the management of fractures of the ankle

SAFETY AND EFFICACY OF POSTEROMEDIAL APPROACH FOR HARAGUCHI TYPE 2 POSTERIOR MALLEOLAR FRACTURES

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Aims

There has been an evolution recently in the management of unstable fractures of the ankle with a trend towards direct fixation of a posterior malleolar fragment. Within these fractures, Haraguchi type 2 fractures extend medially and often cannot be fixed using a standard posterolateral approach. Our aim was to describe the posteromedial approach to address these fractures and to assess its efficacy and safety.

Patients and Methods

We performed a review of 15 patients with a Haraguchi type 2 posterior malleolar fracture which was fixed using a posteromedial approach. Five patients underwent initial temporary spanning external fixation. The outcome was assessed at a median follow-up of 29 months (interquartile range (IQR) 17 to 36) using the Olerud and Molander score and radiographs were assessed for the quality of the reduction.

Results

The median Olerud and Molander score was 72 (IQR 70 to 75), representing a good functional outcome. The reduction was anatomical in ten, with a median step of 1.2 mm (IQR 0.9 to 1.85) in the remaining five patients. One patient had paraesthesia affecting the medial forefoot, which resolved within three months.

Conclusion

We found that the posteromedial approach to the ankle for the surgical treatment of Haraguchi type 2 posterior malleolar fractures is a safe technique that enables good visualisation and reduction of the individual fracture fragments with promising early outcomes.

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Unstable fractures of the ankle have a poorer outcome if the posterior malleolus is involved. The management and indications for fixation of these injuries remain poorly defined. Fixation of posterior malleolar fractures was first described by Lounsbury and Metz in 1922. They used an extensile medial approach to fix large posterior fragments with a bone peg. Traditional teaching subsequently advocated fixation of posterior malleolar fragments based on their size when assessed on a lateral radiograph, with fixation being recommended for fragments representing either a quarter or a third of the articular surface. In recent years, practice has changed as it has become recognised that the size of the posterior malleolar fragment alone is not the only predictor of outcome. Factors such as articular congruence and the stability of the joint are also important determinants of outcome. As the indications for fixation have changed, the use of the posterolateral approach in the interval between the peroneal tendons and flexor hallucis longus when fixing the posterior malleolar fragments has also gained in popularity.

The most frequently used classification of these injuries is that of Haraguchi, dividing them into three types based on their appearance on axial CT. A Haraguchi type 2 posterior malleolar fracture extends medially and often has two distinct fragments: posterior and posteromedial (Figs 1 and 2). Mangnus et al used Cole fracture mapping and quantitative 3D CT to further delineate the types of fracture and considered the posteromedial extension fractures to be a distinct entity, emphasising the instability of this type of fracture due to its involvement of the posterior colliculus and therefore the deep deltoid ligament.

Our aim was to describe the fixation of Haraguchi type 2 posterior malleolar fractures
using a posteromedial approach to the ankle that allows fixation of the characteristic fragments commonly seen with this injury.

**Patients and Methods**

We identified 15 patients who had undergone fixation of Haraguchi type 2 posterior malleolar fractures through a posteromedial approach at two trauma centres between March 2014 and May 2016. Only closed fractures were included. There were nine men and six women with a median age of 37.8 years (interquartile range (IQR) 28.8 to 48.8). All patients underwent pre-operative CT scanning, as is the standard practice for unstable fractures of the ankle with posterior malleolar involvement in our units. The indications for fixation included instability demonstrated by initial posterior dislocation or residual posterior subluxation on radiographs, articular incongruence or disruption to the syndesmosis or deltoid ligament as assessed on CT. A temporary spanning external fixator (Stryker, Kalamazoo, Michigan) was used in five patients. Temporary external fixation was indicated when it was not possible to hold the talus congruently beneath the tibia in a plaster and the soft tissues were too swollen to allow immediate internal fixation. The median time between injury and
surgery in patients who did not require an external fixator was 6.5 days (IQR 4.5 to 9.5) and 11 days (IQR 10 to 13) in those in whom external fixation was used.

The details of the patients were recorded in a prospectively maintained database including operative details, complications and patient reported outcomes using the Olerud and Molander scoring system. A score of > 91 was considered an excellent outcome, 61 to 90 good, 31 to 60 fair and < 30 poor. Radiological evaluation of the reduction was undertaken on standard ankle mortis radiographs to assess the widening of the medial clear space, and lateral radiographs to assess steps or gaps in the tibial articular surface.

**Surgical technique.** The patient is positioned prone under general anaesthetic. No tourniquets were used in this series. The posterior malleolus was addressed first. The incision is made midway between the posterior margin of the medial malleolus and the medial border of the Achilles tendon, which is the interval between the angiosomes of posterior and anterior tibial arteries (Fig. 3). The fascia overlying the neurovascular bundle is divided and the neurovascular structures are mobilised (Fig. 4).

This allows the development of areas either side of the neurovascular bundle to facilitate fixation of the individual fragments of the fracture. The flexor hallucis longus is mobilised to access the posterior fragment and an arthrotomy may be performed. (Figs 5 and 6). Anteriorly, the retinaculum is divided over the tendons (Figs 7 and 8). A window is made and the best approach to the posteromedial fragment is determined from the CT scans. This is often between flexor digitorum longus and tibialis posterior (Fig. 9) but can be anterior to tibialis posterior. The tendons are mobilised to expose the posteromedial fragment. The fragments are provisionally reduced and held with Kirschner-wires. The reduction is verified by ensuring reduction at the cortical apex of the fracture, and fluoroscopically. The fragments are stabilised with small fragment buttress plates and/or cortical lag screws (Fig. 10).
Following fixation of the posterior malleolus and medial extension, the fibula is fixed through a direct lateral approach using standard techniques. The posterior malleolus should be fixed first as the fibular metalwork will obstruct the imaging, although the fibula may be reduced and held before fixing the posterior malleolar fracture. The syndesmosis is finally screened to ensure stability. In our experience, fixation of the posterior malleolar fragment is sufficient to stabilise the syndesmosis.

Post-operatively, patients are splinted for two weeks until the wound has healed. Exercises then start under the supervision of a physiotherapist, with progressive weight-bearing in a removable splint. Weight-bearing out of the splint begins at six weeks.

**Results**

The median follow-up was 29 months (IQR 17 to 36). The Olerud and Molander score was recorded in 14 patients, with a median of 72 (IQR 70 to 75) representing a good functional outcome. Assessment of the reduction showed that the medial clear space was maintained in all but two patients in whom it was increased by 0.2 mm and 0.3 mm, respectively. The reduction of the posterior malleolar fragments was anatomical in ten patients. There was a median step or gap of 1.2 mm (IQR 0.9 to 1.85) in the remaining five.

There were no wound problems. One patient had paraesthesiae of the medial forefoot which resolved after three months. One patient required removal of metalwork because of discomfort.

**Discussion**

This study shows that the posteromedial approach can be safely used to address the management of these complex injuries. The only complication was a transient sensory nerve palsy. At final follow-up, at a median of 29 months, 14 of 15 patients reported a good functional outcome on the Olerud and Molander scoring system.
It has been reported in biomechanical and clinical studies that plain radiographs alone are insufficient to assess the posterior malleolar fragment.\textsuperscript{12-14} Fixation of the posterior malleolus has been shown, in studies in cadavers, to improve the stability of the ankle joint\textsuperscript{15} and to be at least as good as transsyndesmotic fixation.\textsuperscript{16,17} A recent finite element analysis study comparing fixation with two anteroposterior lag screws, two posteroanterior lag screws and a buttress plate showed that while more stable fixation was required with increasing size of the fragments, a buttress plate produced better stability and less displacement irrespective of the size of the fragment.\textsuperscript{18} The current literature neither supports nor disproves open reduction and fixation of posterior malleolar fractures, although there is evidence that the presence of a posterior malleolar fragment has an adverse effect on outcome,\textsuperscript{2,19} and that there may be a higher risk of a poorer outcome\textsuperscript{20} or post-traumatic arthritis\textsuperscript{21} with an increased size of a posterior malleolar fracture.

Fixation of these fractures can be achieved in various ways. Fixation with anteroposterior screws following indirect reduction has been frequently undertaken, although O’Connor et al\textsuperscript{22} suggested that posterior fixation gave better outcomes. Posterior fixation is commonly performed through a posterolateral approach that allows visualisation of posterolateral types of fracture and fixation of the lateral malleolus through the same incision in many cases, and good outcomes have been reported.\textsuperscript{22,24} A limitation of using this approach for Haraguchi type 2 fractures is that it does not allow complete visualisation of the medial component through a single incision and the use of a double incision creates a narrow bridge of skin. For this reason we advocate using the posteromedial approach which we describe. It has been previously used for the fixation of pilon fractures, fractures of the ankle and of the talar process.\textsuperscript{25-27} The operations involve either an approach through the bed of tibialis posterior,\textsuperscript{27} or developing the interval between flexor hallucis longus and the neurovascular bundle to access the posterior tibia. We consider the advantage of the approach described above to be that it allows the development of two windows, either side of the neurovascular bundle, facilitating visualisation of the separate fragments seen in Haraguchi type 2 fractures. This allows fragment-specific fixation to provide stabilisation of the medial fragment involving the posterior colliculus that has an attachment to the deep aspect of the deltoid ligament and the posterior fragment involving the posterior portion of the syndesmosis. A concern when using this approach is that it involves exposure of the neurovascular bundle and care must be taken to mobilise and protect this throughout the procedure. Only one patient developed paraesthesiae that may have been related to mobilisation of the tibial nerve. There were no long-term complications or vascular injuries.

Removal of hardware was required in one patient who had persistent discomfort. While there may be scar tissue around the neurovascular bundle, the metalwork was removed uneventfully.

This study has limitations. It is a small series with short follow-up and without post-operative CT scans to confirm reduction, as this is not our routine practice. However, the outcome measures and clinical and plain radiographic findings suggest this is a reproducibly safe technique allowing fragment specific visualisation and fixation. Further post-operative imaging and longer follow-up would clarify whether anatomical reduction is achieved and whether this improves the outcomes. Post-operative CT scans would also confirm the accuracy of the assessment using plain films. We did not include a control group in this study, as our aim was to describe a new approach to Haraguchi type 2 fractures rather than to compare it with non-operative, anteroposterior fixation or posterolateral fixation, which is generally used to address Haraguchi type 1 injuries.

In conclusion, our understanding and management of posterior malleolar fractures continues to evolve. We have described an approach to Haraguchi type 2 fractures that allows the individual components to be addressed. There were no long-term complications and the early outcomes were satisfactory. We advocate pre-operative CT scanning for all posterior malleolar fractures to assess the morphology of the fracture accurately and consideration of a posteromedial approach in those fractures that extend into the medial malleolus. We highlight a technique that may become as readily used as the posterolateral approach for the appropriate configuration of fracture.

Take home message:
- Our understanding of posterior malleolar fractures and their management is continuing to develop.
- Fixation of Haraguchi type 2 fractures with standard approaches is difficult and may fail to address all components of the injury.
- The posteromedial approach to the ankle is a safe technique and should be considered when fixing a Haraguchi type 2 fracture configuration.

Author contributions:
N. Bali: Collecting the data, Writing the paper, Reviewing the literature, Collecting the images.
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