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Research Article

Role of Fixation of Posterior Malleolus in Trimalleolar Fractures (44-B3), When & How to fix

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Abstract

Purpose: Planning the fixation modality and approach for the posterior malleolus fracture with trimalleolar fracture (44 -B3).

Design: Prospective study

Setting: Level II academic trauma centre

Methods: 48 patients with trimalleolar 44-B3 fractures from 01/01/2010 to 31/12/2017 were studied. Preoperative CT scan use to divide them in Group I-Posterolateral & Group II-posteromedial fragments of posterior malleolus. Postoperative x-rays done to check instability, residual articular displacement and malposition. Final radiological union was assessed and correlated with functional outcome. In Group I (38 cases) fixation was performed by posterolateral approach and medial incision for medial malleolus. In Group II (10 cases) surgical fixation was performed by extended-modified posteromedial approach and lateral approach for fibula fixation.

Results: Subjective assessment was done for pain, range of movements, ability to bear the weight and activities of daily living according to Olerud and Molander score system. The x-rays done at each follow up. Medial clear space was maintained in most but in 4 patients, it was increased by more than 0.2 mm. Reduction of posterior malleolar fragments was anatomical in 44 patients. Follow-up period was 2 years with an average score of 70.

Conclusion: Posterolateral pattern is common in trimalleolar fracture 44-B3. Two different surgical approaches were taken to stabilize malleolar fractures. With the average follow up of two years. Most patients had good to excellent results with a very little rate of complications.

Level of Evidence: Therapeutic Level II.

Keywords: *Trimalleolar fracture (44-B3), Posterolateral & Posteromedial, approach, Posterior malleolus*

Introduction

Fractures of the ankle are common, especially malleolar fracture dislocation.[1,2] Inspite of many publications, there are many unsolved answers for the injuries to posterior malleolus in trimalleolar ankle fracture-dislocations (44-B3). Ankle fractures are the result of a combination of multiple deforming forces including angulation, rotation, axial loading and translation. Knowledge of exact mechanism of ankle fractures is crucial in planning the treatment. Decisions about their management requires the knowledge of exact pattern of bony injury and ligamentous components of the injury. This, in turn, requires a comprehensive understanding of the normal anatomy, and of the different patterns of injury. With the availability of CT scan the injury can be properly assessed which helps in adequate diagnosis, and management. CT scan can assess three-dimensional outline of all malleoli and all associated injuries to the ankle, including syndesmotic instability.[3,4,5,6]

In the past, fixation of posterior malleolar fragments was planned on the basis of their size when assessed on a lateral radiograph, with fixation being recommended for fragments representing more than 25%.[7,8,9] In recent years, practice has changed as it has become recognised that the size of the posterior malleolus fragment alone is not the only predictor of outcome.[10,11,12]

Factors such as articular congruence and the stability of the joint are also important determinants of outcome, which can be properly assessed on CT scan. [6,13] Assessing the size of posterior malleolar fragments radiographically may be impossible because of the irregularity of the fracture line. Haraguchi et al in 2006 on the basis of the computed tomographic images, categorized the posterior malleolus fractures into three types, namely, [4]

1. Posterolateral-oblique (type-I: 67%) fractures were characterized by a wedge-shaped fragment involving the posterolateral corner of the tibial plafond.
2. Transverse medial-extension (type-II: 19%) fractures were characterized by a fracture line extending from the fibular notch of the tibia to the medial malleolus.
3. Small-shell (type-III: 14%) fractures were characterized by one or more small shell-shaped fragments at the posterior lip of the tibial plafond.

We undertook the study of trimalleolar (44-B3) ankle fractures giving utmost importance to when and how to fix the posterior malleolus fractures.

Patients and Methods

We identified 48 patients of ankle fractures with trimalleolar fractures (44-B3) who were treated surgically at our trauma centre between January 2010 and December 2017. Only closed fractures were included, and all patients had preoperative CT scan in addition to a plain radiograph (Fig1A, B, C). There were 35 males and 13 females belonging to the age group of 20 years to 60 years. Isolated posterior malleolus fracture was not seen in this duration at our centre. Inclusion criteria was Closed fresh injury (up to 5-7days) in the age group of 20 to 60 years. Open malleolar injury and polytrauma patients were excluded from this study.

All 44-B3 trimalleoalar fractures were considered as unstable ankle injury despite whether they were associated with ankle subluxation-dislocation. Preoperatively the limb was immobilized in posterior plaster slab till oedema subsided and wrinkle sign was observed, usually 4-7 days after injury. In no patient spanning external fixator was required since the talus was congruent within the plaster slab.

The clinical details and mode of injury was recorded and prospectively maintained. Details of operative technique, complications and patient outcomes were recorded using Olerud and Molander scoring system.14 A score of > 91 was considered as an excellent outcome, 61 to 90 as good, 31 to 60 as fair and < 30 as poor outcome. Radiological evaluation of the reduction was undertaken on standard ankle radiographs to assess the widening of the medial clear space, and lateral radiographs to assess steps or gaps in the tibial articular surface.

We have used the basis of Hiraguchi's classification based on CT scan images, and grouped in two groups, namely,[4]

1. Group I consisted of 44-B3 trimalleolar fracture with posterolateral fracture of posterior malleolus in 38 cases, where surgical fixation (posterior malleolus & fibula) was performed by posterolateral approach and medial incision for medial malleolus.
2. Group II, consisted of 44-B3 trimalleolar fracture with posteromedial fracture of posterior malleolus in 10 cases, where surgical fixation (Posterior malleolus & medial malleolus) was performed by extended-modified posteromedial approach and lateral approach for fibula fixation.

Figure 1A: *X-ray of Ankle showing tri-malleolar fracture in 56 years old lady.*

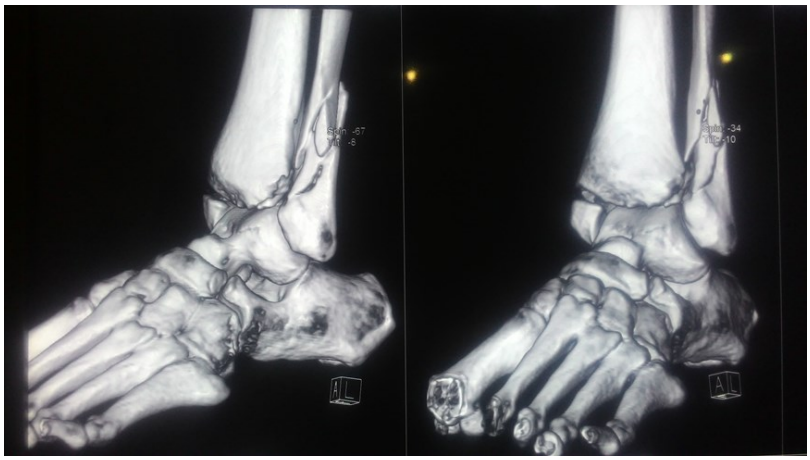

Figure 1B: *3D CT scan confirming Tri-malleolar fracture.*

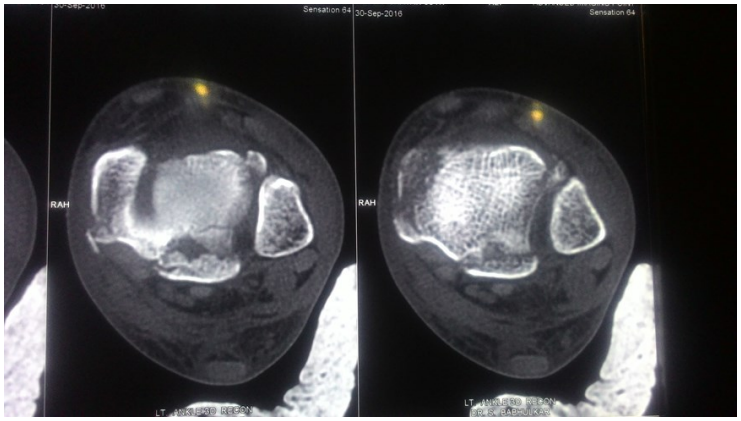

Figure 1C: *Axial CT scans showing postero-lateral fragment of posterior malleolus confirming the size of Posterior malleolus.*

Operative Technique

All patients were operated under spinal anesthesia and pneumatic tourniquet. The surgicalapproaches differed in those two groups. All patients were operated in prone position and if required, were turned to supine position for final fixation of malleoli.

Group I

After draping in prone position, a longitudinal skin incision was made between the posterior fibular margin and lateral border of tendonachalis tendon (Fig 1D, E) 6,15,16 17,18. The sural nerve was identified and protected. Superficial dissection was performed bluntly by developing the plane between peronei and tendonachalis tendon. Blunt dissection was performed between the intermuscular septum between the peroneal tendons and the flexor hallucis longus to avoid sural nerve injury. The flexor hallucis longus muscle was then lifted off the posterior tibia and interosseous membrane and the posterior malleolus fragment exposed .18 The soft tissue attachment of PITFL to the medial malleolus and the joint capsule was carefully handled (Fig.1F, G). The fragment is usually triangular with its apex superiorly and was therefore exposed from medial to lateral for joint inspection. Reducing the fragment in its original foot print assures its perfect reduction since one cannot see the joint properly. Sometimes fibular fracture was exposed first reduced but not fixed which helps in reduction of posterior malleolus. Fibular fracture is not fixed first but reduced since the metal plate will obscure the radiological control of posterior malleolus fracture reduction. Once reduction of posterior malleolus is done it should be temporarily fixed by two "K" wires and reduction confirmed by image intensifier (Fig.1H). Subsequently posterior malleolus is fixed by small fragment buttress plate or sometimes by two cortical lag screws.18 After fixation of posterior malleolus the fibula is fixed through the same incision using standard plate fixation technique or if the fracture is transverse can be stabilized by Rush nail (fig1I, J). Finally, syndesmosis is checked to ensure stability which is achieved since PITFL is stabilized by posterior malleolus fixation.

Figure 1D: *Operative picture showing the incision for postero-lateral approach. Clinical Photograph showing the Proposed incision for postero-lateral approach.*

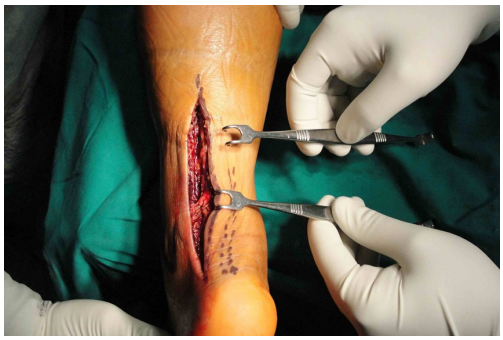

Figure 1E: *Postero-lateral approach operative picture of deeper dissection.*

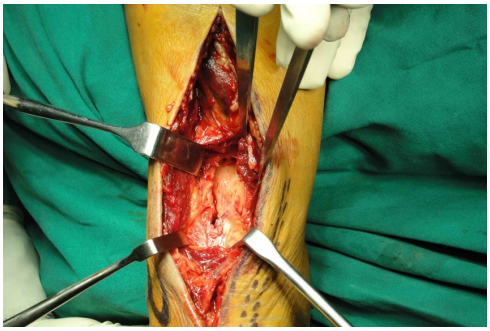

Figure 1F: *Operative picture showing anatomical reduction of posterior malleolus.*

Figure 1G: *Fragment reduces and temporary fixed by 2 K-wires.*

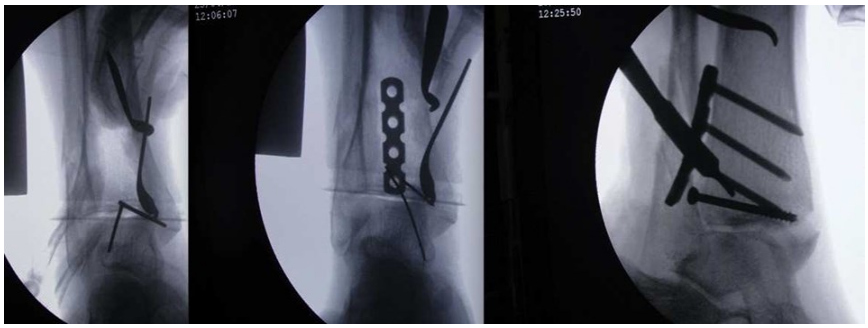

Figure 1H: *Image picture doing surgery showing temporary fixation and fixation by posterior plate and screws.*

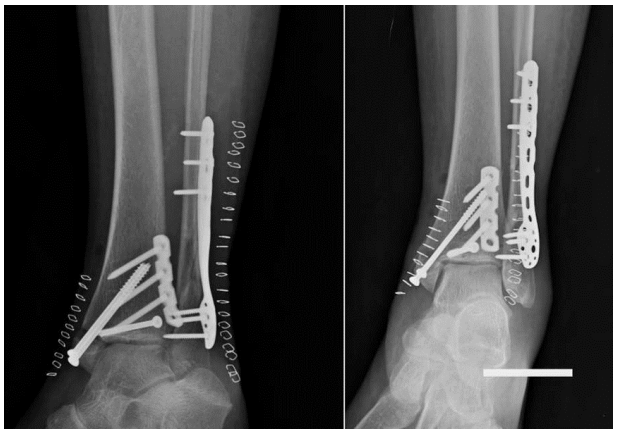

Figure 1I: *Immediate post op x-ray showing good stabilization of posterior malleolus,medial malleolus and fibula fracture.*

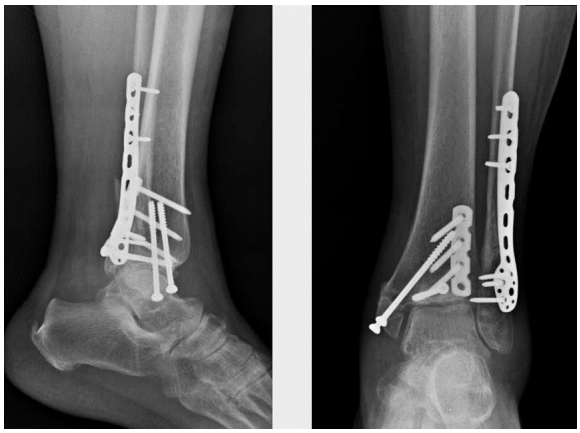

Figure 1J: *months Post op x-ray showing excellent healing of tri-malleolus.*

In the same position medial malleolus is exposed by direct medial incision. However, one can turn the patient from prone position to supine position and then by direct medial incision malleolus fracture is exposed. Once the fracture is reduced under direct vision medial malleolus is fixed by malleolar screw or TBW (Fig.2 A-J). Both the wounds, posterolateral and medial incision were closed in layers. Finally, the fracture fixation and stability of syndesmotic injury is confirmed fluoroscopically, and limb is immobilized in posterior plaster slab

Figure 2A: *Plan x-ray of ankle showing tri-malleolar fracture in young 20 years old female.*

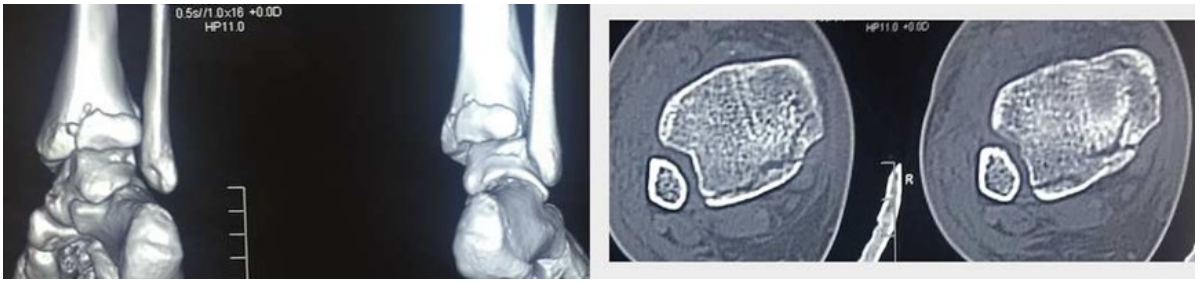

Figure 2B: *Picture showing 3D CT scan and axial cut confirming postero-lateral fragment of posterior malleolus in patient of tri-malleolar fracture.*

Figure 2C: *Operative picture showing propose incision posteriorly. Postero-lateral approach in prone position.*

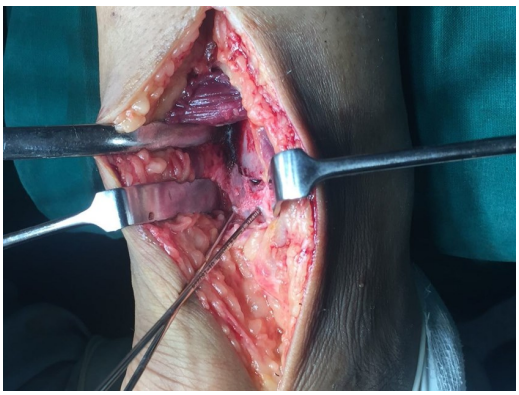

Figure 2D: *Operative picture showing anatomical reduction of triangular postero-lateral fragment temporarily held fixed by 2 K-wires.*

Figure 2E: *Picture showing operative radiography image confirming anatomical reduction of posterior malleolus and fixation by 2 K-wires.*

Figure 2F: *Operative picture showing reconstruction plate fixation and its position.*

Figure 2G *Picture showing operative radiography image confirming anatomical reduction of posterior malleolus and fixation by plate and screws.*

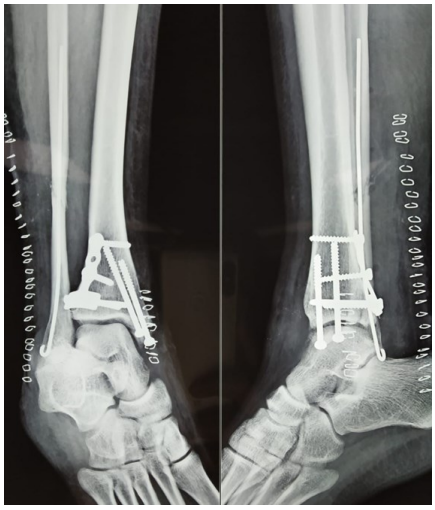

Figure 2H: *Immediate poste op x -ray showing fixation of posterior malleolus by plate, fixation of medial malleolus by 2 screws and fixation of fibula by Rush nail.*

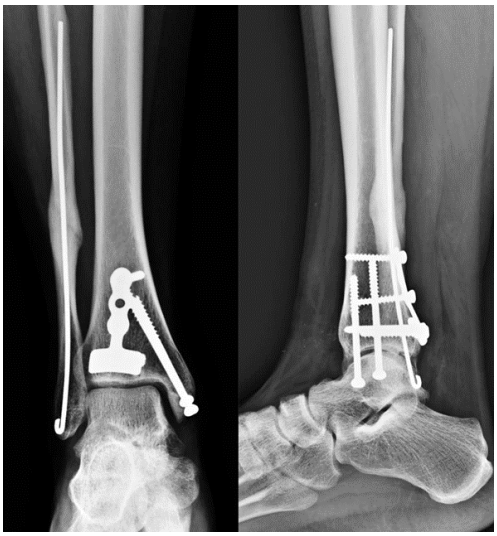

Figure 2I: *Post op x-ray 1 ½ years post op x-ray showing excellent radiological healing of trimalleolar fracture.*

Figure 2J: *Clinical photograph of patient showing scar of postero-lateral approach, which healed by secondary intention.*

Group II

Patient under spinal anaesthesia & pneumatic tourniquet was positioned in prone position. The incision was taken midway between posterior margin of medial malleolus and medial border of tendonachillis tendon, incision was extended distally by turning it slightly anteriorly(Fig.3C).[19,20,21] Then vascular anastomosis of anterior tibial arteries were carefully separated and mobilized. The crural fascia was incised and the tendons of the tibialis posterior and flexor digitorum longus muscles were mobilized and retracted anteriorly. By this modified posteromedial approach, the tibialis posterior and flexor digitorum longus are retracted medially and the flexor hallucis longus muscle belly and tendon along with tendonachallis tendon are retracted laterally. Care is taken not to injure the posteromedial neurovascular bundle. Posterior malleolus along with medial malleolus were exposed by extending the exposure laterally and superiorly. The fractures of the posterior tibial fragment and of the medial malleolus were exposed and confirmed fluoroscopically. This extended modified posteromedial approach seems to provide a greater viewing area of theposterior tibial column and posterior tibial malleolus as compared to other approaches. Additionally, in this approach, there is least traction on the flap containing the neurovascular bundle. Fracture posterior and medial malleolus were reduced, and temporary "K" wire fixation was performed to the posterolateral fragments and lower tibia and confirmed fluoroscopically. Horizontal medial malleolar fracture are typically fixed with obliquely placed malleolar screws and posterior malleolus fixed by small fragment buttress plate (Fig.3 D, E). To enhance the stability, occasionally, medial plate fixation and posteroanterior lag screws are required. Fractures of the posterior malleolus extending in to the medial malleolus in the frontal plane are fixed with posterior-to-anterior screws. When inserting the screws, irritation of the flexor tendons has to be avoided. Once the medial malleolus and posterior malleolus were fixed a direct lateral incision was taken over the fibular fracture and is fixed by the plate or in transverse fracture stabilized by Rush nail. All fixations and syndesmotic stability is confirmed fluoroscopically. Both the wounds were closed in layers.

Figure 3A: *X-ray of ankle showing tri-malleolar fracture-dislocation in young 55 year male patient.*

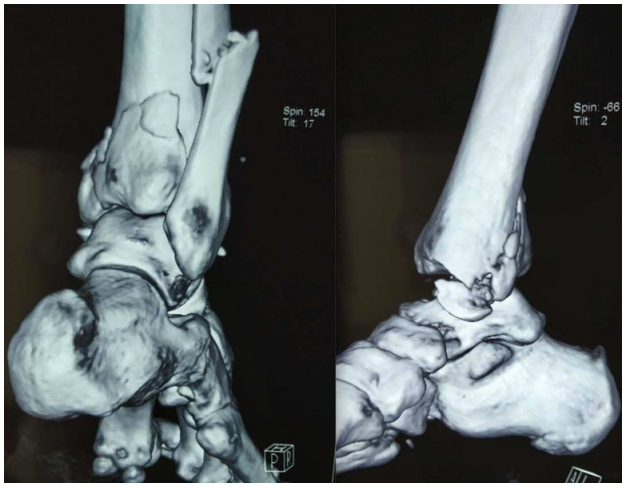

Figure 3B: *Picture showing 3D CT scan confirming posterior medial fragment of postero-malleolus.*

Figure 3C: *Clinical operative picture showing propose incision of modify posterio- medial approach.*

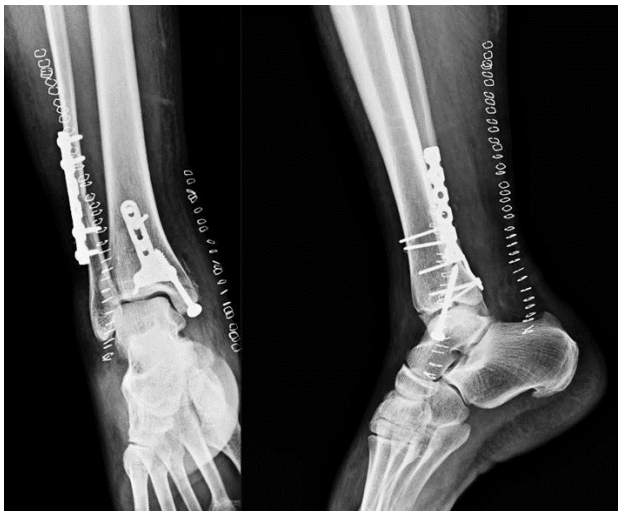

Figure 3D: *Immediate post op x-ray showing fixation of posterior medial fragment by buttress plate and medial malleolus fixation by one screw and fracture fibula fixation by reconstruction plate.*

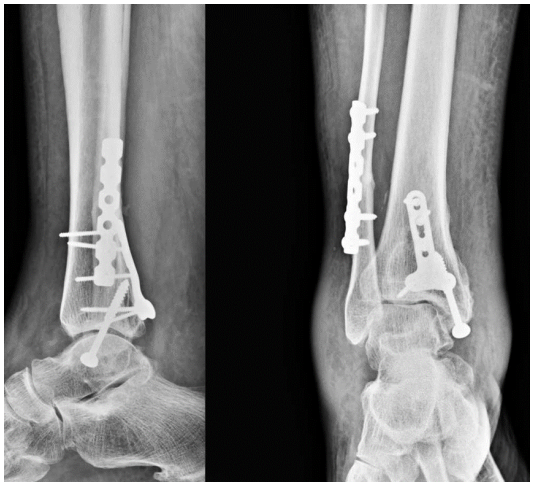

Figure 3E: *2 years post op x-ray showing excellent radiological healing of tri-malleolar fracture. There is no evidence of arthrosis or any evidence of syndesmotic separation.*

Postoperative treatment & Follow up

The stitches were removed after 10-12 days, and all patients were immobilized in posterior plaster slab for 3 weeks. After 2-3 weeks, ankle joints were mobilized, and rehabilitation was started by CPM. Non-weight bearing crutch walking was started after 2-3 weeks and patients were asked to report for follow up after 6, 12 and 14 weeks initially and then every 6 months for 3-4 years. Weight bearing was started between 10-14 weeks depending upon the radiological position.

The x-rays were done at each follow-up and its evaluation included on (anteroposterior, lateral, and mortise views) the films for bony union, maintenance of the ankle mortise by direct measurement of the medial clear space and tibiafibular overlap, breakage of the hardware, and the development of ankle arthrosis.[2] Fracture union was defined as loss of the fracture lines in the distal fibula and medial malleolus.

We have used the scoring system described by Olerud and Molander was recorded in all patients operated on trimalleolar fractures.14 Nine subjective parameters were chosen and the total score of each patient was compared with the results from the four parameters listed below.

1. Subjective evaluation according to a linear analogue scale.
2. Range of motion in loaded dorsal extension, revealed by clinical examination.
3. Signs of osteoarthritis.
4. Presence of dislocations, revealed by radiographic examination.

Results

All patients were regularly followed. There was not a single drop out. Clinically in all patient subjective assessment was done for pain, range of movements, ability to bear the weight and activities of daily living. The x-rays were done at each follow up. Assessment of the reduction showed that the medial clear space was maintained in all but in four patients, it was increased by more than 0.2 mm. The reduction of the posterior malleolar fragments was anatomical in 44 patients. Fixation of posterior malleolus was done by posterior approach with fixation by plate in 45 patients and in 3 patients it was stabilised only by 2 lag screws in cases of posterolateral fragment. There was a step or gap of 1-2 mm in the remaining four patents. Finally, after nine parameters the score was decided as Poor: 0%-30%, Fair: 31%-60%, Good: 61%-90%, Excellent: 91%-100%. The median follow-up was 2 years. The Olerud and Molander score was recorded in all patients, with average score of 70 representing a good functional outcome. Out of 48 patients excellent results were seen in 22 patients, good in 20 patients, and fair in 6 patients. Poor result was not seen in any patient. Buttress plating had superior clinical outcomes at follow-up as compared with those treated by only lag screws.

Complications

There were wound breakdown (soft tissue) in two patients of posterolateral approach. In both patients wound healed with dressing and a course of antibiotics. Both these patients had good functional recovery. There was no breakdown of wound with posteromedial incision. In one patient changes of early ankle arthrosis were observed at the end of one year, and this patient had pain after prolong walking. Three patients had painful ankle movements at the end of three years but did not restrict activities of daily living.

Discussion

Trimalleolar fractures 44-B3 are uncommon, comprising only 7% of all ankle fractures[1,2]; however, they are the larger proportion of fractures requiring surgery because of the unstable nature of the injury. Posterior malleolus is important stabilizer to control the instability of ankle however, the primary restraint to posterior forces is the anterior tibial fibular ligament (ATFL), Posterior tibio-fibular ligament (PTFL) and the fibula. Most posteriormalleolar fractures tend to be small, laterally based fragments, still attached with the ligament of the posterior tibio-fibular ligament (PTFL).[18,23] The fixation of the posterior malleolus has also been recently shown to contribute to the stability of the syndesmosis.[8]

In complex ankle or tibial injuries associated with large, displaced fractures of the posterior malleolus, reduction and fixation of the fragment is essential for the restoration of joint mechanics.[1,3,5–7,18] Harper, Raasch, and Hartford all demonstrated that injury to the posterior malleolus allows for instability if accompanied by lateral malleolar or posterior ankle ligament injury.[7,8,24]

The indications for and treatment of ankle fractures involving trimalleolar fracture remain a surgical challenge.[24,25,26] Necessity of fixation in displaced bimalleolar fracture is common, but in patients with additional posterior malleolar fractures (44-B3 Trimalleolar fracture) the necessity of fixation of posterior malleolar fragment is less clear.[26] As a rule, earlier large posterior malleolar fragments constituting more than 25% of the articular surface were treated surgically.[5,27] Fragment size is frequently cited as one of the main indications for fixation with thresholds for surgery ranging from one-fourth to one-third of the anteroposterior dimension of the articular surface.[8,27] However, some studies indicate that surgical fixation of small fragments can have a beneficial effect on the stability of the joint.[10,11,12]

Most of the posterior malleolus fragments are large with a single triangular posterolateral fragment, however Haraguchi 2006, Ling Yao etal 2014, described three different types of posterior malleolar, posterolateral, Posteromedial & rim fracture-entire posterior tibial lip.[4,5] In such situation posterolateral fragment is a single large piece and posteromedial fragment is considered as a part of continuity of medial malleolus. Precise knowledge of the extent of the fracture can influence preoperative considerations such as patient positioning, choice of the approach, and choice of the operative technique. Assessment of the size of the posterior fragment on plain radiographs do not give consistent, reliable measurement of the fragment of posterior malleolus and hence many surgeons prefer to perform preoperative CT scan, mainly to see the configuration and size of fragment of posterior malleolus.[5,27,28]

Trimalleolar fractures 44-B3 are potentially unstable and posterior malleolus with significant displacement are difficult to reduce by closed reduction and needs open reduction and fixation to ensure adequate reposition. Rarely posterior malleolus fractures without any displacement may be amenable to percutaneous fixation techniques, typically anterior to posterior screws after fibular fixation, based on the principle of ligamentotaxis for reduction of posterior malleolus fragment.29,30,31 However, in our study since we considered trimalleolar fracture 44-B3 as very unstable injury and always opted for open reduction and internal fixation. The surgical approach depends upon the fracture pattern which is decided by preoperative CT scan. Depending upon the fracture pattern we have grouped posterior malleolus fracture in two groups as described earlier.

Group I consisted of trimalleolar fracture with posterolateral fracture of posterior malleolus in 38 cases, where surgical fixation (posterior malleolus & fibula) was performed by posterolateral approach and medial incision for medial malleolus. The posterolateral approach provides excellent exposure of fracture and allows direct application of plate or screws after perfect anatomical reduction.[18]

Initially the plane between peroneal and tendonachalis tendon is developed and with blunt dissection the peroneal tendons and the flexor hallucis longus were exposed. The flexor hallucis longus muscle was then lifted off the posterior tibia and interosseous membrane and the posterior malleolus fragment exposed. The joint and fracture was cleaned of debris, and an anatomic reduction was secured and provisionally held using K-wires. After confirming the anatomical reduction, the fragment is fixed by small fragment buttress plate and sometimes by two lag screws.

The posterolateral approach also allows for simultaneous reduction and fixation of the lateral malleolus through the same skin incision.[18,30] We have fixed all posterolateral posterior malleolus fragments irrespective of the size of fragment, even if it's smaller than 25%. After fixation of posterior malleolus there is no need for further syndesmotic fixation. Secondly, the posterior capsule is also another structure attached to the posterior malleolus; thus, the stability of syndesmosis is achieved after fixation of posterior malleolus. [31,32,33] In all cases we confirmed the syndesmotic stability by clinical testing and confirming fluroscopically. Langenhuijsen[10] found that it was not the size of the fragment that affected outcome rather whether a congruent reduction was obtained, even in posterior malleolar fractures making up only 10% of the joint surface.

Most authors recommend that open reduction and internal fixation (ORIF) should be performed for these fractures to prevent posttraumatic arthritis resulting from articular incongruity.[34,35,36] The stable fixation is achieved either by direct interfragmentary fixation with lag screws and by buttress plate fixation from the posterior aspect.

Group II, consisted of trimalleolar fracture with posteromedial fracture of posterior malleolus, where surgical fixation (Posterior malleolus & medial malleolus) is performed by extended-modified posteromedial approach and lateral approach for fibula fixation.[19,20,21]

The less common posteromedial fragment of posterior malleolus cannot properly be exposed by posterolateral approach. This fragment is in continuity with medial malleolus fragment. We perfomed fixation of such 10 fractures by modified extended posteromedial approach.

The incision is taken midway between posterior margin of medial malleolus and medial border of tendoachillis tendon and is extended distally by turning it slightly anteriorly.[19,20,21] The tendons of the tibialis posterior and flexor digitorum longus muscles are mobilized and retracted anteriorly. By this modified posteromedial approach, the tibialis posterior and flexor digitorum longus are retracted medially and the flexor hallucis longus muscle belly and tendon along with tendoachallis tendon are retracted laterally. Fractures of posterior malleolus along with medial malleolus is exposed by extending the exposure laterally and superiorly and confirmed fluoroscopically after temporary fixation by k wires. Fractures of the posterior malleolus extending into the medial malleolus are then fixed by buttress plate posteriorly and malleolar screws from medial side. This extended modified posteromedial approach seems to provide a greater viewing area of the posterior tibial column and posterior tibial malleolus as compared to other approaches.[19,20,21]

In both the groups the anatomical reduction was confirmed on operation table after temporary fixation by k wires, and after fixation by fluoroscopy and finally degree of articular reduction was confirmed by first postoperative radiograph, and a successful reduction was defined as less than 2 mm of displacement of the posterior malleolus.[37]

In this study we have used Olerud and Molander scoring system in all patients. Majority of patients had good to excellent results, and none had poor, with a average of 70 representing a good functional outcome. Out of 48 patients excellent results were seen in 22 patients, good in 20 patients, and fair in 6 patients. Poor result was not seen in any patient.

Conclusion

Forty-eight patients with trimalleolar 44-B3 ankle fractures in whom the posterior malleolus was treated with open reduction and internal fixation were studied between January 2010 and December 2017. In all patients CT scan was done and posterior malleolus fracture was classified in two groups depending upon the fracture pattern. Commonly the injury had posterolateral pattern 38 patients, 10 cases had posteromedial fragment and none with shell type posterior lip fracture. Two different surgical approaches were taken to stabilize malleolar fractures. Buttress plating had superior clinical outcomes at follow-up as compared with those treated by only lag screws. With the minimum follow up of these patients, majority had good to excellent results with a very little rate of complications.

Conflict of Interest

None

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