International Journal of Orthopaedics Research
www.orthopaedicsjournal.in
E-ISSN: 2663-0923, P-ISSN: 2663-0915
Received: 20-11-2021, Accepted: 05-12-2021, Published: 20-12-2021
Volume 3, Issue 4, 2021, Page No. 6-11

Functional and radiological outcome following surgical management of trimalleolar ankle fractures.

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Abstract
Introduction: Ankle fractures are extremely common. However, the outcomes of operatively treated trimalleolar ankle fractures remain unclear. We aim to evaluate the functional and radiological outcome of trimalleolar ankle fractures.
Method: A retrospective review of 20 patients with operatively treated trimalleolar ankle fractures for a period of 3 years was performed. Demographics, fracture pattern, operative details, postoperative radiographs, CT-scan and complications were extracted and analyzed statistically. Outcome variables were union rates, pain ratings using the visual analogue scale (VAS) and the Olerud and Molander (O&M) score, satisfaction with surgery, and complications.
Result: 20 patients with trimalleolar ankle fractures were recruited. At 3 years postoperatively, most patients regained good function and had good to excellent O&M scores. 14 patients completed the functional outcome survey. However, 7 (50.0%) of 14 patients had residual pain. 09 (64.0%) patients complained of stiffness and six (43.0%) patients had ankle swelling. Increasing posterior malleolar fragment size correlates with poorer functional outcome.
Conclusion: Poor functional results are seen with increasing posterior fragment size in trimalleolar fractures. Residual clinical and functional deficits should be emphasized to patients prior to surgery. Hence more research is required with the aim of managing this group of patients with an attempt to improve their post-operative function and quality of life.
Financial interest: nil
Conflict of Interest: nil
Declaration: Not presented earlier/Published/or Accepted for publication

Keywords: trimalleolar fracture, visual analogue scale (VAS), Olerud and Molander (O&M) score

Introduction
Ankle fractures are common injuries seen in Orthopaedic practice [1]. Ankle fractures can be classified based on the number of malleoli involved namely unimalleolar, bimalleolar or trimalleolar fractures. [2, 3] Uni and bimalleolar fractures account for the majority of ankle fractures while trimalleolar fractures are less common, occurring in 7% of all ankle fractures. [4] Trimalleolar ankle fractures have shown to result in poorer outcome depending on the size of the posterior malleolar fragment. [5, 6] Most surgeons use the size of the posterior malleolar fragment as the single most important parameter to decide if the fragment should be fixed. Several studies have shown that fixation of posterior fragment is indicated if it involves more than 25% of the articular surface. [5, 7–9] Despite this, there is a lack of studies reviewing the functional outcomes of trimalleolar ankle fractures. We aim to evaluate the functional and radiological outcome of operatively treated trimalleolar ankle fractures.

Material and Method
A retrospective review of all patients admitted to our institution for operative fixation of Trimalleolar ankle fractures from January 2017 to March 2020 was performed after obtaining consent. Ethical committee clearance was obtained.
These patients were identified using the diagnosis and their unique UHID number given by the hospital. Their case sheets, X-rays and CT-scans were reviewed.

Inclusion criteria
1. Patients having closed Tri-malleolar ankle fractures.
2. Patients above the age of 18 years

Exclusion criteria
1. Open fractures
2. Poly-trauma
3. Concomitant fractures in the ipsilateral lower limb
4. Pathological fracture
5. Concomitant neurovascular injury in the ipsilateral lower limb
6. Pilon fracture
7. Uni and Bi malleolar ankle fractures
8. Patients who were treated by non-operative methods

All patients who completed at least 1 year of follow up were included in the study. Pertinent data on patient demographics, clinical assessments, pre-operative X-ray and CT-scan, operative

details, post-operative X-rays and complications were extracted and analysed statistically. Fractures were classified radiographically into uni-, bi- and trimalleolar fractures as well as into group A, B, or C according to the Danis–Weber classification. [10] Haraguchi classification was used to determine the extent of posterior malleolar fragment.

Operative details

All surgeries were performed under spinal /epidural anaesthesia and fluoroscopy guidance. Patient was placed in floppy lateral position. The affected limb was scrubbed, painted and drapped. Tourniquet inflated. Using the posterolateral approach posterior malleolar fragment was fixed first. As a guide, posterior malleolar fragment size >25% (Haraguchi type-1 and type-2) were fixed. Distal radius buttress plate was used for fixing posterior malleolus in 18 cases and 2 cases were fixed by 4 mm partially threaded cc-screw with/without washer using the posterolateral approach. (Figure-1) Using the same posterolateral approach but in the other plane lateral malleolus was fixed.

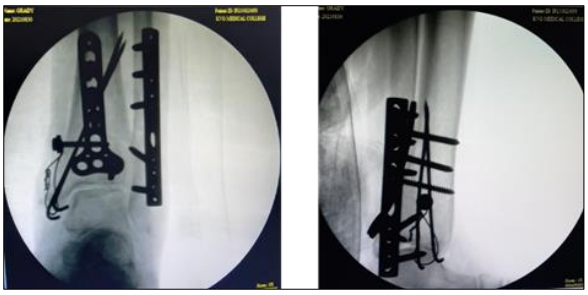

Fig 1: Intraoperative C-arm image showing fixation of all the 3 malleolar fractures.

However if the fragment size was less then 25% then lateral malleolus is fixed first. 12 (60%) of the lateral malleolus fractures were fixed with a one third tubular plate while 07 (35%) cases were fixed with the 3.5 mm DCP plate and 1 case was fixed by rush nail. Syndesmosis fixation was performed at the surgeons' discretion intra-operatively after routine syndesmosis complex examination under fluoroscopy. Cotton's test was employed in our institution to test the integrity of the syndesmosis. 3.5 mm cortical screw is placed at the apex of the syndesmosis 2 cm above the tibiotalar joint. [12] It was inserted obliquely from the fibula to the tibia starting posterolaterally aiming anteromedially with a tricortical purchase while the ankle is in neutral dorsiflexion. Patient was rolled back to supine position for the fixation of medial malleolus.18 (90%) of the medial malleolus fractures were fixed with two 4mm partially threaded cancellous screws while 2 (10%) of them with tension band wiring using 2 Kirschner wires using direct medial approach. (Figure-2)

Fig 2: Showing the fixation of medial malleolus using the direct medial approach.

Post-operatively, below knee POP slab was applied with the ankle in neutral position and the patient was adviced non-weight bearing on the affected limb for 6 weeks. (Figure-3)

Fig 3: Showing below knee pop slab application after the procedure.

Post-op antibiotics were given for 3days and check x-rays were done in ankle AP, lateral and mortise views.

Follow-up protocol

All patients were reviewed 10 days postoperatively for wound inspection and suture removal. At 6 weeks post-operatively pop slab was removed. The patient was allowed to weight bear as tolerated along with ankle range of motion exercises.

Subsequent reviews were done at 3, 6 and 12 months with radiographic monitoring and functional outcome survey using the O&M score. Post-operative radiographs were reviewed and union was defined as cortical bridging between proximal and distal fragments of 3 cortices. Outcome measurements were that of union rates, Visual Analogue Scale (VAS), Olerud and Molander (O&M) score (Table-1) [11], satisfaction with surgery and complications. The O&M score is a validated ankle specific functional scoring system. It is a patient self-reported questionnaire used to evaluate ankle specific functional outcome and impact of certain intervention over time.

In addition, satisfaction with surgery was based on self-reported by the patients. Data entry was performed using a spreadsheet application. Categorical variables were presented as proportions and continuous variables were presented as means. Chi-square test was used for comparison between categorical variables. Satistical significance was set at $p<0.05$ and data analysis was performed using SPSS.

Table 1: Modified Olerud and Molander scoring system

parameter	Degree	score
Pain	None	25
	While walking on uneven surface	20
	While walking on surface outdoors	10
	While walking indoors constant and severe	5
Stiffness	None	10
	Stiffness	0
Swelling	None	10
	Only in evenings	5
	Constant	0
Stair climbing	No problems	10
	Impaired	5
	Impossible	0
Running	Possible	5
	Impossible	0
Jumping	Possible	5
	Impossible	0
Squatting	No Problems	5
	Impossible	0
Supports	None	10
	Taping. Wrapping	5
	Stick or Crutch	0
Work. Activities	Same as before injury	20
of daily life	Loss of Tempo	15
	Change to simpler job	15
	Severely impaired work capacity	0

Scores range from a minimum (zero) to a maximum (100) points.

Results

20 patients were included in our study of a 3years duration. The patients had a mean age of 49 (range 27–65) years. There were 7 male and 13 female patients.

Using the Weber classification, 15 had Weber B and 5 suffered Weber C type of ankle fractures. There was notably more Weber B than C type of fractures in our study sample. Similarly using Haraguchi classification 12 patients had type-I, 8 had Haraguchi type-II fractures. In those patients who suffered fracture dislocation, it was found that the posterior fragment size was larger (25%) than those who did not dislocate their ankle. (Table-II)

Table 2: Comparison of posterior fragment size between trimalleolar ankle fracture with dislocation and those without dislocation.

Trimalleolar ankle fractures	Fracture dislocation	No dislocation	P value
Mean posterior fragment size (%)	25.9	19.6	0.076

14 patients completed the functional outcome survey. Outcome analysis showed 7 (50%) of our patients still complained of residual pain at 1 year while 9 (64%) and 6 (43%) still had persistent ankle stiffness and swelling. Age, gender, fracture dislocation and size of posterior malleolar fragment were not predictors of residual symptoms. Patients who sustained a Weber C ankle fracture had poorer O&M score (67.1) compared to those with Weber B (83.9) injury ($p = 0.039$). Despite that, the majority of our patients still had good to excellent functional outcome scores according to the O&M score (mean score 78.3, range 30–100). The mean VAS was 2.05 (range 0–9). Using the Spearman correlation test, poorer O&M scores were seen with increasing posterior fragment size ($r = 0.781$, $p = 0.039$) (Figure 4). In general, 14 of our patients were satisfied with the ankle surgery postoperatively and all cases achieved union. There were no significant complications in our study except for one case which had prominent screw head with pain on the medial malleolus which was changed under local anaesthesia. Posterior malleolar fragment size, %

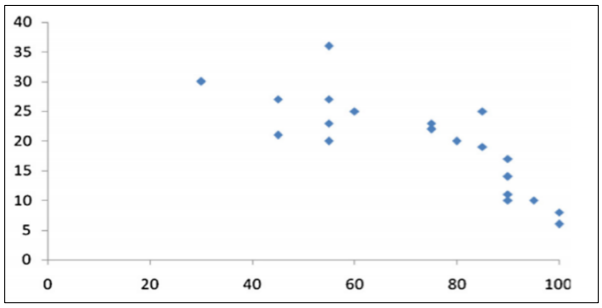

Fig 4: Correlation between posterior malleolar fragment size and the O&M score.

CASE-1

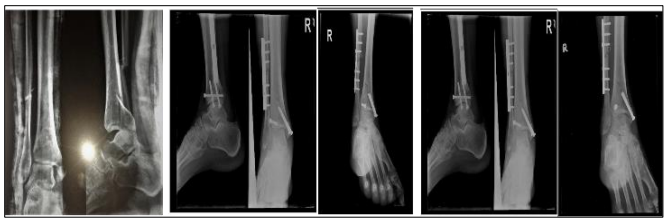

Fig 5: Follow-up radiographs of 36 years old male, showimg stable fixation and union

Fig 6: Dorsiflexion Plantarflexion Squatting and standing on toes

CASE-2

A **B**

Fig 7: (A) Pre-operative radiograph of 62year old female, showing Denis weber type-B tri-malleolar fracture of right ankle. (B) Post-operative radiograph showing anatomic reduction and stable fixation using various implants.

CASE-3

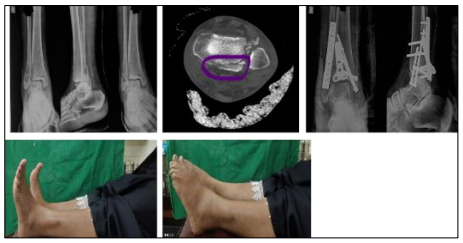

Fig 8: (A) Pre-operative radiograph of 44year old female, showing Denis weber type-B tri-malleolar fracture of right ankle. (B) Post-operative radiograph showing anatomic reduction and stable fixation using various implants.

CASE-4

Fig 9: (A) Pre-operative radiograph of 48year old female, showing Denis weber type-B tri-malleolar fracture of left ankle. (B) Post-operative radiograph showing anatomic reduction and stable fixation using various implants.

CASE-5

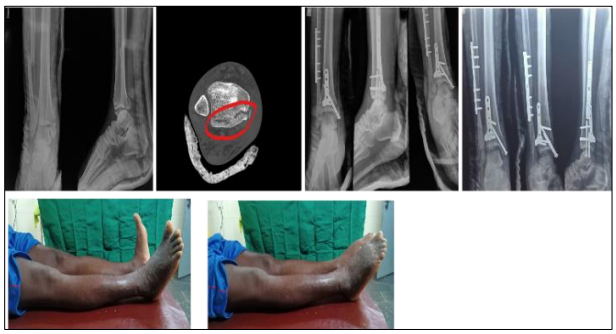

Fig 10: (A) Pre-operative radiograph of 37year old male, showing Denis weber type-C tri-malleolar fracture of right ankle. (B) and (C) Post-operative radiograph showing anatomic reduction and stable fixation using various implants.

CASE-6

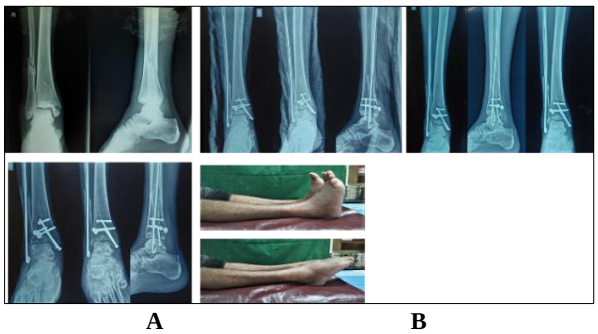

Fig 11: (A) Pre-op, (B) Post-op and follow-up radiographs of 35 year old male

Discussion

Ankle fractures are extremely common with incidences reported to be around 107–184/100,000/year. [13] A concomitant posterior malleolus fracture occurs in 7–44% of all ankle fractures [4, 7]. Presence of the posterior malleolar fragment is associated with poorer outcomes and predisposition to development of osteoarthritis especially if the fragment is larger than 25% of the articular surface. [9, 13] Tejwani *et al*. reported that presence of a posterior malleolar fragment in unstable ankle fractures results in worse outcomes at 1 year but this seems to even out over time at 2 years. [13] Juan *et al*. reported that functional outcomes in terms of AOFAS scores are better in those with posterior malleolar fragment <25% of the articular surface. [15] Despite this, there is a paucity of data about the functional outcomes of trimalleolar ankle fractures especially the patients' ability to return to their pre-injury activities. We found that the incidence of trimalleolar ankle fractures in our study population to be 15% which is comparable with most other papers. of note, there is a higher incidence in females compared to males with a ratio of 2:1. This higher incidence in females is also reported by Juan *et al*., where 77.78% of those with trimalleolar fractures in their study were females. [15] This could be due to underlying osteoporosis in this susceptible group of patients. De Vries *et al*. and Heim showed a statistically significant poorer outcome for ankle fracture-

dislocation compared to non-dislocated ankle fractures. [6, 17] Although we did not find a statistically significant result in presence of a larger posterior fragment in patients with fracture-dislocation, we did find poorer functional score with increasing posterior malleolar fragment size. On top of that, the concomitant soft tissue injury during an ankle fracture-dislocation can also contribute to the poorer outcome. Macko *et al*. and Hartford *et al*. found that there is reduction of the tibio-fibular contact area following posterior malleolar fractures, further predisposing the ankle joint to osteoarthritis. [18, 20] Both McDaniel *et al*. and Jasulka *et al*. have also reported worse results in ankle fractures with a larger posterior malleolar fragment compared to smaller fragments. [5, 7] Our study found that the degree of functional impairment in trimalleolar ankle fracture co-relates with the size of the posterior malleolar fragment. Shah *et al*. reported in their series of 69 patients with Weber B and C ankle fractures that 50% of their patients still had residual pain, 63% were still complaining of stiffness and around 45% still had ankle swelling at 5 years post treatment. [21] Our study showed almost similar results in that a large percentage of our patients continued to have residual ankle pain (52.4%), stiffness (64%) and swelling (43%) post-fixation. Several other studies have already shown that ankle fractures with posterior malleolar fragment often have poorer outcomes, severe osteoarthritic changes and consequent symptoms. [2, 5, 7, 14-20] Limitations of our study include a small cohort of patients and retrospective design. Syndesmosis fixation was not taken as a variable in this study. The size of the posterior fragment was based on plain radiographs earlier but a recent study by Haraguchi *et al*. has suggested that CT-scans should be done to accurately measure the size and anatomy of the posterior malleolus. [25] Hence CT-SCAN was done in majority of our patients to determine the posterior malleolar fragment size and its anatomy.

Conclusion

Poor functional results are seen with increasing posterior fragment size in trimalleolar fractures. Residual functional deficits should be emphasized to patients prior to surgery. Hence more research is required with the aim of managing this group of patients with an attempt to improve their post-operative function and quality of life.

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