Prospective analysis of clinico-radiological outcome of direct internal fixation of posterior malleolus in trimalleolar ankle fractures through posterolateral approach in prone position

Ravi Garg¹, Rohit Nath¹, Tushar Chaurasia¹, Devendra Kumar¹

Abstract

Objectives: This prospective study has been done to evaluate the clinical and radiological outcome of open reduction and direct internal fixation of posterior malleolus in trimalleolar ankle fracture through posterolateral approach in prone position.

Methods: This study is a prospective study of 12 cases of trimalleolar ankle fracture with posterior malleolus fracture treated with open reduction and direct internal fixation technique through posterolateral approach, admitted in the department of orthopaedics, L.L.R. Hospital, Kanpur from June 2017 to June 2019. All cases of posterior malleolus fracture were directly fixed with antiglide/buttress plate in prone position. All patients were assessed using American Orthopedic Foot and Ankle Society (AOFAS) score clinically and post traumatic arthritic score radiologically. Ankle joint mobility was also compared with unaffected side.

Results: Mean follow-up period was 21 months (range: 18-24 months). There were 8 male patients and 4 female patients between 20 and 65 years of age (mean: 44 years). Average time to surgery was 7.5 days (4-21 days). According to AOFAS assessment, result was excellent in 8 patients and good in 4 patients. When compared with uninjured side, there was no significant difference in plantar flexion of ankle (p=0.325) but there was significant difference in dorsiflexion of ankle joint (p<0.001).

Conclusion: Open reduction and direct internal fixation of small posterior malleolus provides satisfactory clinical and functional outcomes and facilitates rehabilitation by creating more stable construction. Posterolateral approach to ankle gives adequate access to the posterior malleolus allowing its anatomical reduction and stable fixation to maintain articular congruency without any step.

Keywords: Ankle fracture, Posterior malleolus, Trimalleolar fracture, Post traumatic arthritic score, AOFAS score.

Introduction

According to Sir Robert Jones “Ankle is the most injured joint of the body but the least well treated”[1]. A trimalleolar fracture is a fracture of the ankle that involves the lateral malleolus, the medial malleolus and the distal posterior aspect of the tibia, which can be termed as the posterior malleolus. The trauma may be sometimes associated with ligamentous injury and dislocation[2]. The main mechanism of trimalleolar fracture is an external rotation injury. This type of unstable fracture requires prompt diagnosis and urgent surgery. The typical presentation of trimalleolar fracture of ankle may be from pain, tenderness to swelling, discoloration, ecchymosis and gross deformity. Additionally, patients are unable to bear weight on the injured ankle. All injured patients should be evaluated for more extensive and serious trauma depending on the circumstances[3]. Posterior malleolar fractures are observed in approximately 14%–44% of all ankle fractures[4,5]. These types of fractures usually include the posterior tubercle of the distal tibia or posteromedial tuberplafond[6]. The most common type of posterior malleolar fracture involves the posterior tubercle, resulting in an avulsion of the posterior inferior tibiobular ligament (PITFL) following a rotational ankle injury[7]. Large posterior malleolar fracture fragments with posteromedial involvement occur along with the axial loading and posterior shearing forces to the ankle mortise[6]. Recent studies have demonstrated that functional outcomes are adversely affected in trimalleolar fractures in comparison to bimalleolar fractures of the lateral and medial malleolus[5,8,9,10,11,12]. Due to the important biomechanical function of the posterior tibial margin in weight-bearing and ankle stability, the affected ankle is prone to degenerative ankle arthritis[13].

Materials and Methods

This study was a prospective study of 12 cases of trimalleolar fracture of ankle with posterior malleolus fracture treated with open reduction and direct internal fixation regardless of the size of fracture fragments and evaluated in the department of Orthopaedics, L.L.R. Hospital, Kanpur from June 2017 to June 2019.

All skeletally mature (>18 yrs) and medically fit patients of trimalleolar ankle fractures with...
posterior malleolus fractures were included in this study. Patients with pathological fracture, pilon fracture, fracture >3 weeks old at the time of surgery, open fracture grade > III A injury and bilateral trimalleolar fractures were not included in this study.

Preoperative evaluation
A thorough history was taken and each patient was investigated clinically, hematologically and radiologically. Cardiac assessment of patients above 45 years was done. First primary treatment was given to all patients in form of below knee pop slab and elevation to reduce edema after confirming with x-rays and 3D CT scan. Fracture was classified according to Lauge-Hansen's classification.

Clinical evaluation
All patients with trimalleolar fracture of ankle presented with mild to severe pain, tenderness, swelling, ecchymosis and marked restriction of movement of ankle joint with gross deformity, depending on the degree of displacement of fracture.

Radiological evaluation
- Traction X ray of affected ankle with leg– AP/Lateral /Mortise view– Laug– Hansen's classification
- CT scan with 3D reconstruction if required– to assess fracture pattern, incisural involvement, degree of comminution and presence of intra-articular loose fragments.

Treatment
Open reduction and internal fixation was performed for trimalleolar fracture. The goal of treatment was anatomical reduction, which was achieved by maintaining proper length, angulation and rotation.

Surgical approach
Surgery was performed in the prone position with a bump under the ipsilateral hip. The longitudinal incision was placed just medial to the posterior border of the fibula. This gave good access to the Volkmann's fragment and optimal access to the lateral malleolus. The lesser saphenous vein and sural nerve were identified and protected. Retracting the peroneal tendons medially gave access to the posterior aspect of the lateral malleolus. The fibular fracture was classically fixed with a plate, but the fixation construct varied according to fracture pattern or comminution. A second interval was then exploited between the peroneal tendons and Achilles tendon more medially within the wound. The flexor hallucis longus was lifted off the posterior tibia allowing access to the posterior malleolus. Care was taken merely to clean and define the fracture edge, and not to devascularize the fragment. The fragment, depending on its size, was temporarily fixed with k-wire then a small buttress/antiglide plate is used to stabilize the reduction. Alternatively, both the posterior and lateral malleolus might be accessed through the same inter muscular plane between the peroneal tendons and the posterior border of the fibula. Lastly, the medial malleolus was addressed through a standard medial incision. Fixation of the medial side was carried out with two 4 mm lag screws or tension band wiring according to fracture pattern. After fixing all fracture, wound was washed and sutured. All patients were followed up in OPD at 6 weeks, 12 week, 6 months and 1 year after removal of stitches at 2 week. Then short leg removable slab was applied and range of motion exercise of ankle was advised at 2 weeks. Partial weight bearing was allowed only after sign of union in the form of bridging.
callus on at least three cortices out of four on radiograph and clinically as the absence of tenderness and movements at fracture site with or without short leg walking cast. Post-traumatic arthritis imaging score on X-ray of ankle joint during follow-up was recorded and classified using the following scores:

- 0: indicated normal joint, 1: indicated osteophytes but no joint space narrowing, 2: indicated joint space narrowing with or without osteophytes, and 3: indicated disappearance or deformation of joint space [14].

Ankle-Hind foot Scale of American Orthopedic Foot and Ankle Society (AOFAS) [15]. It ranges from 0 to 100 points, where 0 is the worst result possible. AOFAS consists of questionnaire examining pain (40 points), function in daily living (28 points), ROM (22 points), and ankle alignment (10 points).

\[ a) \text{Excellent} > 92 \quad b) \text{Good} 87-91 \quad c) \text{Average} 65-86 \quad d) \text{Poor} < 65. \]

Finally, general physical examination of the ankle was performed and ROM of the affected ankle was evaluated. Restriction in dorsiflexion was compared with contralateral, uninjured side; difference was noted as dorsiflexion restriction. Greater dorsiflexion restriction reflects worse outcome. Statistical analysis included mean value of ROM of ankle joint on affected and unaffected side. Paired samples t-test was used to compare ROM value between ankles. P value of <0.05 represented statistical significance.

Table 1: Demographic details of the patient populations

| Numbers of patients (N) | 12 |
|-------------------------|----|
| Male/Female             | 8/4 |
| Age (Years)             | 44 (20 – 65) |
| Diabetic                | 2 |
| Smoking                 | 3 |
| BMI (mean)              | 28.7 |

Table 2: Perioperative Analysis & Outcome Assessment

| Lauge Hansen's classification | SER | 10 (66.67%) |
|-------------------------------|-----|-------------|
| Avg. injury surgery interval (days) | 7.5(4-21) |
| Mean follow up (months)       | 21 (18-24) |
| AOFAS score                   | Excellent 8 |
| Arthritic score               | 0.67 (0 to 1) |

Discussion

In recent years, there has been great attention paid to the importance of anatomical reduction and internal fixation of fracture with posterior malleolus fracture were evaluated. There were 8 male patients and 4 female patients between 20 to 65 years of age (mean: 44 years). Out of which 2 patients were diabetic and 3 patients were smokers. None of the patients have pre-existing ankle arthritis. Etiology was motor vehicle accident for (41.6%) patients, fall from height for (25%), and ground-level fall for (33.33%).

According to Lauge Hansen’s classification, mechanism of injury was supination external rotation (SER) in 10 patients and pronation external rotation (PER) in 2 patients. Average injury surgery interval was 7.5 days (range: 4-21 days). In all cases, posterior malleolus (irrespective to fragment size) were directly fixed with antiglide/burress plate through posteriorlateral approach. Mean tourniquet time was 96 minutes (range: 90 – 120 minutes). Mean follow up period was 21 months (18-24 months). At final follow-up, AOFAS score indicated results were excellent in 8 patients and good in 4 patients. Mean arthritic score was 0.67 (0 to 1).

In all cases reduction was anatomical with a residual step in the articular surface of ≤ 1 mm. The syndesmosis was stable after fixation of the posterior fragment and a syndesmosis screw was not required. There was superficial wound infection, which resolved with use of oral antibiotics after index surgery. No loss of reduction occurred on radiographic follow-up, and no hardware irritation or failure was seen.

At final follow-up average dorsiflexion was 14.6° ± 2.7° (range: 11–23°) on affected side and 21.7° ± 2.5° (range: 17–27°) on unaffected side. Loss of dorsiflexion of ankle joint in affected side was mean 7°. There was significant difference in dorsiflexion of ankle joint between sides (p<0.001). Average plantar flexion was 37.8° ± 3.5° (range: 33–44°) in affected side and 46° ± 3.6° (range: 41–54°) in uninjured side. But there was no significant difference (p=0.325) in plantar flexion of ankle joint between sides.

Table 3: Comparison of range of motion between affected and unaffected side

| Study | Sample size (N) | Mean Age (Yrs) | Classification | Mean Follow up (months) | ROM - Residual ankle articular step off (mm) | AOFAS Score | Arthroscopic | Complications (no of patients) |
|-------|----------------|----------------|-----------------|-------------------------|-------------------------------------------|-------------|--------------|-------------------------------|
| Verhage et al. [16] | 52 | 49 | AOI | 34.07 | 29 | 14.6±2.7 | Excellent | 0.001 |
| Karaca et al. [17] | 57 | 55.9 | AOI | 44.4 | 21 | 21.7±2.5 | Good | 0.325 |
| Our study | 12 | 44 | AOI | 21 months | 0 | 13.8±2.4 | Excellent | 0.001 |

Table 4: Comparison to other study

| Study | Sample size (N) | Mean Age (Yrs) | Classification | Mean Follow up (months) | ROM - Residual ankle articular step off (mm) | AOFAS Score | Arthroscopic | Complications (no of patients) |
|-------|----------------|----------------|-----------------|-------------------------|-------------------------------------------|-------------|--------------|-------------------------------|
| Verhage et al. [16] | 52 | 49 | AOI | 34.07 | 29 | 14.6±2.7 | Excellent | 0.001 |
| Karaca et al. [17] | 57 | 55.9 | AOI | 44.4 | 21 | 21.7±2.5 | Good | 0.325 |
| Our study | 12 | 44 | AOI | 21 months | 0 | 13.8±2.4 | Excellent | 0.001 |
the posterior malleolus fragments[16-18,19,20]. It is thought that a congruent ankle joint without an articular step is needed to achieve a good functional outcome in patients who undergo surgical management for a fracture of the ankle. In the absence of adequate anatomical reduction of the posterior malleolar fragment with a persistent articular step leads to the development of post-traumatic osteoarthritis [21.22].

According to the AO guidelines, indication of fixation of a posterior malleolar fragment is usually when it involves >25% of the tibiotalar articular surface or when there is persistent instability after fixation of the medial and lateral malleoli[23].

De Vries et al[24] and Langenhuijsen et al[25] recommend fixation of posterior fragments if fragment size is larger than 25% or 10%, respectively. Mingo-Robinet et al[26] suggest in a retrospective study involving 45 trimalleolar fractures, that anatomical reduction, and not size of the fragment, was the most important determinant of outcome. Anatomical reduction and fixation of the posterior malleolar fragment also require to reconstructs the fibular notch and the syndesmosis. Cadaver studies show that this technique is biomechanically superior to the use of syndesmosis screws in injuries proximal to the syndesmosis[19].

In AO type 44C fractures, even small posterior malleolar fragments can be fixed. Syndesmosis screws are not needed if the syndesmosis is clinically stable after fixation[20].

Treatment of ankle fractures involving posterior malleolus has been source of intense debate over the last several decades. Both non-operative and surgical treatments have been proposed by many authors. Factors such as size of fragment, joint congruity, and talocrural and syndesmotic stability have to be taken into account for optimal treatment of posterior malleolus fragments. While some authors have found no differences in clinical outcomes and ankle stability in posterior malleolus fragment treatment based on posterior fixation, others have found that reduction and fixation performed on large fragments yields better results [4,10,27,28].

There is no consensus in the literature regarding fragment size of PMF that should be fixed. Lindsjo et al. found significantly higher incidence of post-traumatic OA among patients with posterior fragments involving the tibial plafond (34%) than in fractures with small posterior fragments (17%) or no posterior involvement (4%) [10]. Jaskulka et al[4], reported that even small PM fragments (tibial rim fractures) may increase risk of arthritis. In our study, correlation between fragment size and arthritis was not evaluated. But mean arthritic score was 0.67 on follow-up.

In our study, all posterior malleolus fragments were fixed directly through posterolateral approach and there was normal anatomical reduction. Good clinical results were obtained compared to unaffected ankle, AOFAS assessment was excellent/good for all patients. The posterolateral approach gives an adequate view of the fracture, an anatomical reduction in most cases and sound fixation of the posterior malleolar fragment. Also small fragments are easier to fix and small intra-articular fragments can be removed from the site of the fracture. This approach also provides adequate exposure of the fibula for fixation through a single incision

**Conclusion**

Open reduction and direct internal fixation of small posterior malleolus provide satisfactory clinical and functional outcomes and facilitate rehabilitation by creating more stable construction. Posterolateral approach to ankle gives adequate access to the posterior malleolus allowing its anatomical reduction and stable fixation to maintain articular congruency without any step.

**References**

1. Srivastava DC, Yadav S, Singh A, Gupta A. The Functional Outcome of Fixation of Trimalleolar Fracture, through Fixation of Lateral Malleolus by Plating, Medial Malleolus by Tension Band Wiring and Percutaneous Screw Fixation of Posterior Malleolus: A Prospective Study. Journal of Bone and Joint Diseases Aug-Dec 2016; 31(2):30-32.
2. Orthopaedic Trauma Association (September 2007). "Ankle Fractures". AAOS.
3. Bucholz R, Court-Brown C, Rockwood C. Rockwood and Green’s Fracture in Adult. New York: Lippincott; 2015.p2541-86.
4. Jaskulka RA, Ittner G, Schell D. Fractures of the posterior tibial margin: their role in the prognosis of malleolar fractures. J Trauma1989; 29:1565–70.
5. Court-Brown CM, McBurnie J, Wilson G. Adult ankle fractures—an increasing problem? Acta Orthop Scand 1998; 69:43–7.
6. Neumaier Probst E, Maas R, Meenen NM. Isolated fracture of the postero-lateral tibial lip (Volkmann’s triangle). Acta Radiol 1997;38:359–62.
7. Marsh JL, Saltzman CL. Ankle fractures. Rockwood and Green’s Fractures in Adults. In: Bucholz RW, Heckman JD, Court-Brown CM, editors. 6th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2005. pp. 2147–235. [Google Scholar]
8. De Vries JS, Wijgman AJ, Sierevelt IN, Schaap GR. Long term results of ankle fractures with a posterior malleolar fragment. J Foot Ankle Surg. 2005;44:211–7. [PubMed] [Google Scholar]

9. Langenhuijsen JF, Heetveld MJ, Ultee JM, Steller EP, Butzelaar RM. Results of ankle fractures with involvement of the posterior tibial margin. J Trauma. 2002;53:55–60. [PubMed] [Google Scholar]

10. Lindsjö U. Operative treatment of ankle fracture-dislocations. A followup study of 306/321 consecutive cases. Clin Orthop Relat Res. 1985;199:28–38. [PubMed] [Google Scholar]

11. McDaniel WJ, Wilson FC. Trimalleolar fractures of the ankle. An end result study. Clin Orthop Relat Res. 1977;122:37–45. [PubMed] [Google Scholar]

12. Borg T, Larsson S, Lindsjö U. Percutaneous plating of distal tibial fractures. Preliminary results in 21 patients. Injury. 2004;35:608–14. [PubMed] [Google Scholar]

13. Macko VW, Matthews LS, Zwirkoski P, Goldstein SA. The joint-contact area of the ankle. The contribution of the posterior malleolus. J Bone Joint Surg Am. 1991;73:347–51. [PubMed] [Google Scholar]

14. Domsic RT, Saltzman CL. Ankle osteoarthritis scale. Foot Ankle Int 1998;19:466–71.

15. Rodríguez RC, Masiero D, Mizusaki JM, Imoto AM, Cohen M. Translation, cultural adaptation and validity of the American orthopaedic foot and ankle society(AOFAS) ankle-hindfoot scale. Acta Ortop Bras. (serial on internet).2008;16(2):107-111.

16. McDaniel WJ, Wilson FC. Trimalleolar fractures of the ankle. An end result study. Clin Orthop Relat Res 1977;122:37–45.

17. Mingo-Robinet J, López-Durán L, Galeote JE, Martinez-Cervell C. Ankle fractures with posterior malleolar fragment: management and results. J Foot Ankle Surg 2011;50:141–145.

18. Berkes MB, Little MTM, Lazaro LE, et al. Articular congruity is associated with short-term clinical outcomes of operatively treated SER IV ankle fractures. J Bone Joint Surg [Am]. 2013;95-A:1769–1775.

19. Gardner MJ, Brodsky A, Briggs SM, Nielson JH, Lorich DG. Fixation of posterior malleolar fractures provides greater syndesmotic stability. Clin Orthop Relat Res 2006;447:165–171.

20. Miller AN, Carroll EA, Parker RJ, Helfet DL, Lorich DG. Posterior malleolar stabilization of syndesmotic injuries is equivalent to screw fixation. Clin Orthop Relat Res2010 Apr;468:1129–1135.

21. van den Bekerom MP, Haverkamp D, Kloen P. Biomechanical and clinical evaluation of posterior malleolar fractures. A systematic review of the literature. J Trauma 2009;66:279–284.

22. Fitzpatrick DC, Otto JK, McKinley TO, Marsh JL, Brown TD. Kinematic and contact stress analysis of posterior malleolus fractures of the ankle. J Orthop Trauma 2004;18:271–278.

23. No authors listed. AO Foundation. www2.aofoundation.org (date last accessed 04May 2016).

24. De Vries JS, Wijgman AJ, Sierevelt IN, Schaap GR. Long-term results of ankle fractures with a posterior malleolar fragment. J Foot Ankle Surg 2005;44:211–217.

25. Langenhuijsen JF, Heetveld MJ, Ultee JM, Steller EP, Butzelaar RM. Results of ankle fractures with involvement of the posterior tibial margin. J Trauma 2002;53:55–60.

26. Mingo-Robinet J, López-Durán L, Galeote JE, Martinez-Cervell C. Ankle fractures with posterior malleolar fragment: management and results. J Foot Ankle Surg 2011;50:141–145.

27. Harper MC. Talar shift. The stabilizing role of the medial, lateral, and posterior ankle structures. Clin Orthop Relat Res 1990;257:177–83.

28. Hartford JM, Gorczyca JT, McNamara JL, Mayor MB. Tibiotalar contact area. Contribution of posterior malleolus and deltoid ligament. Clin Orthop Relat Res 1995;320:182–7.

29. Verhage SM, Boot F, Schipper IB, Hoogendoorn JM. Open reduction and internal fixation of posterior malleolar fractures using the posterolateral approach. The bone & joint journal. 2016 Jun;98(6):812-7.

30. Karaca S, Enercan M, Ozdemir G, Kahraman S, Çobanoğlu M, Küçükkaya M. Importance of fixation of posterior malleolus fracture in trimalleolar fractures: A retrospective study.