



Surgical Management of Bimalleolar Fracture of Ankle in Adults: A Prospective Study and Functional Evaluation

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ABSTRACT

Introduction

Malleolar injuries are the most common significant lower extremity fractures. These injuries gain importance, because the whole-body weight is transmitted through the ankle, and locomotion depends on the stability of the ankle. Open reduction and internal fixation have become the mainstay of treatment for most of the unstable bimalleolar fractures of the ankle, as these operative methods restore the anatomy, biomechanics and contact loading characteristics of the ankle.

Methodology

A prospective study of 40 cases of bimalleolar fractures of ankle in adults, managed surgically by various techniques in between Nov 2019 to Dec 2021, satisfying the inclusion and exclusion criteria were studied. The functional outcome was evaluated using the Biard and Jackson's ankle scoring system. The findings were statistically analyzed.

Results

Of the 40 patients, 24(60%) were men. Road traffic accident was the cause of injury in 18(45%). 14(35%) had supination-external rotation injuries. Average time for complete union of fracture was 10.4 weeks. In our study we achieved 85% excellent to good results, 10% fair results, 5% poor results.

Conclusion

The operative result was satisfactory in 85% cases, with good to excellent functional outcome. Cancellous screws or malleolar screws are far better in internal fixation of medial malleolus compared to Kirschner -wire fixation and lateral plating was the best for fibular fractures. TBW done for many PER and PA injuries showed promising results comparable to that with screw fixation and also lesser reports of skin irritation at the wound site.

Keywords: Bimalleolar ankle fractures, functional outcome, Biard and Jackson's ankle scoring system

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INTRODUCTION

Ankle fractures are the most common type of fractures treated by orthopedic surgeons. There has been an increase in the prevalence of such fractures over the last two decades both in the young, active patients and in the elderly [1,2]. Most ankle fractures are complex injuries that are difficult to manage. These injuries gain importance because the whole-body weight is transmitted through the ankle and locomotion depends upon the stability of the ankle joint. They have the potential to produce significant long-term disability and complications in the form of pain, instability, mobility and early degenerative arthritis [3]. As a result of a better understanding of the biomechanics of the ankle, improvements in fixation techniques and findings of outcome studies, there has been a gradual evolution in the effective strategies for the treatment of ankle fractures. The goals of treatment include achieving sound union of fracture and ankle movements and functions normally without pain. As has been shown experimentally Paul L. Ramsey, about one mm lateral shift in Talus, produces about 42 percent of decrease in tibio-talar contact area [2]. This obviously shows the need for perfect anatomical reduction, which could be achieved by open reduction and maintained by internal fixation. The operative method restores the anatomy and contact-loading characteristic of the ankle. Additional advantages include easier rehabilitation without a cast, early mobilization and earlier weight bearing [4]. Although fractures about the ankle have traditionally been considered non-controversial with respect to the indications for operative intervention, recent advances in the understanding of the biomechanics of the ankle have given rise to particular areas of clinical uncertainty. These include the indications for the operative treatment of isolated fractures of the lateral malleolus, the operative techniques for syndesmotic injury and its post-operative management and the reliability of radiographic assessment of fractures about the ankle. The purpose of this study, on Bimalleolar fractures of the ankle is to evaluate the functional outcome and results obtained after surgical management by various methods of internal fixation.

METHODOLOGY

The study was conducted in the Department of Orthopedics, King George Hospital, Visakhapatnam

for a period of 2 years between October 2015 to December 2017.

Inclusion criteria:

1. Patients having unstable bimalleolar fracture of ankle.
2. Closed type of fractures.
3. Patients who were between the age of 20-65 years of age.

Exclusion criteria:

1. Patients who are medically unfit for surgery.
2. Open fractures of ankle.
3. Those associated with tibial pilon fractures.

Those meeting the selection criteria were included and clinically evaluated. All patients were assessed clinically and radiologically. The stability of the structures involved at the fracture site, damage to the neighboring structures, mechanism of injury was assessed. Radiologically, tibio-fibular clear space of >6 mm and widening of the medial clear space of >4 mm was considered as indicators of syndesmotic instability [5]. The fractures were classified using the Lauge-Hansen, [6] AO/OTA classification systems [7] and anatomical types [8]. Closed reduction and a below knee posterior POP slab was applied. All included patients underwent ORIF and received post-operative care. Under spinal anesthesia, patients were placed in supine position. The ipsilateral buttock was raised on a sandbag for better and clear view of the lateral side. Appropriate surgical techniques were applied as per the fracture site. Intraoperatively, the stability was checked by laterally displacing the distal fibula from the tibia and the presence of >3-4 mm of lateral shift of talus suggested instability (cotton test) [9]. We used tension band wiring, Kirschner wires (K-wires) and cancellous screws (Fig. 1) for fixing medial malleolus. One-third tubular plate (Fig. 2) and Rush nails were used to fix lateral malleolus. Post-operative protocol: Parenteral antibiotics were given in the post-op period. After 10 to 12 days, the sutures were removed and a below knee cast was applied for 4 weeks. Non-weight bearing walking was started from

the first or the second postoperative day. Partial weight bearing was started after the removal of the cast (after clinical and radiological signs of union become evident). Active exercises of the ankle were advised. In patients with syndesmotic screw fixation, weight bearing was delayed till screw removal. Follow up of cases was done at regular intervals of 6 weeks for a minimum of 6 months. At each assessment, all patients were questioned with regard to pain, use of analgesics, stiffness, swelling, activities of daily living, use of walking aids, return to work and participation in sports. At examination, the gait, swelling, tenderness of the ankle and the range of motion of the ankle were evaluated. Antero-posterior, lateral and mortise radiographs of the ankle were made at the time of examination. Baird and Jackson's ankle scoring system [10] of subjective, objective and radiographic criteria was used for the study. All the

patients were evaluated and scores were given.

RESULTS

In this 24-month study, we included 40 patients with bimalleolar fracture of the ankle which met the selection criteria. 24(60%) of our patients were men and 16(40%) were women. In our series, majority of the cases i.e. 18 (45%) was in the age group of 31-40 years, followed by 12 (30%) cases in the age group 21-30 years. The youngest being 22 years old and eldest was 63 years. The mean age was 36.25 years. Right ankle was involved in the majority of cases 26(65%) and left ankle in 14(35%) patients. Mode of injury was road traffic accident in 18 (45%) patients, fall from height in 14(35%) patients and twist injury in 8(20%). In total 14(35%) patients had Supination – external rotation injuries and 12(30%) had pronation external rotation injuries (Table 1). The AO Type B was the most common injury involving 20 (50%) patients, followed by Type C in 14 (35%) and was least in Type A (15%).

Table 1: Fracture type (LAUGE-HANSEN TYPE)

LAUGE-HANSEN TYPES	NO OF CASES	PERCENTAGE (%)
Supination- External Rotation	14	35 (%)
Supination -Adduction	06	15 (%)
Pronation- Abduction	08	20 (%)
Pronation- External Rotation	12	30 (%)

In this study, most of the cases were operated between day 2 and 5 (75%). The mean time interval was 3.5 days. Medial malleolus fracture fixation:

Majority of medial malleolus fractures 28(70%) patients were treated with cancellous screws, 10(25%) patients with tension band wiring (Table 2).

Table 2: Medial Malleolus fracture fixation

Method of fixation	NO OF CASES	PERCENTAGE (%)
Cancellous screw fixation	28	70 (%)
k-wire fixation	02	5 (%)
Tension Band wiring	10	25 (%)

Lateral malleolus fracture fixation: Most of the lateral malleolar fractures i.e. 28 cases (70%) were fixed with one-third Tubular plate. 12(30%) cases were managed by Rush nails.

Syndesmotic fixation: In 02 cases (5%), Syndesmotic injury was noted and in these two cases it was fixed with a fully threaded screw. Weight bearing was deferred till screw removal, which was done at 6-8 weeks.

Outcome: In our study, the average time taken for union was 10.4 weeks. Most of the cases (80%) showed union between 8 - 12 weeks.

All cases were assessed radiologically before surgery for confirmation, classification and to assess the extent of the injury and postoperatively to assess the outcome, and union (Figs. 3.1 & 3.2, 4.1 & 4.2). The union was assessed at regular intervals and during follow-up.

Functional outcome: Functional outcome was assessed using Biard and Jackson's ankle scoring system at follow-up. Excellent results were achieved in 24 cases (60%), good in 10 cases (25%), fair results

in 04 cases (10%) and poor results in 02 cases (5%). 06 patients had fair to poor results, were seen in those with associated syndesmotic injury, and in patients with delayed union of medial malleolus and those with superficial or deep infections. The patients with poor results had mild pain during their activities of daily living, diminution in their abilities to run and do work, reduced motion of the ankle and narrowing of joint space (Figs. 5.1 & 5.2) show the restoration of movement at the ankle joint to the pre-injury level.

Combined functional score was calculated using Biard and Jackson's ankle scoring system and grouped into five categories (A-E) (Table 3). Complications: In our study, 20% of patients had complications. 04 patients had superficial infection, 02 patients had deep infection, 02 patients had delayed union of medial malleolus. The infections (superficial and deep) were managed with debridement and antibiotics. Delayed fracture union MM was treated with continued immobilization, which eventually united without surgical intervention.

Table 3: Biard and Jackson's ankle scoring system

Category	A	B	C	D	E	TOTAL
Pain	20(50%)	18(45%)	2 (5%)	-	-	40
Stability	40 (100%)	-	-	-	-	40
Walking	34 (85%)	4 (10%)	2 (5%)	-	-	40
Running	14 (35%)	24 (60%)	2 (5%)	-	-	40
Work	26 (65%)	14 (35%)	-	-	-	40
Motion	34 (85%)	6 (15%)	-	-	-	40
Radiographs	38 (95%)	2 (5%)	-	-	-	40

DISCUSSION

There has been an increase in the prevalence of bimalleolar fractures over the last two decades both in the young, active as well as in elderly patients^[2]. Of all the intra-articular fractures occurring in weight bearing joints, the most common joint involved is the ankle joint. Methods to restore function and to prevent arthritis are either closed treatment, which includes manipulative reduction and immobilization

in plaster cast or open reduction with internal fixation. Burwell and Charnley showed that anatomical reduction and rigid fixation led to early return to function^[11]. There has been gradual evolution in management of ankle fractures due to improved analysis of biomechanics, improvement in fixation techniques and analysis of results of recent studies. The goal of treatment is to provide fracture union

with painless full motion of ankle, with anatomical restoration of the injured ankle. Closed method of treatment is often inadequate in restoring the anatomy and biomechanics of the ankle in unstable malleolar ankle fractures. Conversely, open reduction with internal fixation is an excellent method for restoration of normal anatomy of joints. Several studies indicated that internal fixation of displaced malleolar fractures of the ankle provides better results.^[12, 13] The treatment of malleolar fractures with accurate open reduction and stable internal fixation using AO method and principles was found to give a high percentage of excellent and good results^[14]. This study supports these conclusions. The mean age of patients in this study was 36.25 years with the majority of them (45%) in between 31-40 yrs. The mean age was younger when compared to other studies, Bhargavevem et al^[15] reported mean age of 37.3 yrs. Patil et al^[16] reported their mean age as 36 years. Venkatesh et al^[17] reported 37.87 years. Verhage et al^[18] in their study conducted on 243 patients reported mean age of 52 years. The present study is also comparable with some older studies Beris et al^[14] reported their mean age as 43.8 yrs. Available reports show male preponderance as in a study by Baird and Jackson (70.0%)^[10] and studies by Indian authors^[15-17]; our study population showed male preponderance (60%). However, few studies reported female predominance^[18,19,20]. In the current study, road traffic accidents constituted majority of cases, which was in accordance with study by Lee et al^[20] and Bhargavevem et al^[15]. Fall from height was the commonest mode of injury in the study conducted by Baird and Jackson^[10] which was second commonest in our study. Right ankle was commonly involved in our study in accordance with other studies^[15,17,19,20]. We followed Lauge-Hansen classification system to classify the ankle trauma.^[21] The most common type of injury was SER (35%), followed by pronation-external rotation injury (30%), and our observation is in accordance with previous reports.^[10,15,17,19] The AO Type B was the most common injury involving 20 (50%) patients, followed by Type C in 14 (35%) and was least in Type A (15%). Similar observations were reported in study by Bhargavevem et al^[15]. Avoiding wound complications is of paramount importance and should receive a high priority. Timing of the surgical stabilization appears to be a controllable factor to achieve lower complication rates. Another factor that can be

influenced is the choice of implant, e.g., thinner plates^[22] or fibular nailing in fragility fractures or in patients with comorbidities. Every effort should be made to operate on closed ankle fractures as soon as reasonably possible. A delay in surgery is associated with a significant rise in infectious wound complications, which significantly lowers outcome and patient satisfaction. These fractures should preferably be treated within the first day^[23]. The mean time interval from injury to surgery was 3.5 days which was within acceptable time frame which was comparable to other studies^[15]. All our patients underwent ORIF with majority of medial malleolus fractures fixed with cancellous screws (70%) and lateral malleolus fixed with one third tubular plate (70%). The syndesmotic injury was fixed with a fully threaded screw. These are standard operative techniques followed by orthopedic surgeons worldwide, though preference of the method may vary among the fraternity. Most authors have stated that anatomical reduction of displaced medial malleolus ensures correction of talar displacement and is of paramount importance in treating unstable fractures^[24]. However, Heller^[25] et al. State that talus is more accurately repositioned in mortise by anatomical reduction of lateral malleolus. Observations in this study support the contention of Yablon^[25] et al that lateral malleolus is the key to the anatomical reduction of bimalleolar fractures, because the displacement of the talus faithfully followed that of the lateral malleolus. Poor reduction of the lateral malleolus fracture would result in persistent lateral displacement or residual shortening. This does not necessarily lessen the importance of medial malleolus, but it does serve to emphasize that the lateral malleolus should no longer be ignored. AO group has become widely accepted for treatment of fibular fracture^[26]. Hughes et al^[27] recommended that lateral malleolus should be fixed first. The medial malleolus is then inspected for stability and fixed if necessary. This allows minimal postoperative immobilization and rapid recovery of function. We observed better functional outcome in those who underwent stable internal fixation of the medial malleolus by cancellous, but it was unsatisfactory in those with less rigid fixation using only K-wires. Tension band wiring of the medial malleolus gave results equivalent to those fixed with screws and lesser reports of skin irritation which was more frequent in those patients with screw

fixation. Although early mobilization was advocated by the AO group, other studies [11] have found no significant difference in the results produced after early mobilization. In the current study, immobilization was done for 4 weeks. Partial weight bearing was advised for those with early radiological signs of union and full weight bearing when the signs of union were complete. The range of motion of the ankle was reduced initially, but improved over a few weeks. Study conducted by Smeeing [28] et al which was a multicenter randomized control trial concluded that unprotected weight-bearing and mobilization as tolerated as postoperative care regimen improved short-term functional outcomes and led to earlier return to work and sports, yet did not result in an increase of complications. In our series there was 30 degrees or more plantar flexion in 36 patients (90%) and 20 degrees or more dorsiflexion in 34 (85%) patients. Time taken for union depends on various factors and has been around 10.6 weeks as reported by Bhargavevem [15] et al. while a longer duration of 13 weeks has been reported by Kulloli et al [29]. Mean time for the union was 10.4 weeks in our study population with a range of 8-12 weeks, which was similar to the study by Bhargavevem [15] et al. The results in the current study were compared with that of Burnwell & Charnley [11], Colton, De souza et al [12], Beris et al [14], Bhargavevem et al [15], Venkatesh et al [17]. In Colton [30] series, 70% of the patients had a good to excellent results. Burnwell & Charnley [11] in their series of 132 patients, 102 (77.3%) had good results, 16% had fair results and 6% were found to poor score. In the De Souza [12] series, 150 cases of ankle fractures treated by open reduction and internal fixation using AO/ASIF method, obtained 90% good results. In a study by Beris et al [14], of 144 patients with ankle

fractures, 105 (74.3%) had good to excellent results. The functional results of the present study were comparable with that of the above cited studies, with 85% had good to excellent results, 10% had fair results and poor results in 5%. In the study conducted by Bhargavevem et al [15] out of 30 patients 18(60%) had excellent results, 8(26.6%) had good results and 4(13.3%) had fair to poor outcomes (TABLE: 4). In our 40 patients, there was no instability of ankle or subtalar joints, because we allowed sufficient time for the soft tissues around the ankle to heal. We preferred postoperative immobilization rather than allowing active ankle exercise as there was no difference in the results after 6 months of follow up. Fair to poor results in the current series were seen due to wound infection, associated syndesmotom injury, delayed union of medial malleolus. Restricted activity level and range of movement without radiological evidence of arthritis was noted in four patients. The smaller sample size was the major limitation of our study. We did not study the effect of comorbidities on the outcome of the procedure. Comparing with closed reduction would have described the outcomes better. Effect of the surgery on the subgroups would have been more appropriate. The result of our study is in accordance with a similar previous study. ORIF has become the mainstay of treatment for most of the unstable bimalleolar fractures, as these operative methods restore the anatomy, biomechanics, and contact loading characteristics of the ankle. The study concludes that exercising diligence in the management of ankle fractures, adherence to AO method and principles not only improve the accuracy of ORIF but also yield a higher percentage of the excellent and good result.

Table 4: Functional outcome

Study	Good to Excellent results	Fair results	Poor results
Burnwell and Charnley [11]	102 (77%)	22(17%)	8(6%)
Colton [30]	18 (70%)	4(15%)	4(15%)
De Souza [12]	135(90%)	9(6%)	6(4%)
Beris [14]	105(74.3%)	21(14.6%)	16(11.1%)
Bhargava [15]	26(86.6%)	02(6.6%)	02(6.6%)
Present Study	34(85%)	04(10%)	02(5%)



CONCLUSION

Understanding the mechanism of injury is essential for anatomical reduction and fixation. Fibular alignment (length, rotation) has to be maintained for lateral stability of the ankle. Anatomical reduction with restoration of the articular congruence is essential in all intra articular fractures, more so, if a weight bearing joint like ankle is involved. Open reduction and internal fixation restore the articular congruity of the ankle joint. The operative results were satisfactory in 85% cases, with good to excellent functional outcomes. Functional results were much better in younger age groups and men. Fair to poor results were seen in those bimalleolar fractures

associated with syndesmosis injury, wound infection and those with unsatisfactory reduction. Cancellous screws are better in internal fixation of medial malleolus compared to Kirschner-wire fixation and lateral plating was the best for fibular fractures done for many PER and PA injuries showed promising results comparable to that with screw fixation and also lesser reports of skin irritation at the wound site. It is the method preferred for small transverse fragments and osteoporotic bones of both malleoli especially in the elderly. Rehabilitation is quick because immobilization is for a relatively short duration and is followed by weight bearing.

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Figure 1: intraoperative image of Cancellous screw fixation for Medial malleolus



Figure 2: intra-operative image of semi-tubular plate for Lateral malleolus.



Figure 3.1 & 3.2: Pre and post-operative radiograph of a 52-year-old male showing Pronation – External rotation injury.



Figure 4.1& 4.2: Pre and post-operative radiograph of a 37-year-old male showing Pronation – Abduction injury.





Figure 5.1 & 5.2: follow up clinical images of 37 yr. old male showing complete ankle dorsiflexion and plantar flexion compared to opposite limb

