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ORIGINAL RESEARCH

A study of functional outcome of bimalleolar fracture after internal fixation

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ABSTRACT

Background: In the lower extremity intra-articular fracture around ankle joint is the most common one. These fractures when occurred in olden days, ended up with permanent disability. **Objective:** To analyse the functional outcome of Ankle joint after Internal Fixation of bimalleolar fracture. **Methods:** This was a Prospective study includes 30 cases of closed bimalleolar ankle fractures who were treated surgically at Geetanjali hospital, Udaipur from September 2022 to March 2024.Approval from institution ethical committee was obtained. **Result:** Our study consists of 30 cases of closed bimalleolar ankle fractures. Maximum incidence of the injury was in the fifth decade of life. Injury was more common in males-24 (80%) and females being 6 (20%). Right side was more commonly involved- 19 patients (63.3%). Road traffic accidents contributed to 60% of injuries, followed by self-fall while walking (30%) and fall from height (10%). Out of 30 patients, 18 are SER pattern, 7 patients are PER pattern, 3 cases of SAD pattern and 2 cases of PAB pattern. The most common injury pattern seen in our study was Supination-external rotation type. Among Supination-Adduction type, all patients had good to excellent outcome, we have addressed the fibular fragment which is too small to fix, using small size K wire or lag screw. In both the patients with pronation abduction injury, we have fixed medial malleolus first followed by extra periosteal plating for fibula, In our series 12 cases had complications such as wound infection, non-union and malunion. Superficial infection (27%) with skin necrosis was the commonest complication we encountered. **Conclusion:** Supination-external rotation injury is the most common type of bimalleolar ankle fracture and also common type associated with dislocations and complications. Pronation -External Rotation type had excellent and good results without much complications. The accurate anatomical reduction and restoration of articular congruity and early surgical fixation with appropriate implants results in good functional outcome. Good functional outcome was achieved by restoring sufficient stability and providing good mobility at the ankle joint.

Keywords: Functional Outcome, Bimalleolar Fracture, Internal Fixation

INTRODUCTION

About three centuries ago, scientific study started with sir. Percival pott, who in the year 1768, in his paper "Some few general remarks on fractures and dislocations" discussed on fracture complex occurring around the ankle Dupuytren, Leforte-wagstaffe, Tillaux-Chaput, Maisonneuve and others analyse ankle joint injuries.

After studying large number of cases in 1922 Ashhurt and Bromer classified and analysed the ankle injuries by taking into consideration the direction of forces. Lauge-Hansen in1948-1954 recognized four patterns based on pure injury sequences and takes into account at the time of injury, deforming force direction and position of the foot[1].

Many of the ankle injuries are mixed bony and ligamentous components. MRI nowadays is useful in precisely diagnosing ligamentous injury and repairing these components have to be borne in mind, while treating these fractures.

Achieving anatomical reduction by open methods and internal fixation of Bimalleolar ankle fractures is necessary to avoid complications as in all intra-articular fractures.

With the advent of A.O principles of management, the results of bimalleolar ankle fractures are better with emphasis on anatomical reduction of fracture, stable internal fixation, regaining full length of fibula and early active pain free mobilization.

MATERIAL AND METHODS

This was a Prospective study includes 30 cases of closed bimalleolar ankle fractures who were treated surgically at Geetanjali hospital, Udaipur from September 2022 to March 2024.Approval from institution ethical committee was obtained.

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Inclusion criteria

- Age above 18 years
- Patients having undergone internal fixation of bi-malleolar fractures.
- Patients fulfilling the above-mentioned criteria and willing to participate in the study.

Exclusion criteria

- Patient unfit for surgery.
- Patient with history of previous bimalleolar fracture of either ankle
- Patient having arthritis of either ankle.

The Lauge-Hansen classification and AO classification were used to evaluate the fractures radiologically.

Table 1. LAUGE-HANSEN CLASSIFICATION

Based on the position of foot and direction of force applied to foot, four type of injury patterns described by Lauge-Hansen and their incidences

Injury pattern	Number of cases
Supination-Adduction	3
Supination-External rotation	18
Pronation-Abduction	2
Pronation-External rotation	7

Table 2. AO-DANIS-WEBER CLASSIFICATION

Based on the level of fibula fracture, the AO classification expands on Danis-Weber which is perhaps the most rudimentary classification the following distribution was seen.

Danis-Weber classification	Number of cases
Type A	3
Type B	18
Type C	9

The injury - surgery interval was ranged from one day to two weeks and the average period was six days.

Preoperative care and planning

The patients who were presented in the casualty and out-patient department were examined clinically and radiologically. Closed reduction and immobilization with plaster of Paris was done for all cases. Check x-rays were taken and planned for surgery accordingly. High quality radiographs help in planning for reduction and choosing proper implants. Radiographic views of contralateral ankle are taken in few cases for comparison. The size and position of the malleolar fragment and involvement of distal tibiofibular joint was assessed by computed tomography and was done in four cases. Magnetic resonance imaging to assess soft tissue injury and ligamentous involvement was done in seven cases and is useful to obtain good functional outcome. Displacement and stability of the fracture was assessed by X- rays. In displaced fracture reduction was done immediately to maintain tibiotalar congruity. Stress radiographs were done in ten cases to assess preoperative syndesmotic injury. In syndesmotic instability shentons line broken and dime sign present.

INTRAOPERATIVE MANAGEMENT

All our cases were done under sub-arachnoid block without tourniquet control. The fibula was exposed first. The fracture was reduced after clearing the hematoma at fracture site. A pointed reduction forceps was used to hold reduction. A cortical screw of 3.5 mm was used as a lag screw in anteroposterior direction. Lag screw was used in fourteen cases. The one-third tubular plate is low profile and provide sufficient strength for most fractures and is called Work horse plate of distal fibula. Fibula were fixed with one third tubular plate in 16 cases, reconstruction plate in 10 cases with cortical screws. Syndesmotic screws were used for four cases. Two cases each of fibula fracture were treated by K- wires and conservative methods.

FIBULA

One third tubular plate	-	10
Reconstruction plate	-	9
K-Wires	-	5
Conservative	-	2

The medial malleolus was then exposed, and hematoma drained. The fracture site was then reduced after clearing the soft tissue interposition and held in position with the help of towel clips, pointed reduction forceps and k wires. The definitive fixation was undertaken with malleolar screws, cancellous screws and tension band wiring.

MEDIAL MALLEOLUS		
Cancellous Screws	-	15
Tension Band Wiring	-	9
K-Wires	-	3

The following preoperative findings were observed.

- Periosteal interposition at medial malleolus- 3
- Comminuted small fragments of bone inside ankle joint- 3
- Saphenous vein injury- 2

A suction drain was placed and wound closed in layers after complete haemostasis. Compression bandage was applied and a below knee slab was applied.

POSTOPERATIVE CARE AND MANAGEMENT

Postoperatively, the affected limb was kept elevated on a pillow and active toe movements and quadriceps exercises were started. Patients were put on parenteral antibiotics cefuroxime 1.5 gm for four days and changed to oral antibiotics. First wound inspection was done on second post-operative day. On fifth postoperative day second wound inspection was done, and dressings were changed. Depending on the condition of the wound, wound inspection and change

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of dressings were done, accordingly. If drainage was present it was sent for culture and sensitivity and patient was put on appropriate antibiotics. Suture removal was done by 12th to 14th day. Patient was discharged from the hospital in a below knee cast. Routinely, postoperative X-rays were taken to assess the congruity of the joint and assess the alignment of the fractures.

FOLLOW UP

The maximum follow up was two years and Minimum follow up was six months. Patients were called for review at 4th week, 3rd month, 6th month. If there is substantial evidence of union both clinically as well as radiologically, gradual weight bearing started accordingly[29]. patients were put on physiotherapy for mobilization of ankle joint.

ANALYSIS

The subjective and objective criteria and the scoring systems are given below.

SUBJECTIVE SCORING

Criteria are given Below

Table 3: SUBJECTIVE SCORING

Parameters		Score
1. Pain	Never	25
	Walking on uneven surface	20
	Walking on even surface outdoors	10
	Walking indoors constant and severe	05
2.Stiffness	None	10
	Present	0
3.Swelling	None	10
	Only evenings	05
	Constant	0
4.Stairclimbing	No problems	10
	Impaired	05
	Impossible	0
5.Running	Possible	05
	Impossible	0
6.Jumping	Possible	05
	Impossible	0
7.Squating	Possible	05
	Impossible	0
8.Type of supports	None	10
	Tapping, wrapping	05
	Stick or crutch	0
9.Affecting work and Activities of daily life	Same as before injury	20
	Loss of tempo	15
	Part time work/Simpler job	15
	Severely impaired	0

Subjective score was classified into four groups.

1. poor <60
2. fair 60-80
3. Good81-90
4. Excellent >90

OBJECTIVE SCORING

Objective score was based on clinical and Radiological criteria. Clinical criteria includes pain, Range of ankle movements and Deformity. Radiological criteria on the evidence of osteoarthritic changes, talar tilt, talar shift and restoration of joint congruity.

Table 4. OBJECTIVE SCORING

Parameters		Score
1.Pain	Rest pain	3
	Routine walking	2
	Prolonged walking	1
	Pain free	0

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2.Range of movements (plantar flexion+Dorsiflexion) Normal 65	No movement	4
	0-15	3
	16-30	2
	31-45	1
	Above 45	0
3.Deformity	Present	2
	Absent	0
4.Radiological criteria	Osteo arthritic changes	3
	Unacceptable Talar shift and or Talar tilt	2
	Acceptable Talar shift and or Talar tilt	1
	Normal	0

Objective score was classified into 3 groups.

Good	-	0 -3
Fair	-	4 -6
Poor	-	7 -12

RESULT

Our study consists of 30 cases of closed bimalleolar ankle fractures. Maximum incidence of the injury was in the fifth decade of life. Injury was more common in males-24 (80%) and females being 6 (20%). Right side was more commonly involved- 19 patients (63.3%).

Road traffic accidents contributed to 60% of injuries, followed by self-fall while walking (30%) and fall from height (10%). Out of 30 patients, 18 are SER pattern, 7 patients are PER pattern, 3 cases of SAD pattern and 2 cases of PAB pattern.

Table 5. Mode of injury

MODE OF INJURY		
Road Traffic Accident	-	18
Self-fall, Twisting	-	9
Fall from height	-	3

The results were analysed based on olerud and molander scoring[24] . In olerud and molander, subjective and objective scores was used. The four fracture patterns of Lauge-Hansen classification were analysed for results and complications.

Based on the subjective scoring these are the results.

Overall functional outcome for our patients are as follows.

Table 6. Subjective scoring

Results	**No. of patients**	**Percentage**
Excellent (>90%)	12	40%
Good (81%90%)	12	40%
Fair (60%-80%)	04	13.33%
Poor (<60%)	02	6.66%

Based on the **fracture pattern** the following on functional outcome.

Table 7. Subjective scoring w.r.t. lauge Hansen classification

SUBJECTIVE SCORING	**FRACTURE PATTERN**			
	SER	**PER**	**SAD**	**PAB**
Excellent	6	4	2	0
Good	7	3	1	1
Fair	3	0	0	1
Poor	2	0	0	0

Based on the objective scoring these are the results.

Overall functional outcome for our patients are as follows.

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Table 8. Objective scoring

Results	No. of patients	Percentage
Good (0-3)	22	73.33%
Fair (4-6)	6	20%
Poor (7-12)	2	6.66%

Based on the **fracture pattern** the following on functional outcome.

Table 9. Objective scoring w.r.t. lauge Hansen classification

OBJECTIVE SCORING	FRACTURE PATTERN			
	SER	PER	SAD	PAB
Good	12	7	3	0
Fair	4	0	0	2
Poor	2	0	0	0

COMPLICATIONS

The following postoperative complications were encountered.

- Superficial infections with and without skin necrosis 6
- Deep infections 2
- Non-union 2
- Talar tilt 2
- Talar shift 2
- Malunion 1
- Arthritis 1

Fig. 1. Superficial infection

TREATMENT OF COMPLICATIONS

Patients with superficial infection were treated with repeated saline dressings and appropriate antibiotics. They all responded well to this mode of treatment. Patients with deep infection were treated with repeated saline dressings and antibiotics. Those patients who did not respond were treated with early removal of implants.

One patient with moderate to severe skin necrosis was treated with spilt thickness skin graft, once the area was covered by healthy granulation tissue.

The patient with non-union of medial malleolus was treated with freshening of fracture site and revision fixation done.

Implant Removal

Early implant removal was done in four cases. Out of which in three cases implant removal were done due to persistent infection and one case due to persistent pain over the hardware. Of the three cases of infection two cases went for non-union and one case went for mal union.

Table 10.Complications

Complications	No. of patients				
	SER	PER	SAD	PAB	Total
Superficial Infections	3	1	1	1	6

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Deep infections	1	0	1	0	2
Non union	1	0	0	1	2
Malunion	1	0	0	0	1
Arthritis	1	0	0	0	1
Talar tilt	2	0	0	0	2
Talar shift	2	0	0	0	2

ILLUSTRATIVE CASES

Case: 1

- Age :64years Sex: female
- Classification: A.O : B3
- Injury surgery interval: 2 days Complications: Nil

Fig. 2. PREOP

Fig. 3. Immediate post op

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Fig. 4. 3 month clinical photo.

OLERUD AND MOLANDER SCORING SYSTEM

Total subjective score is **95** and the result of the patient is **Excellent**. Total score is **3**. the objective score of the patient is **Good.**

Case:2

- Age :51years, Sex: Male
- Classification: A.O : B3
- Injury surgery interval: 1 day, Complications :Nil

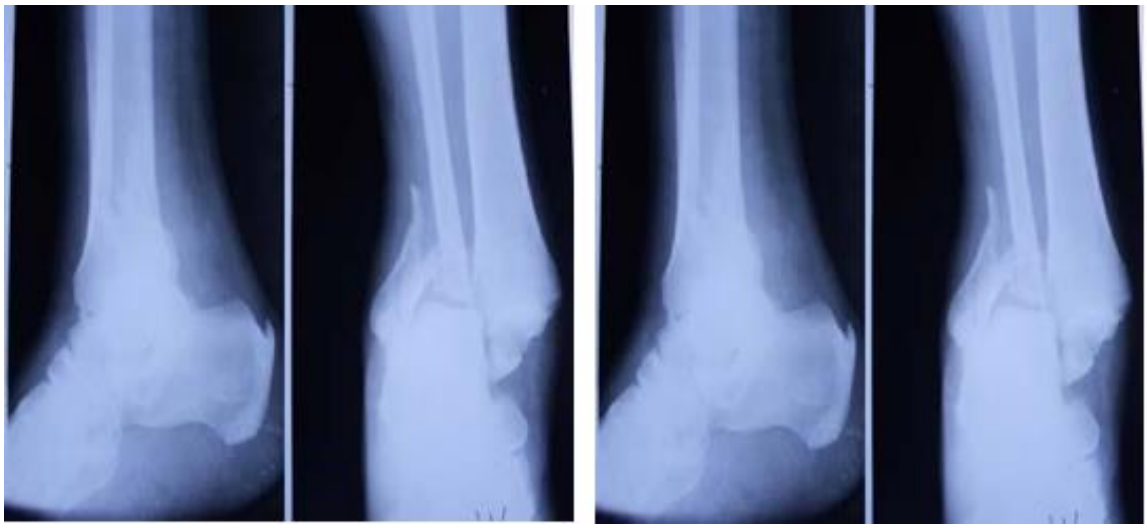

Fig. 5. pre op ankle dislocation with fracture

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Fig. 6. pre op after reduction

Fig. 7. Immediate post op

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Fig. 8. One year follow up X-Rays and clinical picture.

OLERUD AND MOLANDER SCORING SYSTEM

Total score is **95**. The subjective score of the patient is **Excellent.**

Total score is **1**. the objective score of the patient is **Good.**

DISCUSSION

The most common injury pattern seen in our study was Supination-external rotation type. Stress radiographs are useful to assess ankle instability. schonk et al suggested that gravity stress test is comfortable and more sensitive than manual stress test . Weber stated that instability is overestimated by stress radiographs. Evaluation of deep deltoid ligament injury associated with ankle instability is assessed by stress radiographs which help to differentiate SER2 injury from SER4 equivalent injury[2]. SER4 fractures are unstable and needs ligament reconstruction and syndesmotic stability[3]. In SER pattern 13 out of 18 patients had good to excellent functional outcome. Among three patients who had dislocations with SER type of bimalleolar fracture, two had good outcome due to early closed reduction of ankle joint followed by open reduction and internal fixation of malleoli; in another patient with dislocation who had reported late, we had fair outcome indicating the importance of early reduction of ankle dislocation.

Among Supination-Adduction type, all patients had good to excellent outcome, we have addressed the fibular fragment which is too small to fix, using small size K wire or lag screw. We had used anteromedial approach to fix the fracture and address the articular pathology as suggested by Hamilton et al[4] in their study instead of Hockey stick incisions used routinely for other type of fractures.

In both the patients with pronation abduction injury, we have fixed medial malleolus first followed by extra periosteal plating for fibula, the advantage of which (to overcome the higher incidence of non-union in according to their study) has been reported by Ebraheims et al and Aaron et al[5].

In pronation external rotation injury restoration of the fibular length and rotation, ankle mortise and syndesmotic stability is important factor as noted by maverick et al[5]. We had good to excellent results in all seven cases of pronation external rotation injury as we could maintain the syndesmotic stability and fibular length by syndesmotic screws and fibular plating.

Displacement is position of talus in the mortise and depends on intact deep deltoid ligament[6.] Fixing the malleolar fragment will not restore ankle stability and need to repair deep deltoid if torn[7]. Stable fractures do not displace with axial loading[8]. Treatment decisions are based on the stability of fracture. Prognosis is determined by energy of injury[4]. Fixing the malleolar fragment will not restore ankle stability and need to repair deep deltoid if torn. Even though Lauge-Hansen classification describes in detail about the pattern of ankle fracture it does not deal with syndesmotic injuries.

According to Micheal Bekorom[9], pronation injuries/weber C are commonly associated with syndesmotic injuries than supination injuries/weber B, our study also reflects similar incidence of syndesmotic injury among the various fracture patterns.

Patients with fixation of fibula with K wires had less satisfactory results than in those patients where we used a contoured reconstruction or one third tubular plate for fibular fixation. This may be due to the fact that contoured plates accomodate the valgus bend of fibula and provide sufficient stability to the fibular reduction.

We have assessed syndesmotic stability intraoperatively by cotton test or hook test. AO foundation stated that intraoperative cotton or hook test is important to assess the syndesmotic disruption & in turn ankle instability. Boden et al suggested when rigid medial fixation is achieved, no syndesmotic stabilization is required, in the absence of rigid medial fixation if the height of the fibular fracture of more than 4.5 cm above the joint line syndesmotic stabilization is required.

In Hafiz et al study, subjective scoring outcome was

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excellent and good in 84% and objective scoring was good in 78.8% and poor in 4.2%. The results are comparable with our study that the subjective scoring of Olerud and Molander was excellent and good in 12 patients each (80%), Fair in 4 patients and poor in 2 patients. The objective scoring of Olerud and Molander was Good in 22 patients (73.3%), Fair in 6 patients and poor in 2 patients (6.6%).

In our series 12 cases had complications such as wound infection, non-union and malunion. Superficial infection (27%) with skin necrosis was the commonest complication we encountered. Skin necrosis was very much less when plate and screws of 3.5 mm system is used. Miller et al noted infection rate of 2.2% in his series of bimalleolar fractures, and he suggested that the skin incision should be carried straight down to the level of bone, without undermining the skin or subcutaneous tissue and skin necrosis was very much less when plate and screws of 3.5 mm system is used. Non-union of medial malleolus was seen in two cases due to early removal of implant due to deep infection.

One patient among SER/Weber Type B had secondary ankle arthritis probably because of loss of articular reduction due to loosening of K-wire during follow up. Several authors like Huges et al[10], Tunturi et al[11] and Phillips et al[12] implicate factors such as Weber B type fracture pattern, shortened fibula and widened ankle mortise for early post traumatic arthritis.

CONCLUSION

Supination-external rotation injury is the most common type of bimalleolar ankle fracture and also common type associated with dislocations and complications. Pronation -External Rotation type had excellent and good results without much complications. The accurate anatomical reduction and restoration of articular congruity and early surgical fixation with appropriate implants results in good functional outcome. Good functional outcome was achieved by restoring sufficient stability and providing good mobility at the ankle joint.

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