OUTCOME ANALYSIS OF SURGICAL MANAGEMENT OF BIMALLEOLAR FRACTURES

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ABSTRACT

BACKGROUND

Ankle fractures are common injuries manifested by orthopaedic surgeons. Incidence of these fractures is increasing in recent times. Management of these fractures is a challenge to the surgeon. They have the potential to produce significant long-term disability and complications in the form of pain, instability, mobility and early degenerative arthritis. 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.

MATERIALS AND METHODS

A prospective study from November 2015 to June 2017, 40 cases of bimalleolar fractures of ankle in adults were treated at King George Hospital, Visakhapatnam by surgical intervention and studied for a period of 6 – 18 months.

RESULTS

Most common cause of ankle fracture is road traffic accident. Supination external rotation and AO type B are most common type of injury. Cases were operated within 2 - 5 days. Malleolar screw and plate and screws were most commonly used for fixation of medial and lateral malleolus respectively. Time for union is 10 weeks. 60 % of cases had excellent results following surgical management.

CONCLUSION

Ankle fractures are intraarticular injuries prone to arthritis, hence need stable and anatomical alignment with early mobilization to prevent degenerative arthritis. The talus is supported by bicolumnar concept by the malleoli.

KEYWORDS

Bimalleolar Fracture of Ankle, Surgical Outcome.

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BACKGROUND

Ankle fractures are common injuries manifested by orthopaedic surgeons. Incidence of these fractures is increasing in recent times. Management of these fractures is a challenge to the surgeon. 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. 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.

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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.[1] Understanding the biomechanics of ankle helps us in understand the fixation methods. These methods include the dynamic fixations of both the malleoli taking into view the deltoid and anterior talofibular ligaments. Soft tissue healing plays a major role in the final outcome of ankle fractures. The purpose of this study, on bimalleolar fractures of ankle is to evaluate the functional outcome and results obtained after surgical management by various methods of internal fixation.

Aims and Objectives

To study the various methods of internal fixation of bimalleolar fractures of ankle in adults, to assess the duration of fracture healing and functional range of movement of ankle joint and to compare the results of the present study with those in literature.

MATERIALS AND METHODS

A prospective study from November 2015 to June 2017, 40 cases of bimalleolar fractures of ankle in adults were treated at King George Hospital, Visakhapatnam by surgical intervention and studied for a period of 6 – 18 months.

Inclusion Criteria

Patients between 25 to 60 years of age having closed unstable bimalleolar fractures of ankle, treated surgically were considered for the study.

Exclusion Criteria

Open fractures of the ankle, trimalleolar fractures, stable malleolar ankle fractures and patients who are medically unfit for surgery.

All the patients were explained about the aims of the study, the methods involved, and an informed written consent was obtained before being included in study. Permission was taken from ethical committee of the institute. The patients were then assessed clinically to evaluate their general condition and a complete survey was done to rule out significant injuries. Careful examination was done to rule out fractures at other sites. Local examination of injured ankle was done.

Pain elicited with the squeeze test i.e. manual mediolateral compression across the syndesmosis and the external rotation stress test was considered as indicative of clinical syndesmotic instability. Tibiofibular clear space of more than six millimetres and the medial clear space widening of more than four millimetres were considered as indications of syndesmotic instability. Intraoperative the stability was checked by laterally displacing the distal fibula from the tibia, if >3 or 4 mm of lateral shift of talus occurs, it suggests instability (Cotton test). The radiological views were anteroposterior, lateral and mortise views.

The fractures were classified using the Lauge-Hansen, AO/OTA classification systems and anatomical types. Closed reduction and a below knee posterior POP slab was applied. Routine investigations were done. The patients were taken for surgery as early as possible once the general condition is stable and fit for surgery. The routine investigations were as follows: Hb%, Urine for sugar, RBS, Blood urea, Serum creatinine, HIV, HBsAg and ECG.

A. Operative Technique

Under spinal and /epidural anaesthesia, the patient was placed in supine position. The ipsilateral buttock was raised on a sandbag to improve the exposure of the lateral side. Pneumatic tourniquet was applied in all cases. The procedure was performed in a bloodless field, which facilitates good visibility to describe the fracture pattern and thus facilitating anatomical reduction.

B. Surgical Approaches and Fracture Fixation

Lateral Malleolus- Fracture Fixation- Avulsion fractures of the distal fibula were reduced, held with a reduction forceps, and stabilized by either a tension band technique or a lag screw. A larger avulsed fragment of the distal lateral malleolus is best fixed with either a tension band wire or a small oblique screw. AO type B fracture was fixed with one or two lag screws placed perpendicular to the line of the fracture. More secure fixation was achieved with one third semi-tubular plate contoured to fit the concave, slightly spiral, lateral surface of the fibula. Compressing the fracture site with an anterior-posterior inter-fragmentary lag screw was used to augment the strength of the fixation. AO type C fractures were reduced and fixed with a one-third tubular plate. The position of the plate was dependent on the level of the fracture, the condition of the overlying soft tissues, and the extent of the comminution.

Medial Malleolar Fixation Approach

Fracture Fixation- Avulsion fractures of the medial malleolus were best reduced after exposing both the anterior and the medial aspects of the fracture by sharply turning back the periosteum and attached fascia. For intermediate-sized fragments, 2.5 mm drill bit was used to prepare a hole for a 4.0 mm partially threaded cancellous screw or malleolar screw. For larger fragments, two such drills are used for provisional fixation and replaced one at a time with the 4 - mm partially threaded screws. To obtain a lag effect, their threads must cross the fracture and they should be oriented perpendicular to plane of the fracture. When the medial malleolar fragment was too small for screws or if comminuted, K-Wires with a figure-of-eight tension band was used for fixation.

C. Syndesmosis Transfixation

Talus must be reduced in the mortise. Any associated medial or lateral malleolar fractures were fixed. The reduction of the tibiofibular joint must be maintained during placement trans-syndesmotic fixation. The fixation screw or position screw (fully threaded) was used independently or in conjunction with a plate, depending on the type and location of the fibular injury. The screw was inserted at the top of the fibular sulcus in the tibia, fixation is usually obtained by placing one or two screws from posterolaterally in the fibula to antero-medially in the tibia about 1.5 to 3.0 cm above the plafond. Fixation of the syndesmosis was done with the ankle in full dorsiflexion to avoid over tightening of the mortise and loss of dorsiflexion postoperatively.

D. Postoperative Protocol

Non-weight bearing walking was started from first or the second postoperative day. In patients with syndesmotic screw fixation, weight bearing was delayed till screw removal done after 6 to 8 weeks. Follow up of cases was done at regular intervals of 6 weeks for minimum of 6 months. Baird and Jackson's ankle scoring system of subjective, objective and radiographic criteria was used for the study. All the patients were evaluated and scores were given.

Baird and Jackson's scoring system[2]

Scoring system for subjective, objective and radiographic criteria

I. Pain:	
A. No Pain	15
B. Mild pain with strenuous activity	12
C. Mild pain with activities of daily living	8
D. Pain on weight bearing	4
E. Pain at rest	0

II.	**Stability of Ankle:**	
A.	No clinical instability	15
B.	Instability with sports activities	5
C.	Instability with activities of daily living	0
III.	**Ability to Walk:**	
A.	Able to walk desired distances without limp or pain	15
B.	Able to walk desired distances with mild limp or pain	12
C.	Moderately restricted in ability to walk	8
D.	Able to walk short distances only	4
E.	Unable to walk	0
IV.	**Ability to Run:**	
A.	Able to run desired distances without pain	10
B.	Able to run desired distances with slight pain	8
C.	Moderate restriction in ability to run, with mild pain	6
D.	Able to run short distances only	3
E.	Unable to run	0
V.	**Ability to Work:**	
A.	Able to perform usual occupation without restrictions	10
B.	Able to perform usual occupation with restrictions in some strenuous activities	8
C.	Able to perform usual occupation with substantia restrictions	6
VI.	**Motion of the Ankle:**	
A.	Within 10^0 of uninjured ankle	10
B.	Within $15^0$of uninjured ankle	7
C.	Within 20^0 of uninjured ankle	4
D.	< 50% of uninjured ankle, or dorsiflexion < 5 degrees	0
VII.	**Radiographic Result:**	
A.	Anatomic with intact mortise(Normal medial clear space, normal superior joint space, no talar tilt)	25
B.	Same as A with mild reactive changes at the joint margins	15
C.	Measurable narrowing of superior joint space, with superior joint space>2mm, or talar tilt >2mm	10
D.	Moderate narrowing of superior joint space, with superior joint space between 2 mm and 1 mm.	5
E.	Severe narrowing of superior joint space, with superior joint space <1mm, widening of medial clear space, severe reactive changes (sclerotic subchondral bone and osteophyte formation)	0
Maximal Possible Score 100		
Functional grading		**Score**
Excellent		96-100
Good		91 - 95
Fair		81 – 90
Poor		0 – 80
Criteria Points		

Figure 1. Pre-Op X-Ray Post-Op X-Ray

Figure 2

Preop X-ray ***Postop X-ray***

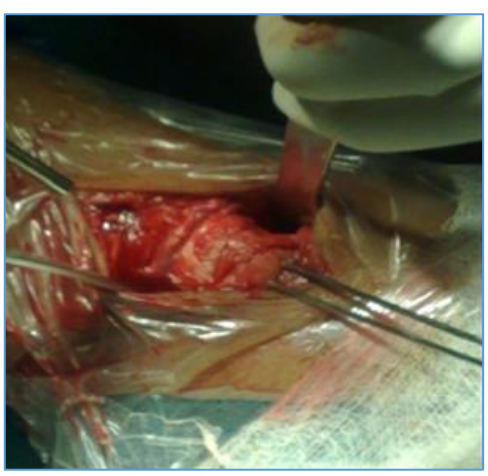

Figure 3. Fixation of Medial Malleolus with Tension Band Wiring

Figure 4. Tension Band Wiring In Figure of 8

Figure 5. Lateral Malleolus # Fixation

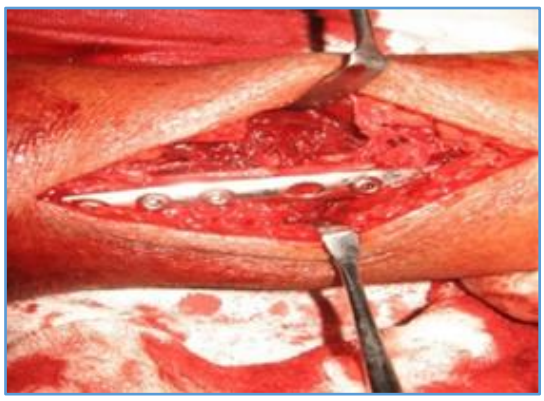

Figure 6. Fracture Reduced and 1/3rd Tubular Plate in Situ

RESULTS

In our series, 40 cases of Bimalleolar fractures of ankle, treated by surgical method at King George Hospital, Visakhapatnam, during the period from November 2015 to June 2017 were studied. The following were the observations made and the available data are analysed as follows.

Mode of injury	No of cases	Percentage %
Road traffic accident	18	45%
Fall	14	35%
Twist injury	8	20%

Table 1. Mode of Injury

18 cases (45%) affected were due to road traffic accident, 14 cases (35%) due to fall, and 08 cases (20%) due to twisting injury. Road traffic accident was the most common mode of injury.

Lauge-Hansen Type	No of cases	Percentage
SER	14	35%
SA	6	15%
PA	8	20%
PER	12	30%

Table 2. Fracture Type (Lauge- Hansen Type)

In the present study, majority of the cases i.e. 14 (35%) had Supination external rotation injury, followed by 12 (30%) cases had Pronation-external rotation injury.

AO type	No. of cases	Percentage
TYPE A	6	15%
TYPE B	20	50%
TYPE C	14	35%

Table 3. AO Fracture Type

The AO type B was the most common, involving 20 (50%) patients followed by type C in 14 patients (35%) and least in type A.

DAY	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6	DAY 7>
No Of Cases	2	8	10	6	6	4	4
%	5%	20%	25%	15%	15%	10%	10%

Table 4. Time Interval Between Injury and Intervention

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

Implants	Malleolar screw	Cancellous screw	TBW	K-wire	Total no. mm #
No. of cases	24	4	10	2	40
Percentage	60%	10%	25%	5%	100%

Table 5. Fixation of Medial Malleolus

Majority of the medial malleolar fractures were fixed with malleolar screws i.e. 24 cases (60%). In the rest of the cases, cancellous screw, tension band wiring, and K-wire was used.

Implants Used	Plating	Malleolar Screw	Rush Pin	Tbw/ k-Wire	Total No. Cases of Lat Malleolar #
No. of cases	28	4	6	2	40
Percentage	70%	10%	15%	5%	100%

Table 6. Fixation Of Lateral Malleolus

Most of the lateral malleolar fractures i.e. 28 cases (70%) were fixed with plate, of which 24 with one-third Tubular plate, 2 with 3.5mm DCP, and 2 with 3.5mm reconstruction plate. In the rest of the cases, malleolar screw, rush pin, K-wires or TBW was used.

Syndesmotic Fixation

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

Union (wks.)	6 weeks	8 weeks	10 weeks	12 weeks	14 weeks	16 weeks
No of Cases	4	8	16	8	2	2

Table 7. Time Taken For Fracture Union

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

Complications	No of cases	Percentage
Superficial infection	4	10%
Deep infection	2	5%
Delayed union	2	5%

Table 8. Complications

In our study, 20% patients had complications. 04 patients had superficial infection, 02 patient deep infection, 02 patient delayed union of medial malleolus. The infections

(superficial and deep) were managed with debridement and antibiotics. Delayed fracture union MM was treated with continued immobilisation, which eventually united without surgical intervention.

Functional Score	No. of cases	Percentage
Excellent	24	60%
Good	10	25%
Fair	4	10%
Poor	2	5%
Table 9. Functional Results		

In the present study, 40 patients with Bimalleolar fractures were treated surgically. Excellent results were achieved in 24 cases (60%), good in 10 cases (25%), fair results in 04 cases (10%) and poor results in 02 case (5%). Excellent results were observed in most bimalleolar fractures. 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.

DISCUSSION

Of all the intra-articular fractures occurring in weight bearing joints, the most common joint involved is the ankle joint. M. Burwelland Charnley showed that anatomical reduction and rigid fixation led to early return to function.[3] The importance of the length of the fibula both suprasyndesmotic and infra syndesmotic is gaining importance in alignment of the ankle. The alignment of ankle plays a major role in development of post traumatic arthritis, which is as important as the congruity of joint surfaces. The soft tissue injuries also play a role in regaining the movement of the ankle joint. Analysis of the instability is very important. There could be more focus towards soft tissue healing and rehabilitation for the final outcomes. Open reduction with internal fixation is an excellent method for restoration of normal anatomy of joint. The treatment of malleolar fractures with accurate open reduction and stable internal fixation using standard fixation methods and principles was found to give a high percentage of excellent and good results. This study supports these conclusions.

In the current study, we have 40 patients with bimalleolar ankle fractures, who were operated upon. All patients were followed up with minimum period of 6 months (Range - 6 to 18 months).

1. *Mode of Injury*

Study	No of cases	Mode of Injury
Baird & Jackson	24	Fall from height
Lees et al	168	Motor cycle accident
Present study	40	Road traffic accident
Table 10. Mode of Injury		

In the current study, road traffic accidents constituted majority of cases, which was in accordance with study by Lee et al.

2. *Type of Injury*

Study	No. of cases	L-h type	Percentage (%)
Robert RS	25	SER	34%
Baird & Jackson	24	SER	44%
Present study	40	SER	35%
Table 11. Type of Injury			

In the present study, Lauge-Hansen classification system was used for operative evaluation. The most common type of injury was Supination-external rotation (35%), followed by Pronation-external rotation injury (30%), in accordance with by Roberts RS,[4] Beris et al,[5] Baird and Jackson.[2]

3. *Functional Results*

The results in current study were compared with that of Burnwell & Charnley,[3] Colton,[6] De souza et al,[7] Beris et al[5]. In Colton[6] series, 70% of the patients had a good to excellent results. Burnwell & Charnley[3] in their series of 132 patients, 102 (77.3%) had good results, 16% had fair results and 6% were found to poor score. In De souza[7] 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,[5] 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%.

Study	Good to excellent	Fair Results	Poor results
Burnwell & Charnley	102(77%)	22(17%)	8(6%)
Colton	18(70%)	4(15%)	4(15%)
Beris et al	105(74.3%)	21(14.6%)	16(11%)
De Souza	135(90%)	9(6%)	06(4%)
Present study	34(85%)	04(10%)	02(5%)
Table 12. Functional Outcomes			

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.[8] However, Heller[9] et al. state that talus is more accurately repositioned in mortise by anatomical reduction of lateral malleolus. Observation in this study support the contention of Yablon 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 # would result in persistent lateral displacement or residual shortening. In the current study, the two patients with poor outcome, didn't have anatomical reduction of the medial malleolus possibly due to soft tissue interposition. Fibula

can be best fixed by lateral plate.[10] Hughes[11] et al 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.

In the current study, the patients treated by cancellous or malleolar screw for medial malleolus fracture had better results. Patients treated by k wires had less satisfactory results. Tension band wiring of the medial malleolus gave results similar to those fixed with screws and lesser reports of skin irritation compared to those patients with screw fixation. The assessment of syndesmosis after the fracture fixation was done by taking mortise view and applying syndesmotic screw in case of disruption of ligament. Yablon[9] stated that anatomical reduction of the fibula is the key factor in achieving good outcome of the treatment of ankle fractures with syndesmotic disruption. In the current series, two patients underwent trans-syndesmotic screw fixation. Excellent and fair outcomes were seen in one patient each.

In our 40 patients there was no instability of ankle or subtalar joints, because we delayed the weight bearing which allowed the soft tissues to heal. Bray noted that incidence of complications are less in patients who underwent immediate surgery when compared to those who underwent delayed surgery.[12] Fair to poor results in the current series were seen due to wound infection, delayed union of medial malleolus. In Pronation-external rotation and Supination-external rotation type of injuries had poor results. Majority of the patients (85%) had well to excellent results in the current study, similar to what was observed in other series like Burnwell & Charnley[3], Colton[6], De Souza et al[7]. This study supports these conclusions and was comparable with those in other studies.

CONCLUSION

Ankle fractures are intraarticular injuries prone to arthritis, hence need stable and anatomical alignment with early mobilization to prevent degenerative arthritis. The talus is supported by bicolumnar concept by the malleoli. Road traffic accidents are most common cause of unstable bimalleolar ankle fractures.

Majority of them, were caused by external rotation injuries, Supination external rotation (35%) and Pronation-external rotation (30%). Length of the fibula plays a major role in alignment of ankle in both coronal and sagittal planes. Malalignment could increase the stress zone on the talus. Articular congruence is a prerequisite before the internal fixation of malleoli. Open reduction and internal fixation restores the articular congruity of the ankle joint. Early fixation decreases the incidence of wound infection and skin necrosis. Bimalleolar fractures associated with syndesmosis injury, wound infection and with unsatisfactory reduction of fracture fragments had poor results. Excellent results are obtained with stable fixation of fracture.

Internal fixation is better with cancellous screws and malleolar screws. Contoured lateral plating was the best for fibular fractures. Comparable results were obtained with TBW for pronation external rotation, and pronation abduction injuries with lesser reports of skin irritation at the wound site. The normal bend of the lateral malleolus if restored while plating improves the functional outcome. Early weight bearing, and mobilization is achieved by surgical management. plaster cast would not show any benefit in the final outcomes when added to improper fixation.

Hence we conclude that, surgical management of bimalleolar ankle fractures restores normal ankle movements and good function. Stable surgical fixation of fracture allows early mobilization and good functional outcome.

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