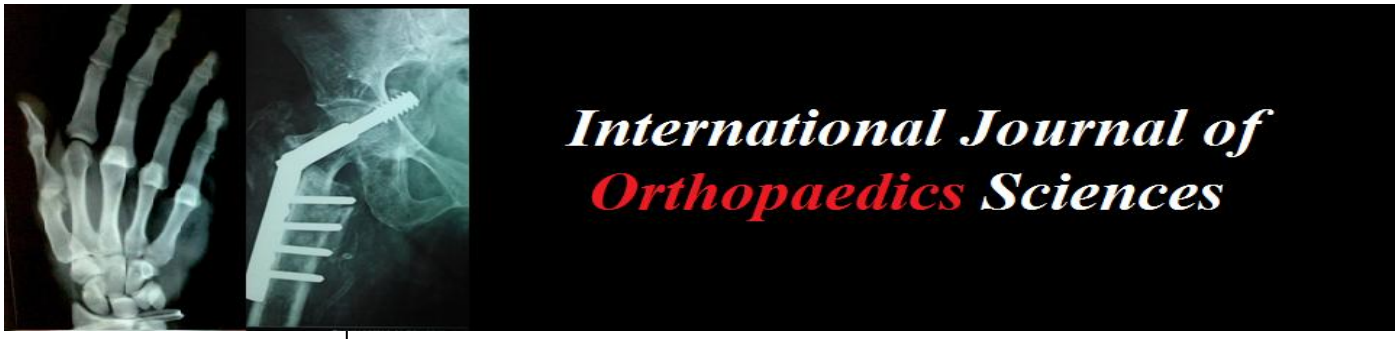

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Dr. Dhoom Singh Jhatoth
MS (Orthopaedics), Civil Surgeon, Specialist (Ortho), Govt. Area Hospital, Nirmal Dist., Telangana, India

Correspondence
Dr. Dhoom Singh Jhatoth
MS (Orthopaedics), Civil Surgeon, Specialist (Ortho), Govt. Area Hospital, Nirmal Dist., Telangana, India
E-Mail: dhoomsinghrathod35@gmail.com

A Prospective study on the surgical management of medial malleolar fractures of ankle joint

Dr. Dhoom Singh Jhatoth

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Abstract
Malleolar fractures are the most common ankle injuries treated by orthopedic surgeons.
Objectives: The present study was undertaken to study the functional outcome of surgically managed medial malleolar fractures of ankle in adults.
Material and Methods: A prospective study was conducted on 12 cases of medial malleolar fractures of ankle in adults, treated surgically by using various implants while 22 conservatively. This study was conducted for a period of 18 months and the results were assessed using criteria of Baird and Jackson's ankle scoring system for evaluating the functional outcome.
Results: This study shows the importance of pre-operative understanding of fracture mechanics for good reduction and internal fixation, in turn better functional outcome. Good functional results were obtained by surgical treatment of medial malleolar ankle fractures. There were no intra-operative complications observed in this study.
Of the 12 patients with medial malleolar fractures treated surgically excellent to good results were achieved in 10 (83.3%) cases, fair and poor in 1 (8.33%) case each.
Conclusion: Conservative treatment in selected fractures is justified. In our study the functional outcome and the results of operative treatment were found to be good as these operative methods restores the anatomy, biomechanics and contact loading characteristics of the ankle.

Keywords: Ankle fracture, internal fixation, Lauge-Hansen, medial malleolus, operative, tension band wiring

1. Introduction
Ankle is the most frequently injured joint of the lower limb but least well treated. Ankle fractures are among the common injuries treated by orthopedic surgeons. Malleolar fractures are one of the most common fractures in orthopaedic traumatology [1, 2]. Malleolar fractures have the potential to produce significant long term disability and complications in the form of pain, instability and early degenerative arthritis.
Various methods of surgical fixation such as closed reduction and internal fixation with two parallel K-wires, closed reduction and internal fixation with two parallel cancellous screws, open reduction and internal fixation using cancellous screws, tension band wiring and modified tension band wiring are available in the literature.
These operative techniques aim to provide anatomical restoration and immediate stability, which facilitates earlier mobilisation. Additional advantages include easier rehabilitation without a cast and earlier weight bearing [3]. The purpose of this study was to assess the functional outcome of surgical treatment of medial malleolar fractures.
Therefore, the aim of the study was diagnosis, demographic analysis of medial malleolar fractures among various injuries; analyze the merits and demerits of different surgical methods of stabilization of medial malleolar fracture of ankle joint.

Materials and methods
The study was conducted in the Department of Orthopaedics, at Kakatiya Medical College, Warangal, Telangana, India on 34 cases of medial malleolar fractures of ankle joint who were admitted in the MGM Hospital, Warangal, Telangana, India for a period of eighteen months. They were classified according to the Lauge Hansen's [4] classification (Table 1).

The patient's age ranged between 11 to 50 years with mean age 30.1 years.

Patients admitted to the Department of Orthopaedics with malleolar fractures of ankle joint satisfying the inclusion criteria were included in the study and with follow up from the time of admission to a minimum of 6 months of post-operative period was done. Patients were informed about study in all aspects and informed consent was taken about their inclusion in the study. Ethical Committee approval was taken from the College Ethical Board.

Inclusion criteria

a) Patients having any malleolar fracture of ankle joint
b) Patients of any sex and in age groups of 11-50
c) Patients who were fit for surgery

Exclusion criteria

a) Open ankle fracture
b) A fracture and open epiphyses
c) A previous fracture of either ankle
d) Patient unfit for surgery and/or anesthesia
e) Patient not giving written consent for surgery

On admission into the ward the cases were diagnosed on history, clinical examination and investigation. Fractures of the ankle were evaluated using plain radiographs in antero-posterior, lateral and mortise views. Statistical data included name, age, sex, ward, chief complaints, history, general examination, diagnosis, investigations, treatment done, operative technique and type of implants used, post-operative complications of surgery and follow up results. Baird and Jackson's [5] scoring system was used for functional assessment.

All the patients were operated by open reduction and internal fixation using malleolar screws (2½ to 3½" long), K-wire fixation and tension band wiring technique. And follow up was done 3 to 24 months. Most patients were followed up once in 3wks and later 6wks. And the clinic radiological outcome was assessed at 24 weeks.

The following implants were used: malleolar screw fixation, under tourniquet control – B/K slab applied, through medial approach under SA done and B/K POP slab applied, K-wires, tension band wiring under SA. The majority of medial malleolar fracture cases was treated with malleolar screws (2½ to 3½" long), K-wire and tension band wiring and analyse the results in the management of medial malleolar fractures.

For operative treatment of the medial malleolus, medial approach is generally used: incision placed slightly posterior of the medial malleolus along the tibia with a distal J-shaped curve.

Treatment of individual fractures

Medial malleolus was fixed with malleolar screw (7 cases), tension band wiring (2 cases,), K- wire fixation (2 cases) and tension band wiring and K- wire fixation (1 case).

Results

In this study 214 cases of ankle joints of either sex with age ranging from 11-50 were studied for a period of 18 months in Kakatiya Medical College, Warangal, and the type of injuries, number of cases and percentages are listed in Table 1. The data in the Table 1 indicates that sprains were n=135, followed by medial malleolar fractures were n=34 (15.88%), followed by bimalleolar fractures with n=25 (11.68%), then by trimalleolar fractures n=7 (3.27%) and the least were lateral malleolar fractures n=4 (1.87%).

Table 1: Total number of ankle injuries treated during the study

S No.	Type of injury	Number of cases	Percentage (%)
1.	Sprains	135	63.00
2.	Lateral malleolus fracture	4	1.87
3.	Medial malleolus fracture	34	15.88
4.	Bi malleolus fracture	25	11.68
5.	Tri malleolus fracture	7	3.27
6.	Dislocations	9	4.2
Total		214	

The cases were treated either by conservative or surgical method (Table 2). Out of 34 medial malleolar fractures n=22 (64.7%) cases were treated by conservative method and n=12 (35.2%) by surgical method.

Table 2: Type of treatment by either conservative or surgical method

S No.	Type of injury	Total number of cases	Conservative		Surgical	
			Number of cases	(%)	Number of cases	(%)
1.	Medial malleolus fracture	34	22	64.7	12	35.2

In this study 12 cases of medial malleolus fractures (Table 2) were treated by surgical method at MGM Hospital, Warangal, Telangana, India. The average age for the whole group was 30.10 (11-50yrs). Male to female ratio was 11:1 with male (91.67%) and female (8.33%) (Table 3). Left side was observed to be more often injured n=7 (58.33%) than right side n=5 (41.67%) (Table 4).

Table 3: Distribution of cases and their percentages (%) depending on the sex incidence

Sex	= n	Percentage (%)
Male	11	91.67
Female	1	8.33

Table 4: Distribution of cases and their percentages (%) depending on side of the ankle

Side	= n	Percentage (%)
Left	7	58.33
Right	5	41.67

In the current study, the type of injury was determined by Lauge Hansen [4] classification. The distribution of cases and their percentages (%) depending on the nature of the causative injuries are shown in Table 5. The major cause of fracture in this study was due to due to fall from height in 6 (50%) cases, followed by vehicular accident in 3 (25%) cases, slipping from steps in 2 (16.67%) cases. The remaining 1 (8.33%) case was slipping and stumbling of foot (Table 5).

Table 5: Distribution of cases and their percentages (%) depending on the nature of the causative injuries

Nature of injury	= n	Percentage (%)
Fall from height	6	50
Vehicular accident	3	25
Slipped from steps	2	16.67
Slipping and stumbling of foot	1	8.33

In this study, it was observed that abduction type of injury was found in majority of cases and is the most pre-dominant type with n=6 (50%), followed by abduction and external rotation in 4 (33.33%) cases and then pronation external rotation in 2 (16.67%) cases (Table 6).

Table 6: Incidence for causative injuries

S No.	Type of injury	Number of cases	Percentage (%)
1.	Abduction	6	50
2.	Abduction and external rotation	4	33.33%
3.	Pronation external rotation	2	16.67

The following implants were used in medial malleolar treatment:
Malleolar screws - 7 cases (2½ to 3½" long)
K-wire fixation - 2 cases
Tension band wiring - 2 cases
K-wire and tension band wire fixation - 1 case

Treatment of individual fractures
In this series, the medial malleolus was approached by medial approach and fixed with single malleolar screw, K-wire, tension band wiring or K-wire and tension band wires. Majority of the medial malleolar fracture cases were fixed with malleolar screws (2½ to 3½" long) (Fig. 2A) in 7 (58.33%) cases, followed by K-wire and tension band wire fixation (Fig. 1A & B, Fig 2B) each in 2 (16.67%) cases and K-wire and tension band wire fixation (Fig. 2C) in 1 (8.33%) case (Table 7).

Table 7: Type of implant used in the surgery

Type of implant	= n	Percentage (%)
Malleolar screws	7	58.33
K-wire fixation	2	16.67
Tension band wire fixation	2	16.67
K-wire and tension band wire fixation	1	8.33

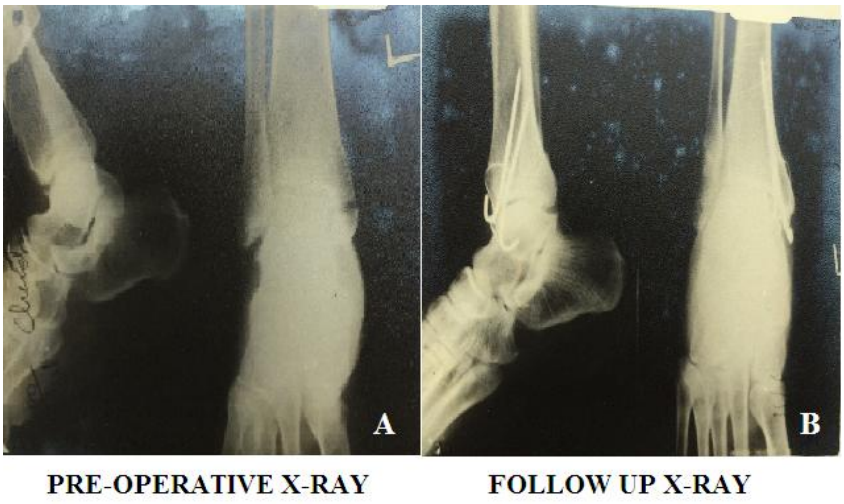

Fig 1A: Pre-operative X-RAY, B- open reduction and internal fixation with K-wire and tension band wiring under SA left medial malleolus

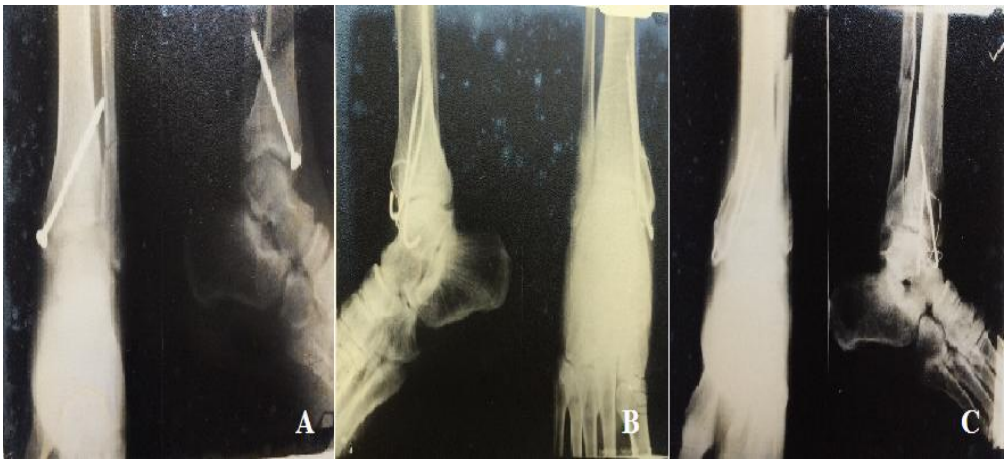

Fig 2: Open reduction and internal fixation with: A- malleolar screws (2½" long), B & C- K-wire and tension band wiring.

Follow up

The follow up of 3 months, then 6 months up to 2yrs was made. Most patients were followed up once in 3wks and then 6wks, later 24wks. Then physiotherapy was started. Partial weight bearing was allowed after 6-12wks. During review these patients were examined clinically for complaints of pain, signs of swelling and range of movements. Any deformity was looked for and the patients were educated regarding physiotherapy. All the patients were followed until union occurred. For all the cases radiological examination was done regularly to assess the progress of the union. Almost all fractures united at the end of 12 weeks.

In this series immobilization with slab for two weeks then partial weight bearing by four weeks and by the end of 10-12 weeks complete weight bearing was allowed. Ahl *et al*. [6] showed that early weight bearing in plaster slab had a tendency to display better clinical results; he also found that addition of ankle movements using ankle arthrosis showed better results.

Functional results

In the current study, out of 12 patients with medial malleolar fractures treated surgically by open reduction and internal fixation, the final result was graded as excellent, good, fair, or poor (Table 8) using healing criteria. Excellent results were achieved in 7 (58.33%) cases, good results in 3 (25%) cases, fair and poor in 1 (8.33%) case each (Table 8). Excellent and good results were obtained in majority (83.33%) of medial malleolar fractures and the patients were able to perform usual occupation without restriction and the rest 2 patients were able to perform usual occupation with restriction in some strenuous activities later after 10-12 weeks fair performance was restored.

1 (8.33%) patient who had fair results had terminal degree of ankle movements restricted and slight limping was present. Fair range of movements restored after 7 weeks. 1 (8.33%) patient with poor results had mild pain with moderate restriction during his daily activities, painful restricted movements of ankle and slight limping was present.

Table 8: Grading of cases in medial malleolar fractures

Grade	Criteria	Number of cases	Percentage
Excellent	Full range of painless ankle movements, no limp	7	58.33
Good	Full range of painless ankle movements, no limp	3	25
Fair	Terminal degree of ankle movements restricted. Slight limping present	1	8.33
Poor	Painful restricted movements of ankle, limping present	1	8.33
Total		12	

Complications No surgery is without complications even in the best hands. But careful selection of cases decreases the overall bad results. Our patients too had some complications the commonest problem was edema that occurred after removal of the slab, casing and initiation of weight bearing. We used an elasto crepe bandage in these patients during day time and advised elevation of foot during night time. In most cases edema subsided with time. In patients where edema did not subside, these patients developed painful movements and pain on weight bearing, later after 10 to 12 weeks painful movements were restored.

In the present study, 1 patient had superficial infection which healed after 2 weeks. 1 patient had little deep infection and the wound healed after 10 weeks. The infections (superficial and deep) were managed with debridement and antibiotics. Later the patient had good recovery and there were no other complications.

According to Makwana [7] the risk of complications after internal fixation is low but higher with closed treatment. Most of the complications were minor and resolved within 3 months. In our series there was no mal-union or non-union of the medial malleolus. For all the cases union occurred in 6 – 8 weeks.

Medial malleolar fractures have varied presentation. Thorough understanding of the mechanism of injury, patho-anatomy and treatment options along with accurate reduction and early mobilisation can give rewarding results.

Discussion

The most common intra articular fracture of a weight bearing extremity needs accurate reduction if residual pain and disability are to be avoided and the incidence of arthritis has to be reduced. The ankle joint fracture treatments involve both risk-benefit and cost-benefit analysis. There has been gradual evolution in management of medial malleolar 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 and with anatomical restoration of the injured ankle which has achieved good results.

Closed method of treatment includes manipulative reduction and immobilization in plaster cast. Method of treatment is risk associated, often inadequate in restoring the anatomy and biomechanics of ankle joint, which can lead to poor outcome. Conversely, open reduction with internal fixation is an excellent method for restoration of normal anatomy of the joint.

In this series, for restoring function and preventing arthritis in majority of the cases open reduction and internal fixation was used. Treatment of medial malleolar ankle fractures with accurate open reduction and internal fixation using AO principles was found to give excellent to good results. In fractures of the ankle only the slightest variations from the normal anatomy are compatible with good function of the joint. This study supports these conclusions. Burwell and Charnley [8] showed that anatomical reduction and satisfactory fixation led to a rapid return of function.

Baird and Jackson Scoring System is based on pain, stability to ankle, ability to walk, ability to run, ability to work, motion of the ankle and radiographic result. The scoring system of Baird and Jackson [5] is a composite score with slight variations from normal. About 83.33% of patients had excellent to good results, 8.33% achieved fair and poor results respectively. All had anatomical reduction of the malleolus radiologically.

The results in this study are compared with Maruti and Venugopal *et al* [9], Al Lamy and Al Obaidy [10] and Beris *et al*. [11]. In the Maruti and Venugopal [9] series, good to excellent results were obtained in about 90% of cases, Al Lamy Al Obaidy [10] series, in 80% of cases, Beris *et al* [11] series, in 74.3% of cases, Ramkumar Reddy *et al* [12] series 70% of cases. Poor results were obtained in 11.7% of the

cases [11], fair results in 20% and poor in 6% of patients [12]. All these results are comparable to the present study where good to excellent results were obtained in 83.33% of patients, fair and poor results in 8.33%.

In the present study Lauge Hansen [4] Classification system was used for operative evaluation. The most common type of injury was abduction type followed by abduction and external rotation type and the least common was pronation external rotation type.

The present study supports the view of Ostrum and Litsky [13], according to which the tension band fixation provides the greatest resistance to pronation forces. Tension band fixation of the medial malleolus fractures, is strong biomechanically and clinically acceptable method for treating displaced medial malleolus fractures.

Fractures of medial malleolus require more exact reduction to restore more normal tibio-talar relationship. The observation in this study supports that anatomical reduction and good post reduction X-rays correlate with good clinical outcome [14].

When malleolar fractures are not reduced accurately they may lead to post traumatic painful restriction of movements or osteoarthritis or both [11]. A thorough understanding of the ankle anatomy, mechanism of the injury, interpretation of the radiographs and adherence to basic principles of fracture management are the basis for a good result. Most authors have stated that anatomical reduction of the displaced medial malleolus ensures correction of talar displacement and is important in treating unstable fractures [15, 16].

In many fractured ankles, the syndesmosis is stable after reduction and internal fixation of the fibular fracture and any associated medial malleolar fracture. Yablon *et al*. [17] stated that anatomical reduction of the fibula is the key factor in achieving a good outcome of treatment of ankle fractures that have accompanying syndesmotic disruption.

Several studies indicated that, internal fixation of displaced malleolar fractures of ankle provides good results [8, 11, 18, 19]. In case of our patients there was no instability of ankle or sub-talar 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.

The treatment of medial malleolar fractures with accurate open reduction and stable internal fixation using AO method and principles was observed to give high percentage of good results [11]. The present study results support these conclusions and are comparable with these studies.

It also supports the views that modified tension band wiring remains an acceptable method for fixation of selected displaced medial malleolar fractures [20].

In our study, fractures were more common in the 21-30 yrs age group, with mean age being 30.1 yrs. However, findings of the studies made by Beris *et al.* [11], Roberts [21], Baird and Jackson [5] and Lee *et al.* [22] showed fractures were common in the 31-40 years age group with slight variation in our present study. Left ankle was most commonly affected in the present study, contradictory to earlier results [11, 21]. Male predominance was observed in this series as in other studies.

In the present study, the most common type of injury was abduction (50%), followed by abduction and external rotation (33.33%) and then pronation external rotation (16.67%), contradictory to the results published by Roberts [21], Beris *et al*, [11], Baird and Jackson [5], Zakir Ali Shah and Uzma Arif [23].

Conclusion

Surgical management of medial malleolar ankle fractures provides good functional outcome. Surgical treatment with rigid internal fixation after understanding mechanism of injury gives good results in terms of early mobilization faster rehabilitation, and more rapid return of function. It is found that the quality of clinical results depend mostly on the accuracy of the reduction and to less extent on the degree of initial displacement.

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