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Analysis of functional outcome following open reduction and internal fixation of closed bimalleolar fracture in adults

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Abstract
Aim: To analyse the functional outcome following operative treatment of bimalleolar fractures using Olerud and Molander Ankle Score.
Material and Methods: 30 patients aged between 18-60 years with bimalleolar fractures who fulfilled the inclusion criteria were included in the study. All patients underwent surgical fixation of the fractures. Subjective assesment of persistent pain and swelling was done at 6 weeks post op. The follow-up assessment which consisted of objective (Olerud and Molander Ankle Score) evaluations, were performed at 3 months and 6 months postoperatively.
Results: Out of 30 patients, the commonest injury pattern seen was supination external rotation followed by pronation external rotation. Statistically significant improvement in the mean olerud and molander ankle score from 3month post to 6 month post op at follow up. The mean Olerud and Molander Ankle Score was statistically significant 56.667±16.365 at 3rd month post-op and 78.5±17.722 at 6th month post-op.
Conclusion: Operative treatment for ankle fractures results in good functional outcome postoperatively. Anatomical reduction of the fracture is associated with better functional outcome.

Keywords: Bimalleolar Fracture, Olerud and Molander Ankle Score, Open Reduction and Internal Fixation

Introduction
Ankle fractures are one of the most common lower extremity fractures treated in orthopaedics and during the last decades the trend towards surgical treatment has increased [1]. The aim is to restore normal anatomy and biomechanics of the joint [2].
The ankle joint is a synovial mortise & tenon joint variety, functionally uniaxial. The lower end of the tibia and its medial malleolus, together with the lateral malleolus of the fibula and the distal tibio-fibular syndesmosis, form a mortise for the body of the talus. Ankle stability is conferred mainly by the medial and lateral ligament complexes, the distal tibiofibular ligaments, the tendons crossing the joint, the bony contours and the capsular attachments [3]. Ankle fractures are common, occurring at a rate of between 7 and 28 per 10 000 person years for different age and gender groups. Incidence of ankle fractures is highest in young males and middle- to older-aged women [4].
A bimalleolar fracture is a fracture of the distal tibia and fibula in which the medial malleolus of the distal tibia and the lateral malleolus of the distal fibula are fractured. Bimalleolar ankle fractures disrupt the medial and lateral stabilizing structures of the ankle joint. These fractures are commonly caused by indirect rotational, translational and axial forces. These result in subluxation or dislocation of the talus out of the ankle mortise, usually associated with a fracture complex [5]. As fractures of the ankle have been treated with various modes of internal fixation devices, the best possible implant is determined according to the anatomy of the fracture.
In the postoperative period, the protocol of mobilization of the ankle has been a topic of conflict. The final outcome of a fractured ankle is of prime importance, as the treatment should benefit the patient just not in short term but also in the long term. The treatment of fractures has its challenges in cases where the fracture is complicated by co-morbid conditions such as

Diabetes mellitus. Ankle fractures in patients with diabetes mellitus (DM) have long been recognized as a challenge to practicing clinicians in terms of delays in fracture healing, difficulties with wound healing, and the development of Charcot arthropathy [6]. Peripheral vascular diseases and neuropathic conditions which complicates the treatment and influences the overall outcome.

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.

Materials and Methods

The present prospective study was conducted among 30 patients with bimalleolar fractures admitted in orthopaedic department of IGGGH & PGI, Pondicherry. Treated between August 2017 to May 2019 with one third tubular plate for lateral malleolus and malleolar screw fixation for medial malleolus.

Inclusion Criteria

1. Patients between the age of 18-60 years
2. Patients with Closed Bimalleolar fracture of ankle
3. All weber type of ankle fracture
4. All Lauge Hansen's type of ankle fracture

Exclusion criteria

1. Patients with bilateral ankle injuries
2. Patients with Pre-existing ipsilateral or contralateral ankle pathology
3. Patients with pathological fracture (e.g. a stress fracture)
4. Patients with refracture of a previous ankle fracture
5. Patients with unimalleolar and trimalleolar fractures
6. Patients with inability to attend clinic for follow-up or inability to follow the postoperative regime.
7. Patients with open fracture and dislocation of ankle
8. Patients with established non-union due to previous fracture.
9. Cases with Pilon fractures
10. Patients with Polytrauma
11. Patients with neurovascular injuries.

Methodology

The patients were examined in the casualty and in the outpatient department. History was recorded and a thorough clinical evaluation was done. Patients were stabilized haemodynamically and were administered adequate analgesia. Patients were put on a below knee splintage either with a malleable splint or a plaster of Paris posterior slab. Once the patient is stabilized the circumstances of the accident and the patient's history were meticulously documented. Documentation starts with a thorough history which includes details of the accident, the time of injury, any loss of consciousness, and other evidence of head injury, temporary or partial paralysis, the probable velocity of injury. Any comorbidities of the patient are documented as they may significantly influence treatment decisions and the final outcome.

Systemic illnesses, like diabetes mellitus, Systemic Hypertension, rheumatoid arthritis, and connective tissue disorders, history of medications, and any pertinent allergies, any history of previous surgery were documented. Smoking is associated with an increased rate of flap failure, delayed union and nonunion and this must be documented. Patients who smoke are urged to stop smoking during the treatment process.

Patients were examined giving special importance to presence of gross swelling, fracture blisters and presence of other associated injuries. Routine investigations were done as were necessary. The diagnoses were confirmed by antero-posterior, lateral and mortise radiographs. The fractures will be classified according to the Lauge-Hansen and Weber's classifications and graded as per Kristensons criteria.

Following the radiological evaluation, patients were briefed regarding the need for operative treatment and were investigated with routine investigations for the surgical procedure. Patients with co-morbid medical illnesses were treated appropriately with the help of general Physicians. Evaluation by anesthesiologists was done. Consent for the surgical procedure was obtained. Antibiotics were administered at the time of induction of anesthesia. The antibiotics used were either a first or second generation Cephalosporin's.

Stabilization was done with a below knee slab, and ORIF was done once the skin condition was good and swelling had subsided.

All the patients were operated under tourniquet control. The duration of surgery varied from 30 mins to 1 hour and 30 minutes averaging 1 hour.

The implants used for the fixation of fractures were as follows: one third tubular plate for lateral malleoli and malleolar screw for medial malleoli.

The basic idea was to achieve anatomical reduction. ORIF was done in all 30 patients. It was done as a planned and elective procedure. Before patients were taken up for surgery, they were put on foot elevation and anti-inflammatory drugs for few days to reduce ankle swelling. Patients with comorbidity like diabetes mellitus and hypertension were optimized before surgery.

Pre Operative Planning

Adequate amount of blood was reserved for intra op or post op requirement. Shaving of injured limb and associated parts was done prior to surgery to prevent contamination with skin flora. Necessary implants were kept ready in OT. For all the 30 patients ORIF with one third semi tubular plate for the fixation of lateral malleoli and malleolar screw for the fixation of medial malleoli was used. Tourniquet was used in all cases. Informed consent was taken from the patient and patients attenders for surgery and associated complications of anesthesia. Patients were shifted to operation theatre after all necessary arrangements were done. Surgical antibiotic prophylaxis was given to all patients within 120 min prior to skin incision.

Surgical procedure

Appropriate anesthesia was administered to the patients. The patients were placed in supine position with a sand bag under the ipsilateral buttock. Following exsanguinations, tourniquet was inflated with time being noted. The affected limb was prepared with a primary scrub with Betadine. The parts were then painted with Betadine and Spirit. Surgical draping was done using the standard methods and the foot was covered with a hand towel or a glove.

Fixation of lateral malleoli

Technique

The line of the incision was made directly over the subcutaneous border of the fibula, the length and center of the incision being dictated by the level and type of fracture

present. The principle structure at risk here was superficial peroneal nerve as it pierces the deep fascia and lies in the subcutaneous fat. It is increasingly vulnerable as one move proximally from the fibular tip, but its course is variable and a substantial branch lies within 5 cm of the tip of the malleolus in 20% of patients 125 [7]. Blunt dissection through fat is recommended. The periosteum should be elevated from the fracture margins only enough to allow an anatomical reduction. Strategic perforations may be made in the anterior fascia to allow the placement of reduction clamps without excessive dissection. Occasionally, the incision may be curved anteriorly at its distal extent to allow an arthrotomy and inspection of the articular surface of the ankle joint, or for access to the tubercle of Chaput.

Skin incision for lateral malleolus

Technique

The patient was placed supine with a bolster under the ipsilateral hip to allow the foot to lie vertically. A tourniquet was applied and, after exsanguination, inflated to 250 mm Hg. The lateral malleolus was addressed first through a longitudinal incision placed directly over the fibula and centered on the fracture. Blunt dissection was performed through subcutaneous fat to avoid damage to the superficial peroneal nerve. The fracture was identified and periosteum and ligamentous attachments are debrided back from the fracture edges by 1 to 2 mm: Just far enough to visualize the fracture clearly. The fracture itself was distracted gently to allow irrigation and curettage of clot and small bone fragments. Reduction was achieved and held by the application of a serrated "lobster claw" clamp. There are a number of maneuvers that may assist with this reduction. Firstly, a gentle torsional movement with the reduction clamp may be sufficient to walk the two fractured surfaces out to length and into place. If more force is necessary, distraction and inversion of the foot and ankle will assist in regaining fibular length.

Plating for lateral malleolus fracture

Technique

The lag screw may be placed in either an AP or a posteroanterior direction. A 3.5-mm gliding hole was drilled first, and a 2.5-mm pilot hole was then drilled through a centering device, followed by countersinking, measuring, and screw placement. A one-third tubular plate was selected of sufficient length to allow the placement of three screws above and below the fracture. Often a seven-hole plate is needed to avoid conflict with the lag screw. The plate was precontoured and then applied to the bone with three bicortical screws in the proximal diaphysis, and three cancellous screws in the distal metaphysis. These distal screws were unicortical and extend to, but not through, the second (subarticular) cortex.

Fixation of medial malleoli

Technique

The medial approach allows access to medial malleolar fractures and exploits an internervous interval between the dorsiflexors (deep peroneal nerve) and invertors and plantarflexors (posterior tibial nerve) of the ankle. A curvilinear incision may be made further anteriorly over the front of the medial malleolus to allow visualization of the medial corner of the plafond, curving posteriorly distal to the malleolus to allow screw or plate placement.

Fixation of medial malleolus with malleolar screw

Technique

The patient was set up as described for fibular fixation. The medial malleolus was most commonly approached through a longitudinal incision placed directly over the malleolus. The skin was incised and then blunt dissection was performed down to bone in order not to injure the great saphenous vein and nerve. The fractures were usually transverse in orientation, and was distracted with an instrument to allow removal of bone debris, and inspection of the talus. A flap of periosteum from the proximal tibial fragment was commonly found to have been pulled into the fracture and this requires to be extracted. A temporary fixation of the fracture was performed using a small reduction clamp, and a small drill hole was placed just proximal to the fracture to allow seating of one of the points of the clamp. The other point was placed at the tip of the malleolar fragment. Definitive fixation was with 3.5mm malleolar screws. The screws cross the fracture orthogonally and are typically 35 mm long— longer screws do not have a longer thread and there is no advantage in placing the thread further from the relatively dense subchondral bone.

Tourniquet was deflated and sterile compressive bandages were applied. Distal vascularity was confirmed with pulse oxymeter probe. All patients were immobilized in below knee pop slab.

Post-op Protocol

Immediate post-op, all patients were shifted to ICU for observation for 6hrs,until the patient recovered from anesthesia, during which the operated limb was kept on pillow elevation to prevent distal edema, vitals monitoring, temperature chart, and I/O chart was maintained. Patients were administered adequate analgesics. Antibiotics were administered for 72 hours postoperatively. The foot was kept elevated over pillows. Radiological evaluation was done in the postoperative period which included both Anteroposterior and Lateral views. These were graded as per the Kristensons criteria 126 [8].

Drain tube was removed on the second post operative day. Patient was mobilized on the first post operative day, non weight bearing on the affected leg with the help of walker or auxiliary crutches. Patients were discharged on the fifth day on an average.

Follow up

Sutures were removed at follow up in the outpatient clinic at the end of two weeks. Patients were advised to continue non weight bearing ambulation with a walker or axillary crutches for a period of six weeks. However in patients who had other associated injuries, ambulation was delayed or mobilized on a wheelchair.

The Plaster slab or cast was removed at the end of 6 weeks. Check x rays were done at six weeks. Presence of callus and status of the joint was noted. The patients were started on active ankle mobilization. Partial weight bearing was stared with support. Weight bearing was decided on the basis of the X-ray picture.

All patients were followed up at 3 weeks, 6 weeks, 3 months and 6 month.

Patients were given follow up dates at each appointment and a supplementary reminder letter was sent to all patients before their 6 month appointment. The primary endpoint was the rate of union at 1 months and upto 6 months if delayed.

The patients were reviewed at three and six months postoperatively and subjective and objective assessment of the patients' ankles were done using a modification of the scoring system proposed by Olerud and Molander (A score of 90 to 100 is considered Excellent; 70 to 89-Good; 50 to 69 points - Fair and less than 50 is considered Poor).

Statistical analysis

The statistical package for the social science system version SPSS 21.0.0. Continuous variables will be presented as mean, SD or median (IQR) for non-normally distributed data. Categorical variables will be expressed as frequencies and percentages. The comparison of continuous variables between timeline will be performed using paired sample t test. The comparison of Nominal categorical data will be done by using Chi-squared test or Fisher's exact test as appropriate. For all statistical tests, a p value less than 0.05 will be taken to indicate a significant difference.

Results

Table 1: Demographic profile of the study population and mode if injury& side involved

Variables	No. of Cases	Percentage
Age in years		
Less than 30 years	17	56.7%
Greater than 30 years	13	43.3%
Sex		
Male	22	73.3%
Female	8	26.7%
Mode of Injury		
RTA	15	50%
Self Fall	10	33.3%
Sports	5	16.7%
Side Affected		
Left	14	46.7%
Right	16	53.3%
Total	30	100%

In our study most of the patients were below 30years. Total 17 (56.7%) patients were Less than 30 years (56.7%). 43.3% of patients were greater than 30 years. Maximum numbers of patients were Male (73.3%). 26.7% of patients were Female. Out of 30 patients majority of them had injury from RTA (50%). 33.3% of patients had injury from Self Fall and 16.7% of patients had injury from Sports. Most of the patients had injured in Right side (53.3%). 46.7% of patients had injured in Left side.

Table 2: Distribution of study population according to type of fracture

Weber Type	No. of Cases	Percentage
A	6	20%
B	16	53.3%
C	8	26.7%
Lauge Hansen		
Pronation abduction (PAB)	3	10%
Pronation dorsiflexion (PD)	1	3.3%
Pronation external rotation (PER)	8	26.7%
Supination adduction (SAD)	5	16.7%
Supination external rotation (SER)	13	43.3%
Total	30	100%

The majority of patients had weber type of B (53.3%). 26.7% of patients had weber type of C and 20% of patients had weber type of A. The maximum number of patients had SER (43.3%). 26.7% of patients had PER and 16.7% of patients had SAD. Similarly 10% of patients had PAB and 3.3% of patients had PD.

Table 3: Pre-op and Post-op Kristenson Criteria

Kristenson Criteria	No. of Cases	Percentage
Pre-op		
Good	5	16.7%
Fair	15	50%
Poor	10	33.3%
Post Op		
Good	24	80%
Fair	6	20%
Total	30	100%

Out of 30 patients majority of them had Fair pre-op Kristenson Criteria (50%). 33.3% of patients had Poor pre-op Kristenson Criteria and 16.7% of patients had Good pre-op Kristenson Criteria. In our study, most of the patients had Good post Op Kristenson Criteria (80%). 20% of patients had Fair post Op Kristenson Criteria.

Table 4: Mean comparison of OMAS (3 Months) wirh OMAS (6 Months)

Parameters	Mean	SD	t' Value	P Value
OMAS (3 Months)	56.667	16.3651	-13.504	< 0.001
OMAS (6 Months)	78.500	17.7215		

The paired sample‘t’ test results shows that there is a significant difference between the mean of OMAS (3 Months) and OMAS (6 Months) (t value=-13.504, P=< 0.001).

Table 5: Complications Encountered

Complications	No. of Cases	Percentage
Delayed wound healing	1	3.3%
Failed reduction	1	3.3%
Superficial infection	1	3.3%
Wound dehisence	1	3.3%
No complications	26	86.7%
Total	30	100%

The maximum number of patients had No complications (86.7%). 3.3% of patients had Delayed wound healing and 3.3% of patients had Failed reduction. Similarly 3.3% of patients had Superficial infection and 3.3% of patients had Wound dehisence.

Discussion

In the present study we have 30 patients with age ranging from 18 to 60 years with closed bimalleolar fracture treated with open reduction and internal fixation in our institute using malleolar screw for medial malleolus and one third tubular plate for lateral malleolus were followed up for 6 months and following observations were made.

In the present study male predominance were found with 22 out of total 30 patients were male which is 73.3% which is comparable to the study by Baird and Jackson142 [9]. In our study most of the patients were below the age group of 30 years with mean age being 30.13 year which was comparable to study by beris et al. [10]

In the present study both Weber and Lauge Hansen system of classification was used. The most common type of injury in our study was Weber’s Type B fractures (53.3%) which was comparable to study done by Hughes JL [11]. The most common mechanism of injury was Supination-external rotation injury with 43.3% incidence. The findings were similar to observations of Beris et al. and Roberts SR [10, 12].

In this study right ankle was more affected i.e., 16 Patients (53.3%). The findings were similar to observations of Beris et al. and Roberts SR [10, 12]. The commonest mode of injury was Road traffic accident. The findings were similar to observations of Lee at al. and Mohapatra A [13-14].

In our study average time required for radiological union was 9.6 weeks, which was in accordance with study by Parvataneni Prathap DA and Maruthi CV. OMAS was 56.667 at 3 month and 78.5 at 6 months which was comparable to study conducted by Vivian R. D’Almeida *et al*.

Fig 1: Pre op

Fig 2: Immediate post op

Fig 3: 3 months post op

Fig 4: 6 months post op

Fig 5: 6 months follow up

Fig 6: 6 months follow up plantar and dorsiflexion

Limitations

1. The main limitations of the present study were small sample size, short study period, study involving a single centre and hence non-generalizability of the study findings.
2. Long term complications like ankle arthritis could not be assessed due to the short duration of study.
3. Variations in patient's adherence to postoperative mobilization regimens could not be accounted for in this study.

Conclusion

Operative treatment for ankle fractures results in good functional outcome postoperatively. Anatomical reduction of the fracture is associated with better functional outcome. Early treatment without delay, anatomic reduction and fracture fixation, stringent postoperative mobilization and rehabilitation should help improve outcome in an operated ankle fracture**.**

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