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A prospective study of functional outcome of Trimalleolar ankle fracture treated surgically

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Abstract

Aim: To assess the functional outcome of surgically treated Trimalleolar fractures by specific modalities to attain a proper anatomical alignment and stability of the ankle joint.

Materials and Methods: The study was conducted in the Department of Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore. This study consisted of 30 patients visiting the outpatient department and emergency department of the hospital. Patients diagnosed with Trimalleolar ankle fractures were included in the study who were operated on during the period between November 2019 and November 2020. The patients were followed up for 12 months. All the fractures in the study group were post-traumatic. Medical history, clinical examination and radiological examination were done, patients diagnosed with Trimalleolar ankle fractures are operated on as early as possible. At follow-up visits, the patient is evaluated clinically (pain score, soft tissue status), radiologically (alignment, fracture reduction and union), and noted complications. Patients were evaluated with the American orthopedic foot and ankle society score (AOFAS) and the results were analyzed using descriptive statistics.

Results: Excellent results were achieved in 7(23.33%), good in 21(70%) fair in 2 (6.66%) of patients cases. The patient with fair result had mild pain with activities of daily living, diminution in the abilities to run, reduced motion at the ankle.

Conclusion: The size of the posterior malleolus fragment is not a clear indication for fixation or non-operative treatment of the posterior malleolus fragment. The anatomical intra-articular reduction of the fragment not leaving room for a step-off has far more impact on clinical outcome.

Keywords: Trimalleolar fractures, intra-articular reduction, posterior malleolus

Introduction

Ankle fractures are one of the most common lower limb fractures for accounting to 9% of all fractures, representing a significant portion of the trauma workload. The annual incidence of ankle fracture is between 107 and 187 per 100,000 persons, and around 2% of ankle fractures are open fractures. Ankle fractures usually affect young men and older women, however, below the age of 50 ankle fractures are commonest in men. After this age, females become predominant [1].

As a weight bearing joint, the ankle is exposed to forces that transiently exceed 1.25times body weight with a normal gait and they may exceed 5.5 times body weight with vigorous activities [2].

A stable anatomical reduction of talus in the ankle mortise and correction of fibula length as a 1mm lateral shift of talus in the ankle mortise reduces the contact area by 42% and displacement of fibula more than 2mm will lead to a significant increase in joint contact pressures.

A fracture of the posterior tibial margin larger than 5% of the involved articular surface may lead to the development of posttraumatic osteoarthritis, especially in fractures that involve the weight-bearing part of the tibiotalar joint. Moreover, persistent postoperative dislocation of the posterior fragment in Trimalleolar fractures may result in ankle instability, osteoarthritis, and functional impairment.

According to the Arbeit gemeinschaft für Osteosynthesefragen (AO), a posterior fragment comprising more than 25% of the intra-articular surface needs to be fixated, as do fragments larger than 10% that remain persistently unstable after fixation of the lateral and medial

malleolus [3].

Recently, studies have stated that anatomical reduction and fixation of the posterior malleolus should be carried out in all cases of Trimalleolar fracture irrespective of its size and type to obtain good clinical and functional outcome.³

This study aims to assess the functional outcome of surgically treated Trimalleolar fractures by specific modalities to attain a proper anatomical alignment and stability of the ankle joint.

Materials and Methods

The study was conducted in the Department of Orthopaedics, Sanjay Gandhi Institute of Trauma and Orthopaedics, Bangalore. This study consisted of 30 patients visiting the outpatient department and emergency department of the hospital. Patients diagnosed with Trimalleolar ankle fractures were included in the study who were operated on during the period between November 2019 and November 2020. The patients were followed up for 12 months. All the fractures in the study group were post-traumatic.

Inclusion criteria

1. Patient's age between 18-60yrs
2. Trimalleolar ankle fracture treated surgically.
3. Ability to understand the content of the subject information / informed consent form and to be willing to participate in the clinical investigation.
4. Written informed consent.

Exclusion Criteria

1. Compound ankle fractures
2. Pathological fractures
3. Previous ankle injury
4. Concomitant fractures in the same limb.
5. Associated neurological deficits
6. Infection
7. Polio affected limb

Sample size estimation

According to the study conducted by R.I Rose *et al.* [4] estimated prevalence of ankle fractures of is 11-15% and according to the study conducted by Charles M Court-Brown *et al.* [5], out of 15% of ankle fracture, 2% accounts for Trimalleolar ankle fractures. So, we included only the Trimalleolar ankle fractures and considering a prevalence of 2% therefore, considering prevalence at 2% with a 95% confidence interval with a standard error of +/- 5, the sample size of estimation was found to be 30.

Pre-operative Protocol

All study patients were put on below-knee posterior splint and limb elevation was given over the Bohler-Braun splint or double pillow, with or without ice pack application and crepe bandage application, to reduce the swelling before the surgery. Adequate medical management of associated comorbid conditions like Diabetes Mellitus, Systemic Hypertension, Chronic Obstructive Pulmonary Disease and Heart Diseases were initialized to optimize the patient's fitness for anaesthesia. Informed written consent for the procedure as per the institution's guidelines and consent for inclusion of the patient for the present study was taken.

Weber classification and Lauge and Hansen classification was used to classify fractures based on radiograph. All the patients were operated within 3-7 days of injury. The limb was prepared for surgery by wash with antiseptic solution. Intravenous antibiotics were administered half an hour before

the surgical procedure.

Operative Technique

Under appropriate anesthesia the patient was put in supine position on table with sand bag underneath the affected side buttock. Pneumatic tourniquet was applied to the proximal thigh after noting the time. The affected limb was draped from the knee joint to the nail tip and then painted betadine solution the foot was covered with a glove. Timing of surgery lasted around 1 to 1 ½ hours, open reduction and internal fixation of the malleolar fractures were performed by tension band wiring, malleolar screw, K- wire fixation or semi tubular plating with screws.

Exposure and Fixation of Posterior Malleolus

Reduction is usually affected by pulling the foot forward and then maximally dorsi-flexing the ankle as well as dorsi-flexing the big toe at the metatarsophalangeal joint. This maneuver aids in reduction of the fragment by tensing the posterior capsule of the ankle and the flexor hallucis longus tendon.

If the fragment is reduced, it is fixed with one or two 4-mm cancellous screws placed in an anteroposterior direction through small stab incisions made anteromedially. The screws are directed lateral to the posterior fragment. In anteroposterior placement the fragment may be pushed apart by the drill bit or the screw, and if the screw threads lie across the fracture line, an adequate lag effect may be prevented.

If the fragment remains anatomically unreduced, an open reduction is carried out, through an extended regular lateral or a posteriorly placed lateral incision or through a regular posterolateral approach. The posterior aspect of the tibia and the fractured fragment is exposed by enlarging the interval between the peroneal tendons and the flexor hallucis longus muscle.

Reduction is effected with a small periosteal elevator. It is inserted into the fracture site while the foot is held in plantar flexion to ease the tension on the posterior capsule. The fragment is gently eased inferiorly by the elevator at the same time that it is pushed anteriorly with the thumb. The reduced fragment is held with two Kirschner wires, and an intra operative lateral view of the ankle is obtained. After confirmation of the reduction, the fragment is fixed with two 4mm AO cancellous screws. The screws are placed at right angles to the fracture just above the plafond and in an oblique direction, posterolateral to anteromedial. In our study 21 cases we have fixed with 4 mm cannulated cancellous screws and 9 cases were fixed with semi tubular plate.

Exposure and Fixation of Syndesmosis Screw

The syndesmosis must be anatomically reduced and held with provisional K wires or reduction clamp before the syndesmosis screws are inserted. The screw must be positioned 2-3 cms proximal to the tibial plafond parallel to the joint surface and angle 30° anteriorly so that it is perpendicular to the tibio fibular joint. The syndesmosis screw must be tightened with ankle in maximal dorsiflexion.

If a small plate has been used to fix the fibular fracture, the transfixing screw can be one of the syndesmosis screw. 3.5 mm tricortical screw is used for fixation. Fixation with 2 screws is more secure than fixation with 1 screw. It should pass through both cortices of fibula and one or both cortices of tibia.

Exposure and Fixation of Lateral Malleolus

The lateral malleolus was approached through a posterolateral incision. The incision was put about 12 cm proximal to the tip of lateral malleolus and extended distally along the posterior margin of the fibula to the tip of malleolus and curved it anteriorly for 2.5cm in line of peroneal tendons. The fibula was exposed sub periosteally by deepening the incision through subcutaneous tissue and deep fascia. Full thickness skin flaps was retracted anteriorly and posteriorly. Soft tissue and periosteum was cleared a few millimeters of the fracture edge and visualization of the fracture was done. The foot was externally rotated to separate fracture fragments, blood clots and intervening soft tissue was removed with a small curet from the fracture site. Reduction of the fracture was now done by reversing the force that caused the fracture. In all fractures other than supination adduction fracture the foot was pulled down and internally rotated thus reducing the fracture and if not reduced the fracture was reduced with a towel clip and rotating internally and was fixed with semitubular or dynamic compression plate with or without lag screw. Plate was contoured to accommodate the lateral bow of the fibula and held in reduction over the lateral side of fibula. Drill holes are made with 2.5mm drill bit. The length of the screw was measured with a screw gauge and tapped with 3.5mm tap. The plate was then fixed with the measured length of cortical screws. The distal two holes were fixed with cancellous screw of length 2mm less than the measured to prevent entry of the tip of screw into the ankle joint. The reduction clamp was then removed and the stability was confirmed.

In 21 cases the lateral malleolus was fixed with 6-hole semitubular plate and 4 cases with locking compression plate, 4 cases with reconstruction plate and one case with 3.5mm6-holedynamic compression plate.

The wound was washed with isotonic saline and covered with a fresh mop. The limb was extended and the medial side exposed.

Exposure and Fixation of Medial Malleolus

A medial longitudinal incision of 8cm was put over the medial malleolus between its anterior and posterior borders with the lower end curving anteriorly at the tip of medial malleolus. The incision was deepened to the bone protecting the long saphenous vein over the anterior part of the incision. The skin and subcutaneous tissue was retracted anteriorly and posteriorly without undue pressure over the skin. The fracture site was exposed and cleared of blood clots and intervening periosteum with a curet exposing small serrations of the fracture. The distal fragment was held with a towel clip and pulled proximally, reducing the small serrations of the fracture. Two K- wires of 2mm diameter and 8cm long were passed one anterior and one posterior from the tip of the malleoli to the proximal tibia transfixing the malleoli to the tibia without entering the joint. The towel clip was removed and a drill hole was made, 5cm proximal to the fracture, on the tibia from anteromedial aspect to anterior aspect with 3.5mm drill bit protecting the soft tissues anteriorly with a right-angled retractor. An AO wire of 20 gauge is passed through the predrilled hole on the tibia from anteromedial to anterior aspect and was made in the figure of eight passing behind the two K-wires and tensioned with an AO tensioner and the tips of wire was cut with a cutter. The two K- wires were bend with bender and punched into bone engaging the wire, protecting the tibialis posterior tendon and neurovascular bundle.

In 10 cases tension band wire was done for medial malleolus. In 20 cases similarly reduction of fracture was done with a towel clip and a drill hole was made perpendicular to the

fracture line with 3.2mm drill bit and then tapped with 4.5mm tap securing the reduction 4.5mm malleolar screw was used. The screws were tightened to provide compression at the fracture site.

The wound was washed with betadine and sutured in layers. Sterile dressings were applied and compression bandage given. Below knee posterior pop slab was given. The tourniquet was removed and the appearance of capillary filling over the toes was confirmed. The patient was shifted to recovery room and then to post operative ward.

Post-Operative Management

IV fluids were infused as appropriate. Antibiotics consisting of Cefazone and Amikacin were continued for 5 and days respectively. Analgesics and Serratiopeptidase were given. Elevation of the affected limb was done. X-rays anteroposterior, lateral and mortise views were taken. Wounds were inspected on 3rd day. Sutures were removed on 12th post operative day on an average. Patient was discharged with instruction of non-weight bearing crutch walk for a period of 6 weeks and to come for follow-up after 3 weeks.

Follow Up

Weight bearing is restricted for 6 weeks. If the bone condition and other factors prevented secure fixation, the fracture was protected and longer. At 3 weeks the POP was removed. Clinical examination was done regarding tenderness and movement of ankle. At 6 weeks x- ray of the ankle was taken both AP and lateral views and looked for signs of fracture union and then were advised partial weight bearing for further period of 6 weeks with elastocrepe bandage and elevation of the limb at night times and active movements of ankle joints. Patients were allowed full weight bearing on the affected limb. Regular follow up was done at 1, 3 and 6 months and 1year after discharge. All the patients were advised removal of implants after complete union after 1 year. Syndesmotic screw is usually removed before weight bearing is allowed. This is usually in 6-8 weeks. Removing the screw too early causes recurrent diastasis of the syndesmosis. Weight bearing with the screw in place has caused screw breakage. Taking these into account, it is usually advisable to leave the screw in place for at least 12 weeks.

Functional Evaluation

Functional and radiological results were analyzed using the ankle scoring system of AOFAS. The evaluation was based on physical and radiological examination. Physical examination included the measurement of active dorsiflexion and plantar flexion of injured ankle compared with the uninjured ankle, with forepart of foot in neutral position. Radiologically the medial clear space superior joint space and talar tilt was measured. The seven categories in the scoring system were given alphabetical grades each being assigned a point score.

Results

Table 1: Age wise distribution of study patients

Variable	Category	N	%
Age	25-40 yrs.	11	36.7%
	41-60 yrs.	16	53.3%
	> 60 yrs.	3	10.0%
Gender	Mean±SD	46.00±14.10	
	Range	25-80	
	Males	21	70.0%
	Females	9	30.0%

Most of patients i.e., 16 (53%) were from 41-60 years age group, followed by 11 (36.7%) patients in 25-40 age group. The youngest patient was 25 years old and oldest was 66 years of age. The mean age in our study was 46years. There were increased distribution of male over female patients male 21 (70%), female 9 (30%).

Table 2: Distribution of mode, side involved and type of Injury among study patients

Variable	Category	N	%
Mode of Injury	Road Traffic Accident	20	66.7%
	Self-Fall	10	33.3%
Side involved	Right	18	60.0%
	Left	12	40.0%
Type injury	Type A	12	40.0%
	Type B	10	33.3%
	Type C	8	26.7%

The majority cases of fracture in our study were road traffic accidents in 20 (66.7%) and in 10 (33.3%) patients fracture was due to slipping and fall. Right ankle was involved in 18 (60%) patients and in 12 (40%) patients left ankle was involved. Majority of patients had Denis Weber type A fractures 12 (40%) followed by type B in 10 (33.3%) patients and least is type C in 8 (26.7%) patients.

Table 3: Distribution of Management of Fracture among study patients

Variable	Category	N	%
Management	MM-MS, LM-STP, PM-CCS	20	66.7%
	MM-TBW, LM-STP, PM-CCS	1	3.3%
	MM-TBW, LM-DCP, PM-STP	1	3.3%
	MM-TBW, LM-RCP, PM-STP	4	13.3%
	MM-TBW, LM-LCP, PM-STP	4	13.3%

Majority 21 (67%) were fixed with 6 holed 1/3rd semi-tubular plate. Locking compression plate was applied in 4(12%) cases reconstruction plate was done in 4 cases (12%) dynamic compression plate was done in 1 (3%) case.

In our study tension band wiring was done 10 (33.3%) of cases with medial malleoli fractures. In 20 (66.6%) case 2” x 4.5 mm malleolar screws were used.

Majority of the cases were operated with one/ two 4.5mm cannulated cancellous screws

Table 4: Comparison of mean AOFAS scores between different time intervals

Time	N	Mean	SD	Min	Max	p-value
3 Months	30	71.93	8.57	56	85	<0.001*
6 Months	30	79.00	8.00	60	91	
1 Year	30	86.00	6.51	69	96	

Test applied: Repeated Measures of ANOVA test

In our present study of functional outcome there is increase in the trends of AOFAS from 3months to 1 year of follow up.

Table 5: Descriptive for Pain Scores, Ankle Plantar & Dorsi Flexion among study patients

Parameters	N	Mean	SD	Min	Max
Pain	30	37.67	4.30	30	40
Ankle Plantar Flexion	30	33.80	6.36	23	45
Ankle Dorsi Flexion	30	11.43	2.82	6	16

In the present study of 30 patients with Trimalleolar ankle fractures treated by open reduction and internal fixation.

Excellent results were achieved in 7 (23.33%), good in 21 (70%) fair in 2 (6.66%) of patients cases. The patient with fair result had mild pain with activities of daily living, diminution in the abilities to run, reduced motion at the ankle.

Discussion

Our study consists of 30 cases of Trimalleolar ankle fracture operated at Sanjay Gandhi institute of trauma and orthopaedics from November 2019 to September 2020. Functional outcome was assessed through AOFAS scoring system.

Out of 30 cases there were 21males and 9 females. Mean age of the patients was 46 years with age ranging from 20 years to 80 years. In our study the mean age of the patients was 46 years which was comparable to previous studies done by Lee *et al.* (mean age of 44years), Beris *et al.* [2] (mean age of 43.8 years). Right side was involved in 18 cases and left side in 12 cases. The study included only ankle fractures.

The mode of injury was RTA in 20(66.7%) cases and self-falls in 10 (33.3%) cases. This result was comparable with results of study done by Lee *et al.* [6] (RTA-75%).

In our study there was found to be supination external rotation type of lauge Hansen classification was most common which was accounting to about 18 cases (65%) which was comparable with the study conducted by Roberts SR *et al.* [7] (40%) braid and Jackson *et al.* [8] (55%) supination external rotation type of injury.

The clinical audit was performed by Schepers *et al.* [9] The systematic review of the literature showed a difference in wound complications of 3.6% (early surgery) versus 12.9% (late surgery) (p<0.0001), which was related in our study where all patients were operated within few days of trauma as the soft tissue edema was reduced with lesser wound complications (5%).

In our study all cases were operated for all three malleolus All patients were approached medial side with incision of 4cm for medial TBW or malleolar screws, lateral incision of posterolateral was used for fixation of both posterior and lateral malleoli where posterior malleoli was fixed with either cannulated cancellous screws or semitubular plate and lateral was fixed with semitubular or dynamic compression plate.

A number of different treatment regimens have been suggested. Burwell and Charnley advocated postoperative joint mobility exercises in bed until motion was restored followed by full weight bearing in a cast.

Lund -Kristensen *et al.* [10] either used no cast or applied one for a few days postoperatively and then allowed full joint mobilization out of the cast. They advocated the use of crutches to maintain a non-weight bearing status. Meyer and Kumler [11]. Used a post operative cast but only for an average of 3.8 weeks followed by non- weight bearing mobilization until fracture union.

Although early mobilization was advocated by AO, Immobilization has also been supportive. Others have found no significant difference in the results produced after early motion or immediate plaster splintage.

In our series, immobilization in a plaster cast/splint immobilization for 3weeks followed by mobilization with nonweight bearing till fracture union was used successfully. The range of motion was reduced initially, but the ankle movement rapidly improved after physiotherapy.

In a study conducted by Beris *et al.* [2] of 144 patients with ankle fractures, there were good results in 74.3% of patients, fair results in 14.6% and poor results in 11.1%.

These were comparable to our study where Excellent results

were achieved in 7 (23.33%), good in 21 (70%) and fair in 2 (6.66%) of patients cases.

Conclusion

A thorough clinical examination at the time of presentation to the emergency is very important, the general condition of the patient should be assessed and stabilised. Standard ankle X-rays are the first means of diagnostics in case of suspicion of an ankle fracture. Preoperative CT-scanning of the intra-articular ankle fractures is mandatory, visualisation of the intra-articular fracture fragments, the posterior malleolus fragment by CT-scan helps to understand the fracture better. We recommend surgical treatment within one week of trauma, once the skin over the ankle appears wrinkled, which means the soft tissue swelling has subsided.

This study recommends fixation of the posterior malleolus first, then lateral malleolus and finally medial malleolus in Trimalleolar ankle fractures with an experienced surgeon. The use of an open posterolateral approach for screw or plate fixation is functionally and radiologically superior to percutaneous anterior-to-posterior fixation. We advise early mobilisation of the ankle joint post operatively to achieve the better functional outcome and avoid ankle stiffness and decrease the range of movements at the ankle joint. The size of the posterior malleolus fragment is not a clear indication for fixation or non-operative treatment of the posterior malleolus fragment. The anatomical intra-articular reduction of the fragment not leaving room for a step-off has far more impact on clinical outcome. Posterior malleolus fracture can achieve anatomical reduction under direct vision with a good treatment effect.

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