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Study of Comparison of Functional Outcome of Surgically Operated Bimalleolar and Trimalleolar Fractures

[1]Gupta Vinay Kumar, [2]Aggarwal Arvind, [3]Chawla Sumit and [4]Priyadarshi Swapnil

[1,4]Department of Orthopaedics, Guru Govind Singh Government Hospital, New Delhi, India

[2,3]Department of Orthopaedics, Maharaja Agrasen Hospital, New Delhi, India

ABSTRACT

Ankle fracture (AFs) is one of the most common injury among all the fractures of the lower limbs found in emergency services. These fractures are a significant cause of morbidity for both the young and elderly population. The operative treatment of ankle fracture is open reduction and internal fixation, followed by immobilization and rehabilitation. Ankle fractures severity can be defined and classified to three sub-groups including unimalleolar, bimalleolar and trimalleolar fractures. Several studies have examined the differences between severity groups regarding functional outcomes and showed conflicting results. In this study, we will analyse the influence of the number and location of malleolar fractures on function, pain, range of motion and development of osteoarthritis in operatively treated participants. To analyse and evaluate the functional outcomes of bimalleolar and trimalleolar fractures in terms of pain, range of motion and functions and to evaluate the complications of surgically treated bimalleolar and trimalleolar fractures. Forty patients of age between 20-60 years with bimalleolar and trimalleolar fractures undergoing surgery formed the study population. These patients were selected based on the inclusion and exclusion criteria. At six weeks both groups of patients were reviewed, specific complaints were sought and check X-rays were taken. The patients were further reviewed at three and six months postoperatively and subjective and objective assessment of the patients' ankles were done using scoring systems: FADI and AOFAS. Statistical analysis used: SPSS software version 25.0. As per Lauge-Hansen Classification, PA (pronation-abduction) was the most common type of injury seen. AOFAS score was found to be significantly higher in bimalleolar fractures. AOFAS score was seen to be raised significantly from pre-operative to 6 months follow up in both the groups. FADI scores of bimalleolar group were higher than trimalleolar group and significant increase in scores from pre-operative period to 6 months follow up in both the groups was observed. There was significant increase in range of motion in 6 months post operatively. Trimalleolar fractures showed more complications than bimalleolar fractures. Operative treatment for ankle fractures results in good functional outcome post- operatively. Bimalleolar fractures were found to have better outcome compared to trimalleolar fractures. A significant improvement was noted in the ankle function from 3rd month to 6th month post-op, assessed using subjective criteria and various scoring systems like VAS score, FADI score, AOFAS score. Bimalleolar Fractures, Trimalleolar Fractures, AOFAS, FADI, Lauge-Hansen classification Operative treatment for ankle fractures results in good functional outcome post- operatively. Bimalleolar fractures were found to have better outcome compared to trimalleolar fractures. A significant improvement was noted in the ankle function from 3rd month to 6th month post-op, assessed using subjective criteria and various scoring systems like VAS score, FADI score, AOFAS score.

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Key Words

Bimalleolar fractures, trimalleolar fractures, AOFAS, FADI, lauge-hansen classification

Corresponding Author

Priyadarshi Swapnil,
Department of Orthopaedics, Guru Govind Singh Government Hospital, New Delhi, India
swapnil.pr14@gmail.com

Author Designation

[1,4]Senior resident
[2]HOD and Senior Consultant
[3]Senior Consultant

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INTRODUCTION

Ankle is a precisely aligned joint with coverage of little soft tissue. As a result, severe injury combined with inadequate or inappropriate treatment can lead to severe morbidity and major disability. As a weight-bearing joint the ankle is exposed to forces that transiently exceed 1.25 times body weight with normal gait, and that may exceed 5.5 times body weight with vigorous activities. Normal gait requires adequate dorsi-flexion, plantar-flexion, inversion and eversion, as well as accommodation to rotational stresses are provided by the subtalar joint, whose function is linked closely with that of the ankle. The ankle is not intrinsically stable in any position and requires support from the muscles that cross it[1].

Ankle fracture (AFs) is one of the most common injury among all the fractures of the lower limbs found in emergency services. These fractures are a significant cause of morbidity for both the young and elderly population[2]. At a young age the incidence is higher in men but the rate per gender reverses after 50 years of age[3]. There has been a constant increase in ankle fracture rates among the young, active patients as well as in the elderly population over the last several decades[4]. The operative treatment of ankle fracture is open reduction and internal fixation, followed by immobilization and rehabilitation[5].

The ankle joint (talo-crural joint) is made up of three bones tibia, fibula and talus. There are three articular surfaces the upper joint surface, which is the dome of the talus and the tibial plafond and the main articulations of the joint the medial joint surface, between the talus and the inner aspect of the medial malleolus the lateral joint surface, between the talus and the inner surface of the lateral malleolus of the fibula. Malleolar fracture have varied presentation understanding of the biomechanics of the joint and mechanism of injury is essential for adequate reduction and stable fixation. Ankle fractures are the result of low energy trauma involving twisting injuries. Ankle fractures severity can be defined and classified to three sub-groups including unimalleolar, bimalleolar and trimalleolar fractures. Several studies have examined the differences between severity groups in regard to functional outcomes and showed conflicting results. Some concluded that a fracture severity classification is a consistent predictor of functional outcome following surgery[6]. However, recent work by Egol *et al*. concluded that the type of fracture had no influence on functional recovery[7]. Most studies used self-assessment questionnaires and functional scores to evaluate the functional status of the patient post an ankle fracture surgery. Although questionnaires are considered a valid method of assessment they are subjective and objective methods of evaluation are warranted. About 15-20% of patients with ankle fractures are clinically significant and vary from Unimalleolar, Bimalleolar and Trimalleolar fractures[8]. A more stable but least invasive osteosynthesis is required to enable early functional outcome. Both Bimalleolar and Trimalleolar fractures affect gait pattern and clinical symptoms to an equal extent in short-term studies[7]. Malleolar Fractures occur because of a rotatory force as opposed to an axial force.

These injuries reflect the relative strength of ligamentous component of ankle mortise compared with bone. Most Ankle fractures are isolated malleolar fractures accounting for two third patients. Bimalleolar fractures occur in one-fourth of the patients and trimalleolar fractures occurring in remaining 5-10%. Open fractures are rare accounting for just 2% of all fractures[9]. Intra articular fractures like bimalleolar fractures need thorough understanding of mechanism of injury, proper anatomical alignment, accurate and stable reduction and fixation with appropriate implants in order to reduce painful restriction of movements and osteoarthritis[10].

There are various classification systems to describe ankle fractures, for example the AO-classification the Lauge-Hansen classification and the number of fractured malleolus[11,12]. Functional outcome studies have been performed among patients with ankle fractures, analysing patient-reported outcome measures (PROM) physical examination and radiographic findings[12,13]. These studies reported good results, with patients experiencing little or mild pain and few restrictions in functional activities 1 year after ankle fracture surgery[14]. Several studies examined the association between the severity of the fracture and the functional outcome, with mixed results. Some concluded that classification of the fracture can be used as a predictor of functional outcome after surgery[11,15]. Others, like Egol *et al*.[7] concluded that the type of fracture had no influence on functional outcome after ankle fracture surgery.

Kinematic analysis may provide a more robust predicator of patient-reported functional outcome and may provide a better correlation between fracture severity and patient satisfaction. Only a few studies have analysed gait in patients treated for ankle fracture. Kinematic analysis of the foot and ankle can be performed with reliable results using a multi-segmented foot model such as the Oxford foot model (OFM)[16].

Why this study was conducted: In the literature, little attention is given to the long-term functional outcome of operatively treated ankle fractures. Some studies have compared combined uni and bimalleolar fractures to trimalleolar fractures. Whereas other studies have focused on the long-term influence of deltoid ligamentous injury in addition to a fibular fracture or on the role of the posterior fragment in ankle

fractures[17]. To our knowledge, no study has compared the functional outcomes of operatively treated bimalleolar fractures with trimalleolar fractures. In this study, we will analyse the influence of the number and location of malleolar fractures on function, pain, range of motion and development of osteoarthritis in operatively treated participants.

Aim:

- To evaluate the functional outcomes of operated bimalleolar and trimalleolar fractures.

Objectives:

- To analyse and evaluate the functional outcomes of bimalleolar and trimalleolar fractures in terms of pain, range of motion and functions
- To evaluate the complications of surgically treated bimalleolar and trimalleolar fractures
- To evaluate the mode of injury

MATERIAL AND METHODS

Study area and population: This descriptive study (prospective and retrospective) was hospital based and was conducted in the department of Orthopedics at Maharaja Agrasen hospital, New Delhi. A clearance from ethical committee of institute was obtained. Written informed consent was also obtained from the patients.

Sample size: It is a hospital-based study of minimum 35 cases who are fulfilling criteria of inclusion/ exclusion. So, to avoid loss of data and to enhance reliability of the study total of 40 subjects were taken.

Study design: Prospective and retrospective study

Source of data: Subjects for the study were selected from the out-patient facility of Department of Orthopedics, Maharaja Agrasen Hospital, New Delhi.

Study period: From June-June 2020-2021

Place of study: Maharaja Agrasen Hospital, West Punjabi Bagh, New Delhi

Case inclusion criteria: All patients who presented to our hospital with losed bimalleolar and trimalleolar fracture and underwent surgery and gave their consent to participate in the study were included in the study. Patients in the age group of 20-60 years.

Case exclusion criteria: Additional injury apart from the ankle fracture, other musculoskeletal disorder, neurological problems.

- Patients with compound fractures, Pilon fractures,
- Old neglected fracture
- Those patients who were medically unfit for surgery and or anaesthesia

Method: This prospective study was carried out in Maharaja Agrasen Hospital, New Delhi, from June-June 2020-2021 and all closed bimalleolar and trimalleolar ankle fractures surgically managed were taken into the study. Fractures were classified according to the Lauge-Hansen system and generally operated by next day of presentation/admission depending upon the favorable local skin condition.

The primary normal motion of the ankle is dorsiflexion and plantar flexion, with osseous anatomy and ligamentous complexes that provide stability in all planes and axes of rotation. Niel Lauge-Hansen used freshly amputated limbs to develop an ankle fracture classification based on foot position at the time of the traumatic event (supination or pronation) and the direction of the deforming forces (abduction, adduction or external rotation). As Lauge-Hansen classification system is one of the most widely used and accepted ankle fracture classification systems, we have used it in our study.

Surgery was performed under pneumatic tourniquet control. Open reduction and internal fixation of the malleolar fractures was performed by tension band wiring, 4 mm cannulated cancellous screws with washers, semi tubular plating with screws or with an intra-medullary device. Appropriate post-operative care was provided based on patient's general condition. Patients were followed up as per specially made proforma for study purpose.

Pre-operative: Patients with above mentioned bimalleolar fractures were admitted and below knee slab was applied routinely in all cases. Oral and parenteral analgesics were given to relieve pain. Following investigations were done in all the cases. Haemoglobin level, urine routine, bleeding and clotting time, blood urea, serum creatinine, random blood sugar, Electro cardiograph (ECG) and chest X-rays were obtained routinely.

Pre anaesthetic evaluation was done for all cases and American society of Anaesthesiologist (A.S.A) grading system used prior to surgery. Parenteral 2nd generation cephalosporin was administered 1 hour prior to surgery. Hair clipping and scrubbing was done morning of surgery else before shifting patient out of waiting room to the operation theatre.

Operative steps: Internal Fixation of the Lateral Malleolus. The lateral malleolus was approached through a posterolateral incision. The incision was put about 10 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 subperiosteally by deepening the incision through subcutaneous tissue and deep fascia. Full thickness skin flaps were retracted anteriorly and posteriorly. The foot was externally rotated to separate fracture fragments, blood clots and intervening soft tissue was removed with a small curette from the fracture site. Reduction of the fracture was now done by reversing the force that caused the fracture. Fixation of the fracture was done using 1/3 tubular plate with or without a lag screw, with lag screws alone or with an intramedullary device namely a Rush pin. Rush pin was used in case of undisplaced pronation-abduction or pronation-external rotation injuries and was passed through an incision made at the tip of the lateral malleolus and passed retrograde under C-arm guidance.

Fixation of the medial malleolus: A medial longitudinal incision of around 8 cm 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 without undue pressure over the skin. The fracture site was exposed and cleared of blood clots and intervening periosteum with a curette 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. The fracture was fixed by passing one or two 4 mm cannulated cancellous screws with washer or by tension band wiring depending on the configuration and size of the fracture fragment.

Posterior lip fractures: Reduction of posterior lip fragments was done indirectly through either posteromedial or posterolateral incisions. The choice was made by the location of the fragment on the AP radiograph. Posterior lip fragments were reattached with one or two lag screws, occasionally supplemented with K-wires, washers. The most secure fixation was provided by interfragmentary fixation with lag screws, which glide through the fragment adjacent to their head and be threaded only into the opposite fragment. Such screws were placed from posterior to anterior if the fragment is exposed using a poster lateral incision.

Post-operatively: Post-operatively, patients were put on a posterior plaster of Paris (POP) slab. Post-operative antibiotics were continued for a period ranging from 3-5 days depending on the presence of other injuries and therapy was prolonged if there were signs of infection. Once pain-free, patient were trained in non-weight bearing crutch walking. The splint was continued till suture removal following which the patients were advised dorsiflexion and plantarflexion exercises.

Follow – up (figure 1,2): At six weeks both groups of patients were reviewed, specific complaints were sought and check X-rays were taken. Ankle girths was measured to assess the amount of swelling in both groups and the range of dorsiflexion and plantar flexion will also be assessed. The patients were further reviewed at three and six months postoperatively and subjective and objective assessment of the patient's ankles were done using FADI and AOFAS. The data was recorded in the appropriate proforma.

The Foot and Ankle Disability Index (FADI) can be used to assess functional limitations related to foot and ankle conditions. FADI is a region-specific self-report of function with 2 components. FADI main which assesses activities of daily living and has 26 items and FADI Sport which assesses tasks that are essential to sports and has 8 items. The FADI and FADI Sport are scored separately as percentages, with 100% representing no dysfunction.

The American Orthopedic Foot and Ankle Scale was designed for use among all patients with foot or ankle dysfunction. It comprises 4 region-specific scales, including ankle-hindfoot, midfoot, hallux metatarsophalangeal and lesser metatarsophalangeal-interphalangeal scales. The maximal score is 100 points indicating no symptoms or impairments. The patient records information regarding pain and function in each region. This scale also incorporates physical examination results recorded by the clinician. Although the American Orthopedic Foot and Ankle Scale has been widely used in studies of foot and ankle surgical outcomes, limitations have also been reported.

Statistical evaluation: Continuous data was summarized as Mean±SD (Standard Deviation) while Discrete (categorical) data in number and percentage. Quantitative data was analyzed by mean, SD, paired t-test. Qualitative data was analyzed by percentage, chi square test. Statistical significance. $p>0.05$ is not significant and $p<0.05$ is significant.

OBSERVATION AND RESULTS

Forty patients of age between 20-60 years with bimalleolar and trimalleolar fractures undergoing surgery at the Department of Orthopaedics, Maharaja Agrasen Hospital, West Punjabi Bagh, New Delhi formed the study population. These patients were selected based on the inclusion and exclusion criteria. Total males admitted for surgery were 27 (67.5%) and total females admitted were 13 (32.5%). Male to female ratio was 2.07:1. Our study showed dominance of males over females in terms of gender distribution. Out of 40 patients studied, majority belonged to age group 41-50 years old and 31-40 years old (16 cases,

Case-1 (bimalleolar fracture)

Fig. 1: Preop X-Ray and Post-OP X-Ray

Fig. 2: 3 Months Follow up and 6 Months Follow up

Fig. 3: Dorsiflexion (6 Months) and Plantarflexion (6 Months)

Fig. 4: Preop X-Ray and Post-OP X-Ray

Fig. 5: 3 Months Follow up and 6 Months Follow up

Fig. 6: Dorsiflexion (6 Months) andPlantar flexion(6 Months)

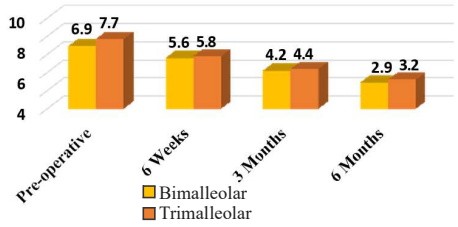

Fig. 7: Comparison of means of pain on vas during pre-operative and follow up period

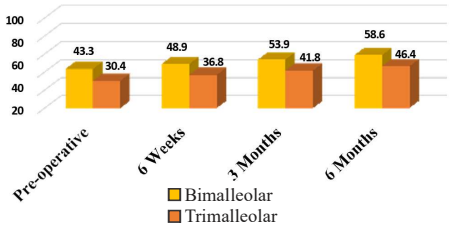

Fig. 8: Comparison of means of aofas score during preoperative and follow up period

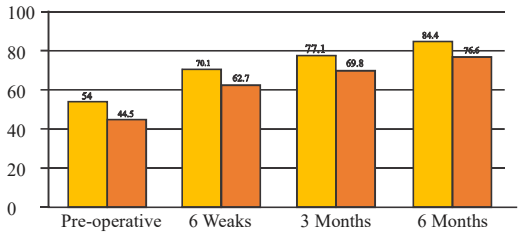

Fig. 9: Comparison of means of fadi score during pre-operative and follow up period

40% and 10 cases, 25% respectively). Nine cases (22.5%) were found in age group 20-30 years old. Least patients- five cases (12.5%) from age group 51-60 years old. It was noticed in our study that the right side of patients was affected predominantly. 31 patients (77.5%) presented with malleolar fractures of right side and nine patients (22.5%) suffered that of left ankle. Road traffic accidents contributed to the majority of cases (25 cases, 62.5%) followed by fall (15 cases, 37.5%). Pronation-Abduction type of injuries were commonly seen in our study (16 cases, 40%) followed by Supination-Everson type injuries (13 cases, 32.5%) Seven cases (17.5%) were of Supination-Adduction type while four cases (10%) were of Pronation-Everson type (Table 1).

Pre operatively mean pain on visual analogue scale was 6.9±0.9 in bimalleolar fractures and 7.7±1.1 in trimalleolar fractures which is found to be significantly higher in later group (p = 0.02). Intergroup comparison between bimalleolar and trimalleolar at 6 weeks, 3

Table 1: Distribution based on fracture classification

Lauge hansen classification	No. of patients (n)	Percentage
SA	7	17.5
SER	13	32.5
PA	16	40
PER	4	10
Total	40	100

Table 2: Comparison of means of range of motion at 3 and 6 months

Duration	Bimalleolar fracture	Trimalleolar fractur	p-value
Plantar flexion			
3 months	34.9±5.1	27.9±5.5	0.0002*
6 months	39.8±5.8	31.7±6.1	0.0001*
p-value	0.005*	0.004*	
Dorsiflexion			
3 months	15.7±2.6	13±2.4	0.0018*
6 months	19.1±2.1	16.3±2.5	0.002*
p-value	0.004*	0.002*	

Table 3: Distribution of complications between the two fracture types

Complications	Bimalleolar	Trimalleolar	Total
Implant impingement	0	1 (20%)	1 (20%)
Delayed union	1 (20%)	0	1 (20%)
Non union	1 (20%)	0	1 (20%)
Wound infection	0	1 (20%)	1 (20%)
Swelling	0	1 (20%)	1 (20%)
Total	2 (40%)	3 (60%)	5 (100%)

months and 6 months follow up were found to be statistically insignificant (Figure 1 and 3). However, there was significant improvement noticed in both groups from pre- operative period to last follow up at 6 months (p<0.0001). The American Orthopaedic Foot and Ankle Society (AOFAS) score was found to be significantly higher in bimalleolar fractures at all the time intervals taken. Similarly, AOFAS score was seen to be raised significantly from pre-operative to 6 months follow up (p<0.0001) in both the groups (Figure 4 and 6).

There was a significant difference in mean Foot and Ankle Disability Index scores of bimalleolar and trimalleolar fracture groups in all time frames provided. FADI scores of the bimalleolar group were higher than the trimalleolar group. Also, scores increased significantly from preoperative period to 6 months follow up (p<0.0001) in both the groups (Figure 9).

Plantar flexion and dorsiflexion were recorded during follow up at 3 and 6 months. In our study, it was noticed that there was a significant increase in range of motion in 6 months postoperatively (Table 2). Five out of 40 patients developed complaints post operatively. Delayed union and non-union were seen in one patient each in the bimalleolar fracture group while implant impingement, wound infection and swelling were seen in one patient each in trimalleolar fracture group (Table 3).

DISCUSSIONS

Anatomic restoration of the joint is the goal of management in fractures about the ankle. Open reduction and internal fixation is the standard of care for unstable ankle fractures[18]. However, very few investigators have examined the functional recovery following operative treatment of various types of ankle

fractures[13]. The purpose of this study was to compare functional outcome of surgically operated bimalleolar and trimalleolar fractures at tertiary care hospital.

There were total 27 males (67.5%) admitted for surgery and total females admitted were 13 (32.5%). Our study showed dominance of males over females in terms of gender distribution. In a study by Porter *et al* [19] 27 subjects were enrolled out of which 19 were males and 08 were females. In a study by Gawali *et al*[20], out of 35 patients, 25 were males while 10 were females. Findings of our study correlate with all the above mentioned studies.

In our study, majority that is 16/40 patients (40%) belonged to age group 41-50 years old while the mean age of study population was found to be 39.6±9.9 years. Mean age of patients in study conducted by Schepers *et al.*[21] was 50.7. Mean age of patients enrolled by Segal *et al.*[12] was 47.3 years . Findings of our study correlate well with other studies. In our study, we included 20 bimalleolar and 20 trimalleolar fractures. Segal *et al.*[12] studied 15 bimalleolar and 14 trimalleolar fractures. Gawali *et al.*[20] had taken 15 cases each of bimalleolar and trimalleolar fractures.

In our study, Road traffic accidents contributed to majority of cases (25 cases, 62.5%) followed by fall (15 cases, 37.5%). Khandelwal *et al.*[22] found that the commonest mode of injury is road traffic accident (34.3%) and fall (45.7%). Reddy *et al.*[23], *Hemant et al* [24] and Vivian *et al.*[25] also confirm the same as well as corresponds to the findings of our study. Based on Lauge Hansen Classification Pronation-Abduction (PA) type of injuries were commonly seen in our study (16 cases, 40%) followed by Supination-Everson (SE) type injuries (13 cases, 32.5%). Reddy *et al.*[23] found that PA type of injuries were most common i.e. 30% (9 cases) followed by SER injuries i.e. 26.7% (8 cases). In study conducted by Vivian *et al*.[25] 37.8% patients (number = 17) sustained supination external rotation followed by supination adduction. Khandelwal *et al.*[22] and Hemant *et al.*[24] observed that the most common injury pattern seen was supination external. Findings of our study correlate with study done by Reddy *et al*. only.

In our study, Pre operatively mean pain on visual analogue scale was 6.9±0.9 in bimalleolar fractures and 7.7±1.1 in trimalleolar fractures which is found to be significantly higher in later group (p = 0.02). Intergroup comparison between bimalleolar and trimalleolar at 6 weeks, 3 months and 6 months follow up were found to be statistically insignificant. However, there was significant improvement noticed in both of groups from pre-operative period to last follow up at 6 months (p<0.0001). In the study by Verhage *et al.*[26] bimalleolar fractures were compared with trimalleolar fractures and there was no significant difference found in functional outcome, except for pain. They found higher VAS scores in trimalleolar fractures compared to bimalleolar. These findings correlate with our observations. However, Hong *et al.*[27] found no notable differences in the VAS and O and M score for both groups. The American Orthopaedic Foot and Ankle Society (AOFAS) score was found to be significantly higher in bimalleolar fractures at all the time intervals taken. Similarly, AOFAS score was seen to be raised significantly from pre-operative to 6 months follow up (p<0.0001) in both the groups. Study Conducted by Verhage *et al*.[26] was a retrospective study with subjective assessment performed during the follow-up period. No significant differences were found between bimalleolar and trimalleolar fractures on all outcomes. Farsetti *et al.*[28] also evaluated AOFAS score during follow-up period in cases of surgically operated ankle fracture cases. Their follow-up ranged from 14-20 years, with an average of 15.8 years. At follow-up the AOFAS score ranged from 68-100 points (average 88 points, standard deviation 10.60 points).

Segal *et al*.[12] tried to examine objective and subjective differences between three severity groups of ankle fractures patients compared to healthy controls. All patients underwent a computerized gait test, completed self-assessment questionnaires (The Foot and Ankle Outcome Score (FAOS) and the SF-36) evaluated with the American Foot and Ankle Score (AOFAS) form and completed the 6-min walk test. There were no significant differences between the bimalleolar fracture group and the trimalleolar fracture groups in terms of AOFAS, FAOS and SF-36 scores. However the study by Segal *et al.*[12] only focused on pre-operative AOFAS scores while the study by Farsetti *et al.*[28] performed AOFAS assessment only during the follow-up period. Our study is unique to evaluate three different scoring systems during a complete clinical course i.e. pre-operatively, post-operatively and during follow-up period as well.

There was a significant difference in mean Foot and Ankle Disability Index scores of bimalleolar and trimalleolar fracture groups in all time frames provided. FADI scores of bimalleolar group were higher than the trimalleolar group. Also, scores increased significantly from pre-operative period to 6 months follow up (p<0.0001) in both the groups. Plantar flexion and dorsiflexion were recorded during follow up at 3 and 6 months. In our study, it was noticed that there was a significant increase in range of motion in 6 months post operatively. At 3 months plantar flexion was observed to be 34.9±5.1 in bimalleolar fractures and 27.9±5.5 in trimalleolar fractures. Plantar flexion at 6 months was improved in bimalleolar fractures to 39.8±5.8 and in trimalleolar fractures to 31.7±6.1. There was significant improvement in dorsiflexion in both bimalleolar and trimalleolar fracture. Dorsiflexion in bimalleolar fracture was 15.7±2.6 at 3 months which improved to 19.1±2.1 at 6 months of follow up. Sahu *et al.*[29] found that the range of motion of ankle

joint at the end of 6 months was 30˚ or more plantar flexion in 37 patients (92.5%) and 20˚ or more dorsiflexion in 33 patients (82.5%). Shah *et al.*[30] observed that ≥30˚ Plantar flexion at 6 Months was seen in 87.5% and ≥20˚ Dorsiflexion in 82.5%.

In our study, 5 out of 40 patients developed complaints post operatively. Delayed union and non-union were seen in one patient each in the bimalleolar fracture group while implant impingement, wound infection and swelling were seen in one patient each in trimalleolar fracture group. In general, complications were more common in the trimalleolar fracture group. Ahmad Hafiz *et al.*[31] found that the most common complications were superficial infection (12 cases, 15%) deep infection leading to non-union (2 cases, 2.5%) followed by joint stiffness (1 case, 1.2%). All superficial and deep infections occurred in cases of open fractures. All superficial infections resolved with local dressing and systemic antibiotics. Deep infections that occurred resulted in poor outcomes-cases with open grade 3A were badly contaminated and had continuing problems with stiffness. In the study by Khandelwal *et al.*[22], out of 35 patients, 5 patients presented with persistent swelling, 8 patients presented with residual pain while 9 patients presented with both of the complaints. However, no significant wound complications were noted.

Ehrenfreund *et al.*[32] in 2013 studied the results of operative management of ankle fracture in the elderly, with regard to functional outcome and complication rates. They did not observe any serious complications such as skin necrosis, deep infection, osteomyelitis and failure of metal work. Study by Vivian *et al.*[25] demonstrated that on follow up at 6 weeks, 11 out of 45 patients had persistent swelling and residual pain, 9 patients had only residual pain and 6 patients had only persistent swelling. One patient was found to have loss of reduction, which was attributed to early weight bearing against medical advice. This is in concordance with a similar study done by Hong *et al.*[33] in 2014 in which he reported residual pain, swelling and ankle stiffness as the most common complications at 1 year follow up.

Jaskulka *et al*.[34] described a significantly worse outcome in trimalleolar fractures. They also found a worse outcome on function, development of osteoarthritis and pain in trimalleolar fractures with a posterior fragment larger than 5% compared to posterior fragments smaller than 5% of the involved articular surface. Limitations of this study are the relatively short follow up period (5.7 years) and the fact that unimalleolar and bimalleolar fractures were not analysed separately. In a prospective cohort-study with a follow-up period of one year, Tejwani *et al.*[17] also described a worse outcome of trimalleolar fractures compared to uni and bimalleolar fractures. Makwana *et al.*[35] in 2001 compared 22 cases of open reduction and internal fixation and 21 cases of conservatively treated patients with ankle fractures and found that ORIF treatment yielded a significantly higher functional outcome score and a significantly better range of movement of ankle.

Bhandari *et al.*[36] in a study on 30 patients with unstable ankle fractures who were treated operatively, found that all these patients experienced significant improvement in all domains of SF-36 questionnaire. Findings of our study correlate well with all the studies mentioned above while they do not match with the findings of Hancock *et al*. Hancock *et al.*[15] in 2005 conducted a prospective cohort study on prediction of outcome after ankle fracture and concluded that fractures managed surgically tended to have poorer outcomes.

CONCLUSION

Ankle fractures are among the most common injuries treated by orthopaedic surgeons. However very few investigators have examined the functional recovery following operative treatment of ankle fractures. The purpose of this study was to analyse the patterns of ankle fractures as well as functional outcomes of surgically treated ankle fractures. A significant improvement was noted in the ankle function from 3rd-6th month post-op, assessed using subjective criteria and various scoring systems like VAS score,FADI score, AOFAS score. Operative treatment for ankle fractures results in good functional outcome post- operatively. Bimalleolar fractures were found to have better outcome compared to trimalleolar fractures.

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