

## FUNCTIONAL OUTCOME OF ANKLE FRACTURES TREATED SURGICALLY: A PROSPECTIVE STUDY

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### ABSTRACT

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#### BACKGROUND & OBJECTIVES

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. Anatomic restoration with open reduction and internal fixation is the goal of management in ankle fractures. The purpose of this study is to analyse the functional outcome following operative treatment of ankle fractures using subjective as well as objective criteria.

#### METHODS

90 patients with ankle fractures who fulfilled the inclusion criteria were included in the study. All patients underwent surgical fixation of the fractures. The follow-up assessment which consisted of subjective (Pain, Walking, Activity, Radiographs, Ankle and Subtalar Joint Function) and objective (Olerud and Molander Ankle Score) evaluations, were performed at 6 weeks, 3 months and 6 months postoperatively.

#### RESULTS

Out of 90 patients, the commonest injury pattern seen was supination-external rotation, followed by supination-adduction. The most common modality of fixation for the lateral malleolus was 1/3<sup>rd</sup> tubular plate and for the medial malleolus was 4 mm cannulated cancellous screws with washer. Syndesmotic screws were not applied in any of the cases. At 6 weeks follow-up 40% (n=36) had complications of persistent swelling, residual pain. We found a statistically significant improvement in the subjective assessment of pain, walking, activity levels, ankle and subtalar joint function from 3<sup>rd</sup> month to 6<sup>th</sup> month postoperatively. However, subjective radiographic assessment failed to show any statistically significant improvement. The mean Olerud and Molander Ankle Score was statistically significant 47.5±19.7 at 3<sup>rd</sup> month post-op and, 81.7±16.2 at 6<sup>th</sup> month post-op. Age was a significant predictor of final outcome, with younger patients having a better functional outcome.

#### CONCLUSIONS

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 mobilisation and rehabilitation should help improve outcome in an operated ankle fracture.

#### KEYWORDS

Bimalleolar, Trimalleolar, Fractures.

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**INTRODUCTION:** Ankle is a precisely aligned joint with little soft tissue coverage. As a result, severe injury combined with inadequate or inappropriate treatment can lead to severe complications 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 dorsiflexion and plantarflexion. 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.<sup>1</sup>

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.<sup>2</sup> However, very few investigators have examined the functional recovery following operative treatment of ankle fractures.<sup>3</sup> The purpose of this study is to analyse the patterns and causes of ankle fractures as well as functional outcome of surgically treated ankle fractures.

**MATERIALS AND METHODS:** A prospective randomised study was carried out in Bangalore Medical College and Research Institute (Victoria Hospital and Bowring & Lady Curzon Hospitals, Bangalore) from August 2013 to February 2016. Ninety cases of closed bimalleolar and trimalleolar ankle fractures surgically managed were taken into the study.

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Fractures were classified according to the Lauge-Hansen system and operated within 24 hrs. of presentation. Surgery was performed under pneumatic tourniquet control. Open reduction and internal fixation of the malleolar fractures were performed by tension band wiring, 4 mm cannulated cancellous screws with washers, semitubular plating with screws or with an intramedullary device. Post-operatively, patients were put on a posterior Plaster of Paris (POP) slab. Post-operative antibiotics were continued for a period ranging from 3 to 5 days depending on the presence of other injuries and therapy was prolonged if there were signs of infection.

Once pain-free, patient was trained in non-weight bearing crutch walking. The splint was continued till suture removal following which the patients were advised dorsiflexion and plantarflexion exercises. At six weeks, both groups of patients were reviewed, specific complaints were sought and check X-rays were taken. Ankle girths were measured to assess the amount of swelling in both groups and the range of dorsiflexion and plantarflexion were also assessed. The patients were further 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.

Table 1: Scoring system devised by Olerud and Molander (maximum 100 points)		
PARAMETER	DEGREE	SCORE
1. Pain	None	25
	While walking on uneven surface	20
	While walking on even surface outdoors	10
	While walking indoors Constant and severe	5
2. Stiffness	None	10
	Stiffness	0
	None	10
3. Swelling	Only in evenings	5
	Constant	0
	None	10
4. Stair-climbing	No problems	10
	Impaired	5
	Impossible	0
5. Running	Possible	5
	Impossible	0
6. Jumping	Possible	5
	Impossible	0
7. Squatting	No problems	5
	Impossible	0
8. Supports	None	10
	Taping, Wrapping	5
	Stick or crutch	0
9. Work, activities of daily life	Same as before injury	20
	Loss of tempo	15
	Change to simpler job	15
	Severely impaired work capacity	0

**Table 1: The Modified Ankle Score of Olerud and Molander (1984)**

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. Subjectively patients were assessed with respect to pain, gait, activity, radiographs, ankle joint function and subtalar joint function. A total score of 18-24 was considered good, 12-18 fair and below 12 poor.

**Internal Fixation of the 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 2.5 cm 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 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 posterolateral incision.

**Syndesmotic Injury:** Syndesmosis stability was checked by laterally displacing the distal fibula from the tibia while observing the relationship of the two bones under fluoroscopic guidance. If more than 3 to 4 mm of lateral shift of the talus occurs, instability is present. However, in this study, none of the patients had syndesmotic fixation done.

**OPERATIVE PHOTOGRAPHS:**

**Fig. 1: Skin Incision over Lateral Malleolus**



**Fig. 2: Exposure of Fracture Site**



**Fig. 3: Fixation of Fracture Using 1/3<sup>rd</sup> Tubular Plate**



**Fig. 4: Intraoperative C-arm Picture**



**Fig. 5: Skin Incision for Medial Malleolus**



**Fig. 6: Exposure of Fracture Site**

**RESULTS:** The study consisted of 90 patients aged between 17-73 years, of which 34 were females and 56 were males. The most common mode of injury was road traffic accidents. 36 patients had left ankle fracture, 52 had right ankle fracture, whereas one patient had bilateral involvement. 72 patients (80%) had medial malleolus fracture, while 74(82.2%) had their lateral malleolus fractured. Sixteen patients had local wounds in the form of abrasions and lacerations. Skin condition was not found to be healthy in 10 patients. 37.8% patients (number=34) sustained supination-external rotation followed by supination-adduction and pronation- external rotation (22.2%, 20 in number).

The most common modality of fixation for the lateral malleolus was one-third tubular plate (86.5%) and for the medial malleolus was 4 mm cannulated cancellous screws with washers (80.6%). Syndesmotic screws were not used in any of the cases. Sixteen patients had superficial wound infection, which was managed with appropriate antibiotics and dressings. The infection resolved in all cases. The average duration of hospital stay was 13 days. On follow up at 6 weeks, 22 out of 90 patients had persistent swelling and residual pain, 18 patients had only residual pain and 12 patients had only persistent swelling. Two patients were found to have loss of reduction, which was attributed to early weight bearing against medical advice. They went on to have a malunion of the fracture and had to undergo a corrective surgery.

There was a statistically significant improvement in the subjective assessment of pain, walking, activity levels, ankle joint function and subtalar joint function from 3 months post-op to 6 months post-op. However, subjective radiographic assessment failed to show any statistically significant improvement from 3 months post-op to 6 months post-op. The mean Olerud and Molander Ankle score at 3<sup>rd</sup> month post-op was  $47.5 \pm 17.9$  and at 6<sup>th</sup> month post-op was  $81.7 \pm 16.2$ . There was a statistically significant improvement in the scores from 3<sup>rd</sup> month to 6<sup>th</sup> month post-op ( $p$  value 0.000).

It was noted that advanced age was associated with a lower OMA score both at 3<sup>rd</sup> month and 6<sup>th</sup> month post-op ( $p$  value 0.002). In our study, we also found that patients who had post-op complications were found to have lower OMA scores at 3 months and 6 months followup ( $p$  value 0.001).

**The Study had the Following Limitations:** The study group was relatively small, with a shorter duration of follow-up. Variations in surgical techniques and experience, fracture patterns, errors of measurement and patient adherence to postoperative mobilisation regimens could not be accounted for in this study.

Sl. No.	Frequency	Percent
1	36	40.0
2	36	40.0
3	6	6.7
4	12	13.3
<b>Total</b>	<b>90</b>	<b>100.0</b>

**Table 1: Mechanism of Injury**

Sl. No.	Frequency	Percent
0	74	82.2
1	16	17.8
<b>Total</b>	<b>90</b>	<b>100.0</b>

**Table 2: Early Complications**

	Frequency	Percent
Absent	36	40.0
Present	54	60.0
<b>Total</b>	<b>90</b>	<b>100.0</b>

**Table 3: Late Complications**

	Frequency	Percent
1,5	2	3.7
2	12	22.2
2,4	22	40.7
4	18	33.3
<b>Total</b>	<b>54</b>	<b>100.0</b>

**Table 4: Types of Late Complications**

	2(6mpain)	3(6mpain)	4(6mpain)	Total
1(3mpain)	10 62.5%	6 37.5%	0 0%	16 100%
2(3mpain)	0 0%	36 90.0%	4 10%	40 100%
3(3mpain)	0 0%	10 29.4%	24 70.6%	34 100%
<b>Total</b>	<b>10</b> <b>11.1%</b>	<b>52</b> <b>57.8%</b>	<b>28</b> <b>31.1%</b>	<b>90</b> <b>100.0%</b>

**Table 5: Subjective Pain Measurement at 3 Months and 6 Months Post-op**

6mpain - 3mpain		
Wilcoxon signed rank test z value	p	
6.02	.000	< 0.01, HS

**INFERENCE:** Significant improvement in pain from 3rd month post-op to 6<sup>th</sup> month post-op.

	2(6mgait)	3(6mgait)	4(6mgait)	Total
1 (3mgait)	4 50.0%	4 50.0%	0 0%	4 100.0%
2(3mgait)	0 0%	24 85.7%	4 14.3%	28 100.0%
3(3mgait)	0 0%	10 18.5%	44 81.5%	54 100.0%
<b>Total</b>	<b>4</b> <b>4.4%</b>	<b>38</b> <b>42.2%</b>	<b>48</b> <b>53.3%</b>	<b>90</b> <b>100%</b>

**Table 6: Subjective Walking Measurement at 3 Months and 6 Months Post-op**

6mgait - 3mgait		
Wilcoxon signed rank test z value	p	
6.07	.000	< 0.01, HS

**INFERENCE:** Significant improvement in walking from 3 months post-op to 6 months post-operatively.

	2(6mactivity)	3(6mactivity)	4(6mactivity)	Total
2(3mactivity)	4 12.5%	28 87.5%	0 0%	32 100.0%
3(3mactivity)	0 0%	50 86.2%	8 13.8%	58 100.0%
<b>Total</b>	<b>4</b> <b>4.4%</b>	<b>78</b> <b>86.7%</b>	<b>8</b> <b>8.9%</b>	<b>90</b> <b>100.0%</b>

*Table 7: Subjective Activity Measurement at 3 Months and 6 Months Post-Op*

6mactivity - 3mactivity		
Wilcoxon signed rank test z value	p	
4.24	.000	< 0.01, HS

**INFERENCE:** Significant improvement in activity levels from 3 months post-op to 6 months post-op.

	1(6mradio)	2(6mradio)	3(6mradio)	4(6mradio)	Total
2 (3mradio)	0 0%	2 33.3%%	4 66.7%	0 0%	6 100.0%
3 (3mradio)	2 5.9%	6 17.6%	26 76.5%	0 0%	34 100.0%
4 (3mradio)	0 0%	0 0%	2 4.0%	48 96.0%	50 100.0%
<b>Total</b>	<b>2</b> <b>2.2%</b>	<b>8</b> <b>8.9%</b>	<b>32</b> <b>35.6%</b>	<b>48</b> <b>53.3%</b>	<b>90</b> <b>100.0%</b>

*Table 8: Subjective Radiographic Assessment at 3 Months and 6 Months Post-op*

6mradio - 3mradio		
Wilcoxon signed rank test z value	p	
1.26	.206	> 0.05, NS

**INFERENCE:** No significant improvement in the radiographic assessment from 3 months to 6 months post-op.

	2(6mankj)	3(6mankj)	4(6mankj)	Total
1 (3mankj)	6 100.0%	0 %	0 0%	6 100.0%
2 (3mankj)	8 20.0%	32 80.0%	0 0%	20 100.0%
3 (3mankj)	0 0%	38 86.4%	6 13.6%	44 100.0%
<b>Total</b>	<b>14</b> <b>15.6%</b>	<b>70</b> <b>77.8%</b>	<b>6</b> <b>6.7%</b>	<b>90</b> <b>100.0%</b>

*Table 9: Subjective Ankle Joint Function at 3 Months and 6 Months Post-op*

6mankj - 3mankj		
Wilcoxon signed rank test z value	p	
4.69	.000	< 0.01, HS

**INFERENCE:** Significant improvement in ankle joint function from 3 months to 6 months post-op.

	2(6mstj)	3(6mstj)	4(6mstj)	Total
1 (3mstj)	4 100.0%	0 %	0 0%	4 100.0%
2 (3mstj)	2 7.7%	24 92.3%	0 0%	26 100.0%
3 (3mstj)	0 0%	50 83.3%	10 16.7%	60 100.0%
<b>Total</b>	<b>6</b> <b>6.7%</b>	<b>74</b> <b>82.2%</b>	<b>10</b> <b>11.1%</b>	<b>90</b> <b>100.0%</b>

**Table 10: Subjective Subtalar Joint Function at 3 Months and 6 Months Post-op**

6mstj - 3mstj		
Wilcoxon signed rank test z value	p	
4.36	.000	< 0.01, HS

**INFERENCE:** Significant improvement in subtalar joint function from 3 months to 6 months post-op.

	Bad(6mtotsc)	Fair(6mtotsc)	Good(6mtotsc)	Total
Bad (3mtotsc)	2 16.7%	10 83.3%	0 0%	12 100.0%
Fair (3mtotsc)	0 0%	10 20.8%	38 79.2%	48 100.0%
Good (3mtotsc)	0 0%	0 0%	30 100.0%	30 100.0%
<b>Total</b>	<b>2</b> <b>2.2%</b>	<b>20</b> <b>22.2%</b>	<b>68</b> <b>75.6%</b>	<b>90</b> <b>100.0%</b>

**Table 11: Total Score (Subjective) At 3 Months and 6 Months Post-op**

6mtotsc - 3mtotsc		
Wilcoxon signed rank test z value	p	
4.90	.000	< 0.01, HS

**INFERENCE:** Significant improvement in total subjective score from 3 months to 6 months post-op.

	Bad (6m omsc)	Fair (6m omsc)	Good (6m omsc)	Excellent (6m omsc)	Total
Bad (3m omsc)	4 7.1%	14 25.0%	26 46.4%	12 21.4%	12 100.0%
Fair (3m omsc)	0 0%	0 0.0%	4 25.0%	12 75.0%	16 100.0%
Good (3m omsc)	0 0%	0 0%	0 0%	18 100.0%	18 100.0%
<b>Total</b>	<b>4</b> <b>4.4%</b>	<b>14</b> <b>15.6%</b>	<b>30</b> <b>33.3%</b>	<b>42</b> <b>46.7%</b>	<b>90</b> <b>100.0%</b>

**Table 12: OMA Score at 3 Months and 6 Months Post-Op**

6m omsc - 3momsc		
Wilcoxon signed rank test z value	p	
5.83	.000	< 0.01, HS

**INFERENCE:** Significant improvement in the OMA scores from 3 months to 6 months post-op.

Olerud and Molander Scores

	Mean	Std. Deviation	change	
3momsc	47.5556	17.92098	34.22000	t = 21.43, p=0.000<0.001, HS
6m omsc	81.7778	16.17221		

Age	Bad (6mtotsc)	Fair (6mtotsc)	Good (6mtotsc)	Total
20 and below	2 25.0% 100.0%	0 .0% .0%	6 75.0% 8.8%	8 100.0% 8.9%
21-30	0 0% 0%	0 0.0% .0%	20 100.0% 29.4%	20 100.0% 22.2%
31-40	0 0% .0%	2 20.0% 10.0%	8 80.0% 11.8%	10 100.0% 11.1%
41-50	0 0% 0%	8 23.5% 40.0%	26 76.5% 38.2%	34 100.0% 11.1%
51-60	0 0% 0%	4 40.0% 20.0%	6 60.0% 8.8%	10 100.0% 11.1%
Above 60	0 0% 0%	6 75.0% 30.0%	2 25.0% 2.9%	8 100.0% 8.9%
<b>Total</b>	<b>2</b> <b>2.2%</b> <b>100.0%</b>	<b>20</b> <b>22.2%</b> <b>100.0%</b>	<b>68</b> <b>75.6%</b> <b>100.0%</b>	<b>90</b> <b>100.0%</b> <b>100.0%</b>

**Table 13: Association between Age and 3<sup>rd</sup> Month OMA Score**

Fishers exact test p=.022, sig

**INFERENCE:** There is a significant association between age and 3<sup>rd</sup> month OMA score with lower age groups having higher scores.

Age	Bad (6m omsc)	Fair (6m omsc)	Good (6m omsc)	Excellent	Total
20 and below	2 25.0% 100.0%	0 .0% .0%	0 .0% .0%	6 75.0% 14.3% 8.9%	8 100.0% 8.9%
21-30	0 0% 0%	0 0.0% .0%	2 10.0% 6.7%	18 90.0% 42.9%	20 100.0% 22.2%
31-40	0 0% .0%	2 20.0% 10.0%	4 40.0% 13.3%	4 40.0% 9.5%	10 100.0% 11.1%

41-50	0 0% 0%	4 11.8% 28.6%	18 52.9% 60.0%	12 35.3% 28.6%	34 100.0% 37.8%
51-60	0 0% 0%	6 60.0% 42.9%	2 20.0% 6.7%	2 20.0% 4.8%	10 100.0% 11.1%
Above 60	2 25.0% 50.0%	2 25.0% 14.3%	4 50.0% 13.3%	0 0% 0%	8 100.0% 8.9%
<b>Total</b>	<b>4</b> <b>4.4%</b> <b>100.0%</b>	<b>14</b> <b>15.6%</b> <b>100.0%</b>	<b>30</b> <b>33.3%</b> <b>100.0%</b>	<b>42</b> <b>46.7%</b> <b>100.0%</b>	<b>90</b> <b>100.0%</b> <b>100.0%</b>

**Table 14: Association between Age and 6<sup>th</sup> Month OMA Score**

Fishers exact test p=.002, HS

**INFERENCE:** There is a significant association between age and 6<sup>th</sup> month OMA score with lower age groups having higher scores.

	<b>Bad (6mtotsc)</b>	<b>Fair (6mtotsc)</b>	<b>Good (6mtotsc)</b>	<b>Total</b>
Complications nil	0 0% 0%	0 .0% .0%	36 100.0% 52.9%	36 100.0% 40.0%
Complications present	2 3.7% 100%	20 37.0% 100.0%	32 59.3% 47.1%	52 100.0% 60.0%
<b>Total</b>	<b>2</b> <b>2.2%</b> <b>100.0%</b>	<b>20</b> <b>22.2%</b> <b>100.0%</b>	<b>68</b> <b>75.6%</b> <b>100.0%</b>	<b>90</b> <b>100.0%</b> <b>100.0%</b>

**Table 15: Association between Presence of Complications and 3<sup>rd</sup> Month OMA Score**

Fishers exact test p=.002, HS

**INFERENCE:** There is a significant association between presence of complications and 3<sup>rd</sup> month OMA score with patients with complications having lower scores.

	<b>Bad (6m omsc)</b>	<b>Fair (6m omsc)</b>	<b>Good (6m omsc)</b>	<b>Excellent (6m omsc)</b>	<b>Total</b>
Complications nil	0 0% 0%	0 .0% .0%	6 16.7% 20.0%	30 83.3% 71.4%	36 100.0% 40.0%
Complications present	2 7.4% 100%	14 25.9% 100.0%	24 44.4% 80.0%	12 22.2% 28.6%	52 100.0% 60.0%
<b>Total</b>	<b>4</b> <b>4.4%</b> <b>100.0%</b>	<b>14</b> <b>15.6%</b> <b>100.0%</b>	<b>30</b> <b>33.3%</b> <b>100.0%</b>	<b>42</b> <b>46.7%</b> <b>100.0%</b>	<b>90</b> <b>100.0%</b> <b>100.0%</b>

**Table 16: Association between Presence of Complications and 6<sup>th</sup> Month OMA Score**

Fishers exact test p=.000<0.001, HS

**INFERENCE:** There is a significant association between presence of complications and 6<sup>th</sup> month OMA score with patients with complications having lower scores.



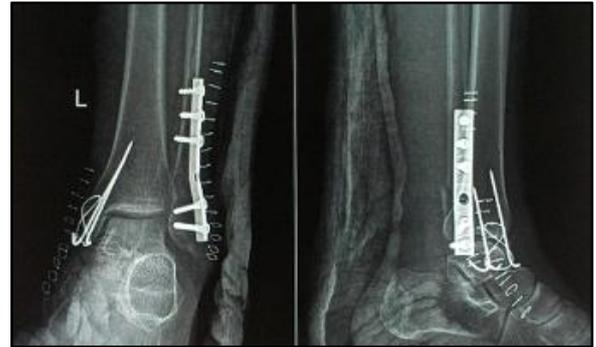
*Pre-op X-ray*



*Pre-op X-ray*



*Post-op X-ray*



*Post-op X-ray*



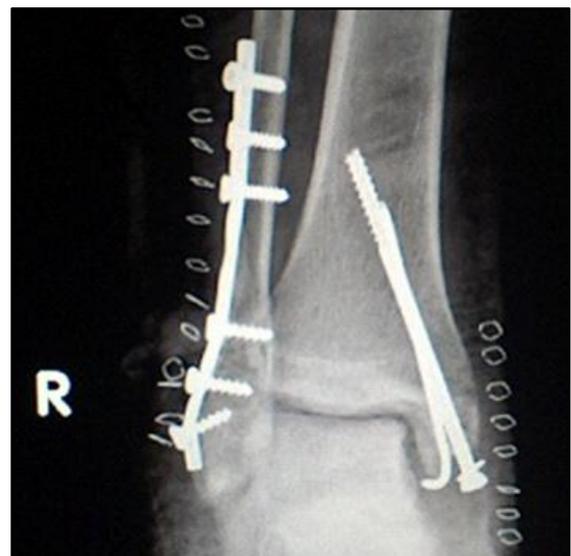
*Pre-op X-ray*



*Pre-op X-ray*



*Post-op X-ray*



*Post-op X-ray*

**DISCUSSION:** The aim of operative treatment for fractures of the ankle is to allow early movement after stable internal fixation. In this prospective randomised study, we have used both subjective and objective methods to assess the functional outcome of the operative treatment of these injuries. The study consisted of 90 patients aged between 17-73 years, of which 34 were females and 56 were males. 36 patients had left ankle fracture, 54 had right ankle fracture, whereas two patients had bilateral involvement.

The most common mode of injury was road traffic accidents. The most common injury pattern seen was supination-external rotation followed by supination-adduction and pronation-external rotation.

The most common modality of fixation for the lateral malleolus was 1/3<sup>rd</sup> tubular plate, and for the medial malleolus was with 4 mm cannulated cancellous screws with washers. Syndesmotic screws were not used in any of the cases.

Kortekangas et al in 2014 in their study compared the functional and radiologic results of syndesmotic transfixation with no fixation in supination-external rotation ankle fractures and found no significant difference in functional outcome or radiologic findings after a minimum follow-up of 4 years.<sup>4</sup> Average duration of hospital stay was 13 days.

In 2011, Hafiz et al conducted a study on 'Ankle Fractures: The operative Outcome' and concluded that operative treatment for ankle fractures results good functional outcome post-operatively, and restores sufficient stability and good mobility of the ankle joint.<sup>5</sup> Egol et al in 2006 conducted a study on short-term functional outcome following ankle fracture surgery and stated that one year after ankle fracture surgery, most patients experience little or mild pain and few restrictions in functional activities.<sup>3</sup> Kumar et al in 1999 described that internal fixation and early mobilisation in displaced ankle fractures are difficult to treat conservatively. However, open reduction and rigid internal fixation affords the most predictable way to carry out an absolute anatomical reduction of fractures. They also noted that displaced ankle fractures should be operated to avoid drawbacks of closed manipulation and for early mobilisation to achieve functional, painless ankle.<sup>6</sup>

Ehrenfreund et al in 2013 studied the results of operative management of ankle fractures 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 metalwork. They recommended that there should not be any delays in treatment, that the reduction is anatomical, that the fracture fixation is satisfactory and that the rehabilitation is commenced early.<sup>7</sup> Schepers et al in 2013 studied the literature regarding the effect of timing of ankle surgery on infectious complications. They recommend that every effort should be made to operate on closed ankle fractures as soon as reasonably possible. A delay in surgery is associated with a significant rise in infectious wound complications, which significantly lowers outcome and patient satisfaction. These fractures should preferably be treated within the first day.<sup>8</sup>

However, in our study, 8 patients had superficial wound infection, which was managed with appropriate antibiotics and dressings. The infection resolved in all cases. Korim et al in 2014 studied patient- and surgery- related risk factors for surgical site infection following open reduction and internal fixation of an ankle fracture. They found that diabetes, nursing home residence and Weber C fractures were significant risk factors for infection. Both superficial and deep infections result in lower functional scores as assessed using the Olerud and Molander Ankle Score.<sup>9</sup>

Our study demonstrated that on followup at 6 weeks, 22 out of 90 patients had persistent swelling and residual pain, 18 patients had only residual pain and 12 patients had only persistent swelling. One patient was found to have loss of reduction, which was attributed to early weight bearing against medical advice. He went on to have a malunion of the fracture and had to undergo a corrective surgery.

This is in concordance with a similar study done by Hong et al in 2014 in which he reported residual pain, swelling and ankle stiffness as the most common complications at 1 year followup.<sup>10</sup> There was a statistically significant improvement in the subjective assessment of pain, walking, activity levels, ankle joint function and subtalar joint function from 3 months post-op to 6 months post-op. However, subjective radiographic assessment failed to show any statistically significant improvement from 3 months post-op to 6 months post-op. Leeds et al in 1984 based on the findings in his series concluded that adequate reduction of syndesmosis is necessary to achieve stable ankle following supination-external rotation, pronation external rotation fractures of the ankle and that the reduction of syndesmosis will be unsatisfactory if lateral malleolus is not well reduced.<sup>11</sup>

Weening et al conducted a study in 2005 on the predictors of functional outcome following trans-syndesmotic screw fixation of ankle fractures. Of 425 ankle fractures treated, 51 fractures had syndesmotic screw fixation. 70% of the injuries were pronation-external rotation and 30% were supination-external rotation injuries. The most common constructs for fixation included lateral plates with syndesmotic screws (45%). At final follow-up, patients achieved good function and quality of life (Mean Olerud and Molander score 74.1). The only significant predictor of functional outcome was reduction of the syndesmosis. They, however, felt 16% of the syndesmotic screws may have been unnecessary.<sup>12</sup>

Tucker et al in 2013 studied the functional outcome following syndesmotic fixation in Weber Type C injuries. Out of 63 patients, 43 underwent screw removal while 20 retained the screws. The 'retained' group scored higher mean Olerud and Molander scores. The authors advocate that syndesmosis screws be left in situ and should only be removed in case of symptomatic implants beyond 6 months postoperatively.<sup>13</sup> Kortekangas et al in 2014 in their study compared the functional and radiologic results of syndesmotic transfixation with no fixation in supination-external rotation ankle fractures with intraoperatively confirmed syndesmosis disruption. 13 patients underwent

syndesmotic screw fixation while 11 did not. The authors found no significant difference in functional outcome or radiologic findings after a minimum follow-up of 4 years.<sup>4</sup> Ali et al in 1987 reviewed 100 consecutive patients over the age of 60 years with unstable ankle fractures. Fifty were treated operatively and fifty non-operatively. The mean follow-up was 7 years. Patient satisfaction with regard to pain, deformity and stability was significantly better in the operated group.<sup>14</sup>

Belcher et al in 1997 conducted a retrospective study on 40 patients who had undergone open reduction and internal fixation of an uncomplicated, closed malleolar fracture. He concluded that the patients had measurable functional impairment 8-24 months post operation when compared with controls, despite adequate treatment and no evidence of degenerative changes.<sup>15</sup>

Makwana et al 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.<sup>16</sup> Bhandari et al in 2004 conducted a prospective observational cohort study to evaluate health-related quality of life in 30 patients with unstable ankle fractures treated operatively. They found that patients experienced significant improvement in all domains of SF-36 questionnaire. Smoking history, presence of a medial malleolar fracture and lower levels of education were significant independent predictors of lower physical function up to 3 months post operation.<sup>17</sup>

Hancock et al 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. They further explained this result by the high percentage of surgical patients who had bimalleolar or trimalleolar fractures.<sup>18</sup> Shivarathre et al in 2011 studied the results of operative fixation for unstable ankle fractures in patients aged over 80 years. The most common fracture pattern was Danis-Weber B type. 86% of the patients were able to return back to their pre-injury mobility at the last followup.<sup>19</sup>

Sanders et al in 2012 conducted a randomised multicentre trial to compare clinical and functional outcomes after operative and non-operative treatment of undisplaced, unstable, isolated fibula fractures and concluded that patients managed operatively had equivalent functional outcomes compared with non-operative treatment; however, the risk of displacement and problems with union was substantially lower in patients managed with surgery.<sup>20</sup> Berkes et al in 2013 examined the impact of articular surface congruity on the functional outcomes of operative treatment of supination-external rotation IV ankle fractures. Post-operative CT scans were used to assess ankle joint congruity. At the time of final follow-up, the group with articular incongruity had a significantly worse Foot and Ankle

Outcome Score with regard to symptoms and activities of daily living. They recommended that surgeons should scrutinise ankle fracture reductions and strive for perfection to allow for the best possible clinical outcome.<sup>21</sup> Hoelsbrekken et al in 2013 in his study compared internal fixation with no fixation of the medial malleolus after open reduction and internal fixation of the lateral malleolus and if needed, the posterior malleolus.

They concluded that non-operative treatment of minimally displaced fractures of the medial malleolus after operative fixation of the fibula yields satisfactory results. However, long-term follow-up is needed due to increased risk of non-union and uncertainty regarding the development of posttraumatic arthritis.<sup>22</sup> Hong et al in 2014 evaluated the clinical and functional outcome of trimalleolar fractures and the ability of patients to return to sporting activities.

In their retrospective study of 31 patients, they found that 11 patients had residual pain, 13 patients had persistent ankle stiffness, 10 patients had swelling at 1 year follow-up. Only 4 patients were able to return to sports. Increasing posterior malleolar fragment size was associated with poorer functional outcomes.<sup>10</sup> Thakore et al in 2014 in their study on ankle fracture and employment: a life-changing event for patients found that ankle fracture patients are likely to suffer high rates of unemployment or disability shortly after their injury. They suggested that improving patient compliance with attendance for rehabilitation may improve employment outcomes.<sup>23</sup>

Ponzer et al in 1999 studied 53 patients with type B ankle fracture who were treated operatively. They found that about 60 percent of the patients had an excellent OMA score and a good clinical outcome. Only a few had radiographic postoperative dislocation or signs of arthritis.<sup>24</sup> Lash et al in 2002 studied 74 patients operated for ankle fractures. At a 2-year follow-up, all fracture types averaged Olerud and Molander ankle scores of 71.1. Lifestyle outcomes were reflected in the patients' ankle function outcomes.<sup>25</sup> Nilsson et al in 2003 evaluated 54 patients, aged 17-64 years, 14 months post-operatively following ankle fractures. The median OMA score obtained was 75. Only 10 of the patients reported complete recovery and 16 scored > 90, indicating good function. They attributed poor results following surgery to insufficient rehabilitation.<sup>26</sup> Syed et al in 2011 studied 12 patients who had Weber type-C injury treated with syndesmosis only fixation.

The treatment plan was followed only if the fibular length could be restored and if the syndesmosis could be anatomically reduced. Through a percutaneous or mini open reduction and clamp stabilisation of the syndesmosis, all but one patient had a single tricortical screw fixation across the syndesmosis. Excellent to good outcomes were noted in 83% of the patients assessed using Olerud and Molander scale.<sup>27</sup>

Hong et al in 2013 evaluated the functional outcome and limitation of sporting activities after bimalleolar and

trimalleolar ankle fractures. At 1-year follow-up most patients gained good function and had good to excellent Olerud and Molander scores. However, out of the 47 patients, 26(55.3%) had residual pain, 29(61.7%) complained of stiffness and 21(44.7%) had ankle swelling. Of the 33(70.2%) patients who were involved in sporting activities prior to the ankle injury, 9(27.3%) were able to return to pre-injury level of sporting activities with no difficulties.<sup>28</sup>

**CONCLUSION:** In this study of 90 patients with ankle fractures who were treated operatively, the following salient findings were noted:

- Operative treatment for ankle fractures results in good functional outcome post-operatively.
- Anatomical reduction of the fracture was associated with better functional outcomes.
- A significant improvement was noted in the ankle function from 3<sup>rd</sup> month to 6<sup>th</sup> month post-op, assessed using subjective criteria as well as the Olerud and Molander Ankle score.
- Age was a significant predictor of the final outcome, with younger patients having a better outcome.
- No significant wound complications were noted.
- The most common late complications reported were persistent swelling and residual pain.

Early treatment without delay, anatomical reduction and fracture fixation, stringent postoperative mobilisation and rehabilitation should help improve outcome in an operated ankle fracture.

**SUMMARY:** 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 causes and 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 3<sup>rd</sup> month to 6<sup>th</sup> month post-op, assessed using subjective criteria as well as the Olerud and Molander Ankle score. Age was a significant predictor of the final outcome with younger patients having a better outcome. Operative treatment for ankle fractures results in good functional outcome post-operatively. Anatomical reduction of the fracture leads to a better functional outcome.

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