

# The outcome of displaced intraarticular fracture of calcaneum: Open reduction and internal fixation with locking plates versus closed reduction and percutaneous K wires fixation

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## ABSTRACT

### Background

The treatment of displaced intraarticular fracture of the calcaneum is challenging because of complicated bony structure, complex fracture anatomy, fragile soft tissue, and difficulty in achieving anatomic reduction and rigid fixation. In this study, we aimed to compare the outcome treatment by percutaneous K wires fixation and locking plate osteosynthesis.

### Method

The prospective study was conducted among patients who were admitted and operated on for calcaneum fractures in the Department of Orthopedics, Shaikh Zayed Postgraduate medical institute Lahore Pakistan from October 2014 to October 2015. Of the 30 cases, half received treatment with K-wire and the other half of the patients underwent plating. Pre- and post-operative Bohler's and Gissane's angles, the width of calcaneums, the height of posterior facet, and complications were noted for all patients. Functional outcome was assessed using the American Orthopaedic Foot and Ankle Society (AOFAS).

### Result

Bohler's angle and posterior facet height increased significantly postoperatively ( $p < 0.05$ ) and Gissane's angle decreased significantly postoperatively ( $p < 0.05$ ) for both groups of patients. In both groups, 80 % of the patients had excellent and good functional rate according to the AOFAS scoring system. The average duration of surgical procedure in plating and of hospital stay was less in the K wires group compared with the plating group.

### Conclusion

There is no significant difference in treating the displaced intraarticular calcaneum fracture with locking plates or percutaneous k wires. Percutaneous k wires treatment method is economical, less invasive, decreases surgical time with a shorter hospital stay.

Keywords: **Intraarticular calcaneum fractures, K wires fixation, locking plate fixation.**

## Introduction

Due to the complicated bony structure, complex fracture anatomy, fragile soft tissue covering, difficulty in achieving anatomic reduction, and maintaining rigid fixation, treatment of DIACF has always been a big challenge<sup>1</sup>. An extended period

of time of rehabilitation may be required before the patient get back to work which has a major impact on the socio-economic level regarding the cost burden is concerned<sup>2</sup>. About 40-85% of patients with DIACF get back to work within 9 months but 20 % are not able to return to work normally

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within a year<sup>3</sup>. Displaced intraarticular fractures of calcaneum treated conservatively has shown poor functional outcomes<sup>4</sup>. Open reduction with plate osteosynthesis of DIACF is the standard treatment<sup>5</sup>. Skin, soft tissue, and cutaneous flat necrosis had been a potential complication in the 30% of the cases operated in the form of ORIF with plate osteosynthesis<sup>6</sup>. To minimize the complications of open procedures, noninvasive percutaneous methods have been advocated. The closed reduction with k wire fixation produces results comparable to the open technique with a lower rate of complication in all types of displaced intraarticular calcaneal fractures<sup>7</sup>. The study has reported no remarkable difference between treating the DIACF with CRIF with percutaneous k wires and ORIF with plate osteosynthesis with smaller wounds, less soft tissue problems, economical and easier with k wires<sup>8</sup>. However pin tract infections, inadequate joint reduction, dislocation of fragments and post-operative stiffness has been reported as major problems with a patient treated with percutaneous k wires<sup>9,10</sup>.

## Materials and methods

This comparative study of 30 cases was performed in Shaikh Zayed Postgraduate Medical Institute at the Department of Orthopedics from October 2014 to October 2015.

The prospective participants were counseled and only those who consent to be placed in either of two categories were included in the study. The technique being performed on each category was decided at random by the lottery method. There were two study groups i.e. Group A and Group B each consisting of 15 patients. In group A "open reduction and internal fixation with locking plate" was carried out and in group B closed reduction with "percutaneous K wires fixation" was carried out.

Subjects of any sex between the age group between 18-60 years were taken for the study. The subject with Sanders II and III fractures with greater than 2 mm displacement and subjects with recent fractures presenting within 2 weeks of injury were included in the study. However, the patient with severe closed soft injury, having an open calcaneal fracture, peripheral vascular disease, diabetic patients, one who has developed a habit of smoking, and a patient who was unfit for surgery based on pre-operative evaluation were excluded

from the study. The functional outcome of the surgery was evaluated by "American Orthopaedics Foot and Ankle Society Hind Foot score (AOFAS)" and was graded as excellent, good, fair or poor.

The data were entered and analyzed in SPSS Version 22. Radiological parameters like "**Bohler's angle, the crucial angle of Gissane, the height of posterior facet of calcaneum width of the calcaneum and articular congruity**" at 12, 16, 20, 24, 30 weeks were described by mean  $\pm$  SD. The comparison between two groups for 30 weeks post-op changes were made using Mann Whitney U-test. For comparison of change within each group, the Wilcoxon sign rank test was used. Procedure duration and hospital stay were compared between two groups by using Mann Whitney U-test. The functional outcome rates and complication rates for both groups were described by using frequency and percentage and for the comparison of this Chi-square test was used. P-value  $\leq 0.05$  was considered significant.

## Results

16 years and 65 years were minimum and maximum age in both the groups with a mean age  $35.7 \pm 10.2$  in GROUP A and  $37.7 \pm 11.1$  in GROUP B. Out of 30 patients, 19 patients were male and 11 patients were female, with male : female ratio was 2:1 and 1.5:1 in Group A and Group B respectively. The fall from a major height was the commonest mode of injury in both groups. Right side was the commonly involved side on both groups. 8 and 9 patients had calcaneal fracture of the left side in group A and group B respectively. Out of 30 patients, 9 were tongue type of fractures and 21 were joint depression type. The ratio of joint depression type to tongue type was 2:1 in open reduction and internal fixation with locking plate and 3:1 in closed reduction with percutaneous K wires fixation group. Out of 30 patients, 20 patients had Sander II fractures and 10 had Sander III fractures. The ratio of Sander II to Sander III ratio were of 2:1 in both ORIF with locking plate group and CRIF with k wire fixation group.

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The normality of data was tested for all quantitative variables like Gissane angle, Bohler's angle, and height of posterior articular facet, the duration for the surgical procedure, and duration of hospital stay. It was noted that the change for angles, width height, and durations was deviating from normality significantly for at least one of the groups and pre or post-op procedure.

	Group	Shapiro-Wilk		
		Statistic	df	Sig.
Bohlar Angle pre-op	Group A	.987	15	.997
	Group B	.964	15	.764
Bohlar angle post-op	Group A	.891	15	.069
	Group B	.795	15	.003
Pre op angle of gissane	Group A	.956	15	.627
	Group B	.970	15	.852
Post op angle of gissane	Group A	.859	15	.023
	Group B	.803	15	.004
Pre op height of posterior facet	Group A	.968	15	.831
	Group B	.952	15	.564
Post op height of posterior facet	Group A	.969	15	.836
	Group B	.973	15	.897
Duration of surgical procedure (minutes)	Group A	.971	15	.866
	Group B	.901	15	.098
Duration of hospital stay (days)	Group A	.864	15	.027
	Group B	.942	15	.414
Difference for Bohlar angle	Group A	.829	15	.009
	Group B	.908	15	.125
Difference for Gissane angle	Group A	.964	15	.768
	Group B	.731	15	.001
Difference for height of posterior facet	Group A	.878	15	.045
	Group B	.947	15	.472

**Table 1: Comparison for pre and post-surgery Bohler's angle within each group**

		Mean	Median	Q1	Q3
Group A	Bohler's angle pre-op	7.5±4.2	7.0	5.0	11.0
	Bohler's angle post-op	30.5±7.2	30.0	27.0	35.0
Wilcoxon Test	Z = -3.41 p-value = 0.001				
Group B	Bohler's angle pre-op	4.7±3.0	5.0	2.0	7.0
	Bohler's angle post-op	31.5±9.4	32.0	30.0	39.0
Wilcoxon Test	Z = -3.41 p-value = 0.001				

**Table 2: Comparison for difference of Bohler's angle after surgery between two groups**

	Mean	Median	Q1	Q3
Group A	23.0±6.8	25.0	21.0	28.0
Group B	26.9±9.3	27.0	23.0	35.0
Mann Whitney U test	Z = -1.68		p-value = 0.092	

**Table 3: Comparison for pre and post-surgery Gissane angle within each group**

		Mean	Median	Q1	Q3
Group A	Gissane angle pre-op	80.7±5.4	80.0	77.0	86.0
	Gissane angle post-op	119.4±7.0	119.0	117.0	122.0
Wilcoxon Test	Z = -3.41		p-value = 0.001		
Group B	Gissane angle pre-op	84.0	84.0	81.0	86.0
	Gissane angle post-op	120.6	125.0	117.0	128.0

**Table 4: Comparison for difference of Gissane angle after surgery between two groups**

	Mean	Median	Q1	Q3
Group A	38.7±10.2	38.0	31.0	47.0
Group B	36.6±12.1	39.0	36.0	42.0
Mann Whitney U test	Z = -0.21		p-value = 0.835	

**Table 5: Comparison for pre and post-surgery height of posterior facet within each group**

		Mean	Median	Q1	Q3
Group A	Height of posterior facet pre-op	45.9±5.1	45.0	42.0	49.0
	Height of posterior facet post-op	48.8±3.6	48.0	46.0	52.0
Wilcoxon Test	Z = -2.20		p-value = 0.028		
Group B	Height of posterior facet pre-op	47.2±5.5	47.0	44.0	50.0
	Height of posterior facet post-op	49.3±3.8	50.0	46.0	52.0
Wilcoxon Test	Z = -2.16		p-value = 0.024		

**Table 6: Comparison for difference of posterior facet height after surgery between two groups**

	Mean	Median	Q1	Q3
Group A	2.9±4.3	5.0	-2.0	6.0
Group B	2.1±5.6	1.0	-2.0	5.0
Mann Whitney U test	Z = -0.69		p-value = 0.512	

**Table 7: Comparison for pre and post-surgery width of calcaneum in each group**

		Mean	Median	Q1	Q3
Group A	Width Pre-op	46.27±4.83	47.00	43.00	49.00
	Width post-op	41.47±2.00	42.00	40.00	43.00
Wilcoxon Test	Z = -3.21		p-value = 0.001		
Group B	Width pre-op	45.40±3.38	45.00	43.00	48.00
	Width post-op	42.60±1.92	43.00	41.00	44.00
Wilcoxon Test	Z = -2.47		p-value = 0.014		

**Table 8: Comparison for difference of width in calcaneum after surgery between two groups**

	Mean	Median	Q1	Q3
Group A	4.80±4.02	4.00	2.00	7.00
Group B	2.80±3.63	2.00	.00	6.00
Mann Whitney U test	Z = -1.42		p-value = 0.157	

**Table 9: Comparison of duration of surgical procedure between two groups**

	Mean	Median	Q1	Q3
Group A	76±11	75	70	85
Group B	25±4	25	21	26
Mann Whitney U test	Z = -4.68		p-value < 0.001	

**Table 10: Comparison for duration of hospital stays between two groups**

	Mean	Median	Q1	Q3
Group A	8.4±2.2	9.0	6.0	10.0
Group B	4.9±1.9	5.0	3.0	7.0
Mann Whitney U test	Z = -3.59		p-value < 0.001	

**Table 11. Complications in Patients in Both Groups**

Complications	Group A (15)		Group B (15)	
	No. of patients	Percentage	No. of patients	Percentage
Superficial infection	1	6.67	0	0
Pin tract infection	0	0	2	13.33
No infection	14	93.33	13	86.67

**Table 12: Comparison of AFOAS scoring rate in two groups**

Grade	Group A (15)		Group B (15)	
	No. of patients	Percentage	No. of patients	Percentage
Excellent	3	20	2	13.3
Good	9	60	10	66.67
Fair	2	13.33	2	13.33
Poor	1	6.67	1	6.67
Chi-square = 0.25		P-value = 0.96		

## Discussion

The common mechanism of injury is fall from a major height<sup>1,12</sup> which accounted for 83% of the fractures in our study.

In our study male: female ratio of patients was 1.71:1. In literature male to female ratio in DIACF is reported to be 2.4:1<sup>13</sup>, male outnumbering the female patients consistent with our study.

Ages ranged from 16-65 years with the majority of patients were from the 3<sup>rd</sup> to 4<sup>th</sup> decade of life. O

Farrel et al.<sup>14</sup> had similar results. In our study, there was no case of bilateral calcaneum fracture and all were unilateral fractures and most of them were right-sided. In a series reported by O Farrel et al.<sup>14</sup>, 80 percent of the fractures were unilateral and the majority of them were right-sided.

61% of the intraarticular fractures of calcaneum are depression type<sup>15</sup>. In our study 70% of the fractures were joint depression type according to Essex Lopresti classification.

According to sander classification, in our study, 67 %(20 cases) were Sander II and 33%( 10 cases) were of Sander III. Prad et al.<sup>16</sup> reported a series of 21 patients of DIACF treated with ORIF with plate, 71%(15 cases) were of Sanders II and 29%(6 cases) were of Sanders III. Similarly, Cao et al.<sup>17</sup> reported 33 cases of calcaneal fractures treated locking plate with minimally invasive technique, 60.61% of cases were Sanders II and 39.39 % were Sanders III.

In our study, there were significant improvements in Bohlers angle, angle of Gissane, the height of posterior facet, and width of calcaneum in both the groups treated with ORIF with locking plate and CRIF with percutaneous fixation Kirshner wires. However, the difference in change between the two groups was insignificant. Li et al.<sup>8</sup> compared DIACF using CRIF with k wires versus ORIF with AO locking calcaneal plates and found no remarkable

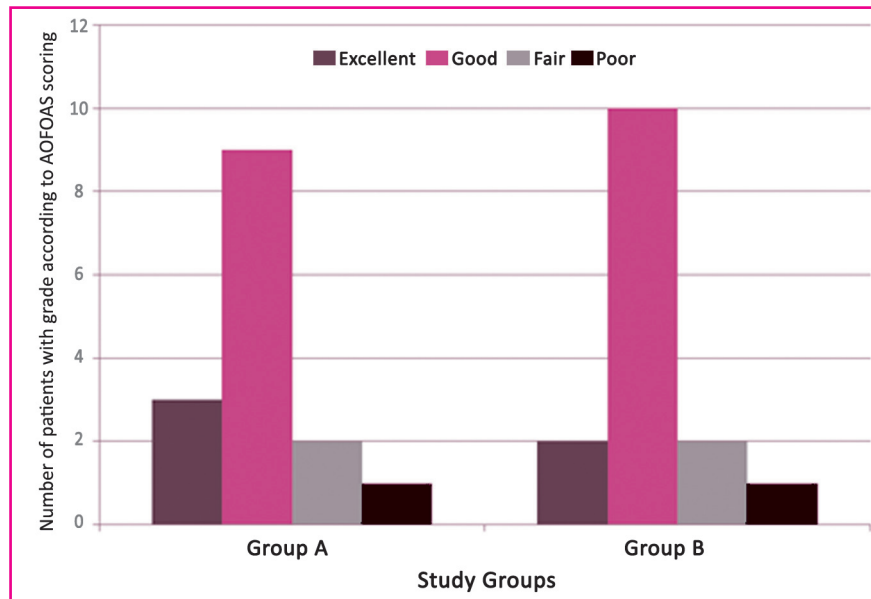


Figure 1: Bar diagram showing number of patients with grade according to AOFOAS scoring

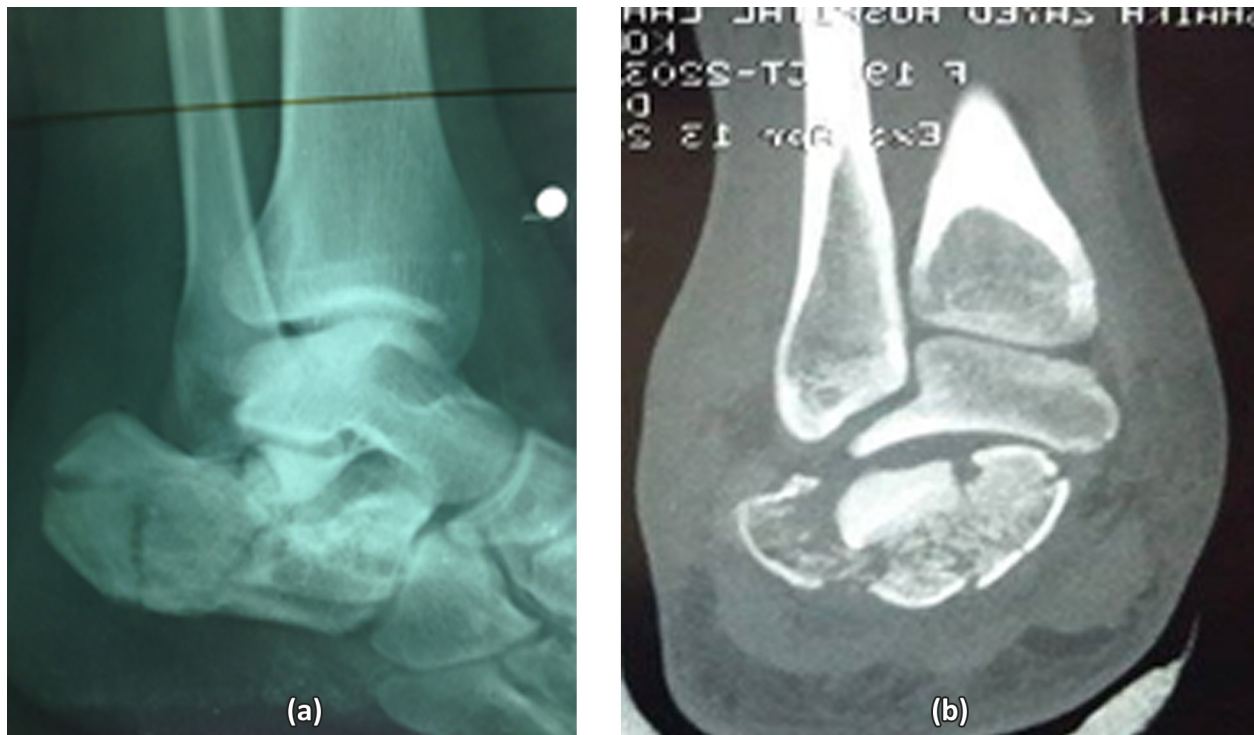


Figure 2: a, b: Preoperative X-ray, Preoperate CT scan

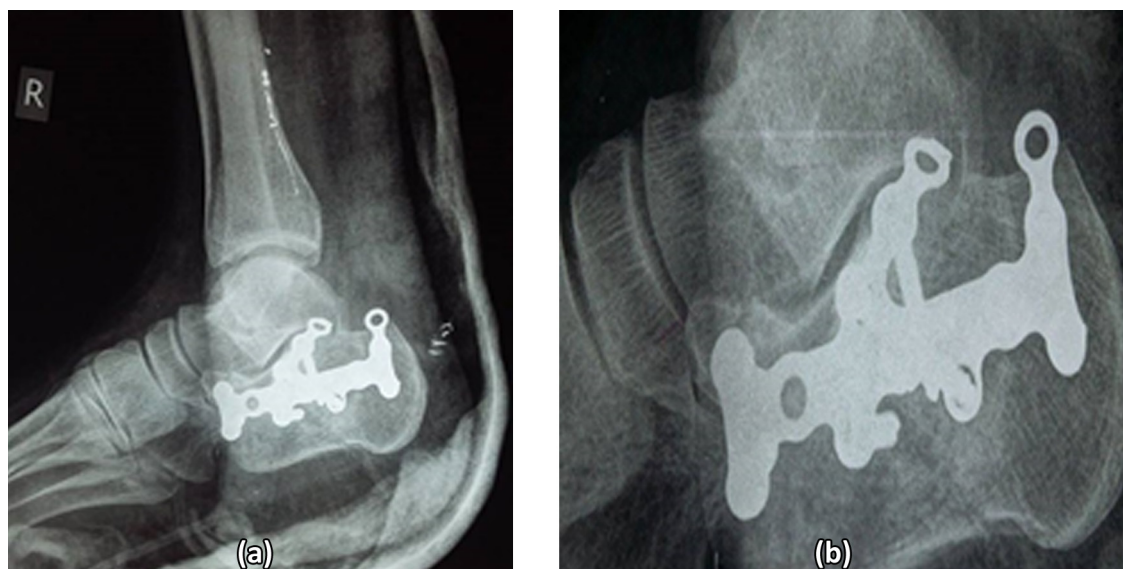


Figure 3: a, b: first op day, 30<sup>th</sup> week

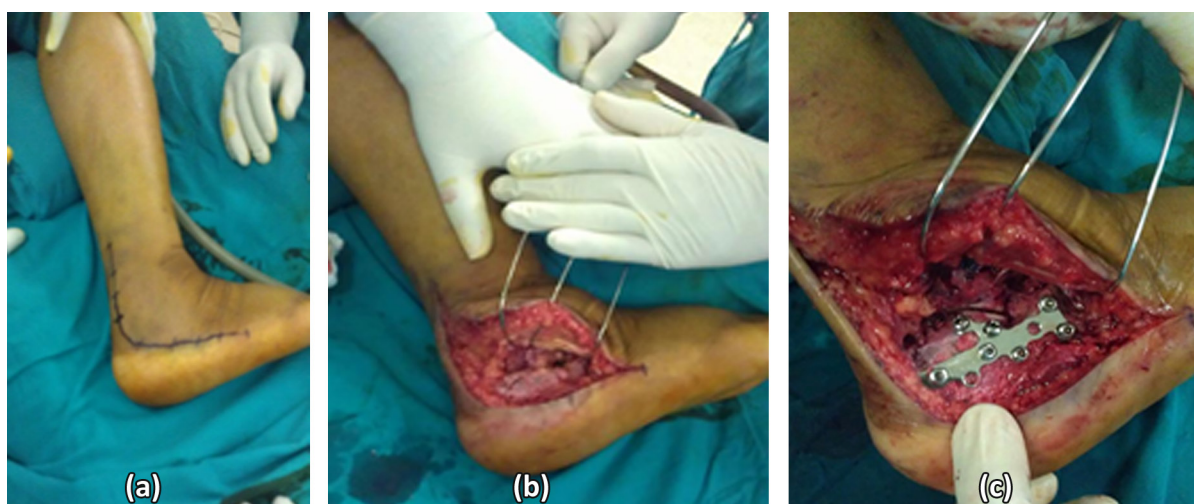


Figure 4: a, b, c - Marking of incision, exposure, application of plate

difference in treating the DIACF with either plates or k wires.

Cao et al.<sup>17</sup> reported 33 cases of calcaneal fractures treated locking plate with minimally invasive technique, there was a significant improvement in Bohler's angle, gissane angle, and functional outcome(AOFAS scoring)(  $p < 0.001$ ).

Sena et al.<sup>18</sup> in his prospective study of 12 cases of DICAf treated with CRIF with K wires found that Bohler's angle were reduced to almost normal and patient were early ambulatory to return to their normal work.

In our study, the meantime for surgical procedure in ORIF with plate osteosynthesis and CRIF with k wires group were  $76 \pm 11$  minutes and  $25 \pm 4$  minutes respectively which significantly better in K

wire group ( $p < 0.001$ ). Koski et al.<sup>19</sup> retrospectively analyzed the soft tissue complications after ORIF of DIACF and the risk factors responsible for these complications in 148 operated patients. He suggested that a longer duration of surgery seems to have a relationship with the post-operative severity of soft tissue complications.

Similarly in our study, the patient treated with CRIF with k wire had significantly lesser hospital stay compared to the open reduction internal fixation group. This could possibly reduce the economic burden of hospital stay in patients.

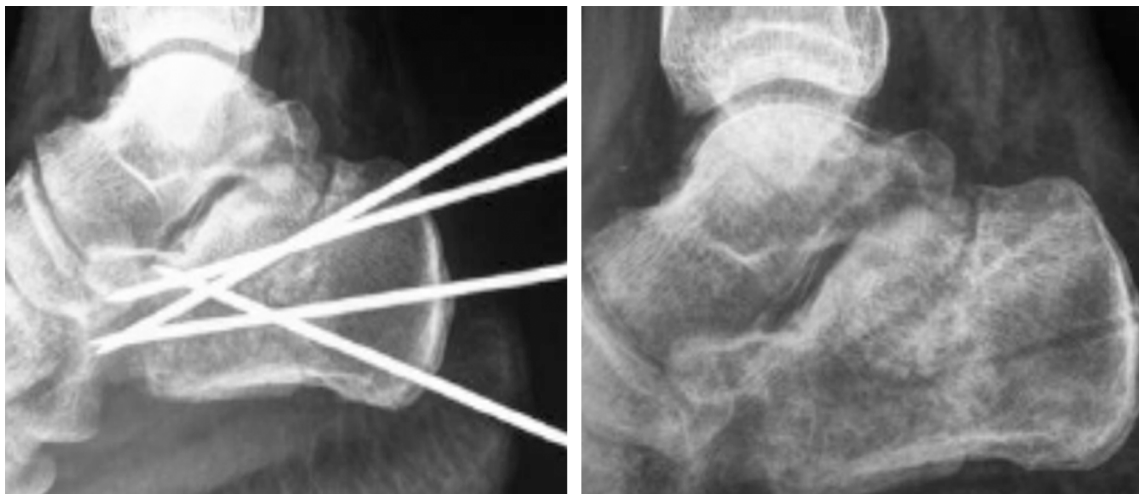
Backs et al.<sup>20</sup> in a retrospective cases series of 191 patients to evaluate the postoperative wound infections following ORIF of DIACF with extended lateral approach found that post-operative infection



Figure 5: a, b, - Pre op x-ray. Pre-operative CT scan



Elevation of posterior facet with schanz pin



12<sup>th</sup> week

30<sup>th</sup> week

was seen in 25 %(47 patients) cases. Superficial and deep infection was seen in 21 cases (11%) and 26 cases (13.6%) respectively.

Infection and wound edge necrosis were seen in 23 cases and 12 cases among which 20 cases required operative management for the soft problem in a retrospective study by Koski et al.<sup>19</sup> to evaluate the soft tissue complications after ORIF with plate in displaced intra articular fractures.

Sena et al.<sup>18</sup> treated 12 patients of DIACF with CRIF with K wires. Only case had superficial pin tract infection. However, superficial infection was seen only in one case. In our study group treated with ORIF with locking plate, which settled with antibiotics, and dressing. In other group treated CRIF with K wires, two cases had superficial pin tract problems, which settled daily pin tract care and antibiotics. Neither of any patients had wound necrosis nor did any cases require any surgical intervention for soft tissue management. In our study, we operated only after the soft swelling had subsided and fracture blisters had healed. Proper attention was given during elevating the full thickness flap during the surgery through an extended L approach. Patients had very close follow up and were repeatedly advised for the pin tract care. This possibly explains the low rate of infection in our study.

In our study, good and excellent functional outcome was seen in 80% of patients, 13.33% had fair outcome and 6.67% had a poor outcome in the group treated with ORIF with locking plate. In other groups treated with k wires, 80% of patients had good and excellent function outcomes, 13.33% had fair outcomes and 6.67% had a poor outcome. No significant difference between the two groups was seen.

In a study by Li et al.<sup>8</sup> to compare 81 DIACF using CRIF with k wires versus ORIF with AO locking calcaneal plates found that there were no significant statistical differences in functional scoring in two treated group. In group treated with AO locking plate, AOFAS score was 49 to 100, average score was 87.5. The functional outcome was excellent and good in 81.6 and in group treated with k wires, the AOFAS ranged from 75 to 100, 90.6 on average. The excellent and good rate was 87.8 %.

Schepers et al.<sup>21</sup> retrospectively studied 61 cases of DIACF treated CRIF with k wires fixation found that good to the excellent functional outcome was seen

in 84% of the patients and favored the results for percutaneous technique in treating the DIACF with the open surgical technique.

Walder et al.<sup>22</sup> in his study of 67 patients with DIACF treated with closed reduction and percutaneous fixation with k wires found that Bohler's angle was restored in 70% of patients. Almost two-third of the patients had very good functional outcomes.

Locking plates cost considerably higher than k wires, and plated patients had a longer hospital stay than their k wire counterparts raising the eventual cost of treatment. Follow-up of the patients can be made possible by proper explanation of the nature of injury and operative procedures, possible complications, rehabilitation programs, and expected time of removal of splintage and fracture union. Interpersonal communication is very vital to gain the confidence of the patients and either the postal address or telephone number of the patients are important for obtaining desired follow-up and proper data collection.

## Conclusion

Both locking plate osteosynthesis and k wiring procedures in intraarticular calcaneal fracture treatment give an appreciable improvement in Bohler's angle, Gissane angle a height of posterior facet and width of the calcaneum. The changes for these three measures are insignificantly different between the two procedures. Infection rates and functional outcomes were also not different between the two procedures. Shorter procedure duration and hospital stay, and lesser cost of implants weighed favorably towards k-wire than the open fixation method.

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