



A COMPARATIVE STUDY OF OPERATIVE MANAGEMENT WITH CONSERVATIVE MANAGEMENT OF CALCANEUM FRACTURES

Orthopaedics

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ABSTRACT

Background Calcaneal fractures account for approximately 2% of all fractures, with displaced intra-articular fractures comprising 60% to 75% of these injuries¹. Studies in fracture patterns, soft-tissue management, and outcomes of calcaneal fractures have led to the debate on the optimal management of calcaneal fractures. Several Prospective randomized studies have shown equivocal outcomes with operative and nonoperative treatment. However, recent trends in the literature suggest that restoration of physiologic parameters of length, height, and alignment of the calcaneus may lead to better long-term results. Initial studies using extensile approaches showed higher rates of wound complications with operative treatment; however, recent studies have shown lower complication rates with sinus tarsi and other minimally invasive techniques. Regardless of the mode of treatment, calcaneal fractures are associated with numerous complications and guarded outcomes with significant long-term morbidity.

Objectives

1. To comparatively study the functional outcome of calcaneum fracture when treated conservatively with that of operative management
2. To study complication when treated conservatively with that of operative management

METHODS Study was conducted in Department of Orthopedics, Basaveshwara Teaching and General Hospital, Kalaburagi. 30 patients with 30 calcaneum fracture were included in the study. Outcome of conservative and operative management was compared using Creighton Nebraska health foundation scoring system. Pre treatment and post treatment (at follow up) Bohler's angle was also compared. Chisquare analysis and paired t test was done to compare the results of conservative and operative management. **RESULTS** Restoration of the Bohler's angle was better with operative management as compared to conservative management. Functional outcome for type I fractures was better with conservative management. For type II and type III functional outcome was relatively better with operative management for type IV fractures the outcome was significantly better with operative management. A significant correlation was seen between the post treatment Bohler's angle and C-N scores.

Interpretation & Conclusion Conservative management has better functional outcome for undisplaced fractures. Where as displaced and comminuted fractures anatomical reduction and restoration of Bohler's angle is very important. Bohler's angle has a prognostic importance and correlates well with the functional outcome.

KEYWORDS

Calcaneum fracture; conservative; operative; Bohler's angle; C N Score.

INTRODUCTION

Fractures of the calcaneus remain among the most challenging for the orthopedic surgeon. Calcaneal fractures account for approximately 2% of all fractures, with displaced intraarticular fractures comprising 60% to 75% of these injuries¹.

Calcaneal fractures are most commonly the result of a high energy motor vehicle crash or a fall from a height. Ninety percent of calcaneal fractures occur in men between 21 and 45 years of age, with the majority being in industrial workers; thus, the economic implications of this injury are substantial.

The controversy between the operative and nonoperative interventions remains ongoing subsequent analysis and other related publications has pushed the pendulum towards the surgical option².

More high level research is needed for accurate determination of operative exposures, techniques, instrumentations and other parameters are ideal.

The advent of CT scan provides information regarding size and number of fracture fragments, sustentaculum displacement relative to the superomedial fragment, posterior facet congruity, lateral malleolus impingement on the tuberosity³ and hence a newer classification system with prognostic significance.

Classification

Calcaneal fractures initially classification based on conventional radiographs but posed difficulties in planning treatment. Nowadays CT based classifications, treatment has improved.

ESSEX-LOPRESETI (1952)⁴:

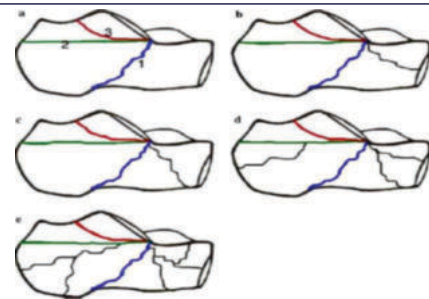


Fig 1: Essex- Lopresti Classification. Line 1 represents primary shear fracture, Line 2 – secondary compression fracture giving the tongue fragment, Line 3- secondary compression fracture of the joint depression type.

Tongue Type Fracture: The articular fragment remain attached to the tuberosity fragment.

Joint Depression Type:

The articular fragment was separate from the adjacent tuberosity.

Shoeur And Remy (1975): Based on the number of articular bony fragments.

First Degree: Undisplaced shear type fractures with separation of joint surfaces .

Second Degree: Includes secondary fracture lines and a minimum of three

fragments, of which two should include the articular surface.

Third Degree: Highly comminuted fractures.

Crosby And Fitzgibbons

- **TYPE I** - Undisplaced
- **TYPE II** - Displaced
- **TYPE III** - Comminuted

Sanders (ct Based)⁵

This classification refers to intra-articular fractures and was developed in 1993 after following 120 patients for a minimum of 1 year. It utilizes the axial and coronal hindfoot CT cuts. The planes of Reconstructions are the semicoronal (perpendicular to posterior facet) and the axial (parallel to the sole of foot). The cut showing the widest part of the undersurface of the posterior facet of the talus is taken into consideration and this is divided into three equal columns by two lines (A & B).

Another line C that is drawn from the medial edge of the posterior facet of the talus, divides the corresponding calcaneus from the sustentaculum. Thus the entire calcaneus is divided into four segments: lateral, central, medial and sustentaculum segments. Four types of fractures are then described according to the number and location of the fracture fragments (fig 2).

Type I-

Undisplaced fractures with less than 2mm displacement regardless of fracture lines.

Type II-

Two part fractures of the posterior facet. Based on the location of the primary fracture line. It is further divided into three types IIA, IIB, IIC.

Type III-

Three part fractures of the posterior facet. Usually centrally depressed fragment further its divided into three types based on the primary fracture line. Types IIIAB, IIIAC, IIIBC.

Type IV-

Highly comminuted 4 parts articular fragment. Often had more than four articular fragments Universally Sander classification is most commonly used. In our study we have followed sanders for planning our treatment.

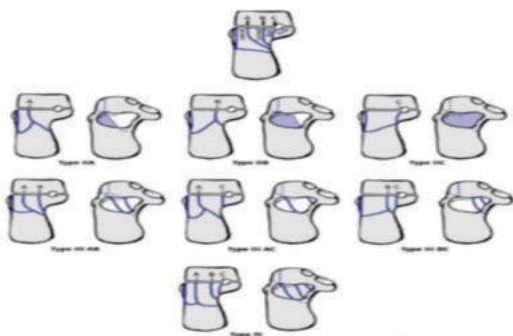


Fig 2: Sander's classification.

Mechanism Of Injury

Calcaneal fractures with intra-articular involvement and displacement can occur due to high velocity injury which usually is due to fall from height. In this mode of injury the patient's weight is concentrated on the heels on axial loading. Other modes of injuries like high velocity injuries are due to motor vehicle accidents. Axial load injuries are associated with spine and pelvic injuries. The pattern of comminution and the location of the fracture lines are dependent on the position of foot at the time of impact, the forces of impact and bone quality.

According to Carl et al two primary fracture lines were consistently observed. One line divided the calcaneus into medial and lateral portions. The other fracture line divided the calcaneus into anterior and posterior portions, starting laterally from angle of Gissane running medially. These two fracture lines resulted in a variety of tongue and joint depression type fractures.

METHODOLOGY

This study was done to evaluate and compare the results of conservative with operative management for calcaneus fractures on basis of subjective, clinical and radiological criteria.

Inclusion Criteria

1. Patients with isolated calcaneus fracture
2. All patients within the age group of 16 to 60 years, all gender

Exclusion Criteria

1. Open fractures and Soft tissue compromise for open reduction and internal fixation
2. Medically unfit patient like patients with stroke, paralysis, poliomyelitis.

This study was a prospective research, conducted from 1st of March 2021 to 31st of August 2022, on 30 patients who had been diagnosed with 30 intra-articular fractures of calcaneus.

These patients were treated at the Department of Orthopedics at Basaveshwara Teaching and General Hospital in Kalaburagi, affiliated with M.R Medical College Kalaburagi. The study included newly diagnosed intra-articular calcaneus fracture. The patients were evaluated clinically and through imaging every two weeks, as well as six months after the start of treatment, using appropriate assessment tools.

When patients were first seen after the injury, a comprehensive history was taken, including information on the time and cause of the injury, as well as any relevant past medical history, particularly diabetes and smoking.

During the physical examination, special attention was given to whether the fracture was open or closed, signs of severe swelling, fracture blisters, indications of compartment syndrome, and any other related injuries.

Routine laboratory tests were conducted as needed. The diagnosis was confirmed through anteroposterior (dorsoplantar), lateral and axial radiographs. CT scans were also done to examine the fracture pattern, the displacement of fracture fragments, the degree of comminution, and to categorize the fracture using Sanders classification. Bohler's angle was also measured. Out of 30 fractures, 15 were managed conservatively and 15 were surgically managed.

Patients under conservative group were initially placed in a below-knee cast, only if there was no significant swelling. If there was swelling, it was first reduced through methods such as elevating the limb, applying ice packs, and taking anti-inflammatory medication before the cast was applied. Patients were instructed to use crutches while walking. The cast was removed after 6 to 8 weeks, and the healing of the fracture was evaluated through X-rays. Once the fracture has joined, patients were advised to start bearing partial weight on the limb, which was gradually increased until they could bear full weight.



Fig 3: Below knee cast

The main reason for surgical intervention in this case was when a displaced fracture occurs within the joint of the subtalar bone, causing misalignment and a decreased Bohler's angle. The specific technique used for reduction and fixation will depend on the type of fracture, the surgeon's expertise, any other injuries present, and the patient's ability to pay for the procedure. This surgery was performed through closed reduction within the first 48 hours of injury or through open reduction and fixation, as long as the patient's wound was healing well and the surgery was performed within 3 weeks of injury. The ultimate goal of the surgery was to restore the joint to its normal alignment and achieve a congruent subtalar joint.

Among the surgical group which consisted of 15 patients 5 patients underwent CRIF with CC screw, 6 underwent ORIF with Reconstruction plate with CC screw and 4 underwent ORIF with Calcaneum anatomically countered locking compression plate.

Pre-operative planning:

Then the affected limb's X-ray was taken, once the diagnosis was confirmed radiologically below knee PoP slab was applied and limb was kept elevated. Routine investigations were done which included CBC, PT INR, RFT, LFT, Serum Electrolytes, Urine Routine, Blood Grouping, HIV, HBsAg, RBS, ECG, Chest X-ray, X-ray calcaneum AP and axial view, CT-Foot with ankle. Preparation of the part was done on the day of surgery. Prophylactically Tetanus Toxoid injection and intravenous analgesics were given and intravenous antibiotics were given if required to all patients pre-operatively.

Surgical procedures:

The duration from the date of injury to date of surgery ranged from 2-6 days, average was 4 days.

Anaesthesia:

All the cases were operated under sub-arachnoid block.

Surgical Procedure:

CRIF with CC screw

Surgical technique

Under the action of sub-arachnoid block the patient was placed prone on the operating table.. The ankle and foot were scrubbed thoroughly with betadine 7.5% and 10% solution, painted with betadine 10% solution and draped under aseptic precaution.

Under the guidance of fluoroscopy stab incision was taken over the calcaneal tuberosity two guide wires were inserted in such manner that fracture would get compressed when screw fixed through them. Self-tapping 6.5 mm partial threaded CC screw was inserted after drilling. Reduction was confirmed under fluoroscopy.

Post Operative care and rehabilitation

Post operatively below knee slab applied, at 4 weeks slab was removed, ankle movements were initiated with non weight bearing. Complete weight bearing was started after union was seen radiologically.

Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoringsystem score and measurement of Bohler angle

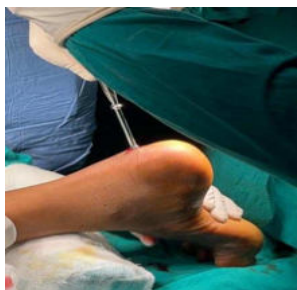


Fig 4: 6.5mm CC screw fixation



Fig 5: C-arm image with both 6.5mm

ORIF with Reconstruction plate with CC screw

Surgical Technique

Under the action of sub-arachnoid block the patient was placed lateral on the operating table.. The ankle and foot were scrubbed thoroughly with betadine 7.5% and 10% solution, painted with betadine 10%

solution and draped under aseptic precaution. Among the 6 patients 4 were approached through sinus tarsi approach and 2 through extensile lateral approach

In sinus tarsi approach incision made in line with the tip of the fibula and the base of the 4th metatarsal, extensor digitorum brevis retracted cephalad to expose sinus tarsi and posterior facet ,peroneal tendons retracted posteriorly, K-wires inserted for provisional fixation aimed towards the sustentaculum one or two screw are placed lateral-to-medial to engage sustentaculum and support facet one 6.5mm CC screw from posterior-to-anterior to support axial length of calcaneus, 3.5mm reconstruction plate was applied underneath a well developed soft tissue envelope with screws engaging anterolateral and tuberosity fragments. In sinus tarsi approach incision made in line with the tip of the fibula and the base of the 4th metatarsal, extensor digitorum brevis retracted cephalad to expose sinus tarsi and posterior facet ,peroneal tendons retracted posteriorly, K-wires inserted for provisional fixation aimed towards the sustentaculum one or two screw are placed lateral-to-medial to engage sustentaculum and support facet one 6.5mm CC screw from posterior-to-anterior to support axial length of calcaneus, 3.5mm reconstruction plate was applied underneath a well developed soft tissue envelope with screws engaging anterolateral and tuberosity fragments.

In case of lateral approach extensile lateral L-shaped incision made vertical portion in between posterior fibula and achilles tendon horizontal portion in line with 5th metatarsal base. Full-thickness skin, soft tissue, and periosteal flaps were developed peroneal tendons was retracted superiorly lateral calcaneal wall visualized provisional fixation was K-wires and later definitive fixation with plates and screws was done

Post Operative care and rehabilitation

Post operatively below knee slab applied, at 4 weeks slab was removed, ankle movements were initiated with non weight bearing. Complete weight bearing was started after union was seen radiologically.

Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoringsystem score and measurement of Bohler angle

ORIF with Calcaneum anatomically countered locking compression plate

Surgical technique

Under the action of sub-arachnoid block the patient was placed lateral on the operating table.. The ankle and foot were scrubbed thoroughly with betadine 7.5% and 10% solution, painted with betadine 10% solution and draped under aseptic precaution.

Among the 4 patients 3 were approached through extensile lateral approach and 1 was approached through sinus tarsi approach.

Approach was similar to reconstruction group here after reduction was fixed with k- wire later definitive fixation was done with calcaneum anatomically countered plate . two patients had void posterior facet which was filled with ipsilateral autologous bone graft.

Post Operative care and rehabilitation

Post operatively below knee slab applied, at 4-6 weeks slab was removed, ankle movements were initiated with non weight bearing. Partial weight bearing was started after 10-12 weeks and later converted to full weight bearing. Functional and radiological evaluation was done using Criegton Nebrasaka health foundation scoring system score and measurement of Bohler's angle.



Fig 6: Calcaneum plate fixation by sinus tarsi approach.



Fig no 7: Pre and post operative x-ray of right calcaneum fracture treated with ORIF with calcaneum anatomical countered plate



Fig no 8 : Pre and post operative x-ray of right calcaneum fracture treated with CRIF with CC screw



Fig no 9: X-ray showing calcaneum fracture (pre treatment)



Fig no 10: 6 months follow up x-ray post treatment by casting

RESULTS AND OBSERVATION

A total of 30 cases were enrolled in the study 15 cases of intra-articular fractures managed conservatively and 15 cases managed operatively.

Statistical Analysis

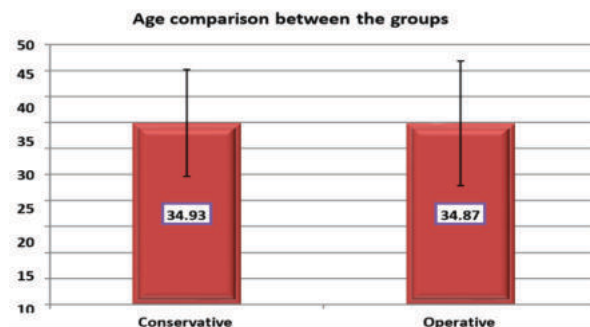
Data were entered into Microsoft Excel and statistical analysis was carried out in SPSS software version 17.0. Comparison of age categories, gender, mode of injury, side involved between the conservative and operative surgical procedure was done with the chi squared test and presented as frequency and percentages. Quantitative variables like Bholer's angle and C-N score between the two study groups were compared with independent t test and were presented as mean (standard deviation).

Pearson correlation was used to find the correlation between the post-Bholer's angle and C-N scores. Bar diagram, pie charts and scatter

plots were used for graphical representation of data. P value of less than 0.05 was considered as statistically significant.

Table-1: Comparison of mean age between the groups

Groups	Number	Mean	SD	Mean difference	P value
Conservative	15	34.93	10.3	0.07	0.98
Operative	15	34.87	12.0		

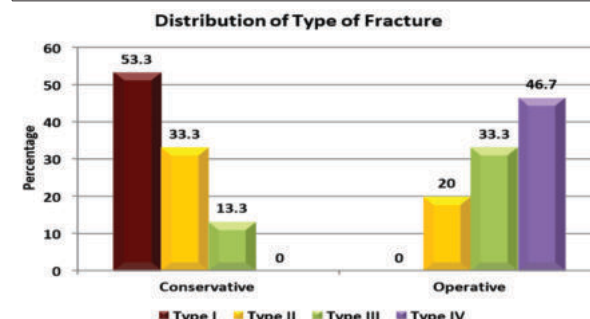


Graph 1: Age comparison in both group Mean age was similar in both group

Table-2: Comparison of Sander's type involved between the groups

Sander's type	Conservative		Operative	
	n	%	N	%
Type I	8	53.3	0	0
Type II	5	33.3	3	20
Type III	2	13.3	5	33.3
Type IV	0	0	7	46.7
Total	15	100	15	100

Chi square p value=0.001 (Significant)



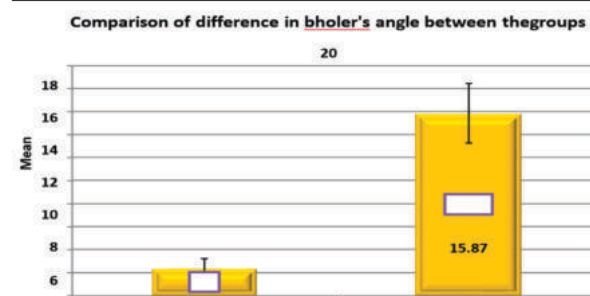
Graph 2: Type of fracture

All type I i.e. undisplaced fractures were treated conservatively. In type II and type III were treated equally. All type IV were treated surgically.

Table-3: Comparison of mean post and pre- treatment Bholer's angle between the groups

Groups	Number	(Post-pre) Bholer's angle	SD	Mean difference	P value
Conservative	15	2.4	0.83	13.47	<0.001
Operative	15	15.87	2.59		

Independent t-test, p value- Highly significant



Graph 3: Pre and Post treatment bholer's angle comparison

There is a statistical significance difference in mean Bohler's angle of operative and conservative group. It shows operative management is better than conservative management for restoration of Bohler's angle.

Table-4: Comparison of C-N scores categories between the groups and sander's types

	Result	Excellent		Fair		Good		Poor		P value
		n	%	n	%	n	%	n	%	
Type I	Conservative	2	25.0	3	37.5	3	37.5	0	-	-
	Operative	0	-	0	-	0	-	0	-	
Type II	Conservative	0	-	4	80.0	1	20.0	0	-	0.07
	Operative	1	33.3			2	66.7	0	-	
Type III	Conservative	0	-	0	-	0	-	2	100.0	0.03
	Operative	2	40.0	0	-	3	60.0	0	-	
Type IV	Conservative	0	-	0	-			0	-	-
	Operative	0	-	2	28.6	5	71.4	0	-	

In our series, with conservative management most of the patients had good outcome(37.5%) with type I fractures excellent(24%) fair (37.5%), fair(80%) and good(20%) outcome with type II fractures, poor(100%) outcome with type III.

In the operative group, among the patients with type II fractures, 2 patients had good result and 1 had excellent result. With type III fracture 3 of them had good and 2 had excellent result and with type IV fracture 5 of them had good results and 2 had fair results.

DISCUSSION

This study is aimed to determine the best method of treatment for calcaneal fractures by comparing the outcomes of surgical and non-surgical management. Two different measures(C N Score and Bohler's angle) were used to evaluate the results and the correlation between them was analyzed. The findings were then compared to previous studies on the same subject

In this study, 30 patients with calcaneum fracture were taken and divided into two groups namely conservative management and operative management group and results were compared on the basis post treatment C N scoring and bohrer's angle which gave favorable results

Kamath et al in their study observed that the mean age in years in conservative group was 35 years and in operative group was 34.9 years⁶. In our study mean age in conservative group was 34.93 and operative group was 34.87.

Patrick Pflüger et al in their study observed that average number of male patients were 55(69.6%) and female patients were 24(30.4%)⁷. In our study the average number of male patients were 24(80%) and female patients were 6(20%).

Ravikumar et al in their study observed that 72% patients had fall from height and other 28% had RTA⁸. In our study 63.35% patients had fall from height and 36.65% had RTA.

Table 5: Comparison between present study and previous ones

	SERIES	YEA R	CAS ES	EXCEL LENT	GOO D	FAIR	POOR
CONSER VATIVE	ROWE	1963	20	22.3 %	48.3%	16.5%	12.4%
	CROSB Y	1993	30	27%	20%	17%	37%
	PRESE NT STUDY	2022	15	13.3%	26.7%	46.7%	13.3%
	SERIES	YEA R	CAS ES	EXCEL LENT	GOO D	FAIR	POOR
OPERAT IVE	ROWE	1963	31	12.9%	51.6%	29.0%	6.5%
	SANDE RS	1992	120	25%	40.8%	10.8%	23.3%
	ZWIPP	1992	90	16.4%	44.7%	32.4%	6.5%
	PRESE NT STUDY	2022	15	20%	66.7%	13.3%	-

Comparing to other similar series (Rowe⁹, crosby¹⁰) the results of conservative management in the present study showed excellent (13.3%), fair(46.7%), good(26.7%) and poor(13.3%) results. The outcome of surgically managed cases is comparable to the results got in other studies (Rowe⁹, Sanders⁵ and zwipp¹¹) showed good(66.7%), fair(13.3%) and excellent(20%) results.D Makki et al¹² in their study carried out a retrospective review of 47 intra-articular fractures of the calcaneum treated by open reduction and internal fixation in 45 patients by a single surgeon. They concluded that Restoration of Bohler's angle was associated with a better outcome and that prompt osteosynthesis should be considered for intra-articular fractures of the calcaneum in order to restore the shape of the hindfoot. Our study shows that there is statistically significant difference in pre and post treatment Bohler's angle in operative group in comparison to conservative group. Our study shows that restoration of the Bohler's angle is possible with operative management with p value being <0.001.

Paul et al¹³ in their study assessed the long-term results after operative and non-operative treatment of undisplaced and displaced calcaneal fractures. They reviewed 70 patients at an average period of 6.5 years. They concluded that Patients with undisplaced calcaneal fractures had a good outcome. Those with displaced fractures treated surgically who presented at follow-up with a BA >10° had a satisfactory functional outcome and those with displaced fractures who had non-operative treatment had a poor outcome. The poorest outcome was consistently seen in patients who were treated operatively without restoration of BA. They also concluded that BA has a prognostic importance. Our research found a strong relationship between the post-treatment Bohler's angle and C-N score in the operative treatment group, and a moderate correlation in the conservative group. Overall, there is a good correlation between these two factors that is statistically significant.

Complications

- In operative group two cases had superficial infection which was detected within first 2 weeks postoperative period and it healed within 4 weeks time after regular follow up dressings and antibiotics.
- In operative group two cases had terminal restriction of range of motion
- In conservative group two cases went into sub-talar arthritis and were advised for ankle arthrodesis.
- Henceforth in our study there were no complications like non union, implant failure, re-fracture.

CONCLUSION

- In the conservative treatment group, the functional outcomes for undisplaced fractures are better when compared to those of displaced fractures.
- Surgically managed displaced and comminuted fractures tend to have a comparatively improved functional outcome compared to conservative treatment, provided the Bohler's angle is restored.
- The goal of treating displaced and comminuted calcaneal fractures is to achieve an anatomical reduction and restore Bohler's angle. This is typically achieved through surgery i.e. CRIF/ORIF. The post reduction Bohler's angle is a predictor of functional outcome.
- From this study we conclude that the Sanders type I fracture managed conservatively had better functional outcome, in case of Sanders type II and type III fractures that were managed operatively had better functional outcome than those managed conservatively considering the restoration of the Bohler's angle and all the Sanders type IV fracture that were treated surgically had good functional outcome.

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