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Original Research Article

Correlation of Bohler's Angle and Functional Outcome of Surgically Treated Displaced Intra-Articular Calcaneus Fractures

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Abstract:

Introduction: With controversy still existing over the functional significance of Bohler's angle, the study aims to evaluate the correlation of post-operative Bohler's angle in predicting the functional outcomes of intra-articular calcaneus fracture

Material & Methods: 37 displaced intra-articular fractures were selected. Fractures were classified as per Sander's Classification. All the patients underwent operative intervention. The post-operative Bohler's angle were determined on lateral radiographs. Patients were kept on routine follow-ups. American Orthopaedic Foot and Ankle Society (AOFAS) score was calculated at final follow up of 1 year.

Results: We obtained Excellent results in 4, good in 19, fair in 10 and poor in 4 patients. The post-operative Bohler's angle had significant correlation with final AOFAS hind foot score.

Conclusion: Surgical restoration of Bohler's angle to near normal range is of utmost significance to obtain better functional outcomes.

Keywords: AOFAS score, Sander's Classification

Introduction

Fractures of calcaneum account for 65% of tarsal injuries [1,2,3]. Most (60%-75%) of them are displaced intra articular fractures [1]. These fractures typically are the result of high energy trauma, such as fall from height or motor vehicle accident.

Ninety percent of calcaneal fractures occur in males between age group of 21 to 45 years and common in industrial workers, thus socioeconomic effects are substantial for this fracture [4]. Treatment option ranges from conservative to operative, with the goal of treatment being anatomic reduction, stable fixation and focus on early functional rehabilitation while avoiding soft tissue complications.

Bohler's angle, also called the calcaneal angle or tuber joint angle, is an accepted radiographic parameter utilised in the evaluation and predicting morbidity associated with calcaneus fractures [5]. It is indicated on a lateral radiograph by a line drawn from the highest point of the anterior process of the calcaneus to the highest point of the posterior facet and a line drawn tangential to the superior edge of the tuberosity [4]. The normal value for this angle is between 20° to 40°. It serves as an important diagnostic tool to assess the integrity of the calcaneal articular surface and evaluate the extent of displacement [13]. Various studies have examined the functional significance of restoration of Bohler's angle but yielded mixed results. Many authors have agreed upon the hypothesis that Bohler's angle has a significant role in assessment of functional outcome of displaced intra-articular calcaneal fractures. However, some studies have reported no correlation between the same. The aim of this study is to evaluate the role of restoration of Bohler's angle in predicting the functional outcomes of displaced intra-articular calcaneal fractures managed with internal fixation.

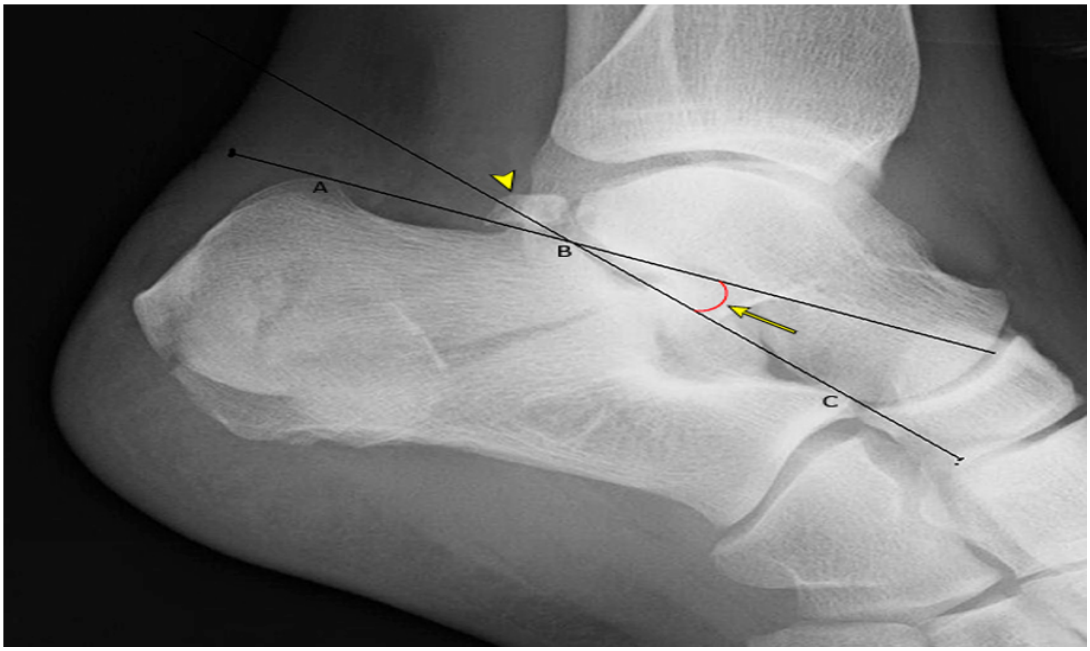

Figure 1: Lateral Radiograph of foot depicting Bohler's angle

Material & Methods

This was a prospective observational study done in Government Medical College, Jammu. All patients who met the following inclusion criteria, over a period from November 2020 to December 2021 were enrolled in the study

Inclusion Criteria:

1. Age > 18 years
2. Displaced Intra articular Fractures
3. Closed calcaneus fractures.

Exclusion Criteria:

1. Open fractures
2. Undisplaced and Extra-articular fractures

Patients with severe medical co-morbidities

Pre-operative screening included lateral and axial radiographs along with CT scan of the involved calcaneus. Lateral radiograph of the opposite calcaneus was obtained as control. All Fractures were classified as per Sander's classification. All patients who fit into our inclusion criteria were treated with operative intervention either by (i) Calcaneal locking plates and screws using extensile lateral approach (ii) Essex Lopressti manoeuvre and CC screws (iii) minimal invasive surgery with percutaneous CC screws fixation. The surgery aimed to achieve anatomic reduction and to restore Bohler's angle. All surgeries were performed by a single team of surgeons. The patients were put on a below knee posterior slab and kept non weight bearing for 8 weeks with mobilisation on crutches. Partial weight bearing was started after 8 weeks and advanced to full weight bearing over a period of 12 weeks. Post-operative radiographs were obtained and Bohler′s angle calculated, by a single observer. Patients were routinely followed up at 6 weeks, 3, 6 and final follow up was completed at 12 months. Functional outcomes were analysed using American orthopaedics foot & ankle society score at final follow-up. The correlation between Bohler′s angle and AOFAS hind foot score and Bohler′s angle was analysed with bivariate correlation (Spearman′s rank correlation).

According to Spearman correlation, rs value in the range of 0.9 to 1.0 is very strong correlation, 0.7 and 0.89 is strong correlation, between 0.5 and 0.69 moderate, 0.3 and 0.49 is moderate to low, 0.16 and 0.29 is weak to low and less than 0.16 is too low correlation [33]. A p-value less than 0.05 were considered statistically significant.

Figure 2: preoperative radiograph of foot showing reduced Bohler's angle

Figure 3: Lateral Radiograph showing Plate fixation

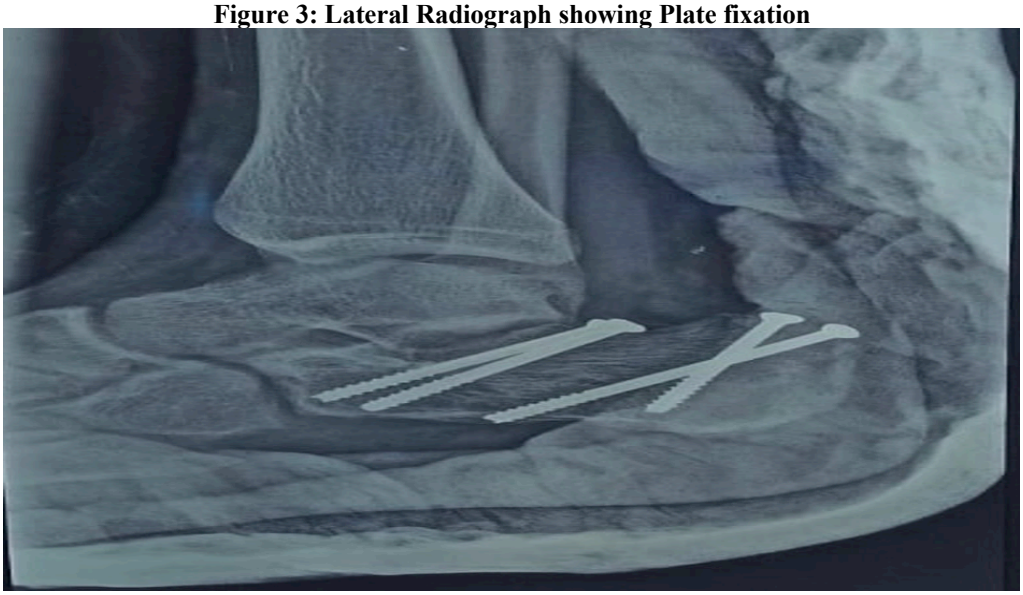

Fig 4 Lateral radiograph showing CC screw fixation

Results

37 displaced intra-articular calcaneus fractures were included in the study. Around 2/3rd of the patients were <40 years of age with male predominance (76 %).

Fall from height was the leading cause of fracture in 86% of the cases. Approximately half (46%) of the fractures were Sander's type III followed by type II (32%) and type IV (22%) injuries. Functional outcome was assessed at final follow up of 1 year using AOFAS score and were classified as excellent, good, fair and poor. We obtained Excellent results in 4 patients, good in 19, fair in 10, and poor result in 4 patients. The post-operative Bohler's angle had a strong positive correlation (rs value=0.87; p value=0.002) with AOFAS hind foot score.

Table 1: Patient Demographics

Observation	Result
Age **(i) < 40 years** **(ii) >40 years**	 **(i) 24** **(ii)13**
Sex **(i) Male** **(ii) Female**	 **(i) 28** **(ii)09**
Mode of trauma **(i) Fall from height** **(ii) RTA**	 **(i) 32** **(ii)05**
Sander's Type **Type II** **Type III** **Type IV**	 **12** **17** **09**

Abbreviation: RTA- Road Traffic Accident

Table 2: depicting Sander's type and AOFAS score

		AOFAS score		
	> 90	**75-89**	**60-74**	**<60**
Sander's type II	3	7	2	
Sander's type III	1	8	3	2
Sander's type IV		4	5	2
Total	4 Excellent	19 Good	10 Fair	4 Poor

Abbreviation: AOFAS- American Orthopaedics Foot and Ankle Society

Discussion

Calcaneus is the most commonly fractured tarsal bone with intra-articular fractures being more common than the extra-articular ones. Historically, most calcaneus fractures have been treated closed but conservative management of these fractures is commonly associated with continuing disabling pain and stiffness.

Consequently, with the better understanding of fracture patterns with 3D computed tomography (CT) scans and modern surgical techniques and hardware, many operative procedures are preferred for the treatment of calcaneus fractures, that includes percutaneous reduction and screw fixation or open reduction internal fixation with reconstruction plates as well as locking anatomical plates. The operative management has resulted in improved outcomes and lowered morbidity associated with these fractures. Various radiographic parameters have been studied in the standard radiographs obtained to evaluate the type as well as severity of calcaneus fractures. Two important angles namely Bohler's angle and Gissane's angle can be drawn on a lateral radiograph. Among them, Bohler's angle is the most commonly studied parameter in predicting the functional outcomes of calcaneus fractures. The Bohler′s angle can be used to guide the fracture reduction intraoperatively. Restoring the Bohler′s angle back to normal range of 20–40 degrees is one of the surgical goals in clinical practice [10], which is one of the important factors to obtain satisfactory results [13,14]. However, evidence that affirms the role of Bohler's angle in predicting the functional outcomes of calcaneus fractures is still inconclusive.

In our study, based on the statistical analysis of the data obtained from 37 patients, we found a strong positive correlation between post-operative Bohler's angle and American Orthopaedics Foot and Ankle Society score similar to the results found by Parmar HV et al, Buckley R et al and Su Y et al which signifies that post-operative Bohler's angle has a significant role in the prediction of functional outcome [17,18,22]. In contrast, studies done by Pozo JL et al, Ibrahim T et al, Letournel E showed no correlation between Böhler′s angle and functional outcomes. [9,12,19]. However, Loucks C et al reported a negative correlation between Bohler's angle and functional outcomes [8]. The drawbacks of the study includes small sample size which leads to selection bias and exclusion of other factors such as reduction quality of posterior articular facet and the restored height and width of

calcaneus, which may possibly affect the functional outcome.

Conclusion

The postoperative Böhler's angle has a significant positive role in predicting the functional recovery. Restoration of Böhler's angle should be an important reduction index during surgical treatment of displaced intra-articular calcaneal fractures, to achieve satisfactory functional outcomes.

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