

FRACTURE CALCANEUM PLATING VS CLOSE REDUCTION

Sachin Gopalrao Saoji¹¹Associate Professor, Prasad Institute of Medical Sciences, Sarai Shahzadi, Banthara, Kanpur Road, Lucknow (U.P). India.

Received : 10/06/2023
 Received in revised form : 15/07/2023
 Accepted : 26/07/2023

Keywords:
 Calcaneal, injuries, fractures, closed reduction.

Corresponding Author:
Dr. Sachin Gopalrao Saoji,
 Email: ssaoji987@gmail.com

DOI: 10.47009/jamp.2023.5.4.419

Source of Support: Nil,
 Conflict of Interest: None declared

Int J Acad Med Pharm
 2023; 5 (4); 2084-2089



Abstract

Background: Calcaneal injuries, a common type of fractures, account for about 60% of tarsal bone defects.^[9] Higher intensity injuries, such as those caused by falls or vehicle accidents, frequently results in calcaneal fractures. Approximately 75% of all calcaneal fractures patients are the intra-articular variety. The tongue and joint depression forms of evacuated intra-articular calcaneal fractures were classified through Essex-Lopresti. Aimed at intra-articular tongue-type calcaneal ruptures, closed reduction is the best option since the fracture block is substantial as well as may be abridged with ease by utilizing expertise in technological aspects. One of the most often utilized least invasive methods is the sinus tarsi route. This study's main objective was to contrast fracture calcaneum plating with close reduction. **Aims and Objective:** To find efficacy between the plating and close reduction in the management of calcaneal fracture. **Materials and Methods:** A retrospective cohort study included 58 patients who received percutaneous cannulated screw (PCS) fixation or minimally invasive longitudinal approach (MILA) after closed reduction for traumatic fracture. Preoperative management, surgical procedures, and post-operative management were the same for both groups. Operative time, hospital stay time, preoperative time, and blood loss were measured, as well as the calcaneus' dimensions and angles. The study aimed to compare the outcomes of PCS and MILA groups. **Results:** The PCS group (13.2 mL) saw less loss of blood than the MILA group (17.9 mL). In comparison to the MILA group, the PCS group's mean OT was shorter (61.2 vs. 85.9 min). The PCS group's mean POT was 1.7 days shorter than that of the MILA group (2.7 days). The major complication seen in PCS and MILA groups is total hind foot pain 7.7% and 9.4% respectively. The total complication rate is higher in MILA (21.9%) compared to PCS (7.7%) group. While the AOFAS hindfoot scores among both groups exhibited an upward trend, the VAS ratings were decreasing. The PCS group's postoperatively VAS scores were lower compared to the MILA group. In the PCS and MILA groups, there were no discernible variations in the AOFAS hindfoot scores at any of the follow-up intervals of 1, 3, 6, and 12 months, as well as at the final follow-up. **Conclusion:** The findings of this study suggest that while plate fixation may be a more effective treatment than screw fixation for calcaneal fractures, PCS fixation may have certain advantages over MILA.

INTRODUCTION

The most frequent tarsal bone damage is called a calcaneal fracture (CF).^[1,2] The person's body experiences injuries in around 2% of cases.^[3,4] The most typical problems of calcaneal fracturing are highly energetic trauma, including higher altitude falls.^[1,5,6], vehicle accidents.^[4], as well as lower power trauma, including traumatic injuries.^[2] A substantial number of calcaneal fracturing happen to young adults during their first years of employment.^[4,7] Due to the persistent pain, the time

it takes to mobilize, the 20% of patients, this trauma has a substantial financial effect on the individual as well as community.^[7,8] because to the lengthy stay in the hospital, the expensive healthcare costs, as well as the extended recovery times for patients who are unable to return to work for up to 3 to 5 years following the accident.

Calcaneal injuries, a common type of fractures, account for about 60% of tarsal bone defects.^[9] Higher intensity injuries, such as those caused by falls or vehicle accidents, frequently results in calcaneal fractures. Approximately 75% of all calcaneal fractures patients are the intra-articular

variety. The tongue and joint depression forms of evacuated intra-articular calcaneal fractures were classified through Essex-Lopresti.^[10] The subtalar joint is penetrated by tongue-like patterns, as well as the subordinate fracture line escapes via the calcaneal tuberosity on the back. The largest tarsal bone, the calcaneus, is in charge of supporting the body.^[2] There is commonly observed irregularity of calcaneal elevation, varus, in addition to a broader heel as a result of the shattered deformity.^[11] A radiographic examination is necessary to evaluate the fractured line as well as compared it with the AO categorization or Sanders categorization.^[3] The Bohler's as well as Gissane's angles are two techniques for calculating aberrant calcaneal height.^[2,11,12]

The Bohler's as well as Gissane's angles of the calcaneum are important determining factor features in the identification, treatment, as well as diagnosis of calcaneal fracturing.^[13] The Bohler angle is measured on the lateral ankle X-ray as the angle generated by the junction of a lines from the behind tuberosity's apex towards the dorsal facet's apex as well as a lines from the subsequent facet's peak towards the front process' apex.^[10] Bohler's angle suggests calcaneus fracture with displacement alterations. The calcaneal fracture, which typically varies from 20° to 40°, was well predicted by the angle of 20°.^[10,11] Gissane's measurements of angles, nevertheless, with a normal angle extending from 120° to 140°.^[6] were immediately subordinate towards the lateral portion of the talus. The Bohler as well as Gissane angle is another effective indicator of the postoperative treatment diagnosis.^[9] Treatment options for calcaneal fractures including intra-articular displacement are discussed.^[1,3,7,8] Compared to conservative treatment,^[7] surgical management is an intrusive technique that may raise the risk of infection.^[5] However, because to the quick recovery time, improved anatomical reduction and significantly reduced time away from work, surgical plating treatment is preferable.^[3,6,14]

An extensible L-shaped wound was used to do unilateral reductions as well as internal fixation is the typical surgical method; however, problems such significant infections causing wound infection, but this may cause a delay often in the wound recovery process happen. Many minimally invasive procedures, such as arthroscopically aided fixation, external fixation, percutaneous fixation, in addition to numerous small slit approaches, have been proposed to reduce the rate of problems.^[14] Aimed at intra-articular tongue-type calcaneal ruptures, closed reduction is the best option since the fracture block is substantial as well as may be abridged with ease by utilizing expertise in technological aspects. One of the most often utilized least invasive methods is the sinus tarsi route. This study's main objective was to contrast fracture calcaneum plating with close reduction.

MATERIALS AND METHODS

Study Design

A retrospective cohort study was conducted on 58 patients who came to the outpatient department of our hospital with a traumatic fracture. The patients who underwent percutaneous cannulated screw (PCS) fixation and then it is plated with a minimally invasive longitudinal approach (MILA) after closed reduction was included in the study. The patients were divided into two groups PCS and MILA group. Preoperative management: The fractures were assessed using preoperative calcaneal radiography, computerized tomography (CT) scans, and three-dimensional reconstructions of the injured foot. The MILA group underwent surgery once the swelling in their hind feet went down, but the PCS group was able to have surgery done right away.

Surgical procedure: Initially, on both ends of the Achilles tendon, two Steinmann pins (3.0 mm) were introduced into the fracture site in the PCS group through the calcaneal tuberosity.

Closed reduction and temporary fixation using two Kirschner wires were accomplished in the MILA group, and then a plate of the appropriate size and location was applied to the lateral surface of the skin of the hindfoot. Via these holes, Kirschner wires (2.0 mm) were inserted into the calcaneus.

Post-operative management: After the surgical procedure, radiography and CT scans of the damaged calcaneus were taken to assess the reductions and fixation. The identical postoperative exercise regimen and rehabilitative procedures were given to the two groups. Two weeks later, all individuals had their sutures removed, and they were told to touch their toes. At 1, 3, 6, and 12 months postoperatively, all patients received standard physical examinations, plain radiographs, and a final follow-up at 27 months. If the patient exhibited symptoms that necessitated implant removals, such as deep infection and posterior heel discomfort that wouldn't go away with medication, the implants were removed.

Operative time (OT), hospital stay time (HST), preoperative time (POT), and blood loss were measured in both groups. POT is the amount of time between the initial injury and the procedure. Using plain radiography, the calcaneus' height, breadth, and length were measured, together with the Gissane's, Böhrer's, and varus or valgus angles. Normal Gissane's and Böhrer's angles are 100° to 130° and 25° to 40°, respectively.

Inclusion and Exclusion Criteria

Included are patients who visited our hospital's outpatient clinic, adhere to the study protocol, & offer their informed consent. Those who consent to take part in the research voluntarily do so. The study did not include patients that failed to adhere to the study protocol, did not complete it, or did not give their consent.

Statistical Analysis

Data entry and statistical analysis were done using ANOVA statistical software. The proper percentage comparisons between the various groups were made using the mean values, standard deviations, and t-tests. Significant data was defined as a P value of 0.05.

Ethical approval

Each patient needed to give written consent before the beginning of the study. The study process has been approved by the Ethical Committee of the concerned hospital.

RESULTS

Table 1 shows the characteristics of the patients included in the study. 58 patients who came to the hospital with traumatic fractures were included in the study, they were divided into two groups PCS and MILA group with 26 and 32 patients in each

respectively. The pCS group had 21 male and 4 female patients with a mean age of 35.9 and a BMI of 22.9. The major cause of traumatic fracture in this group is traffic accidents (16), then due to falls (7). In the MILA group, there are 26 male and 6 female patients with a mean age of 34.1 and BMI of 23.0, with a major cause of traumatic fracture being traffic accidents (20), then due to falls (8). Regarding demographics, the affected foot's side, or the cause of the injury, no discernible differences were discovered between the two groups. The PCS group (13.2 mL) saw less loss of blood than the MILA group (17.9 mL). In comparison to the MILA group, the PCS group's mean OT was shorter (61.2 vs. 85.9 min). The PCS group's mean POT was 1.7 days shorter than that of the MILA group (2.7 days). The major complication seen in PCS and MILA groups is total hind foot pain 7.7% and 9.4% respectively. The total complication rate is higher in MILA (21.9%) compared to PCS (7.7%) group.

Table 1: Comparison of characteristics of patients among PCS and MILA rroup

Characteristics	PCS (n=26)	MILA (n=32)	p-value
Age (years)	35.9 ± 11.2	34.1 ± 10.9	0.657
Gender			0.841
Male	21	26	
Female	4	6	
Body mass index (BMI)	22.9 ± 2.7	23.0 ± 3.2	0.231
Injury mechanism			0.921
Traffic accident	16	20	
Fall from height	7	8	
Others	3	4	
Injury site			0.575
Right	12	18	
Left	14	14	
POT (days)	1.7 ± 0.4	2.7 ± 1/4	<0.001*
HST (days)	1.5 ± 0.5	2.3 ± 0.7	<0.001*
OT (min)	61.2 ± 11.1	85.9 ± 13.3	<0.001*
Blood loss (ml)	13.2 ± 8.5	17.9 ± 10.1	0.045*
Complications			
Wound complications	0	1 (3.1%)	0.507
Sural nerve injury	0	1 (3.1%)	0.507
Superficial infection	0	2 (6.2%)	0.261
Total hind foot pain	2 (7.7%)	3 (9.4%)	1
Total	2 (7.7%)	7 (21.9%)	0.111
Reoperation	1 (3.8%)	3 (9.4%)	0.394

In the PCS and MILA groups, there were no discernible variations in the Böhler's angle, Gissane's angle, varus or valgus angle, calcaneal height, width, and length before, after, or during the follow-up interval. Yet, over the postoperative and follow-up phases, the PCS group's calcaneal breadth was narrower than that of the MILA group (table 2).

Table 2: radiographic assessment of PCS and MILA group

	PCS group	MILA group	p-value
Böhler angle (°)			
Preoperative	11.4 ± 5.2	12.3 ± 7.8	0.59
Postoperative	25.3 ± 3.4	25.3 ± 3.9	0.896
1 month	24.5 ± 3.4	25.3 ± 3.8	0.805
3 months	24.5 ± 3.1	25.2 ± 3.5	0.864
6 months	24.6 ± 3.1	25.3 ± 3.5	0.884
12 months	24.4 ± 2.9	25.2 ± 3.3	0.863
Final follow-up	25.0 ± 2.9	25.3 ± 3.0	0.933
Gissanes angle (°)			
Preoperative	117.1 ± 13.2	121.2 ± 13.2	0.227
Postoperative	123.2 ± 4.7	124.5 ± 5.1	0.362
1 month	122.7 ± 4.3	123.3 ± 5.1	0.586
3 months	122.7 ± 4.6	123.1 ± 5.1	0.921

6 months	122.9 ± 4.5	122.7 ± 5.0	0.912
12 months	122.8 ± 4.3	122.2 ± 4.8	0.597
Final follow-up	122.9 ± 4.3	122.4 ± 4.9	0.374
Calcaneal width (mm)			
Preoperative	45.9 ± 4.9	44.6 ± 3.2	0.252
Postoperative	43.7 ± 4.6	41.5 ± 3.4	0.014*
1 month	44.4 ± 4.8	41.5 ± 3.3	0.006*
3 months	43.6 ± 4.4	41.5 ± 4.7	0.021*
6 months	44.1 ± 3.8	41.5 ± 4.4	0.008*
12 months	44.1 ± 4.7	48.3 ± 4.8	0.534
Final follow-up	49.3 ± 5.7	48.4 ± 4.2	0.378
Calcaneal length (mm)			
Preoperative	83.1 ± 5.8	81.6 ± 5.4	0.561
Postoperative	84.4 ± 5.8	82.6 ± 6.4	0.437
1 month	82.7 ± 4.1	80.9 ± 5.3	0.147
3 months	82.4 ± 4.5	80.7 ± 5.6	0.095
6 months	83.9 ± 5.6	81.6 ± 6.4	0.063
12 months	83.6 ± 5.4	80.9 ± 5.4	0.098
Final follow-up	83.3 ± 5.4	81.3 ± 5.7	0.115
Calcaneal height (mm)			
Preoperative	43.3 ± 5.2	42.4 ± 3.2	0.25
Postoperative	50.3 ± 4.3	48.5 ± 3.3	0.016*
1 month	49.7 ± 4.4	47.9 ± 3.5	0.25
3 months	50.2 ± 4.3	48.2 ± 3.3	0.116
6 months	49.6 ± 3.5	48.0 ± 4.3	0.375
12 months	49.4 ± 4.5	48.2 ± 4.8	0.534
Final follow-up	49.3 ± 5.8	48.5 ± 4.2	0.378
Varus (+) or valgus (-) (°)			
Preoperative	3.7 ± 2.7	4.6 ± 3.2	0.107
Postoperative	2.4 ± 2.7	2.5 ± 1.5	0.112
1 month	2.6 ± 2.4	2.7 ± 1.5	0.184
3 months	2.9 ± 1.5	2.9 ± 1.5	0.294
6 months	2.8 ± 1.9	2.9 ± 1.9	0.288
12 months	2.8 ± 2.4	3.0 ± 1.6	0.223
Final follow-up	2.9 ± 2.4	3.0 ± 1.6	0.274

Table 3 shows the functional outcomes in both the groups. While the AOFAS hindfoot scores among both groups exhibited an upward trend, the VAS ratings were decreasing. The PCS group's postoperatively VAS scores were lower compared to the MILA group. In the PCS and MILA groups, there were no discernible variations in the AOFAS hindfoot scores at any of the follow-up intervals of 1, 3, 6, and 12 months, as well as at the final follow-up.

Table 3: Outcome measures of PCS and MILA

	PCS group	MILA group	p-value
VAS			
Preoperative	6.6 ± 1.0	6.8 ± 0.9	0.651
Postoperative	5.2 ± 0.5	5.7 ± 1.1	0.004*
1 month	3.5 ± 1.2	2.7 ± 1.1	0.154
3 months	0.8 ± 0.9	1.0 ± 1.0	0.202
6 months	0.5 ± 0.8	0.7 ± 0.8	0.148
12 months	0.4 ± 0.8	0.6 ± 0.8	0.148
Final follow-up	0.4 ± 0.6	0.4 ± 0.8	0.452
AOFAS			
1 month	63.5 ± 6.8	62.1 ± 7.9	0.281
3 months	75.5 ± 7.7	73.5 ± 7.4	0.823
6 months	85.7 ± 8.2	84.3 ± 9.2	0.543
12 months	89.2 ± 6.1	89.0 ± 5.9	0.463
Final follow-up	90.8 ± 6.8	88.6 ± 7.0	0.106

DISCUSSION

A potential analysis of 20 individuals through migrant intra-articular fractures was conducted as well as reported by Nair et al. in 2017. Twenty calcaneal fractures in 24 patients, total, were nominated at random as well as secured with plating, such as a locking calcaneal plate. The majority of the 20 fractures were on the right side. The incidence of subtalar arthritis is reduced through

open reduction as well as internal fixation of displaced intra-articular calcaneal fractures through locking calcaneal plate. Although conservative therapy was once regarded as the gold standard, internal fixation is becoming more popular and has outstanding results. If there is substantial edema or the development of fracture blisters, operation aimed at calcaneus fractures should be postponed, preferably aimed at 10–14 days. Based on the findings of our little study, we draw the conclusion

that opens reduction as well as internal fixation through a bolting calcaneal plate is an appropriate therapeutic selection through a positive post-operative prognosis aimed at displaced calcaneal fractures.^[15]

Retrospective research was conducted on 77 patients who had calcaneal fractures of the intra-articular tongue category by Cao et al. in 2022. There were no discernible variations between the two groups' calcaneal height, length, Gissane's as well as Böhler's angles, VAS scores, AOFAS hind foot scores, otherwise difficulty rates over the course of the follow-up. However, the PCS group's postoperative VAS scores were considerably lower than those of the MILA group ($p < 0.05$) than those of the latter. Moreover, the PCS group's OT, POT, and HST were noticeably shorter than those in the MILA group's ($p < 0.05$). The PCS group experienced less blood loss than the additional group ($p = 0.044$). The MILA group, nevertheless, experienced much less postoperative calcaneal widening than the PCS group ($p < 0.001$) did. When treating tongue-type calcaneal fractures with closed reduction, PCS fixation outperformed MILA in terms of OT, POT, HST, blood loss, soreness, in addition to level of comfort. The benefit of MILA, meanwhile, is that it can restore calcaneal breadth. The two techniques shown comparable ability to sustain the closure decrease while participating in the same rehabilitation programme.^[16]

A case series of plating process was examined and explained by Pradana et al. in 2022. From December 2020 to July 2021, we cared for six patients who had calcaneal fractures repaired surgically, primarily by one surgeon. The Sanders classification is used to categorise calcaneal fractures. Four individuals in this study are over the age of 40, and two are under the age of 25. Bohler and Gissane angles ranged from 8° to 65° and 134° to 158° , respectively, preoperatively. All six patients underwent surgical plating. Clinical examination utilizing the AOFAS score produced satisfying performance for all those undergoing calcaneal plating operation. Three participants indicated AOFAS score fair range results with the smallest value of 88%, while three patients recorded AOFAS score outstanding ranging benefits between 95% and 99%. The majority of the participant's Bohler as well as Gissane angles returned to normal values following surgical plating, according to the radiological results. According on the Bohler & Gissane angles, the calcaneal plating approach leads to an improved decrease in anatomical size. These findings indicate that, according to the AOFAS score, anatomical decrease can enhance clinical outcomes. Consequently, an intra-articular calcaneal fractures can be successfully treated using the plating technique.^[17]

In their analysis and investigation of locking plate fixation for intra-articular calcaneum fractures, Salunke et al. (2014). The appropriate reduction of intra-articular fragments during open reduction and plating fixation constitute the surgical therapy of

calcaneum fractures. Intra-articular fractures have been fixed using locking plate methods. For the therapy of displaced intra-articular calcaneal fractures, the locking plate fixation offers a quick as well as effective fixation. With the open reduction as well as internal fixation approach with locking plates, calcaneal injuries can be reduced more effectively therefore allow for earlier mobilisation.^[18]

Mustafa et al. (2018) examined the functional results and complications of surgically treating calcaneal fractures. 26 calcaneal fractures were present in 24 patients overall. The study included 24 individuals (22 unilateral and 2 bilateral), through a mean follow-up of 18 months, a mean age of 35.41 years (range 18-60 years), 3 (12.5%) female patients, as well as 21 (87.5%) male patients. The most frequent cause of wound was a fall from an elevation in 23 (95.8%) of the patients, followed by a traffic accident in 1 (4.16%). Three patients suffered spinal injuries that were related. According to the Maryland foot score, 25% of patients had excellent outcomes, 62.5 % had good results, No of the patients who are experiencing negative outcomes. Synovitis, widening, and superficial infection are all complications. Sanders Type II/III as well as IV and joint depression type are best treated with ORIF, which restores articular congruity through a small profile locking plate. Uniform Sanders Type IV, which was believed towards be connected through subpar outcomes, had a successful consequence in the shorter period. More than 90% of patients can achieve good or exceptional results with the usage of optimal surgical scheduling, procedure, as well as beneath sterilized safeguard while avoiding most problems. Hence, ORIF should be promoted in these patients.^[19]

CONCLUSION

The findings of this study suggest that while plate fixation may be a more effective treatment than screw fixation for the recovery of calcaneal width after closed reduction for tongue-type calcaneal fractures, PCS fixation may have certain advantages over MILA in terms of shorter operative time, less blood loss, shorter time between injury and surgery, shorter time between surgery and discharge, and lower postoperative VAS scores. The two approaches were found to have similar effectiveness in maintaining reduction under the same rehabilitation program. However, the study had several limitations that must be considered when interpreting the results. Firstly, the study was a single-center retrospective cohort study with a small sample size, which may have introduced selection bias and limited the generalizability of the findings. Further multicenter randomized controlled trials with larger sample sizes are necessary to confirm the results of this study. Secondly, the follow-up

duration was relatively short, which prevented the assessment of long-term complications such as subtalar arthritis. Future studies should include longer follow-up periods to evaluate the long-term outcomes of the two approaches. Finally, errors in patient records during follow-up may have led to trial errors and affected the accuracy of the results. In conclusion, the findings of this study suggest that while plate fixation may be a more effective treatment than screw fixation for calcaneal fractures, PCS fixation may have certain advantages over MILA. However, the limitations of this study highlight the need for further research to confirm these findings and to evaluate the long-term outcomes of the two approaches. Clinicians should consider these findings when deciding on the optimal treatment approach for patients with tongue-type calcaneal fractures.

REFERENCES

1. H.G. Kulkarni, V.S. Mane, K.L. Gaonkar, et al., Plating for intra-articular calcaneal fractures... Is it an overkill? *J. Clin. Orthop. Trauma* 6 (3) (2015) 153–159.
2. M. Galluzzo, F. Greco, M. Pietragalla, et al., Calcaneal fractures: radiological and CT evaluation and classification systems, *Acta Biomed.* 89 (2018) 138–150.
3. N. Gusic, I. Fedel, N. Darabos, et al., Operative treatment of intraarticular calcaneal fractures: anatomical and functional outcome of three different operative techniques, *Injury* 46 (2015) S130–S133.
4. C.B.G. Leite, R.S. Macedo, G.H. Saito, M.H. Sakaki, K.E. Kojima, T.D. Fernandes, Epidemiological study on calcaneus fractures in a tertiary hospital, *Rev. Bras. Ortop. (Engl. Ed.)* 53 (4) (2018) 472–476.
5. S. Meena, S.K. Gangary, P. Sharma, Operative versus non-operative treatment for displaced intra-articular calcaneal fracture: a meta-analysis of randomized controlled trials, *J. Orthop. Surg.* 24 (3) (2016) 411–416.
6. D. Gülabi, F. Sari, C. S, en, et al., Mid-term results of calcaneal plating for displaced intraarticular calcaneus fractures, *Ulus Travma Acil Cerrahi Derg.* 19 (2) (2013) 145–151.
7. S. Baliga, A. Sutherland, J. Bruce, Surgical versus conservative interventions for displaced intra-articular calcaneal fractures, *Cochrane Database Syst. Rev.* (2010);(1).
8. P. Mq, N. Ja, Long-term functional outcomes after operative treatment for intra-articular fractures of the calcaneus, *J. Bone Joint Surg. Am.* 91 (8) (2009);1854–1860.
9. Atkins R.M., Allen P.E., Livingstone J.A. Demographic features of intra-articular fractures of the calcaneum, *Foot Ankle Surg.* 2001;7:77–84.
10. Bremner A.E., Warrick C.K. Fractures of the calcaneus. *J. Fac.* 1951;2:235–241.
11. D.O. Lee, J.H. Yoo, D.W. Son, D.H. Kim, Is the Bohler angle reliable for operative reduction of calcaneus fracture? *J. Orthop. Sci.* 24 (3) (2019) 521–525.
12. J.D. Isaacs, M. Baba, P. Huang, et al., The diagnostic accuracy of Böhler's angle in fractures of the calcaneus, *J. Emerg. Med.* 45 (6) (2013) 879–884.
13. R. Ramachandran, S. Shetty, Assessment of Bohler's and Gissane's angles of the calcaneum in a group of South Indian population – a radiological study, *J. Curr. Res. Rev.* 7 (15) (2015) 17–20.
14. S.T. <collab>R B R M</collab>, Operative compared with non-operative treatment of displaced intra-articular calcaneal fractures: a prospective, randomized, controlled multicenter trial, *J. Bone Joint Surg. Am.* 84 (10) (2002);1014–1019.
15. Nair V, Herode P, Chaudhary A, Desouza C, Sharma K. Management of calcaneum fracture in adults treated with plating. *Indian Journal of Orthopaedics.* 2017;3(4):398-401.
16. Cao Y, Xu X, Guo Y, Cui Z, Zhao Y, Gao S, Tian Y, Lv Y, Zhou F. Percutaneous cannulated screw fixation vs. plating with minimally invasive longitudinal approach after closed reduction for intra-articular tongue-type calcaneal fractures: a retrospective cohort study. *Frontiers in Surgery.* 2022;9.
17. Pradana AS, Mustamsir E, Breilyan S, Putra DP, Phatama KY, Hidayat M. Plating technique outcome evaluation in calcaneal fracture based on American orthopaedics foot and ankle score and Böhler-Gissane angle: A case series. *International Journal of Surgery Case Reports.* 2022 May 1;94:107131.
18. Salunke AA, Vachalam D, Menon PH, Saseendar S, Junhao T, Singh G. Locking plate fixation for intra-articular fractures of the calcaneum. *International Surgery Journal.* 2014;1(2):64-7.
19. Mustafa SM, Hwaizi LJ. Outcome of Treatment of Displaced Intra-articular Fracture Calcaneus by Plate and Screws. *Open J Orthop Rheumatol.* 2018;3(1):012-9.