MAK HILL Publications Research Journal of Pharmacology

Review Article
doi: 10.36478/makrjp.2024.3.1.6

OPEN ACCESS

Key Words
Functional outcome, Intra articular, calcaneum fracture, plate fixation

Corresponding Author
Sanjeev Kumar Gupta,
Department of Orthopaedics, MGM Medical College Vashi, Navi Mumbai, Maharashtra, India

Author Designation
[1]Associate Professor
[2,3]Assistant Professor

Received: 15 July 2024
Accepted: 18 August 2024
Published: 20 August 2024

Citation: Sanjeev Kumar Gupta, Devendra Kommuru and Shravan Singh Rajput, 2024. A Study of Functional Outcome of Intra Articular Calcaneum Fracture Managed Surgically with Plate Fixation . Res. J. Pharm., 18: 1-6, doi: 10.36478/makrjp.2024.3.1.6

A Study of Functional Outcome of Intra Articular Calcaneum Fracture Managed Surgically with Plate Fixation

[1]Sanjeev Kumar Gupta, [2]Devendra Kommuru and [3]Shravan Singh Rajput

[1-3]Department of Orthopaedics, MGM Medical College Vashi, Navi Mumbai, Maharashtra, India

Abstract
Intra-articular calcaneal fractures pose a substantial orthopaedic issue because of its intricate nature and the crucial function of the calcaneus in foot mechanics. These fractures, known as intra-articular fractures of the calcaneus, typically happen due to severe trauma, such as falls from significant heights or motor vehicle collisions. The complex structure of the calcaneus and its connection to the subtalar joint provide significant difficulties in treating these fractures. Complications arising from the impact on the subtalar joint commonly include persistent pain, joint stiffness and post-traumatic arthritis. These issues can significantly impair a patient's mobility and overall quality of life. It is crucial to address intra-articular calcaneal fractures well in order to recover function and prevent long-term impairment.

INTODUCTION

Approximately 70-80 percent of all calcaneal fractures are classified as intraarticular fractures, which have generally been associated with less than optimum functional outcomes. The management of these fractures remains a subject of controversy, with persuasive arguments presented for both conservative and surgical interventions. There is a current dispute over the efficacy of non-operative versus operative treatment. The lack of standardised outcome measures has further hampered the comparison of studies evaluating treatment outcomes[1,2].

The anticipated functional results of surgically treating intra-articular calcaneal fractures using plate fixation primarily aim to restore the patient's capacity to carry out routine tasks, alleviate discomfort, and enhance mobility. Below is a concise overview of the main anticipated outcomes:

Surgical fixation is performed to realign and restore the proper positioning of the calcaneus and subtalar joint. This procedure helps to decrease aberrant stress on the joint and prevent the development of post-traumatic arthritis, ultimately reducing chronic pain. Consequently, patients generally undergo a substantial decrease in chronic pain, particularly in comparison to non-operative treatment[3-7].

Range of Motion: One of the main objectives of surgery is to reinstate the typical biomechanics of the foot. Frequently, this leads to enhanced mobility, namely in the subtalar joint, which is vital for traversing uneven terrain. While there may still be some stiffness, particularly in more severe fractures, the overall mobility is typically superior compared to conservative treatment.

Functional Capacity: By achieving superior pain management and enhanced joint functionality, patients can anticipate the ability to resume the majority of their everyday activities. This include tasks such as ambulation, maintaining an upright posture, and, in certain instances, resuming participation in athletic or other strenuous endeavours.

Plate fixation enables prompt resumption of normal function by providing secure fixation, which permits quicker weight-bearing in comparison to non-operative treatments. Early mobilisation is crucial for preventing problems such as muscular atrophy and deep vein thrombosis, and it is essential for achieving faster functional recovery[8].

Greater Likelihood of Returning to Pre-Injury Work Levels: A significant number of patients are able to resume their previous work levels after an accident, especially if their job does not require excessive physical exertion. Surgical fixation facilitates the restoration of foot structure and function, leading to a faster and more comprehensive recovery for professional duties.

Enhanced Quality of Life: A successful surgical procedure generally results in a significant increase in patient contentment as it restores foot functionality, alleviates pain, and enables the resumption of regular activities. Nevertheless, patient satisfaction might be affected by the lack of consequences, such as wound problems or irritation caused by medical devices[9-16].

Potential Hazards: Although the functional outcomes of the procedure are mostly favourable, there are potential hazards involved, including complications with wound healing, infection and discomfort connected to the hardware used. These problems have the potential to impact the overall success of the surgery and the patient's long-term functional prognosis[17-18].

In general, patients with intra-articular calcaneal fractures who undergo plate fixation can expect acceptable functional outcomes. Most patients experience effective pain management, better mobility and a successful resumption of their normal activities and job[19]. Nevertheless, the outcome of the operation relies on many aspects, such as the intricacy of the fracture, the effectiveness of the surgical realignment and the occurrence or non-occurrence of postoperative problems.

MATERIALS AND METHODS

This study was conducted in the Department of Orthopaedics and used a descriptive cross-sectional design. Consent was gained from all participants, both verbally and in writing. The study cohort comprised individuals who were admitted to the institution with a confirmed diagnosis of calcaneal fracture. Upon obtaining authorisation from the appropriate authorities, an examination of hospital data was conducted to identify suitable patients, which included case files, surgery particulars, and discharge summaries. The study involved adult patients aged 18 years and older who had experienced displaced intra-articular calcaneal fractures. These fractures were treated utilising open reduction and internal fixation techniques, specifically utilising calcaneal locking plates and screws. Patients who had calcaneal fractures that were not displaced, complicated fractures, or those who had reduced sensation in their lower limbs were not included.

Exclusion Criteria:

- Patients aged <18 years.
- Patients who has attained menopause.

The preoperative evaluation included acquiring plain radiographs, namely lateral and axial images of the calcaneus, as well as computed tomography (CT) scans. The fractures were categorised according to the CT findings using the Sanders categorisation system. The collected data encompassed patient age, sex, injury mechanism, laterality, fracture type as per the Sanders classification, complications.

Patients were monitored by in-person visits or telephone contact, and the American Orthopaedic Foot and Ankle Society (AOFAS) Hind foot questionnaire was used to evaluate outcomes. This scoring system assesses the intensity of pain and the extent of functional limitations across nine categories. These categories include pain (worth 40 points) and function (worth 50 points), which encompasses factors such as walking distance, walking surfaces, gait abnormalities, sagittal motion, hind foot motion, ankle-hind foot stability, and alignment. The highest score achievable is 100 points, indicating the most favourable outcome. Grades ranging from 90-100 were categorised as excellent, 80-89 as acceptable, 70-79 as fair and anything below 70 as poor.

The researchers used convenience sampling and determined the minimum sample size using the following formula:

The value of n is calculated using the formula $n = Z^2 \times p \times q / e^2$, where Z is the standard deviation, p and q are the probabilities and e is the margin of error. In this case, the value of n is equal to 1.96.The result of the equation $^2 \times 0.02 \times (1\text{-}0.02)/(0.1)^2$ is 7.52.

Z represents the value 1.96 at a 95% confidence interval. p represents the prevalence of calcaneal fractures, which is 2% based on references. q represents the complement of p. e represents the margin of error, which is 10%.

It was discovered that the minimum sample size is 8. Attempts were made to reduce selection bias and interpretation bias. The data were documented on a standardised proforma, assigned codes, and inputted into the Statistical Package for the Social Sciences (SPSS) version 16.0. The data was subsequently processed and analysed utilising fundamental descriptive statistics, which were then presented in the form of percentages and frequencies.

RESULTS AND DISCUSSIONS

Age Distribution:

- **Mean Age:** 46.8 years.
- **Age Range:** 24-65 years.
- **Standard Deviation:** 12.21 years.
- The majority of the patients are middle-aged.

Radiological Union Time:

- **Mean Time:** 14.13 weeks.
- **Range:** 11-17 weeks.
- **Standard Deviation:** 2.23 weeks.
- Most patients achieved radiological union within 12-17 weeks.

AOFAS Score:

- **Mean Score:** 85.53.
- **Range:** 68-95.
- **Standard Deviation:** 8.55.
- The majority of patients achieved good to excellent functional outcomes.

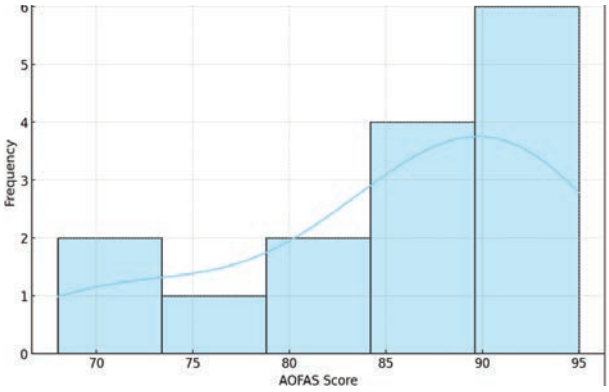

Fig. 1: Distribution of AOFAS Scores

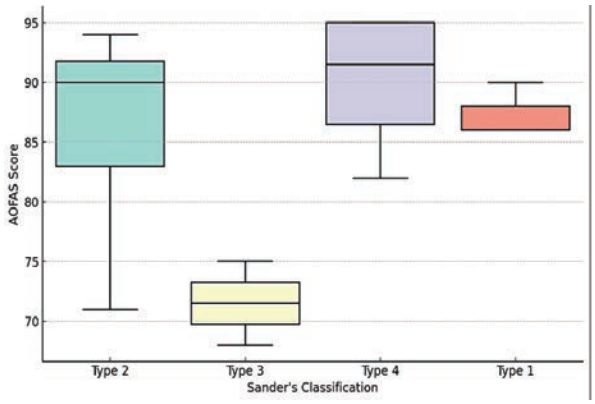

Fig. 2: AOFAS Score by Sander's Classification of Fracture

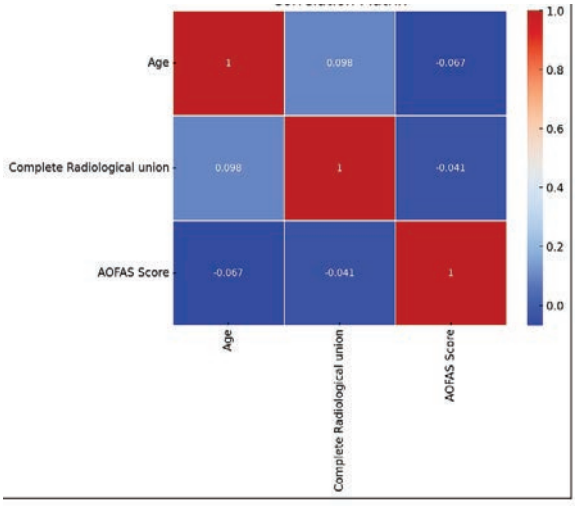

Fig. 3: Correlation Matrix

Table 1: Age distribution

	Age
Count	15
Mean	46.8
Std.	12.20773
Min	24
25%	35.5
50%	46
75%	54.5
Max	65

Master Chart

Serial Number	Age	sex	Side	Mode of injury	Sander's classification of fracture	Complete Radiological union	AOFAS Score
1	34	male	right	RTA	Type 2	11	92
2	45	female	left	RTA	Type 2	13	89
3	36	male	right	RTA	Type 3	12	68
4	24	male	right	RTA	Type 2	14	94
5	45	female	right	Fall from height	Type 4	17	95
6	34	female	right	RTA	Type 1	15	86
7	53	male	right	RTA	Type 4	17	82
8	35	male	left	RTA	Type 2	16	81
9	65	male	left	RTA	Type 2	17	91
10	54	female	right	RTA	Type 3	13	75
11	54	male	right	Fall from height	Type 2	17	71
12	46	female	right	RTA	Type 4	13	95
13	65	male	right	RTA	Type 1	11	86
14	55	male	left	RTA	Type 4	12	88
15	57	male	right	RTA	Type 1	14	90

Correlation Analysis:

- **Age and AOFAS Score:** Slight negative correlation (-0.067), indicating that older age might be slightly associated with lower AOFAS scores, but the correlation is very weak.
- **Radiological Union and AOFAS Score:** Very weak negative correlation (-0.041), suggesting that longer healing time might slightly affect the AOFAS score, but again, the correlation is minimal.

Graphical Analysis:

- **Distribution of AOFAS Scores:**
- The distribution shows a concentration of scores in the higher range (80-95), indicating generally good functional outcomes post-surgery.

AOFAS Score by Sander's Classification:

- The boxplot suggests variability in AOFAS scores depending on the fracture type. For example, Type 2 fractures generally have higher scores, whereas Type 3 and Type 4 show more variability and lower scores in some cases.

Correlation Heatmap:

- The heatmap confirms weak correlations between the variables analyzed, indicating that age and radiological union time have minimal impact on the final AOFAS score.

Calcaneal fractures are the most frequent fractures of the tarsal bones, with intra-articular fractures making up about 75% of all calcaneal fractures. These fractures frequently occur as a result of severe trauma, such as falling from a great height or being involved in a car accident. They are particularly problematic because of the intricate structure of the calcaneus bone and the fact that they affect the subtalar joint, leading to substantial health issues. The management of intra-articular calcaneal fractures continues to be a topic of continuing discussion, with proponents of both conservative and surgical methods. Nevertheless, surgical treatment, namely employing plate fixation, has gained significant popularity due to its goal of restoring the anatomical integrity of the calcaneus and enhancing functional results.

Utilising Plate Fixation for Surgical Management: The standard treatment for fractures within the joint of the heel bone usually requires a surgical procedure called open reduction and internal fixation (ORIF) with the use of plates to stabilise the bone. The main objective of this surgical technique is to re-establish the typical structure of the calcaneus, specifically focussing on restoring the bone's height, width and alignment, as well as ensuring the proper alignment of the subtalar joint. Attaining these goals is essential for reducing the risk of long-term consequences, including post-traumatic arthritis, chronic pain and functional restrictions.

The typical method is a lateral extensile approach, which offers exceptional visibility of the broken pieces and enables precise realignment and stabilisation. Subsequently, a locking device is employed to stabilise the fracture, ensuring firm fixation and facilitating prompt mobilisation. This method is especially beneficial when the fracture is displaced and there is substantial damage of the subtalar joint surface.

Functional Outcomes: Various clinical and radiological parameters can be used to evaluate the functional success of surgically managed intra-articular calcaneal fractures with plate fixation. These factors encompass

pain evaluation, extent of movement, capacity to support weight, resumption of work, and general level of patient contentment. Moreover, functional results are sometimes quantified using particular scoring systems, such as the American Orthopaedic Foot and Ankle Society (AOFAS) score and the Maryland Foot Score.

Discomfort and Movement: A major issue that often arises after calcaneal fractures is the presence of enduring discomfort, namely in the subtalar joint. Studies have demonstrated that utilising plate fixation in surgical management can effectively decrease pain levels in comparison to nonoperative treatment. Surgical intervention to restore joint congruity and alignment is effective in lowering aberrant joint loading and minimising the likelihood of post-traumatic arthritis, a prevalent cause of persistent pain.

Regarding mobility, patients who undergo surgical fixation typically demonstrate improved outcomes in terms of range of motion, namely in the subtalar joint. The enhanced mobility is credited to the anatomical repair of the calcaneus, which enables a more natural biomechanical function of the foot. Nevertheless, it is typical to experience a certain level of rigidity in the subtalar joint, especially in intricate fractures, which might impact activities that involve sideways movements of the foot.

Weight-Bearing and Resumption of Work: Postoperative weight-bearing is generally recommended to facilitate bone healing and minimise the risk of problems such as deep vein thrombosis and muscle atrophy. Research has demonstrated that patients who undergo open reduction and internal fixation (ORIF) with plate fixation can resume weight-bearing activities sooner compared to those who are managed conservatively. Early mobilisation is crucial for the patient's total functional recovery.

Resuming employment is another significant measure of functionality, especially for individuals involved in physically strenuous jobs. Studies have shown that surgical treatment is linked to increased likelihood of returning to pre-injury job levels, particularly when the fracture is effectively realigned and securely fixed. Nevertheless, it is crucial to acknowledge that the duration of recuperation might differ considerably based on the extent of the fracture, the patient's general well-being and the requirements of their job.

Assessing Patient Satisfaction and Quality of Life: Patients typically report high levels of satisfaction after undergoing surgical fixation for intra-articular calcaneal fractures, especially when the treatment effectively restores the foot's normal architecture. The majority of patients see enhancements in pain management, mobility and the capacity to carry out routine tasks. Nevertheless, the occurrence of problems such as impaired wound healing, infection and discomfort caused by medical devices can have a detrimental effect on patient satisfaction and overall quality of life.

CONCLUSION

The utilisation of plate fixation in the surgical treatment of intra-articular calcaneal fractures has notable benefits in terms of restoring anatomical structure, alleviating discomfort, enhancing mobility and expediting the resumption of occupational activities. Although the surgery carries inherent risks and possible problems, the overall functional outcomes are typically positive. In order to make the decision to choose surgery, a comprehensive evaluation of the fracture pattern, patient's health, and functional requirements should be conducted. The objective is to enhance the patient's long-term results and quality of life.

REFERENCES

1. Böhler, L., 1931. Diagnosis, pathology, and treatment of fractures of the os calcis. JBJS., 13: 75-89.
2. Almeida, V.D.A.V.D., T. Devasia, N. M and A. Kamath, 2014. Functional assessment following open fixation of calcaneal fractures. J. Evol. Med. Dent. Sci., 3: 10482-10489.
3. Santosha, S. Gulrez, A.M. Singh, S. Waikhom and V. Pakhrin, *et al*., 2016. Open Reduction and Internal Fixation of Displaced Calcaneum, Intra-Articular Fractures by Locking Calcaneal Plate. J Clin Diagn Res JCDR., 10: 18-21.
4. Palange, N., G. Prasannakumar, N. Shah and E. Pawar, 2019. Study of functional outcome of displaced intra-articular fractures of the calcaneum treated with open reduction, bone grafting, and plate fixation. J. Orthop.s Allied Sci., Vol. 7, No. 1 .10.4103/joas.joas_1_19.
5. Vaclav, R., I. Daniel and M. Michal, 2009. Operative treatment of intra-articular calcaneal fractures with calcaneal plates and its complications. Indian J. Ortho., 43: 271-280.
6. Shrestha, R., D. Shrestha, S.R. Kayastha and H. Winker, 2017. Displaced Intra-Articular Calcaneal Fractures: Evaluation of Clinical and Radiological Outcome Following Open Reduction and Internal Fixation with Locking Branched Calcaneal Plate. Kath Univ Med J., 58: 130-136.
7. Kulkarni, H.G., V.S. Mane, K.L. Gaonkar, P.P. Patil, M.S. Shaha, N.S. Patel and N.R. Desai, 2015. Plating for intra-articular calcaneal fractures is it an overkill? J. Clin. Orth Trauma, 6: 153-159.
8. Makki, D., H.M. Alnajjar, S. Walkay, U. Ramkumar, A.J. Watson and P.W. Allen, 2010. Osteosynthesis

of displaced intra-articular fractures of the calcaneum. J. Bone Joint Surg.. Br., 92: 693-700.
9. Buckley, R., S. Tough, R. McCormack, G. Pate and R. Leighton, *et al*., 2002. Operative compared with nonoperative treatment of displaced intra-articular calcaneal fractures. J. Bone Joint Surg.-Am., 84: 1733-1744.
10. Järvholm, U., L. Körner, O. Thorén and L.M. Wlklund, 1984. Fractures of the calcaneus: A comparison of open and closed treatment. Acta Ortho Scand., 55: 652-656.
11. Griffin, D., N. Parsons, E. Shaw, Y. Kulikov and C. Hutchinson, *et al*., 2014. Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomised controlled trial. BMJ, 349: 44-83.
12. Wei, N., P. Yuwen, W. Liu, Y. Zhu, W. Chang, C. Feng and W. Chen, 2017. Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures. Medicine, 96: 9027-9027.
13. Dhillon, M.S., K. Bali and S. Prabhakar, 2011. Controversies in calcaneus fracture management: A systematic review of the literature. Musct Surg., 95: 171-181.
14. Bruce, J. and A. Sutherland, 2013. Surgical versus conservative interventions for displaced intra-articular calcaneal fractures. Coch Data Syst. Rev., Vol. 0 .10.1002/14651858.cd008628.pub2.
15. Veltman, E.S., J.N. Doornberg, S.A.S. Stufkens, J.S.K. Luitse and M.P.J.V. Bekerom, 2013. Long-term outcomes of 1, 730 calcaneal fractures: Systematic review of the literature. J. Foot Ankle Surg., 52: 486-490.
16. Palmersheim, K., B. Hines and B.L. Olsen, 2012. Calcaneal fractures: Update on current treatments. Clin. Podi Med. Surg., 29: 205-220.
17. Pelliccioni, A.A.A., C.K. Bittar and J.L.A. Zabeu, 2012. Tratamento cirúrgico de fraturas intra-articulares de calcâneo sanders ii e iii: Revisão sistemática. Acta Ortop Bras., 20: 39-42.
18. Sanders, R., P. Fortin, T. DiPasquale and A. Walling, 1993. Operative treatment in 120 displaced intraarticular calcaneal fractures. Clin. Orthop.s Related Res., 290: 87-95.
19. Kitaoka, H.B., I.J. Alexander, R.S. Adelaar, J.A. Nunley, M.S. Myerson and M. Sanders, 1994. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot amp Ankle Int., 15: 349-353.