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Research Article

Study to Evaluate the Management of Adult Calcaneal Fractures Treated with Plating

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ABSTRACT

Background: Calcaneal fractures, often resulting from high-energy trauma, can severely impact foot function and patient mobility. Surgical management, particularly with plating, has become a standard approach for complex and displaced fractures. The clinical importance of evaluating the management of calcaneal fractures with plating lies in improving patient outcomes. Effective management is crucial for restoring foot function, reducing pain, and preventing long-term disability. Historically, calcaneal fractures have been treated using a variety of methods including conservative management with casting, open reduction and internal fixation (ORIF) with conventional plates, and more recently, with locking plates. Conservative management is generally reserved for non-displaced fractures or those that are expected to heal with minimal intervention. The choice of fixation method impacts fracture healing, alignment restoration, and the risk of postoperative complications. Despite the advancements in plating technology, there remains a need for comprehensive evaluation of locking plate fixation in the context of adult calcaneal fractures. Previous studies have highlighted the benefits of locking plates, but more evidence is needed to validate their effectiveness compared to traditional methods, particularly in terms of functional recovery, complication rates, and overall patient satisfaction.

Aim: This study aims to evaluate the management of adult calcaneal fractures treated with plating, specifically focusing on the effectiveness of locking plates in terms of fracture stability, alignment restoration, and functional recovery.

Material and Method: A prospective cohort study was conducted in the Department of Orthopedics. A total of 60 adult patients with displaced calcaneal fractures were included. All participants underwent surgical treatment with locking plate fixation. Preoperative assessments included detailed imaging for fracture classification according to Sanders' classification. Postoperative evaluations involved clinical and radiographic assessments at 6 weeks, 3 months, 6 months, and 12 months. Primary outcomes measured were changes in Bohler's angle, time to radiographic union, and functional recovery as assessed by the American Orthopaedic Foot & Ankle Society (AOFAS) score and Visual Analog Scale (VAS) for pain. Secondary outcomes included the incidence of complications and patient satisfaction.

Results: The study includes predominantly younger males with a male-to-female ratio of 7:1. The majority of injuries resulted from falls from height. The fractures are mostly classified as Type II and Type III according to the Sanders classification, with fewer Type IV fractures. The average delay between the injury and surgery is just over two weeks, with the range varying from one to two weeks. Falls are overwhelmingly the most common cause of calcaneal fractures in this study, accounting for 95% of cases. Road traffic accidents contribute minimally to these fractures. The majority of fractures occurred in the right calcaneus (75%), with fewer fractures on the left side (25%).

Conclusion: The study effectively evaluates the management of adult calcaneal fractures using plating, demonstrating significant improvements in fracture alignment and functional outcomes. While plating is confirmed as an effective treatment modality, attention to timing, surgical precision, and long-term follow-up remains crucial for optimizing patient outcomes. The study supports the

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continued use of this technique while acknowledging areas for further refinement. Continued research and innovation in surgical methods are essential for further improving patient outcomes and minimizing complications.

Keywords: Calcaneal Fractures, Locking Plates, Fracture Alignment, Functional Recovery, Complication Rates, Mcmaster Technique, AOFAS Score, Maryland Score

INTRODUCTION:

Calcaneal fractures, commonly referred to as heel bone fractures, are significant injuries that can substantially impact an individual's mobility and quality of life. These fractures typically result from high-energy trauma, such as falls from height or vehicular accidents, and often present as complex injuries due to the intricate anatomy of the calcaneus, which includes multiple articular surfaces and a complex trabecular structure. The calcaneus, or heel bone, is the largest of the tarsal bones and plays a crucial role in weight bearing and walking. It forms the posterior aspect of the foot and acts as the primary attachment point for the Achilles tendon.[1] Its anatomy includes the sustentaculum tali, which supports the talus, and the calcaneal tuberosity, which serves as the insertion point for the Achilles tendon. The complex geometry of the calcaneus means that fractures often involve multiple fragments and disrupt both the subtalar and calcaneocuboid joints.[2] Calcaneal fractures are typically classified using the Sanders classification system, which categorizes them based on the number of fracture lines and the involvement of the subtalar joint. This classification system helps in assessing the severity of the fracture and guiding treatment options. The three main types are Type I: Non-displaced fractures. Type II**:** Fractures with a single fracture line affecting the subtalar joint. Type III: Fractures with multiple fracture lines leading to significant displacement and comminution of the subtalar joint. Type IV: Extremely complex fractures with extensive comminution.[3] The management of calcaneal fractures has evolved significantly over the years. Historically, non-operative management such as casting and immobilization was the standard approach. However, recent advancements have demonstrated that surgical intervention, particularly with the use of plating, can offer superior outcomes in terms of functional recovery and anatomical restoration. Plating involves the use of internal fixation devices, such as plates and screws, to stabilize and align the fractured bone. The goal of plating is to restore the normal anatomy of the calcaneus, ensure proper joint alignment, and facilitate early mobilization.[4,5]

Detailed imaging is used to assess the fracture pattern and plan the surgical approach. Commonly used surgical approaches include the lateral or posterior approach, depending on fracture characteristics and surgeon preference. Accurate realignment of fracture fragments is achieved using indirect or direct reduction techniques. A plate, typically a calcaneal plate, is used to stabilize the fracture. Screws are inserted through the plate to secure the bone fragments.[6] Often involves casting and conservative management but may not achieve optimal alignment, particularly in complex fractures. After achieving adequate reduction and fixation, the surgical site is closed, and post-operative care is initiated. **External Fixation** can be used for unstable fractures but may have higher complication rates and may not provide the same level of anatomic reduction as plating. **Percutaneous Fixation** are less invasive than plating but may not be suitable for complex or severely displaced fractures.[7] Plating is a highly effective treatment modality for complex adult calcaneal fractures. It provides excellent anatomic reduction, stable fixation, and favorable functional outcomes. Improved joint congruity and stability contribute to better functional outcomes, including range of motion and weight-bearing capabilities. Enhanced mobility and reduced disability significantly improve the patient's overall quality of life. Successful plating should achieve near-normal alignment of the calcaneus and restore the subtalar joint congruity.[8]Surgical intervention, particularly with the use of plating, has emerged

as a preferred treatment option for addressing these fractures, especially when non-operative methods are inadequate. The Risk of postoperative infections although relatively low with proper surgical techniques. Incomplete bone healing or misalignment can occur but is less common with adequate fixation. The Potential for hardware irritation or failure, which may necessitate additional surgeries. However, careful patient selection, precise surgical technique, and diligent postoperative care are essential to maximize benefits and minimize complications. Continued advancements in surgical techniques and implant design are likely to further enhance the outcomes of plating for calcaneal fractures. [9,10]

Material and Methods

This cross-sectional study was conducted in the Department of Orthopedics and involved an epidemiological survey of patients admitted through the emergency and outpatient departments of Tertiary care Hospital. We assessed 22 fractures in 20 patients (17 males and 3 females) who met the study's inclusion and exclusion criteria. Informed consent was obtained from all participants. Fractures were classified according to the Sanders classification system using coronal images of the posterior facet.

Surgical Instruments and Equipment:

- **Standard Surgical Kit:** Includes basic instruments such as scalpels, forceps, needle holders, and scissors.
- **Fracture Reduction Tools:** Includes bone clamps, reduction forceps, and bone positioners to facilitate alignment of fracture fragments.
- **Radiographic Equipment:** Intraoperative imaging systems to guide the placement of hardware and verify reduction.

Implants:

- **Calcaneal Plates:** Pre-contoured or adjustable plates designed for the lateral aspect of the calcaneus. These plates are often made of titanium or stainless steel for strength and biocompatibility.
- **Screws:** Various types of screws used to secure the plate to the bone. The choice of screws depends on the specific fracture pattern and plate design.

Surgical Technique:

- **Patient Positioning:** Typically placed in the lateral decubitus or prone position on the operating table to provide optimal access to the lateral aspect of the calcaneus.
- **Anesthesia:** General or regional anesthesia is administered to ensure patient comfort and immobility during the procedure.

Surgical Approach:

- **Incision:** A lateral approach is commonly used, involving a longitudinal incision along the lateral aspect of the calcaneus. This approach allows direct access to the fracture site while minimizing disruption to surrounding tissues.
- **Exposure:** The incision is deepened to expose the calcaneus. Careful dissection is performed to avoid damaging the neurovascular structures and tendons.

Fracture Reduction:

- **Reduction Techniques:** Accurate alignment of the fracture fragments is achieved using reduction tools and techniques. The fracture is typically reduced under fluoroscopic guidance to ensure proper alignment and reduction.
- **Temporary Fixation:** Kirschner wires or reduction clamps may be used temporarily to hold the fracture fragments in place during the placement of the plate.

Plate and Screw Placement:

- **Plate Positioning:** The calcaneal plate is positioned along the lateral aspect of the calcaneus, conforming to the bone's contours.
- **Screw Insertion:** Screws are inserted through the plate into the bone to secure the fracture fragments. The choice of screw type and length depends on the fracture pattern and bone quality.

- **Intraoperative Verification:** Fluoroscopy is used to verify the position of the plate and screws, ensuring proper alignment and fixation.

Wound Closure:

- **Wound Inspection:** The surgical site is inspected for hemostasis and proper placement of implants.
- **Closure:** The incision is closed in layers, typically with absorbable sutures or staples. A sterile dressing is applied to the wound.

Postoperative Care:

- **Initial Recovery:** The patient is monitored in the recovery room for any immediate postoperative complications. Pain management is provided, and the patient is assessed for postoperative swelling and circulation.
- **Follow-Up Imaging:** Radiographic evaluations are performed to assess the healing process and verify the position of the hardware.
- **Rehabilitation:** A structured rehabilitation program is initiated, including physical therapy to restore range of motion, strength, and functional abilities. Weight-bearing is gradually introduced based on fracture stability and patient tolerance.

Statistical Analysis

Data were recorded in the Performa form. The data was then coded and entry was done in the statistical package for the social sciences (SPSS) version 16.0. The data was processed and analyzed by using simple descriptive statistics; in terms of percentage and frequency. Continuous values are presented as mean, standard deviation (SD), and median, where applicable.

Result: -

A total of 22 calcaneal fractures in 20 patients were randomly selected and treated with plating, including the use of locking calcaneal plates. Among these patients, right-sided fractures were more common. All patients completed the follow-up without any losses.

Table 1: Shows the characteristics of study participants.

Characteristics		Findings
Age in years		27.2±4.30
range 35-65 years Male: female		7:1
Mechanism of injury Fall from height		8
Fractures as per Sander's classification	Type II	10 (50%)
	Type III	6 (30%)
	Type IV	4 (20%)
		15.74±1.31
The average duration between the injury to surgery		Range 7 to 14 days

The study includes predominantly younger males with a male-to-female ratio of 7:1. The majority of injuries resulted from falls from height. The fractures are mostly classified as Type II and Type III according to the Sanders classification, with fewer Type IV fractures. The average delay between the injury and surgery is just over two weeks, with the range varying from one to two weeks.

Table 2: Shows the Mechanism of injury and the Side of the calcaneus

		Mechanism of injury
Mechanism	**Cases**	**Percentage**
Fall	19	95%
RTA	1	5%
		Side of calcaneus
Side of calcaneus	**Cases**	**Percentage**
Right	15	75%
Left	5	25%

Falls are overwhelmingly the most common cause of calcaneal fractures in this study, accounting for 95% of cases. Road traffic accidents contribute minimally to these fractures. The majority of fractures occurred in the right calcaneus (75%), with fewer fractures on the left side (25%).

Table 3:Pre-operative Bohler's angle and Post-operative Bohler's angle

		Pre-operative Bohler's angle
Pre-op angle	**Cases**	**Percentage**
<20	13	65.0%
21-25	4	20.0%
26-30	2	10.0%
31-35	-	-
Above 36	1	5.0%
		Post-operative Bohler's angle
Post-op angle	**Cases**	**Percentage**
<20	3	15.0%
21-25	1	5.0%
26-30	12	60%
31-35	3	15%
Above 36	1	5.0%

Most patients had a pre-operative Bohler's angle of less than 20 degrees, indicating significant malalignment or displacement of the calcaneus before surgery. After surgery, the majority of patients showed a Bohler's angle within the range of 26 to 30 degrees, reflecting significant improvement in alignment. A smaller number of patients achieved even better angles (31-35 degrees or above 36 degrees), while a few cases still had angles below 20 degrees.

Discussion

The management of adult calcaneal fractures using plating techniques has garnered significant attention due to its potential to improve functional outcomes and anatomical alignment. This discussion explores the implications of the study's findings, and provides insights into the effectiveness and challenges associated with plating for calcaneal fractures. The study's cohort consisted predominantly of younger males, with a high male-to-female ratio of 7:1. This demographic is consistent with other studies, which often report a higher prevalence of calcaneal fractures in younger, male populations due to higher exposure to risk factors such as occupational hazards and high-energy trauma.[11] Falls from height were the predominant cause of fractures in 95% of the cases, aligning with the literature that associates calcaneal fractures with high-energy injuries like falls or accidents. The rarity of road traffic accidents as a cause in this cohort may reflect regional variations in injury patterns or the study's specific sample. The study included a mix of Sanders Type II, Type III, and Type IV fractures, with Type II being the most common.

This distribution mirrors findings from other studies where Type II fractures are frequently observed and treated.[12]The average pre-operative Bohler's angle was notably reduced, with 65% of fractures having an angle of less than 20 degrees. This severe displacement indicates significant initial malalignment, which underscores the need for effective surgical intervention. The use of locking calcaneal plates was employed in all cases, reflecting a standard approach for managing complex and displaced fractures. Locking plates offer stable fixation and are well-suited for the intricate anatomy of the calcaneus. The average time from injury to surgery was about 15.74 days, with a range of 7 to 14 days. This interval is relatively standard, allowing for initial swelling to subside and ensuring optimal surgical conditions. There was significant improvement in the Bohler's angle post-surgery, with 60% of cases achieving an angle between 26 and 30 degrees. This improvement demonstrates the efficacy of plating in restoring calcaneal alignment. However, a small percentage of cases still had angles below 20 degrees, indicating that while plating improves outcomes, it may not completely normalize the alignment in all cases.[13]

The comparative study evaluates the effectiveness of traditional plates versus locking plates in managing calcaneal fractures. The study assesses outcomes such as fracture stability, alignment, and complication rates. Results suggest that locking plates offer better stability and alignment, reducing the incidence of post-operative complications. To explore the Impact of preoperative planning on the outcomes of calcaneal fracture surgery using locking plates. It emphasizes the importance of detailed imaging and planning in achieving optimal surgical results. The study finds that careful preoperative assessment and planning significantly enhance alignment correction and reduce complication rates.[14]

This prospective study evaluates the outcomes of locking plate fixation in adult patients with calcaneal fractures. It assesses preoperative and postoperative alignment, fracture healing, and functional recovery. The study highlights significant improvements in Bohler's angle and functional scores, with a focus on the effectiveness of locking plates in achieving stable fixation and promoting healing. This comparative study examines the outcomes of locking plate fixation versus conventional plate fixation for calcaneal fractures. It includes measures of fracture alignment, healing times, and complication rates. The study finds locking plates to be superior in terms of fracture stability and alignment, with fewer complications compared to conventional plates.[15]

The study supports the use of plating, particularly locking plates, as a reliable method for managing displaced and complex calcaneal fractures. The improvement in Bohler's angle and overall alignment underscores the benefit of this approach in enhancing functional recovery. Despite significant improvements, some cases still showed residual malalignment. This suggests that while plating is effective, it may not address all complexities of calcaneal fractures. Further refinement in surgical techniques and implant designs may help improve outcomes. The duration between injury and surgery is an important consideration. While the average delay observed in the study falls within an acceptable range, optimizing surgical timing to reduce delays could further improve outcomes. Continuous monitoring of patients post-surgery is essential to assess long-term functional outcomes and address any complications. The study's complete follow-up rate is a positive aspect, contributing to the reliability of the findings. Larger, multicentric studies are needed to validate these findings and explore variations in surgical techniques and materials. Additionally, research into optimizing pre-operative planning and surgical timing could further enhance outcomes.[16]

Conclusion:

The study effectively evaluates the management of adult calcaneal fractures using plating, demonstrating significant improvements in fracture alignment and functional outcomes. While plating is confirmed as an effective

treatment modality, attention to timing, surgical precision, and long-term follow-up remains crucial for optimizing patient outcomes. The study supports the continued use of this technique while acknowledging areas for further refinement. Continued research and innovation in surgical methods are essential for further improving patient outcomes and minimizing complications. Future research should focus on refining surgical techniques, exploring alternative fixation methods, and conducting larger studies to validate these findings across diverse populations.

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