A Dissertation on

"ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF INTRA-ARTICULAR CALCANEAL FRACTURES"

DISSERTATION SUBMITTED TO

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In partial fulfilment of the regulations for

The award of the degree of

M S ORTHOPAEDICS

Reg No: 221712155

KILPAUK MEDICAL COLLEGE

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DECLARATION

I, **Dr. SOMUMURTHY NAGARAJAN** solemnly declare that this dissertation titled **"ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF INTRA-ARTICULAR CALCANEAL FRACTURES"** is bonafide work done by me in the department of Orthopaedics, Govt Royapettah hospital under the aegis and expert guidance of **Prof DR.R.BALACHANDRAN M.S., Ortho., D.Ortho.,** Professor of Orthopaedics, Govt. Royapettah Hospital, Govt Kilpauk medical college , Chennai-600010. This dissertation is submitted to the **Tamilnadu Dr.M.G.R. Medical University, Chennai,** in partial fulfillment of the University regulations for the award of degree of **M.S.Orthopaedics (BRANCH-II)** examination to be held in May 2020.

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This is to certify that this dissertation titled "**ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF INTRA-ARTICULAR CALCANEAL FRACTURES"** is the bonafide original work of **Dr. SOMUMURTHY NAGARAJAN** in the partial fulfillment of the requirements for M.S Orthopaedics (Branch II) Examination of The Tamil Nadu Dr.M.G.R Medical University to be held in MAY 2020. The period of study is from June 2017 – October 2019

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Ethical Committee Approval Certificate

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The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "ANALYSIS OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF INTRA-ARTICULAR CALCANEAL FRACTURES" submitted by Dr.Somumurthy Nagarajan, Post Graduate, M.S. Ortho, Government Royapettah Hospital, Government Kilpauk Medical College, Chennai - 10.

The Proposal is APPROVED.

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

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CONTENTS

INTRODUCTION

INTRODUCTION

Calcaneal fractures accounting for 65% of tarsal injuries. Calcaneal fractures account approximately 2% of all fractures. Most (60%-75%) of them are intra articular. 10% have associated with spine fractures and 26% are associated with other extremity injuries. Several of these fractures are affecting both calcaneum .90% calcaneal fractures occur in between age group of 21 to 45 yrs of age.

Displaced intra-articular fractures of calcaneum typically the result of high energy trauma, such as fall from height or motor vehicle accident. Among them incidence more common in male workers. so functional outcome of calcaneal fracture plays important socio economic role among the worker families.

The suitable management of calcaneal fractures is unsettled. Tracing the method of treatment of these fractures is illustrated by period of aggressive surgical fixation of these fractures and later by a period of resorting to closed treatment methods.

Till the end of 19th century calcaneal fractures treated non operatively with rest and limb elevation.

Advanced imaging modalities that increased desire of restoring the distorted anatomy of this bone. The operative treatment of calcaneal fractures includes percutaneous k-wire, percutaneous screw, non-locking compression plate and locking compression plate.

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

Research is still to be needed towards determining exactly which operative exposures, techniques, instrumentations and other parameters are ideal. 3D advancement of CT scan provides information regarding size and number of fracture fragments, sustentaculum displacement relative to the super medial fragment, posterior facet congruity, lateral malleolus

AIM OF STUDY

To analyse the functional and radiological outcome of displaced intra-articularr ccalcaneal fractures treated by open reduction and internal fixation

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Historically the treatment of calcaneal fractures depended on the diagnosis that were available at that period of time. Because of the absence of adequate diagnostic tools till the wake of nineteenth century, the only treatment available was careful neglect (ie conservative management) . This is because special views and advanced CT scan of the calcaneum are needed to make decisions regarding reduction of intra-articular aspect of the calcaneum.

Cotton and Wilson recommended **(**1908**)** that one should not do an open reduction of a calcaneal fracture at all. The famous quote by McLaughlin compared open reduction and fixation of a calcaneal fracture to "**nailing of a custard pie to the wall".**

Later in 1931 Bohler's supported open reduction but still the main reasons for the dominance of non operative treatment were due to the practical problems not only connected specifically with operative treatment of calcaneum but also to other general problems like ineffective anesthesia, deficiency of good quality intraoperative radiography like fluoroscopy and the type of antibiotics at that period. Also the poor understanding of the principles of internal fixation leads to more complications.

Conn in 1935 found poor results with the standard treatment methods, recommended primary triple arthrodesis, in a delayed manner. In this method he achieved exceptional results.

Later in 1943 Gallie, supported sub-talar arthrodesis as ultimate treatment but only after union of the fracture.

Palmer tried operative treatment of acute displaced intra articular calcaneal fractures using a standard lateral Kocher's approach. He reconstructed the joint by elevating the fracture fragment with bone graft and published his work in 1948. Later 1952, Essex Lopresti reported similar findings.

Not all surgeons were contented with the results of open reduction and fixation, Dick and Harris began started using Gallie's technique of subtalar arthrodesis for malunited fractures of calcaneum as the treatment of choice, even for acute calcaneal fractures. They showed excellent results with patients returning to work early. Following this many surgeons performed sub-talar arthrodesis for acute calcaneal fracture.

Even after all these in a long term follow up Lindsay and Daver, concluded that sub-talar arthrodesis was not only unnecessarily but also resulted in problems. They concluded that best results were got only with conservative treatment of patients. As a result the operative treatment of acute calcaneal fractures once again went into disrepute. So only later, between 1960s and70s most workers advocated of conservative management.

In the last 20 years, because of improved anesthesia, introduction of antibiotics principles of internal fixation and preoperative imaging CT and intra operative imaging intensifier have permitted surgeons to employ operative fixation for many intra-articular fracture, obtaining good results.

If the personality of fracture is not carefully studied and mode of fixation are not carefully selected and the basic principles of open reduction and internal fixation adhered to by the surgeon then results cannot be expected. Even if these newer techniques promise good results in displaced intra articular calcaneal fractures, experience with these for most intra articular fractures that treatment remains challenging.

Maintenance of Bohler's angle is necessary for satisfactory results along with maintenance of articular congruence of posterior facet of calcaneum and crucial angle of Gissane. Open reduction and internal fixation with locking compressive plate in displaced intra-articular fracture calcaneum shows good outcome. Results are more favorable in less comminuted as compared to more comminuted.

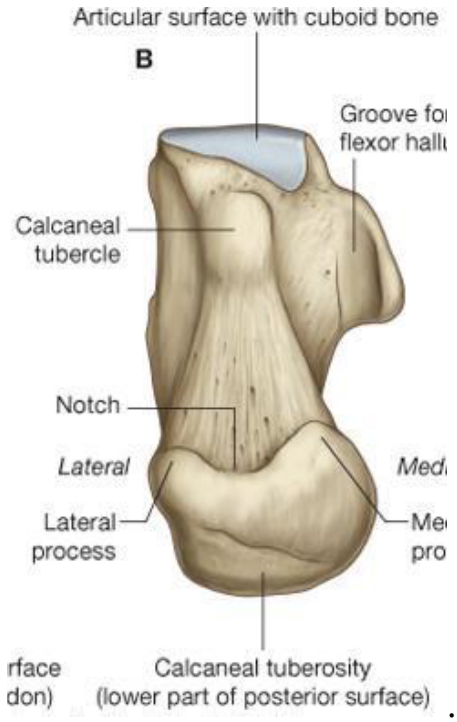
Controversies also exists with regards to primary bone grafting to prevent collapse. A series of cases have been reported with no significant collapse, even without using bone graft for calcaneal fixation, showing no specific benefit with use of the bone graft to prevent collapse.

However, Leung et al, Thordarson et al, and Schildhauer etal recommended use of bone graft or cement to increase stability and compressive strength of fixation and rapid rehabilitation. Zhongguo et

al study reports bone graft in the surgical treatment of calcaneal fractures carries no advantage.

CALCANEUM SURFACE ANATOMY

Calcaneum as a bone forms the base or vertical support for body weight. It is the biggest of all tarsal bones...**Plantar surface** has prominence at back called calcaneal tuberosity, lateral process give rise to part of abductor digiti minimi whereas medial process gives attachment to abductor hallucis. the plantar aspect of calcaneum, a small process in the slightly lateral portion is called the lateral process of tuberosity gives origin to muscle attachment to plantar fascia



Superior surface has 2 parts articular and non-articular.has variable length and extends posterior to form heel. Articular Part has 3 facet posterior, middle and anterior facet joints

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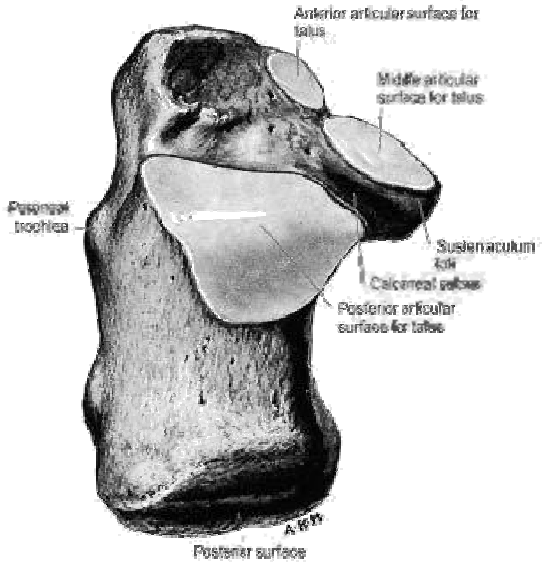
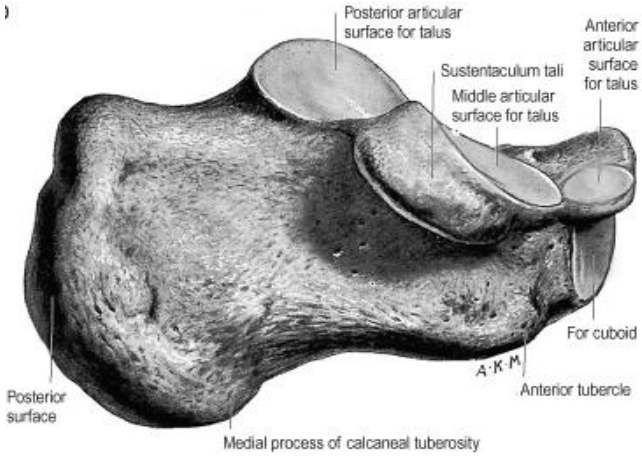
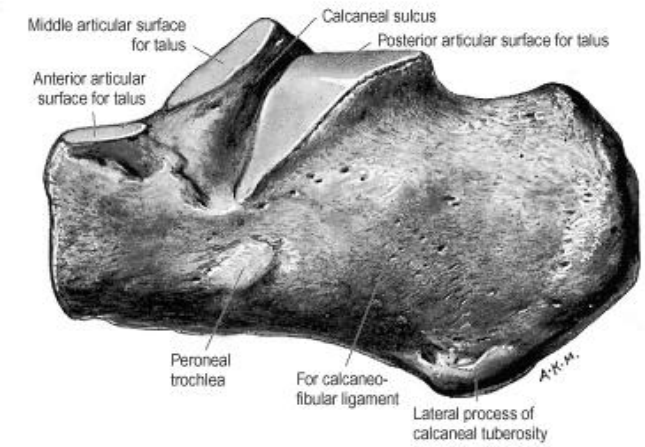


Medial surface has shelf like projection called sustentaculum tali have an articular surface for middle calcaneal facet. Calcaneum has a thin cortical shell which encloses a mass of Cancellous bone that remodels with various stresses applied to it. So it has been described being ‘Egg like’ i.e. hard on the outside and soft on the inside.



Anterior surface is the smallest articular surface to the calcaneo-cuboid joint. **posterior surface** has 3 distinct areas upper area is smooth ,slopes anteriorly and support bursa, middle part gives insertion to Achilles tendon. lower part is covered by fibro fatty tissue. **Lateral surface** is rough almost flat ,broader posteriorly and narrowed anteriorly. It has ridge that separates 2 groove superior for peroneus brevis tendon and inferior for peroneus longus tendon. Lateral aspect is particularly vital as mainly this lateral surface area is exposed during the most common surgical approach used for fracture fixation



CADAVER ANATOMY

PLANTAR VIEW

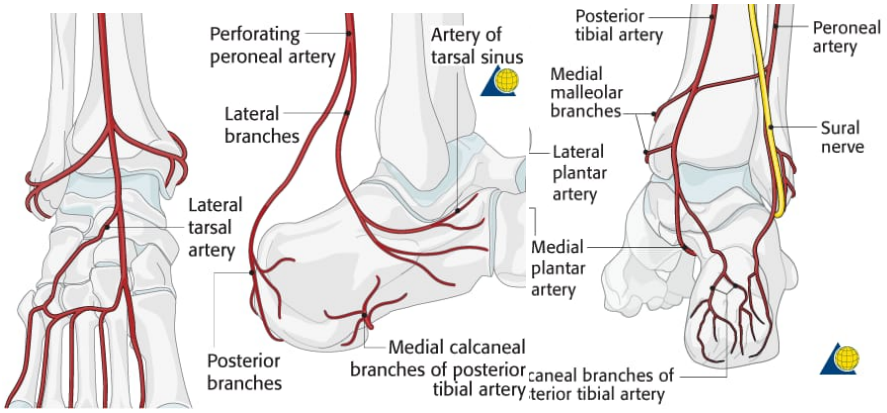
LATERAL VIEW

SUPERIOR VIEW

MEDIAL VIEW

BLOOD AND NERVE SUPPLY OF CALCANEUM

Blood supply of calcaneus is derived from medial and lateral calcaneal arteries. The medial calcaneal artery arises from posterior tibial artery while the lateral calcaneal artery arises from peroneal artery. There is also some degree of blood supply coming from peroneal artery, posterior calcaneal anastomosis, medial and lateral plantar arteries .calcaneum receive its nerve supply from tibia ,sural and deep peroneal nerves



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SOFT TISSUE RELATION

The main ligament of the joint is the interosseus talo calcaneal ligament, a thick, strong band of two partially joined fibers that bind the talus and calcaneus. It runs through the sinus tarsi, a canal between the articulations of the two bones.

There are four additional ligaments that form weaker connections between the talus and calcaneus.

The anterior talo-calcaneal ligament (or anterior inter osseous ligament) attaches at the neck of the talus on the front and lateral surfaces to the superior calcaneus.

The short band of the posterior talo-calcaneal ligament extends from the lateral tubercle of the talus to the upper medial calcaneus.

The short, strong lateral talo-calcaneal ligament connects from the lateral talus under the fibular facet to the lateral calcaneus, and runs parallel to the calcaneo-fibular ligament (Fig.2)

- The medial talo-calcaneal ligament extends from the medial tubercle of the talus to the sustentaculum tali on the medial surface of the calcaneum.

OSSIFICATION

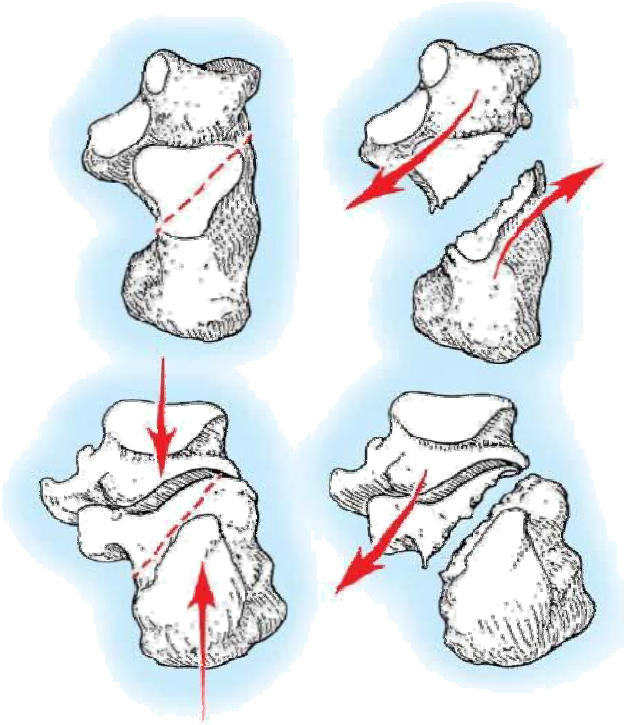
Calcaneum ossifies from one primary during the third month of intrauterine life. One secondary center which appears at six to eight years ,at 14- 16 years secondary centre fuses[6]

MECHANISM OF INJUIRY

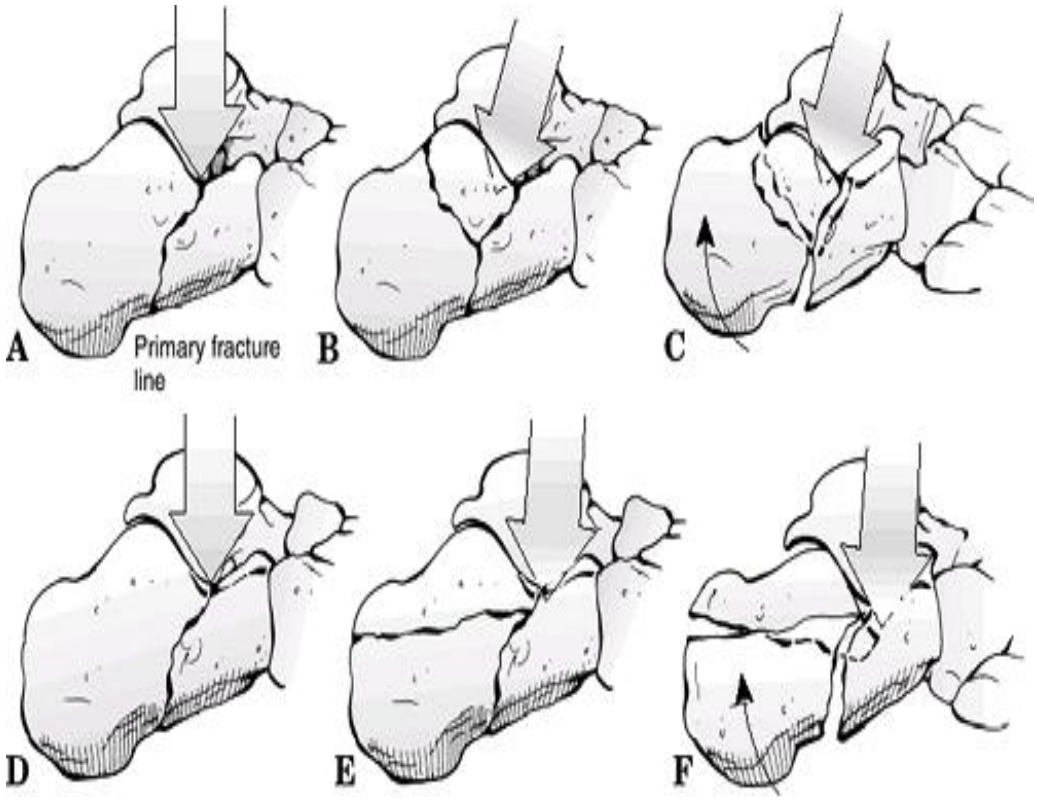
Calcaneal fractures with intra-articular involvement and displacement can occur due to high velocity injury which usually is due to fall from height. In this mode of injury the patient's weight is concentrated on the heels on axial loading. Other mode of injuries like high velocity injuries are due to motor vehicle accidents. Axial load injuries are associated with spine and pelvic injuries. The pattern of communition and the location of the fracture lines are dependant 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 calcaneum to medial and lateral portion. The other fracture line divided the calcaneum into anterior and posterior portions, starting laterally from angle of Gissane running medially. A secondary fracture line was created with increased force. if the force was directed posteriorly,the fracture would continue

posterior to and in to the posterior facet thereby producing joint depression type fracture. if the force directed axially a tongue type fracture was produced.



The primary fracture line



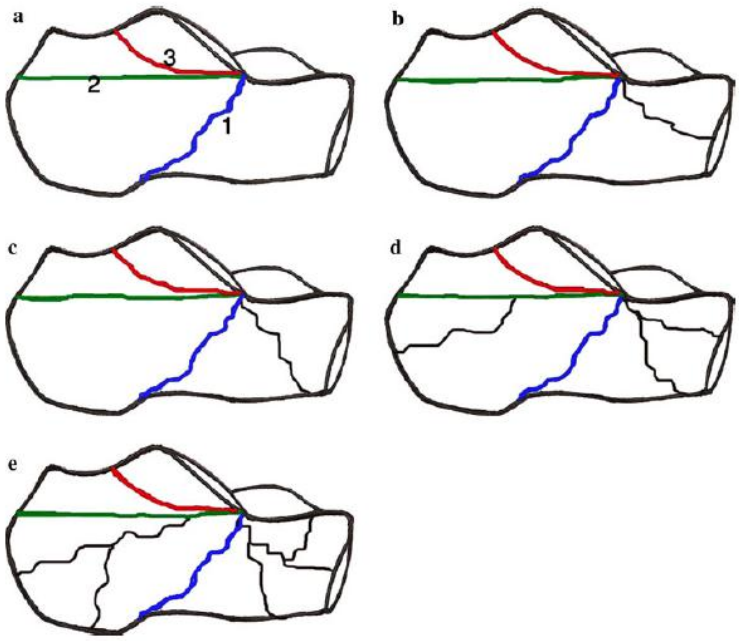
Mechanism Of Injury. A-C Joint depression type. D-F Tongue type

CLASSIFICATION

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

1.ESSEX LOPRESETI

A. Joint Depression Type



Essex- Lopresti Classification. Line 1 represents primary shear fracture, Line 2 –secondary compression fracture giving the tongue fragment, Line 3- secondary compression fracture

1.**Tongue type Fracture:** The articular fragment extended towards posterior tuberosity of calcaneum. Due to pull of tendon Achilles fracture fragment seems to be tongue shape.

2.Sanders type of classification

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 hind foot CT cuts. The planes of reconstruction are the semi coronal(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.

TYPE I– Un-displaced fractures with less than 2mm displacement regardless of fracture lines

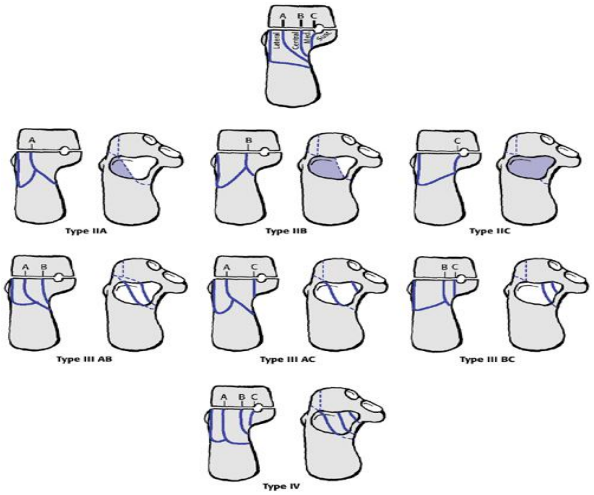
TYPE II- Two part fractures of the posterior facet. Based on the location of the primary fracture line. It is further divided into three types IIA, IIB, IIC.

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.

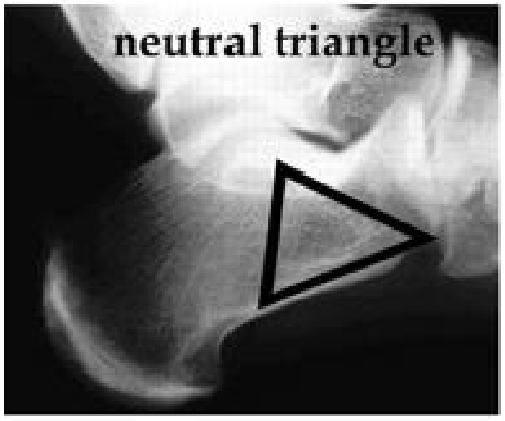
Type-1



RADIOLOGICAL ANATOMY

Calcaneum is an important bone as it transmits the body weight to the ground and also helping the calf muscle action by creating a strong lever. Traction trabeculae extending from the inferior cortex of calcaneum converges over the compression trabeculae supporting the posterior and anterior articular facets.

The area under the thalamic segment of the bone with relatively sparse trabeculae called neutral triangle. This area is considered to be of little significance in the pathological anatomy of fractures. But when the posterior subtalar joint is depressed the vacuous neutral triangle might fail to support the articular surface even after it has been elevated to its original state. The adjuvant is in favors of grafting in the region in the depressing fractures affecting this area.



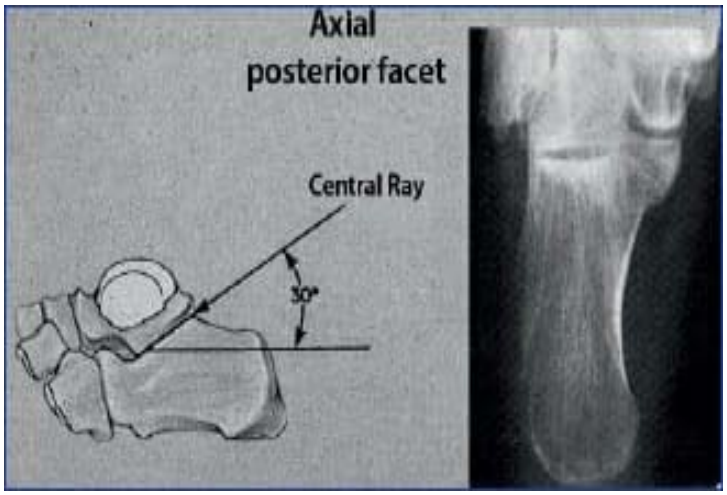
Two important angles are seen on the lateral radiograph of the calcaneus. The tuber angle of Bohler's, usually between 20 and 40 degrees, is formed by two lines. The first line is drawn from the highest point of the anterior process of the calcaneus to the highest point of the posterior facet. The second line runs tangential to the superior edge of the tuberosity . A decrease in this angle may indicate that the weight-bearing surface of the calcaneus (the posterior facet) has collapsed, shifting the weight of the body anteriorly.

The second angle, the crucial angle of Gissane, is seen directly inferior to the lateral process of the talus and is represented by two cortical struts that extend laterally and form an obtuse angle. The first strut extends along the lateral border of the posterior facet, and the second extends anteriorly to the beak of the calcaneus. The angle is usually between 110to 135 degree. If the angle is greater than 130 degree suggests fracture posterior subtalar surface.

Figure: Normal critical angle of Gissane

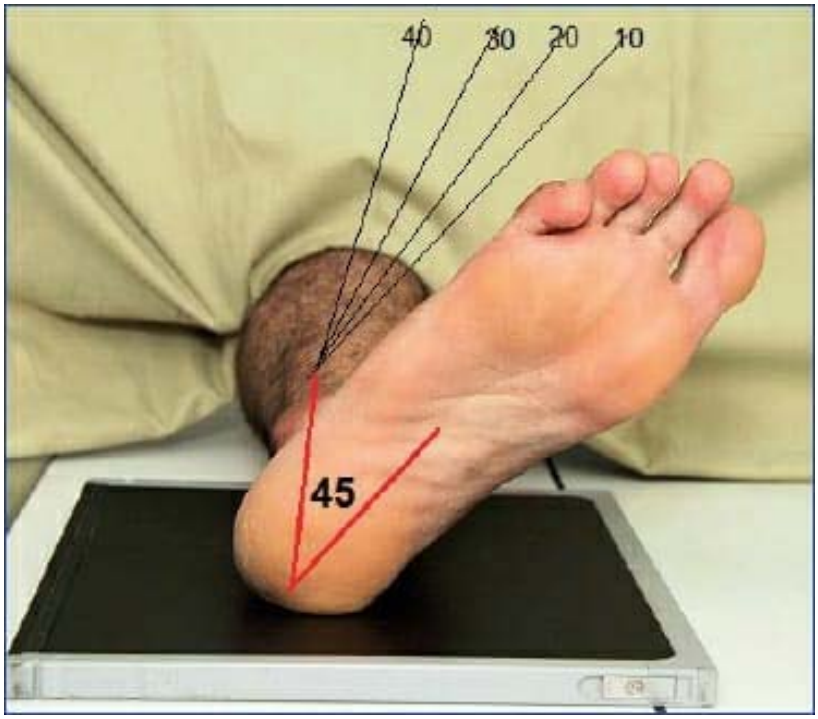
Harris Axial View;

The Harris axial view of the heel visualizes the joint surface, loss of height, increase in width and angulations of the tuberosity fragment. Axial view is taken with ankle dorsiflexed by means of a bandage held by the patient and the x-ray tube tilted 45 degrees from the foot with its axis parallel to the posterior compartment of the joint



Broden's view;

Special radiographic view to visualize subtalar joint. position of patient in supine position with knee slightly flexed, lower leg 45 degree internally rotated and central beam directed towards lateral malleolus. Film obtained in 10,20,30,and 40 degree respectively.



EVOLUTION OF IMPLANTS FOR CALCANEUM

The management of fractures of calcaneus has undergone a change from the initial use of supervised neglect to the use of complicated closed reduction devices .Today there are complex implants , used for internal fixation needs better understanding of complex fracture anatomy and the maneuvers required to reduce the various fracture fragments. They also needs good knowledge about trauma mechanisms, better delineation of vascular zones and their relationship to skin incision, better stability with newer implants and bolder surgical interventions, whether by open or percutaneous means.

Best implant for a particular type of calcaneal fracture is not arrived. Also there is no definite proof about the modality of fixation. This is again due to availability of numerous implants, different methods of reduction, and many surgical approaches to the fractured calcaneum.

The ideal achievement in any intra-articular fracture are better anatomical articular reconstruction, maintenance of the articular surface reconstitution of Bohler’s and Gissane angle, less invasive

faster surgery , minimal wound complications and early mobilization of the ankle.

Modified surgical techniques (appropriate use of the extensile lateral approach) and minimally invasive techniques when indicated, and better fixation devices for stability.

A clear and better understanding of the hind foot biomechanics has also helps to fix the extra articular fractures and the tongue type of fractures with modifications of the technique described by Essex lopresti, Gissane, and the other authors.

Despite the contrary evidence favoring both modalities, today there is a gradual shift in the management of calcaneal fractures from conservative to surgical treatment. This is due to better understanding and clarity of patterns of fractures by radiological techniques like Computerized tomography .There is still confusion in the aspects of open reduction an internal fixation, and many difficulties persists.

One main reason for failure of surgical intervention is inappropriate implant or incision choice. Complications manifest in the form of inadequate fixation and inadequate 3 dimensional reconstruction and wound related complications. Implant decision is a complex issue .This is because the complex anatomy of the calcaneum, an odd shape of the bone which breaks like an egg and difficult to maintain various articular surfaces and tuberosity in position till healing process is completed. Its odd shape is the reason behind difficulty in application of implants. Regaining the Bohler's and Gissane angle and reconstruction of posterior facet are all the complex task. It is always accompanied with some soft tissue compromise

IMPLANTS USED IN OUR STUDY

Cancellous Screw:

Avulsion Extra-articular fractures are comparatively easily stabilized and fixed with 1 or 2 lag screws can be applied percutaneous with minimal surgical trauma.

K-Wire:

For complex calcaneal fractures K wires are inadequate. While in un-displaced avulsion fractures or un-displaced body fractures, if carefully applied K-Wires give percutaneous stabilization, though early mobilization cannot be achieved. K wires are ideal for temporary stabilization. But now these are supplemented with external fixation as a support to maintain the fracture reduction of different fragments.

Implants for depressed intra-articular fractures have always created controversy and confusion but there is agreement developing regarding that the depressed facet should be elevated and the tuberosity should be maintained, the posterior depressed facet and anterior process should be aligned.

As already told the evolution and modifications of implants have made the calcaneal implant more complex, and the user is often confused by the complex looking plates. The implants are costly due to patents, better technology.

Initially in the 1980s, the main goal of fixation was the facet reconstruction which is achieved by 2 screws in compression mode and this is followed by offloading by a single neutralization plate on the lateral surface. It also maintained the configuration of the tuberosity and the anterior process in relation to the reconstructed facet, bone grafting is needed indeed. This gave the surgeons fairly good results when employed by surgeons with experience; however weight bearing needed to be postponed. In this method, there was poor maintenance of elevated posterior facet and late collapse of the

fracture reconstruct happened. There were also plate related lateral complications. Thus the implant development progressed further.

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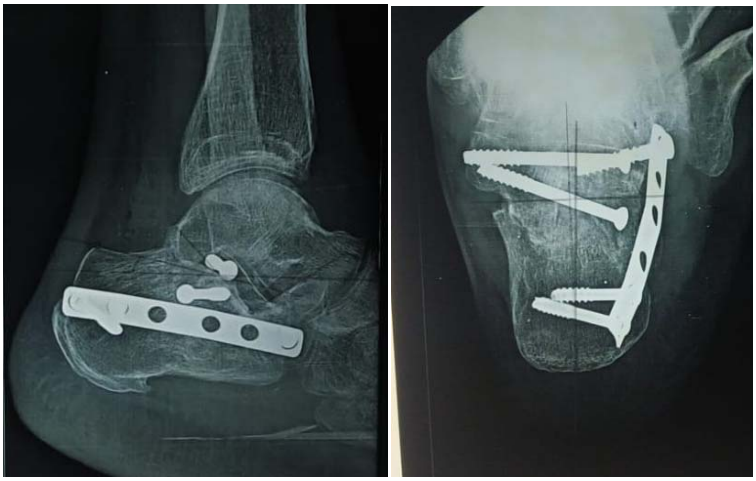
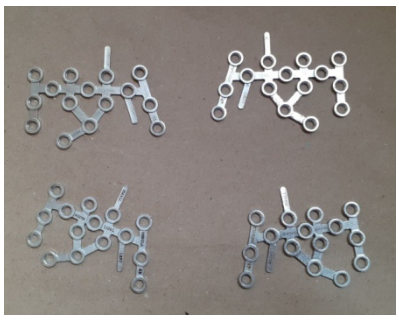


Calcaneal Locking Plate:

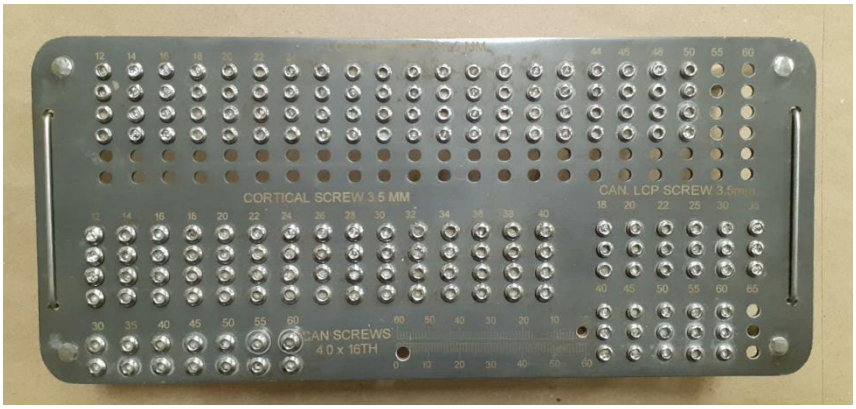
These type of implants allowed stable fixation .The plate profile/thickness was reduced which in turn allowed us to minimize soft tissue breakdown. The plates were also made less rigid for molding to irregular surfaces of calcaneum, and their complex structure allowed varied non parallel screw placement to ensure rigid support of the bone fragments at various levels. This lead to the development of thinner, single construct calcaneal locking plates. These have better results in comminuted fractures also. With the emergence of locking plate concept by Wagner and AO group, the

concept was extended for use in foot and ankle. Synthesis Medical GmBH, Solothurn Switzerland marketed a versatile locking calcaneal plate up to 15 locking holes

Calcaneal locking plate



Non-locking calcaneal plate



TREATMENT OPTIONS

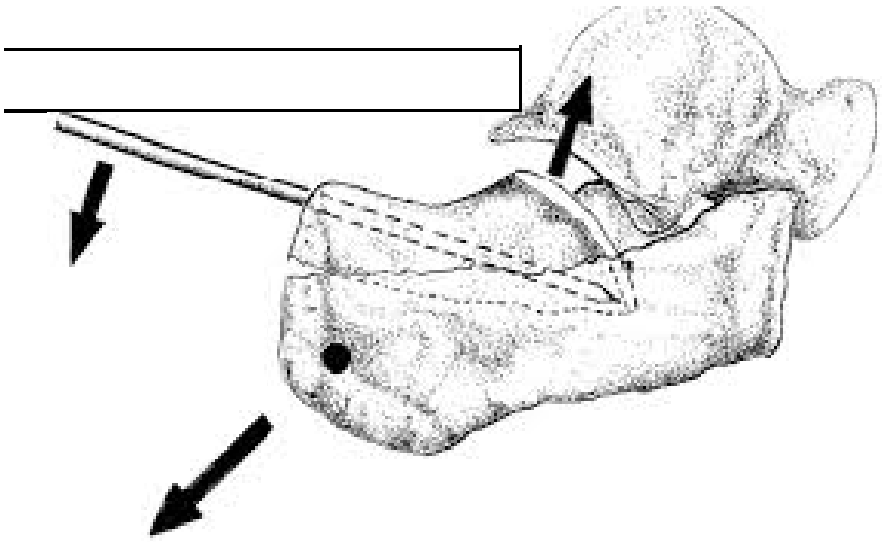
1**. Closed Treatmentt:** Iindicated for un-displaced calcaneal fracture (ie) sanders type-1.It consists of “RICE” Rest, Ice application, Compression, Elevation of limb and NSAIDS. It is accomplished in two ways.

a) One has to accept the fracture as it presented to the surgeon without making an attempt to reduce, with short term immobilization, non weight bearing for 6-8 weeks followed by gradual early motion.

b) By external pressure fracture is manipulated manually or with tongs for reduction and immobilization done, later early physiotherapy for range of motion exercises are advised. Weight bearing is allowed after 8 weeks. Manipulating the fracture can be done by Omoto technique.

2. Semi Open technique:

a) Essex Lopresti close reduction by manipulation of the fragment with percutaneous pin and fixation.



Essex-Lopresti Reduction Technique

3. **Open surgical technique**.

Type II and III Sanders with displacement more than two millimeters in the setting of soft tissue conditions that have no increased risk of complications and a patient — who can comply with post operative care and advise. Type IV Sanders are usually treated by primary subtalar fusion and percutaneous k-wire fixation

COMPLICATIONS OF INTRA-ARTICULAR CALCANEALFRACTURE

It can be divided into

1) Immediate complications

Fracture blisters, swelling, and Compartment syndrome

2) Late Complications

Mal-union, Arthritis, calcaneo -fibular abutment, heel pad problems

Fracture blisters and swelling

Acute calcaneal fracture accompanies significant soft tissue swelling. Fracture blisters may occur over the foot usually within 24-48 hours after injury and have clear fluid or blood. If there are extensive blisters then surgery is contra indicated. If incision is done through these blisters then wound infection is possible, so initial swelling must be reduced by RICE technique(i.e.) rest ,ice pack compression and limb elevation.

Compartment Syndrome;

This is caused by bleeding from Cancellous bone fragments crushing high energy injury coupled with anatomic soft tissue constraint by the plantar aponeurosis. Calcaneal compartment, continuous with the deep posterior compartment of the leg has been described to be the compartment at risk after calcaneal fractures, incidence is 10%. There is persistent pain, which is out of proportion to injury with severe swelling. There may be toe flexor weakness and stretch pain on passive extension of toes. There may be associated plantar hyperesthesia apart from fracture blisters and plantar ecchymosis e present. Most reliable physical finding is tense swelling of the foot. Compartment pressure should be measured over calcaneal, medial, lateral, superficial and interosseus compartment of involved foot.

IMPENDING COMPARTMENT SYNDROME

If the compartment pressure reaches 30 mmHg (or) with is under 10-**80** mmHg of diastolic blood pressure, then it is the time to do a faciotomy.

Nerve Injury:

Acute neurologic injury most commonly occurs. e.g. iatrogenic ally in the lateral approach, Sural nerve involved and in the medial approach - calcaneal branch of posterior tibial nerve is involved. Injury to both medial and lateral plantar nerve can happen when screws or wires are inserted from the lateral approach especially antero-inferior aspect of the posterior facet.

Nerve Entrapment also can happen later due to soft tissue scarring or bony mal-union or exostosis formation causing the impingement. This is usually from conservative treatment. The medial plantar, lateral plantar and calcaneal branch of tibial nerve medially may be involved and cause pain. Sometimes the sural nerve laterally also may be involved. When examined, Tinel's sign may elicit over the area of the involved nerve. This pain around the distribution of the nerve, may be apparent both at rest and while standing. Selective nerve blocks with anesthetics also may help to diagnose nerve involvement.

Impingement of Tendon:

Tendon impingement and calcaneo-fibular impingement can occur by

a) Fracture spikes protruding through the tendons.
b) Dislocation of the tendons from their anatomic groves
c) Entrapment of tendons between fracture fragments
d) Impingement of tendons between malunited bony fragments.

Peroneal tendinitis can be caused by implant irritation when a lateral approach is used.

Heel pad pain

Heel pad pain is the second most common site of pain after a calcaneal fracture. It is due to injury to the heel pad close to calcaneum during the time of injury. Diagnosis is done by the presence of significant heel pain, over to the area of soft tissue and heel pad under the bone, tenderness on the side to side palpation or thumping over the heel pad. There will be thinning and increased mobility of the heel pad. Thus the heel pad will be softer and less firm compared to the uninjured site. Bony calcaneal spurs, heel exostosis develop from the undersurface of calcaneum in patients with injury to the plantar cortex of calcaneum after injury. It is due to proliferative bony changes at the origin of the plantar fascia.

Mal-union ; occur commonly in conservative treatment but may occur inadequately or improperly done reduction in surgeries. It results in

a) Widened heel syndrome
b) Pain and instability secondary to tendon impingement
c) Post traumatic arthritis of subtalar or calcaneo-cuboid joint
d) Hind-foot mal-alignment and altered gait secondary
e) Nerve impingement.

Arthritis may affect - subtalar or calcaneocuboid joint .Subtalar incongruity or penetration of implants into the sub-talar joint may cause late arthritis. There is significant unloading of the posterior facet with as little as 2 mm of articular surface depression, supporting the concept of articular surface reduction as aim of treatment in operative treatment of calcaneal fracture. Even in an anatomically reduced fracture, arthritis can occur due to cartilage injury that is caused by initial trauma. Thus it is also the severity of initial injury that determines the ultimate outcome and not the accuracy of articular surface reduction as obtained in one study.

MATERIALS

AND

METHODS

MATERIALS AND METHODS

This study was conducted in Government Royapettah Hospital, Kilpauk Medical College and the study period was June 2017 to october 2019. This study was conducted to analyze the functional and radiological outcome of intra-articular calcaneal fractures treated by open/closed reduction

Inclusion criteria;

- Age 18-65 years inclusive
- B/L and unilateral calcaneal fracture
- Fracture according to sander's classification type-2,3&4
- Injury <3 weeks

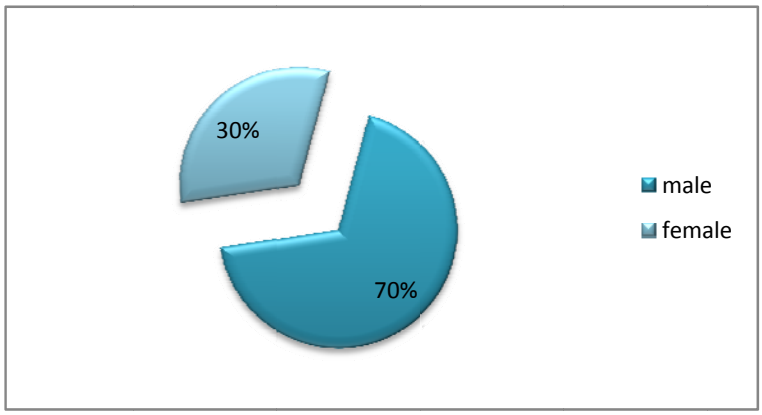
Exclusion criteria:

- Age <18 yrs &> 65 yrs
- Fracture according to sander's classification type-1
- Medical contraindications
- Injury >3 weeks

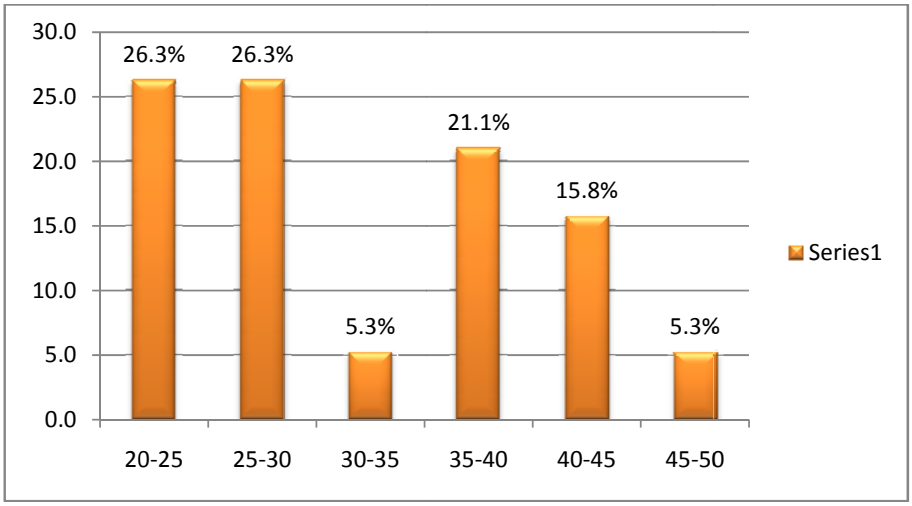
OBSERVATION

The following observation were made in our study

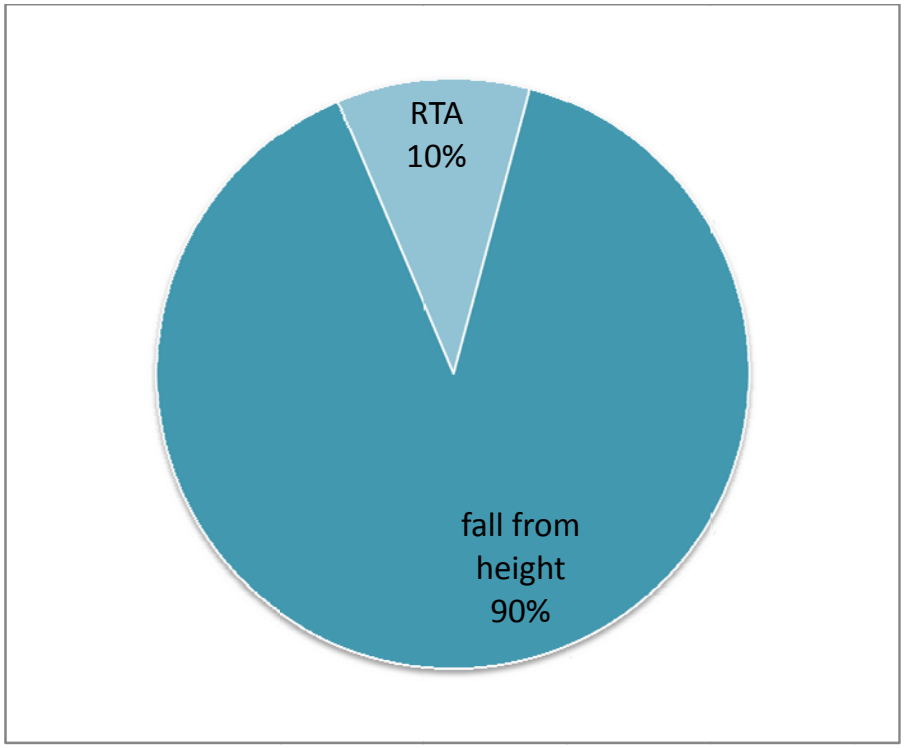
Sex Distribution; In our study the total number of male patients was 14 and female patients was 6



Age Distribution: In our study, most of the patients were in the age group between 20-30 yrs old

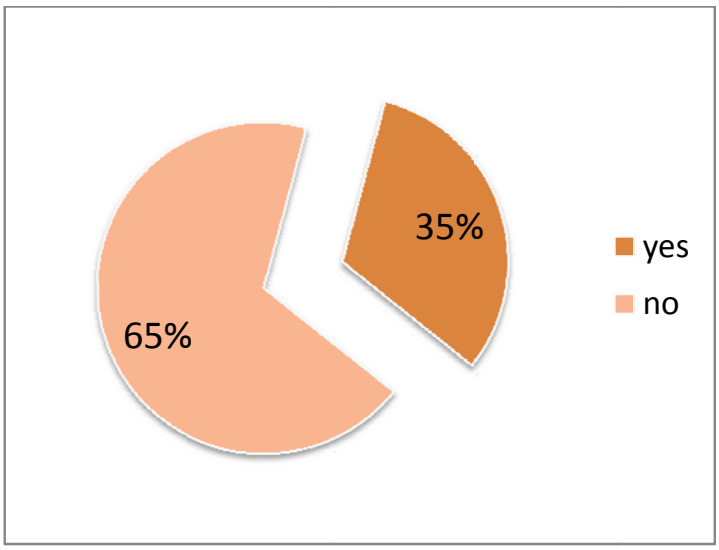


Mode of Injury;18 patients-Fall from height,2 patients-Road traffic accident

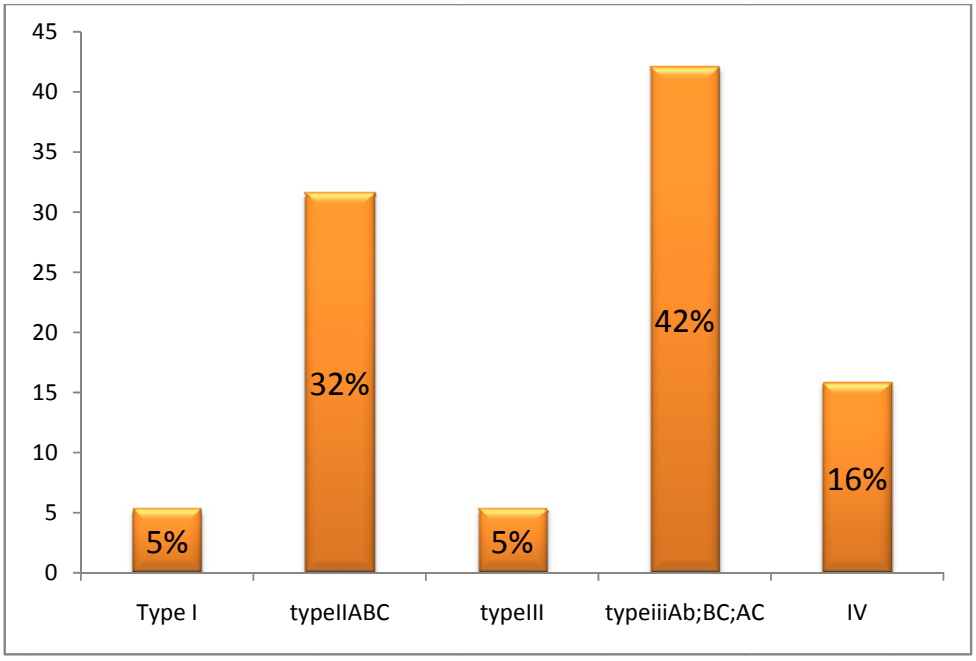


Associated Injury: In our study 6 patients had associated injury as follows

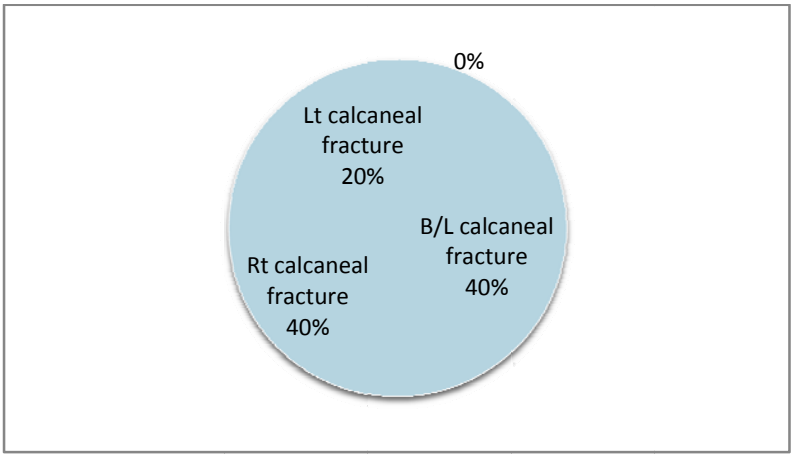
1. Fra**c**ture both bone Rt leg ,Rt medial malleolus fracture, Rt talus neck fracture
2. Grade-2 comp injury with fracture both bone Lt leg, un-displaced Bi-columnar fracture Lt acetabulum
3. Lt distal radius fracture
4. Grade-3a comp injury with 3rd MT fracture rt foot and rt side heel pad de-gloving
5. Un-displaced Rt superior and inferior pubic rami fracture,L1 anterior wedge compression fracture
6. D12, L2 burst fracture with neurological deficit



Type of Injury Based on Sander's classification; In our study group ,we classified calcaneal fractures according to sander's classification and most of the patients fall in sander's type-2 & 3



Side Of Involvement: In our study group nearly 40% patients of Calcaneal fracture involved in both side (i.e.) 8 cases involving both side, 8 cases on rt side, 4cases on Lt side



In our study group the following surgical procedure were done

s.no	Procedure	Number of fractures
1.	ORIF with PO	16
2.	CRIF with Cancellous screw fixation	4
3.	CRIF with k-wire fixation	6
	TOTAL	26

PRE OPERATIVE PROTOCOL

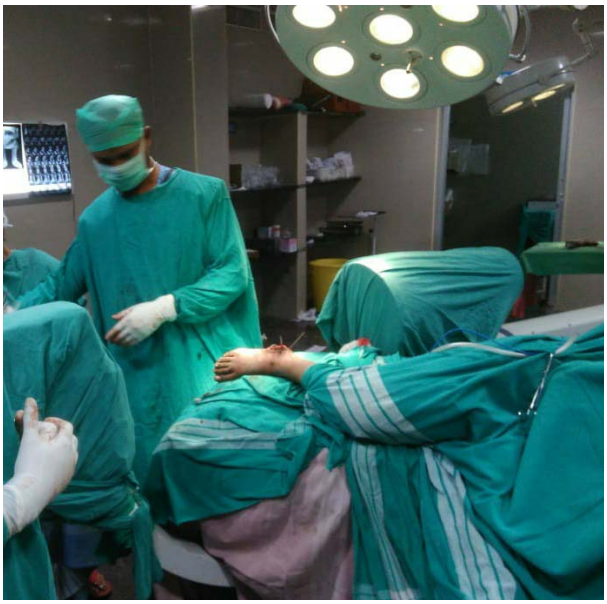
All study patients in our group were initially immobilized with BK slab and limb elevation was given. If patients suspected for associated injury such as pelvis fracture, spine fractures we initially stabilize the vitals, surgery opinion obtained to rule out abdomen and bladder injury. Adequate medical management of associated co-morbid conditions like Diabetes Mellitus, Systemic Hypertension, Chronic Obstructive Pulmonary Disease and Heart Diseases were initialized to optimize patient's fitness for anesthesia. For all the study patients plain radiographs (AP, lateral and Harris axial views) and CT calcaneum were taken and thoroughly reviewed to study the personality of the fracture pattern including the number of articular fragments and extent of fracture displacement ,extent of overall loss of calcaneal height and length, extent of communition through anterior process. This allows to anticipate certain technical maneuvers to facilitate fracture reduction as well as to save tourniquet time duration which may decrease the wound complication rate. The peri-operative antibiotic used was Cefotaxime given 1 gm 12th hourly intra-venous starting 30 minutes before the procedure.

TIMING OF SURGERY

In this study, the most accepted time is to wait until the swelling resolves and the blisters re-epithelialize before proceeding with surgery. Factors such as swelling of foot and ankle, swelling associated with blisters and soft tissue damage can lead to the risk of skin necrosis and infection post-operatively. To minimize such complications strict limb elevation, ice pack compression are given. Resolution of swelling was assessed by "**WRINKLE TEST"** i.e. skin wrinkles are seen over the lateral aspect of foot, when ankle is in dorsiflexion and eversion.

POSITION OF THE PATIENT

Patient is placed in Lateral decubitus position. C-arm is placed(as shown in fig) in order to take fluoroscopy images of both Harris axial view and lateral views without changing its position.



POSITION OF PATIENT AND C-ARM

SURGICAL TECHNIQUE

1.ORIF with PO(Lateral Extensile Approach)

Out of 20 cases in our study population 16 cases we used Standard **Extensile lateral approach(Benirschki and sangeorzan)** for surgical fixation of displaced intra-articular calcaneal fractures. The lateral extensile incision is marked. The line starts approximately 2cm above the tip of lateral malleolus, just lateral to Achilles tendon vertically toward plantar surface bent and continued till the bony prominence of 5^{th} metatarsal.

The knife should be taken" straight to bone" with care taken not to bevel the skin, the corner should not in acute bend. then the flap raised with full thickness. The calcaneo-fibular ligament and peroneal tendon is visualized. The tendon are dissected from peroneal tubercle .1.6 mm k-wire are strategically inserted ton retract the flap using "no touch technique".1^{st} k-wire inserted into fibula to retract them.2^{nd} k-wire placed in talar neck retracting mid portion of peroneal tendon.3^{rd} k-wire is placed on distal aspect of tendon and flap.

The posterior inferior corner of calcaneal tuberosity is predrilled and schantz pin placed from lateral to medial. The tuberosity is pulled plantar ward and distracted into varus which disimpact several fracture line in the lateral wall like joystick placement. The articular fragment evaluated. The most plantar edge of the depressed fragment is located and elevated with hoke osteotome. The posterior tuberosity is disimpacted from sustentaculum which restores the height and length of calcaneus .if reduction is unstable a k-wire placed from back of the heel through the posterior tuberosity and into the medial sustentacular component. If type-2 fracture the lateral fragment is skewered with (2)1.6mm k-wire reduced across the fracture line. If type-3 fracture should assemble from medial to lateral (i.e.) the central fragment is reduced provisionally stabilized with sustentacular fragment with 1.6mm k-wire. Lateral fragment is then skewered with2 k-wires to the central and sustentacular fragment. To reduce anterior fragments, A laminar spreader is use to stretch the ligament allowing the central piece to be more easily re-positioned.the lateral wall and body reduced with valgus manipulation of schanz pin. Then obtain a intra-op lateral view to look for calcaneal pitch, post facet height, posterior and anterior articulating surfaces. broadens view in order to visualize posterior facet joint. Harri's axial view to view calcaneal height , varus and valgus deformity.

If large cavity is present then void can be filled with bone graft. 3 main component the anterior process ,the posterior tuberosity and posterior facet are secured with calcaneal locking plate secured with 2 screws on each component and verified on fluoroscope and all k-wires removed. Assessment of peroneal tendon following removal of k-wire removal(i.e.) it should easily reduce to the retro fibular groove. Wound is closed in layer with interrupted suture and 2-0 monofilament suture for skin layer using modified Allogower-Donati technique

2. CRIF with Cancellous screw fixation/k-wire fixation;

In our study group 4 patients treated with CRIF with Cancellous screw fixation and 6 **ca**lcaneal fractures treated with k-wire fixation

For the following patients a)sanders type -2 fracture and type-4 fractures b) displaced calcaneal tuberosity fracture. Reduction of articular surface by simple manipulation through schanz pin and assessed under c-arm. Placement of guide pin is confirmed with lateral and Harris axial view of ankle.Definitve fixation achieved with large cannulated(6.5mm ,4mm)

lag screw. For sander's type-4 and comminuted fracture without any reduction CRIF with K-wire done and immobilized with BK slab.

POST OPERATIVE MANAGEMENT

In our study patient Limb elevation, intravenous antibiotics for five days. Closed suction drainage is kept for 24 — 48 hours. Short leg splint is removed at fifth postoperative day. If the flap shows uncomplicated healing and the wound is healthy, early active range of motion is begun at that time. At second Postoperative week, active range of motion of the ankle joint is started and gentle passive movement of sub talar joint done. Suture removal at 2weeks. Touch toe Weight bearing is allowed after 12 weeks, till that protection can be provided with removable posterior splint. Full weight bearing is allowed only when there is sign fracture union (i.e.)obliteration of fracture line.

Rehabilitation;

- Strict limb elevation until swelling subsides and then gentle ankle and toe movements are encouraged
- Strict non weight bearing for 6 to 8 wks
- Partial weight bearing allowed after confirming radiological signs of union
- Full weight bearing allowed after confirming fracture union

Follow up :

All patients were followed up once in two weeks for the first 6 weeks, then once in a month for 6 months and then the patient is reviewed once in 3 months. In each follow up, X rays were taken to assess radiological union, surgical scar examined, range of movements checked and appropriate rehabilitation advised which was custom made for each patient depending on his fracture pattern and radiological healing. The minimum follow-up period was 6 months and the maximum was 24 months with an average follow up period of 13 months. Functional outcome of the patients is assessed by AOFAS score, only when the patient was able to walk. So in our study group assessment was done with period varying from 12 wks -6 months

Functional Assessment of Our study population based on American Orthopedic Foot And Ankle Society Scoring system

1. PAIN	points
None	40
Mild	30
Moderate	20
Severe	0
2. ACTIVITY LIMITATION	
No limitation	10
Limitation only in recreational activity	7
Limitation both daily and recreational activity	4
Severe limitation of daily activities	0
3. WALKING DISTANCE	
Greater than 6 metres	5
4-6 metre	4
1-3 metre	2
Less than 1 metre	0
4. WALKING SURFACES	
No difficulty	5
Some difficulty	3
Severe difficulty	0
5. GAIT	
None	8
Obvious	4
Marked	0
6. SAGITAL MOTION (flexion and extension)	
Normal or mild restriction	5
Moderate restriction	3
Marked restriction	0
7. HIND FOOT MOTION (inversion &eversion)	
Normal or mild restriction	6
Moderate restriction	4
Severe restriction	0
8. HIND FOOT STABILITY	
Stable	8
Unstable	0
9. ALIGNMENT	
Good	15
Fair	8
Poor	0
EXCELLENT >85 GOOD 70-85 FAIR 55-70 POOR <55	

ANALYSIS

&

RESULTS

ANALYSIS OF FUNCTIONAL OUTCOME;

1. Timing of surgery; In our study patients who were operated early had good functional outcome

Timing of surgery	Mean AOFAS
<5 days	79±5.2
6- 10 days	74±13.6
>10days	63±4.2

2.Radiological analysis; We analyzed pre operative and post operative Bohler's angle and Angle of Gissane in lateral view and Harris axial views. Normal range of Bohler's angle is 20-40 degree; Angle of Gissane is 110-130 degree. Pre-operatively 75 % of the patients had reduced Bohler's angle and 55% of the patients had increased angle of Gissane. Post operatively we restored Bohler's angle for 30% of patients and no significant restoration in angle of Gissane was noticed. We analysed the P value for Bohler's angle was 0.03 and the P value for Angle of Gissane was 0.515, denoting that Bohler's angle significantly influences the functional outcome than the Angle of Gissane.

Out of 20 patients who had varus angulations, we were able to reduce the deformity in 18 patients. The mean pre operative varus angle of 10.125 was reduced to 6.83.

Angle of Bohler's and its p-value:

pre op bohlers angle	Frequency	Percent
<20	15	75
20-40	5	25
Total	20	100.0

post op Bohler's angle	Frequency	Percent	p-value
<20	9	45	
20-40	11	55	0.03
Total	20	100.0	

Angle of Gissane and its p-value:

Pre op Angle of Gissane (AOG)	Frequency	Percent
110-130 degree	9	45
>130 degree	11	55
Total	20	100.0

		Frequency	Percent	p-value
	110-130 degree	11	55	
	>130degree	9	45	0.515
	Total	20	100.0	

3. Ankle foot alignment;12 patients had good hind foot alignment, 5 patients had fair alignment and 3 patients had poor alignment. Broadening of heel pad and decreased heel height was noticed in 3 patients.

4. Range of movements: Normal range of dorsiflexion of ankle is 10-30 degree and plantar flexion is 20-50 degree. Post operatively we achieved dorsiflexion of 10 degree and plantar flexion of 15 degree in 16 patients. 3 patients had severe restriction of movement. In 1 patient we could not analyze the range of movement as the patient had L1 Burst fracture with neurological deficit.

5. Bone Grafting; In our study, bone grafting was done for 9 patients (9 fractures) and was found to have better outcome than those patients treated without bone grafting. For further evaluation, long term follow up is needed.

6. Time of union;8 patients had union by 12 wks, 7 patients had union by 12 – 16 wks,4 patients had union by 16-24 wks, 4 patients and 1 patient had union >24 wks.

7. **Type of procedure and outcome:**

In this study of 20 patients(26 fractures) 16 patients who underwent ORIF with PO had mean AOFAS score of 76.42, 4 patients who underwent Cancellous screw fixation had AOFAS score of 83.75 and 6 patients who underwent K-wire fixation had AOFAS score of 63.75.Cancellous screw fixation showed better outcome.

s.no	Procedure	Number of fractures	AOFAS SCORE (mean)
1.	ORIF with PO	16	76.42
2.	CRIF with Cancellous screw fixation	4	83.75
3.	CRIF with k-wire fixation	6	63.75
	TOTAL	26	

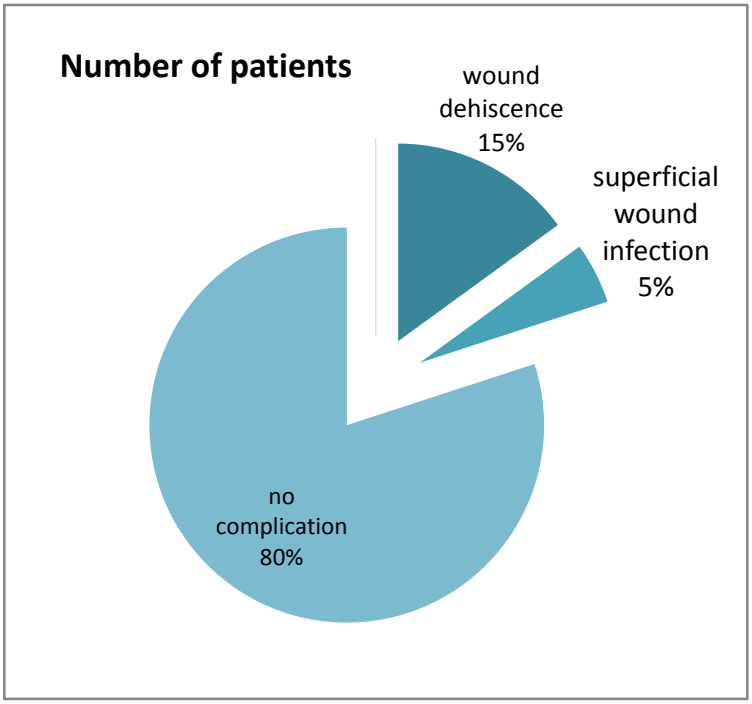
RESULTS

Clinical examination of surgical scar, ankle-hind foot alignment, walking surface and ability to squat were assessed at each follow up. Clinical & Radiological signs of union were also recorded. Functional outcome was analyzed based on AOFAS score and the results were calculated at the end of our study period , based on the findings recorded at the final follow up of each patient.

In our study, 15 patients had good outcome and 5 patients had fair outcome.

COMPLICATIONS

In this study 4 patients had immediate post op complication. Of which, 3 patients had wound dehiscence and 1 patient had infected wound. Wound dehiscence was treated with antibiotics and sterile non-adhesive dressing and all 3 patients recovered by 10 days.1 patient with infected wound underwent wound debridement. After 2 weeks wound healed and progression of union was noticed.



CASE

ILLUSTRATIONS

CASE ILLUSTRATIONS

CASE – 1 : 51 yr/male fracture LT calcaneum (sanders type 3 AC) AOFAS SCORE 89 (excellent)

Pre-op x-ray **Immediate Post-op X-ray**

Final follow-up x-ray




Functional outcome (EXCELLENT)

CASE - 2: 42y/m LT calcaneal fracture (sanders type -2a)

AOFAS score – 77(good)

Pre-op x-ray

Immediate post op x-ray

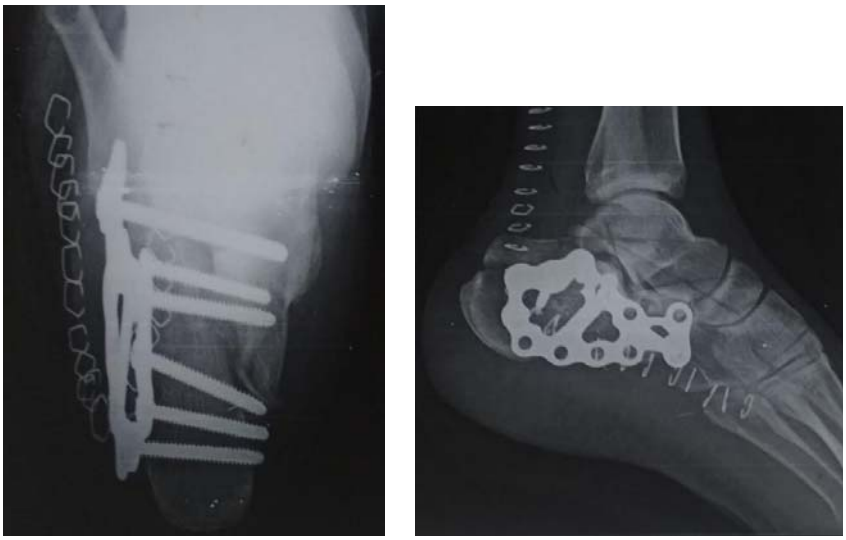
Final follow-up x-ray

Functional outcome (GOOD)

CASE - 3: 31 y/m RT calcaneal fracture (sanders type-2A)

AOFAS score – 80, Good

Pre op x-ray



Post-op x-ray

Final follow-up x-ray

Functional outcome (GOOD)

CASE - 4 : 22y/male B/L calcaneal fracture(RT sanders type -3AC,LT sanders type-1) AOFAS score-84(Good)

Pre-op x-ray

Immediate Post op x-ray

7th POD with wound dehiscence

After treatment

Final follow-up x-ray

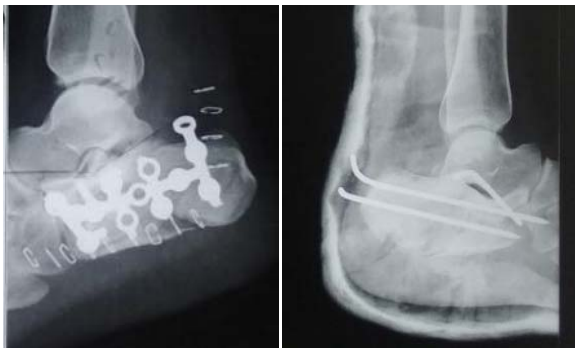
Functional outcome (Good)

CASE - 5 :25y/f B/L Calcaneal fracture(Rt side sanders type-3AB,Lt side sanders type -4) AOFAS score Lt-48 (poor) Rt-68 (fair)

Rt **Lt**

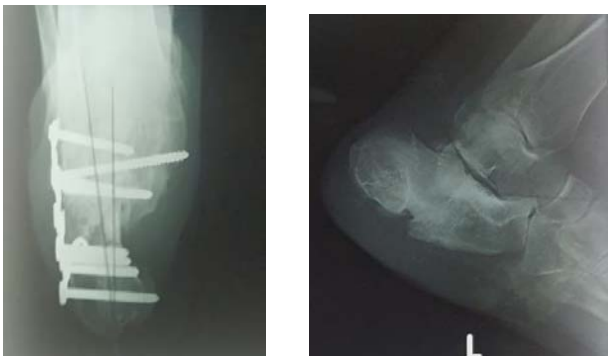
Pre op x-ray

Rt **Lt**



Immediate post op x-ray

Rt Lt



Final follow-up x-ray

Functional outcome (poor)

DISCUSSION

DISCUSSION

Fractures of calcaneum are the most common tarsal bone fractures with overall incidence of 2% of all fractures with displaced intra-articular fractures comprising 60%-75% of the cases. Intra-articular fractures occur after eccentric axial loading of the talus on the calcaneus.

The first widely accepted classification was proposed by Essex lopresti in 1952 based on involvement of sub-talar joint. Soeur and Remy devised a classification system for intra-articular fractures in 1975 based on mechanism of injury and taking sustentacular fragment as the key to surgery. With the advent of CT scan, a new classification system was developed by Crosby and Fiotzgibbns based on posterior facet. Sanders et al[6,9,25] proposed a classification system based on coronal view of CT scan, in which 3 fracture lines A,B,C Separate the posterior facet of the calcaneus into 4 potential pieces. The literature review says it is the most widely accepted classification as it considers both fracture pattern and also guides further treatment course.

Operatively[14] treated patients with sanders type 2,3 & 4 have better outcome with respect to pain, return to work, heel width, gait abnormalities and radiographic outcomes than patients treated conservatively. Open[14] reduction and internal fixation with calcaneal Locking plate through an extended lateral approach is the mainstay of treatment. Due to the risk of wound dehiscence, CRIF with Cancellous screws is preferred. A clear idea about indication, contraindications and the timing of surgery are important. Pre-operative CT scans are essential. Sub talar incongruity or penetration of implants into the joint may cause late arthritis during long term follow up.

The period of study was between June 2017 to October 2019. Although the period of study was short, studies have shown that early function is comparable to final long term outcome. We studied functional and radiological outcome in 20 patients (26 fractures) of which 16 fractures were treated by ORIF with P.O, 4 fractures were treated by CRIF with Cancellous screws and 6 fractures by CRIF with K wires. The average follow up period was 13 months ranging from 6 to 24 months.

In our study, pre op Bohler's angle of less than 20 degree was restored to normal range (20 to 40 degree) in 6 patients. The P value for pre op and post op value of Bohler's angle was 0.03 and the P value for angle of Gissane was 0.515 showing that restoration of Bohler's plays a significant role in functional outcome than angle of Gissane as also observed in the studies. conducted by **Joseph D. Isaacs et al** in 2013 and **Vishal et al** in 2016[30,31]. Among 26 fractures pre operative varus >15 degree were 13 fractures and post operatively it was corrected and reduced <15 degree for 9 fractures. Varus correction also influences the functional outcome

Joseph D. Isaacs et al concluded that Bohler's angle serves as a useful screen tool in calcaneal fractures. **Vishal et al** concluded that ORIF of clinical fractures yielded good clinical outcome if Bohler's angle more than 10 degree is achieved. It was also noted in the study that there was a significant correlation between Bohler's angle and AOFAS score (P less than 0.01). There was no significant correlation between angle of Gissane and AOFAS score.

In our study, mean AOFAS score was 79 when the timing of surgery was less than 5 days and it decreased to 63 when the timing of surgery was delayed by more than 10 days showing that early fixation of calcaneal fractures plays a definite role in the functional outcome[16]

In our study 4 patients had immediate post op complication. Of which, 3 patients had wound dehiscence and 1 patient had infected wound.wound[17] dehiscence is the most common immediate post op complication.

The study conducted by A.K singh et al it was concluded that intra-articular fractures treated with internal fixation and bone grafting, patients were able to return to full weight bearing earlier than those treated without bone grafting. However the long term efficacy in both the groups was similar showing that patients treated without bone grafting have functional outcome as good as patients treated with bone grafting[32].

But in our study 9 patients were treated by plate osteosynthesis with bone grafting and 7 patients were treated without bone grafting . Functional outcome (AOFAS score) was found to be better in patients for whom bone grafting was done. However long term follow-up is needed for further evaluation.

In our study of 20 patients, 15 patients had good outcome, 5 had fair outcome based on AOFAS score.

Drawback in assessing the outcome:

- 20 yr female Rt calcaneal fracture(sanders type 3 AC),ORIF with PO done associated with D12 ,L12 burst fracture with neurological deficit. Hence pt not ambulant AOFAS score could not be elicited.
- 39 yr female rt calcaneal fracture (sanders type 4) with grade 3b comp injury 3rd metatarsal associated with heel pad de-gloving injury

  In the study conducted by WU et al, it was concluded that 35 fractures fixed with ORIF with PO had AOFAS score 78. Scheper et al concluded that 61 fractures fixed with ORIF with P.O. had AOFAS score 83. In our study, we did combined procedures for

calcaneal fractures depending on the fracture pattern. We observed that patients who underwent ORIF with P.O. had AOFAS score of 76.42, patients who underwent Cancellous screw fixation had AOFAS score of 83.75 and patients who underwent k wire fixation had AOFAS score of 63.75.

In our study group 2 patients with B/L calcaneal fractures had combination methods of surgical fixation (i.e.) ORIF with PO For sanders type-3fracture and CRIF with k-wire for sanders type -4 fracture on either side calcaneum..CRIF with k-wire fixation only fair outcome than ORIF with PO due to its severity of fracture pattern

CONCLUSION

With the short term follow-up of our study, we conclude that displaced intra-articular fractures needs to be treated by surgical methods to correct the Bohler's angle. Among the methods closed reduction with Cancellous screw fixation had given better Functional outcome. Supplementation with Bone Graft helps in early mobilization. Earlier fixation gives better functional outcome.

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PATIENT CONSENT FORM

Study detail:

"Comparison of *Functional outcome analysis of posterior plating vs lateral plating for lateral malleolus fixation in ankle fractures*"

Study centre : GOVT ROYAPETTAH HOSPITAL, CHENNAI

Patients Name :

Patients Age :

Identification Number :

Patient may check (✓) these boxes

I confirm that I have understood the purpose of procedure for the above study. I had the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I hereby make known that I have fully understood the use of above surgical procedure, the possible complications arising out of its use and the same was clearly explained to me and also understand that this technique is a new method of treatment of patella fractures and this study is done to know the usefulness of the same in management of patella fractures ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well-being or any unexpected or unusual symptoms. ☐

I hereby consent to participate in this study. ☐

I hereby give permission to undergo complete clinical examination and diagnostic tests including hematological, biochemical, radiological tests. ☐

Signature/thumb impression:

Patients Name and Address: place date

Signature of investigator:

Study investigator's Name: place date

நோயாளி ஒப்புதல் படிவம்

ஆராய்ச்சியின் விவரம் :

ஆராய்ச்சி மையம் :

நோயாளியின் பெயர் : நோயாளியின் வயது :

பதிவு எண் :

நோயாளி கீழ்கண்டவற்றுள் கட்டங்களை (✔) செய்யவும்

1. மேற்குறிப்பிட்டுள்ள ஆராய்ச்சியின் நோக்கத்தையும் பயனையும் முழுவதுமாக புரிந்துகொண்டேன். மேலும் எனது அனைத்து சந்தேகங்களையும் கேட்டு அதற்கான விளக்கங்களையும் தெளிவுபடுத்திக் கொண்டேன். ☐

2. மேலும் இந்த ஆராய்ச்சிக்கு எனது சொந்த விருப்பத்தின் பேரில் பங்கேற்கிறேன் என்றும், மேலும் எந்த நேரத்திலும் எவ்வித முன்னறிவிப்புமின்றி இந்த ஆராய்ச்சியிலிருந்து விலக முழுமையான உரிமை உள்ளதையும், இதற்கு எவ்வித சட்ட பிணைப்பும் இல்லை என்பதையும் அறிவேன். ☐

3. ஆராய்ச்சியாளரோ, ஆராய்ச்சி உதவியாளரோ, ஆராய்ச்சி உபயத்தாரோ, ஆராய்ச்சி பேராசிரியரோ, ஒழுங்குநெறி செயற்குழு உறுப்பினர்களோ எப்போது வேண்டுமானாலும் எனது அனுமதியின்றி எனது உள்நோயாளி பதிவுகளை இந்த ஆராய்ச்சிக்காகவோ அல்லது எதிர்கால பிற ஆராய்ச்சிகளுக்காகவோ பயன்படுத்திக்கொள்ளலாம் என்றும், மேலும் இந்த நிபந்தனை நான் இவ்வாராய்ச்சியிலிருந்து விலகினாலும் தகும் என்றும் ஒப்புக்கொள்கிறேன். ஆயினும் எனது அடையாளம் சம்பந்தப்பட்ட எந்த பதிவுகளும் (சட்டபூர்வமான தேவைகள் தவிர) வெளியிடப்படமாட்டாது என்ற உறுதிமொழியின் பெயரில் இந்த ஆராய்ச்சியிலிருந்து கிடைக்கப்பெறும் முடிவுகளை வெளியிட மறுப்பு தெறிவிக்கமாட்டேன் என்று உறுதியளிக்கின்றேன். ☐

4. இந்த ஆராய்ச்சிக்கு நான் முழுமனதுடன் சம்மதிக்கின்றேன் என்றும் மேலும் ஆராய்ச்சிக் குழுவினர் எனக்கு அளிக்கும் அறிவுரைகளை தவறாது பின்பற்றுவேன் என்றும் இந்த ஆராய்ச்சி காலம் முழுவதும் எனது உடல் நிலையில் ஏதேனும் மாற்றமோ அல்லது எதிர்பாராத பாதகமான விளைவோ எற்படுமாயின் உடனடியாக ஆராய்ச்சி குழுவினரை அணுகுவேன் என்றும் உறுதியளிக்கின்றேன். ☐

5. இந்த ஆராய்ச்சிக்குத் தேவைப்படும் அனைத்து மருத்துவப் பரிசோதனைகளுக்கும் ஒத்துழைப்பு தருவேன் என்று உறுதியளிக்கின்றேன். ☐

6. இந்த ஆராய்ச்சிக்கு யாருடைய வற்புருத்தலுமின்றி எனது சொந்த விருப்பத்தின் பேரிலும் சுயஅறிவுடனும் முழுமனதுடனும் சம்மத்திக்கின்றேன் என்று இதன் மூலம் ஒப்புக்கொள்கிறேன். ☐

நோயாளியின் கையொப்பம் / பெருவிரல் கைரேகை ஆராய்ச்சியாளரின் கையொப்பம்

இடம்:

தேதி:

+

PROFORMA

Patient’s Name:

Age:

Sex:

Occupation:

Address:

Contact no:

Date of Injury:

Mode of Injury:

Date of admission:

I.P. No:

Diagnosis:

Type of Fracture:

Treatment given on admission:

Investigations: Complete hemogram,

Blood urea, sugar, Sr. Creatinine

Bleeding time and clotting time

ECG, Chest X-ray

Plain X-ray AP and Lateral view of the affected limb CT

Scan for intra articular fracture patterns

Associated illness:

Plan:

Date of surgery:

Timing of surgery:

Procedure done:

Implants used:

Intra operative complications, if any:

Post-operative complications, if any:

Post-operative mobilisation started at:

Follow up:

Post-operative weight bearing started at:

Partial:

Full:

Immediate post op

4 weeks post op

8 weeks post op

3 months post op

6 months post op

Final follow up

MASTER CHART

Name	mode of injury	age	procedure	pre op bohlers angle	post op bohlers angle	ASSOCIATED INJURY	IMMEDIATE POST OP COMPLICATION	AOFAS	bone grafting	implant	pre op radiological varus	post op radiological varus	approach
pattudurai(m)	fall from height	25	orif with Rt calcaneum fracturewith k-wire fixation/lt calcaneum with po with bf	not elicited	rt-22* lt-10*	fracture bb rt leg,rt medial malleolus fracture,rt talus neck of fracture	nil	excellent	+	calcaneal locking plate	lt-6*,rt-3*	rt-22*,lt-10*	lateral extensile
basker(m)	fall from height	42	ORIF with PO RT Calcaneum,crif with k-wire	not elicited	rt-12* lt-not elicited	grd-2 comp injury with fracture bb lt leg,bicolumnar fracture lt acetabulum,lt distal radius,	nil	fair		grh calcaneal locking plate rt side,lt side k wire	rt-14* lt-18*	rt-6*,lt-18*	lateral extensile
simsai(f)	fall from height	25	orif with po RT Calcaneum,crif with k-wire lt calcaneum	rt-not elicited lt-10*	rt-12* lt-10*		wound dehisence	poor	rt side +	calcaneal locking plate rt side,lt side k wire	rt-10*,lt-18*	rt-7*,lt-15*	lateral extensile
kumar(m)	fall from height	40	percutaneous k-wire fixation rt calcaneum	rt-22*,	rt-22*			good		k-wire fixation	rt-12*	rt-6*	percutaneous
iyappan(m)	RTA	55	orif with po lt calcaneum	not elicited	not elicited	lt distal radius fracture		good		calcaneal locking plate	rt-10*	rt-6*	lateral extensile
subhashini	fall from height	38	orif with cc screw fixation	lt-18*	lt-28*			good		cancellous screws	rt-4*	rt-not corrected	percutaneous
anbu(m)	fall from height	42	crif with cc screw fixation lt calcaneum	not elicited	lt-10*		wound dehisense	good		cancellous screws	rt-6*	rt-not corrected	percutaneous
kamachi (f)	rta	39	CRIF k-wire fixation Rt side,orif with po lt side	rt-15*	rt-20*	grd 3b comp injury 3rd mt rt foot with heel pad degloving	wound dehisence	fair		k-wire fixation	rt-14*	rt-10*	percutaneous
murali(m)	fall from height	45	orif with po screw plate construct	lt- -30*	lt-12*			fair		plate screw construct	lt-4*	lt-4*	lateral extensile
ganesh	fall from height	22	rt-orif with po lt -orif with po	rt-0*,lt-10*	rt-18*,lt-10*			good	rt side +	calcaneal locking plate rt side	rt-15*	rt-6*	lateral extensile
karthick(m)	fall from height	30	orif with po rt calcaneum	rt-not elicited	rt-23*		infected wound	good	rt side +	calcaneal locking plate	rt-13*	rt-5*	lateral extensile
basker(m)	fall from height	31	orif with po rt calcaneum	rt-not elicited	rt-23*			good		grh calcaneal locking plate rt side	rt-10*	rt-6*	lateral extensile
nandhini(f)	fall from height	21	orif with po rt &lt	rt-not elicited lt-10*	rt-10* lt-15*	rt sup and inf pubic rami fracture,l1 ant wedge compression fracture		good		b/l calcaneal locking plate	rt-16*,lt-12*	rt-6*,lt-8*	lateral extensile
vinitha (f)	fall from height	20	orif with po rt calcaneum	rt-10*	rt-30*	d12,l2 burst fracture with neurological deficit		rt-not elicited	rt side+	calcaneal locking plate			lateral extensile
gopi(m)	fall from height	30	crif with cc screw fixation rt calcaneum	rt-not elicited	rt-15*	nil;	nil	good		cancellous screws	rt-12*	rt-8*	percutaneous
anbhalagan(m)	fall from height	27	orif with po lt calcaneum	lt-not elicited	lt-not elicited	nil;	nil	good		calcaneal locking plate lt side	lt-16*	lt-8*	lateral extensile
mathan(m)	fall from height	37	orif wih po	lt-15*,rt-22*	lt-15*,rt-22*	nil	nil	fair		b/l calcaneal locking plate	rt-4*,lt-6*	rt-4*,lt-6*	lateral extensile
saran kumar(m)fall from height		30	ORIF with po	Lt-not elicited,Rt-not elicited	lt-18*,rt-22*	nil	nil	good		b/l calcaneal locking plate	rt-12*,lt-8*	rt-8*,lt-4*	lateral extensile
saraswathy(f)	fall from height	28	crif with cancellous screw fixation	lt-22*	rt-22*	nil	nil	good		cancellous screws	rt-4*	rt-4*	percutaneous
raman (m)	fall from height	36	crif with k-wire fixation	rt-12*	rt-6*	nil	nil	good		crif with k-wire fixation	rt-8*	rt-4*	percutaneous