

**“FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL
FEMUR FRACTURE WITH INTRA-ARTICULAR EXTENSION FIXED
WITH VA-LCP (VARIABLE ANGLE-LOCKING COMPRESSION
PLATE) -A PROSPECTIVE STUDY”**

BY

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**DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER
EDUCATION AND RESEARCH, KOLAR, KARNATAKA**

In partial fulfilment of the requirements for the degree of

**MASTER OF SURGERY
IN
ORTHOPAEDICS**

Under the Guidance of

**DR. ARUN H.S MBBS, MS ORTHOPAEDICS
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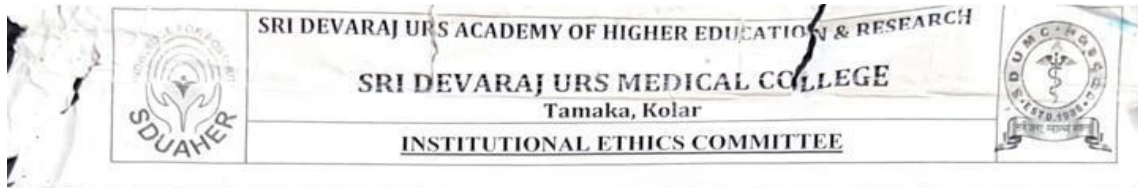
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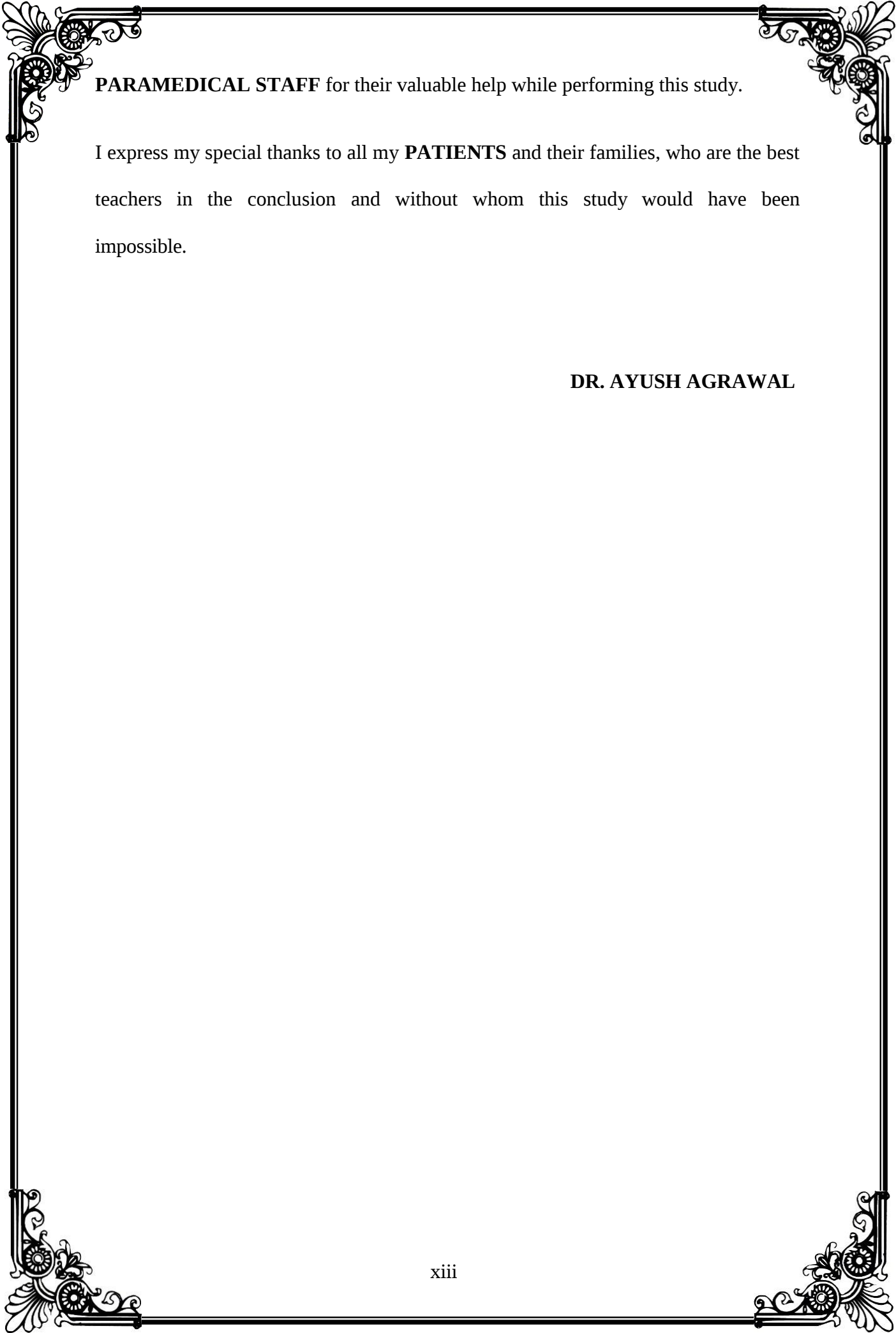
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ABSTRACT

Background: Distal femur fractures, often resulting from high-velocity injuries, pose significant challenges due to their complexity. This study aims to evaluate the efficacy of Variable Angle Locking Compression Plates (VA-LCP) in treating these fractures, focusing on both functional and radiological outcomes.

Methods: This prospective observational study included 40 patients aged 20-70 years with distal femur fractures treated at R.L. Jalappa Hospital and Research Centre. Data on demographics, comorbidities, fracture type, and outcomes were collected. Patients underwent open reduction and internal fixation with VA-LCP and were followed up at 1 month, 3 months, and 6 months postoperatively.

Results: The study revealed significant improvements in functional outcomes as measured by NEER's score, with most patients showing substantial increases by 6 months post-op. The majority of fractures were successfully united within an average of 20 weeks. Complications were minimal and included superficial infections and knee stiffness in a few cases.

Conclusion: VA-LCP provides effective stabilization for distal femur fractures, enabling early mobilization and resulting in positive functional and radiological outcomes. This technique is particularly beneficial for complex intra-articular fractures.

Keywords: Distal femur fracture, VA-LCP, Variable Angle Locking Compression Plate, radiological outcome, functional outcome, fracture fixation.

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ABBREVIATIONS

Abbreviation	Full Form
VA-LCP	Variable Angle Locking Compression Plate
CBC	Complete Blood Count
ESR	Erythrocyte Sedimentation Rate
BT	Bleeding Time
CT	Clotting Time
RBS	Random Blood Sugar
ECG	Electrocardiogram
AO	Arbeitsgemeinschaft für Osteosynthesefragen
NEER	Neer's Score (Functional outcome score used to evaluate postoperative recovery)

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INTRODUCTION



INTRODUCTION

Background

Rapid industrialization and evolving lifestyles have led to an increase in road traffic accidents, often resulting in high-velocity injuries like distal femur fractures. These injuries are complex, especially in high-energy scenarios, and carry significant implications for patient health and recovery, including an association with organ damage in motor vehicle collisions. The treatment of such fractures poses challenges for orthopaedic surgeons, given the vital role of the knee joint in function and mobility.¹ With severe injuries often involving complex bone fractures due to high kinetic energy impacts, advanced surgical interventions and meticulous post-operative care are essential. Total knee arthroplasty is increasingly considered in complex cases, especially in the elderly.² Effective treatment modalities are critical for managing these injuries, focusing not only on anatomical correction but also on restoring knee biomechanics. The evolution of implant designs, including variable angle-locking compression plates (VA-LCP), has broadened the options available to surgeons, promising improved outcomes for these challenging fractures.³ The purpose of this research is to assess the effectiveness of VA-LCPs in the treatment of distal femur fractures with intra-articular extension, potentially improving clinical results and advancing the development of orthopaedic therapeutic approaches.

Overview of the Distal Femur Fractures

Because of their intricacy and effect on the knee joint, distal femur fractures—which are typically the consequence of high-velocity events like falls, car accidents, and sports-related injuries—present a significant challenge in the field of orthopaedics. These fractures, which can be intra-articular or extra-articular, demand meticulous management to restore joint alignment and stability. There has been a noted rise in the occurrence of these injuries

worldwide, particularly in situations involving high-energy trauma.⁴ For example, research indicates that distal femur fractures represent approximately 0.4% of all fractures globally, with an annual incidence rate of roughly 37 occurrences per 100,000 persons.

In India, the scenario is similarly concerning. With the nation's rising rates of road traffic accidents due to rapid urbanization and increased vehicle usage, there has been a notable surge in high-velocity trauma cases leading to such fractures. Reports suggest that in India, the incidence of distal femur fractures is higher in urban areas, intricately linked to vehicular accidents and industrial mishaps.⁵ The treatment of these injuries varies, involving methods such as retrograde nailing and locking compression plating, which are critical in ensuring successful recovery. However, the severity of these injuries, particularly among the elderly, is marked by increased mortality rates compared to other types of fractures. The incidence of distal femur fractures is particularly high in older adults, often correlated with osteoporotic conditions, which contribute to the complexity of the treatment.⁶

The prevalence of these fractures demonstrates varying patterns across age groups. In younger populations, these injuries are typically related to high-energy trauma, whereas in the elderly, especially those with osteoporosis, low-energy fractures are more common. This trend underscores the need for targeted prevention and treatment strategies catering to specific age-related risks.⁷ In middle-aged individuals, a combination of traumatic injuries and the onset of bone density reduction contribute to the risk of fractures.⁸ Given these global and regional trends, understanding the epidemiology and specific characteristics of distal femur fractures is crucial for evolving effective treatment protocols. This includes addressing the increased susceptibility to low-energy fractures in the elderly and acknowledging the varying fracture risk factors across different age groups and demographics.⁹ Such

comprehensive understanding is fundamental to advancing orthopaedic treatments and improving clinical outcomes in patients with distal femur fractures.

Treatment Modalities

The evolution of fracture fixation treatment has been marked by continuous innovation, transitioning from traditional methods to modern fixation devices. This evolution reflects a deeper understanding of bone healing, biomechanics, and the advent of new materials and techniques, all driven by the goal of enhancing patient outcomes, minimizing complications, and effectively addressing various fracture types.¹⁰ Historically, internal fixation began with rudimentary methods that were often cumbersome and prone to complications. Over the years, these methods have been refined, leading to more reliable and efficient devices. Today's sophisticated internal fixation techniques offer improved accuracy in fracture alignment and stability, crucial for effective bone healing. The AO (Arbeitsgemeinschaft für Osteosynthesefragen) philosophy, emphasizing scientific principles and education in orthopaedic surgery, has been central to modern fracture care's evolution. Similarly, external fixation has a rich history of its own.¹¹ Initially a simpler, less invasive alternative to internal fixation, it has adapted to cater to a broader range of fractures. It is particularly useful in situations where internal fixation is less suitable, such as in high-infection-risk cases or where the soft tissue is compromised.

Infection control in fracture-fixation has been a guiding factor in the development of both internal and external fixation methods. The need for effective infection management has led to innovations in materials and designs, aiming to minimize associated risks. This shift in treatment modalities underscores a significant advancement in orthopaedic care, balancing patient needs with technological progress to offer better, more effective fracture management solutions. The move towards less invasive methods in treating fractures, as seen in recent

research, marks a key development in orthopaedic care. These methods aim to lessen damage to surrounding tissues, reduce pain after surgery, and help patients recover faster.¹² This approach is increasingly popular, showing a shift in focus towards treatments that not only fix fractures effectively but also help patients heal and get back to normal quicker. Orthopaedic surgery has come a long way, evolving from older methods to using advanced devices today, all with the goal of improving outcomes for patients, reducing problems during and after surgery, and dealing with distinct kinds of fractures effectively. This change shows the ongoing efforts to improve and innovate in the treatment and care of bone fractures.

Expanding on the treatment modalities for fractures, especially in the context of distal femoral fractures, it is evident that the choice of fixation device plays a crucial role in determining patient outcomes. The complexity of these fractures, often involving the knee joint and requiring precise alignment and stabilization, makes the selection of an appropriate fixation method a critical decision in orthopaedic surgery.¹³ The Retrograde intramedullary nail and the Dynamic Condylar Screw (DCS) have been two widely studied options for treating these fractures.¹⁴ Christodoulou et al. (2005) provided valuable insights into this area by comparing these two methods in elderly patients with supracondylar femoral fractures.¹⁵ Their study highlighted that while both methods are effective, there might be differences in terms of recovery times, complication rates, and suitability depending on patient age and bone quality.

The study by Petsatodis et al. (2010), comparing the condylar buttress plate, fixed-angle condylar blade plate, and dynamic condylar screw in treating supracondylar intra-articular distal femoral fractures, offers insights into a range of fixation options.¹⁶ It examines the mechanical stability of each device, their ease of use in surgery, and their impact on post-operative recovery. These devices differ in design and use, affecting bone healing and

functional recovery. Biomechanical strength and stability of various fixation methods have been explored, like in Heiney et al.'s (2009) study comparing the Trigen retrograde intramedullary nail, DCS, and locking compression plate condylar plate.¹⁷ This research is important as it assesses the mechanical properties of these devices, essential for choosing the right method for different fracture types and patient needs. Andrade et al.'s (2010) comparison of 95 blade plates and dynamic condylar screws also offers valuable insights, highlighting factors influencing the choice of device based on fracture pattern and bone quality.¹⁸ The results of Gill et al.'s (2021) study on the use of the dynamic condylar screw and condylar blade plate in adults with Type A distal femur fractures advance our knowledge of the long-term consequences of these devices on healing and mobility.¹⁹

The introduction of locking compression plates (LCP) in fracture care represents a significant advancement in orthopaedic surgery, particularly for managing complex periarticular fractures that are close to joint areas.²⁰ These fractures require precise reduction and stable fixation to ensure optimal joint function during post-recovery. LCPs have become essential in treating such fractures, providing a unique blend of conventional plating techniques and modern technology to increase fixation strength and promote better healing outcomes. The unique locking mechanism of LCPs offers a significant advantage in securing fracture fragments, especially in cases with compromised bone quality, such as osteoporosis. This feature is especially beneficial for elderly patients, who are more prone to periarticular fractures. The LCPs enable surgeons to effectively manage these challenging cases, ensuring better stability and alignment of the fracture.²¹

Additionally, research has concentrated on using LCPs for fractures surrounding the knee that are peri- and intra-articular. These studies highlight LCPs' ability to enable early joint mobilization, which is crucial in the recovery process. Early mobilization helps in preventing

long-term complications like joint stiffness, a common problem with traditional fracture treatment methods. The flexibility and stability provided by LCPs allow for such early mobilization, which is key to successful recovery in periarticular fractures.²²

The biomechanical principles underlying locking compression plates (LCPs), as explained in numerous studies, highlight their effectiveness in fracture management. The design of LCPs, involving locked plates and screws, forms a fixed-angle structure that offers more stable and secure fixation compared to traditional plates. This stability is crucial in managing complex fractures and in areas where bone quality is compromised, ensuring reliable screw placement. Furthermore, recent advancements in LCP technology, such as 'far cortical locking,' introduce an element of flexible fixation. This feature permits controlled micro-movements at the fracture site, aiding the healing process by mimicking the biomechanical conditions usually provided by external fixators.

Schmal et al. (2011) examined the biomechanical characteristics of external fixators and locking plates in a comparable setting.²³ Their findings suggest that locking plates can act as 'internal fixators', offering a balance between the rigid fixation needed for immediate stability and the flexibility necessary for natural bone healing. This is particularly important for periarticular fractures, where preserving blood supply and promoting bone healing are as essential as ensuring mechanical stability. Greiwe and Archdeacon's (2007) discussion on the advancements in locking plate technology highlights continuous improvements in plate design and materials, enhancing biomechanical features and clinical effectiveness. Additionally, a study conducted on 2017 on the use of locking compression plates (LCPs) in managing periarticular knee fractures emphasizes the crucial role of these plates in complex cases. In such scenarios, traditional fixation methods may fall short in providing the necessary stability and anatomical fixation.²⁴

The integration of locking compression plates into the arsenal of fracture management tools represents a paradigm shift in treating periarticular fractures. Their design innovation, coupled with biomechanical superiority, offers enhanced fixation stability and a promising pathway for improved healing and functional recovery in patients.

Statement of the problem

One major problem in orthopaedic surgery is the efficient care of distal femur fractures, especially those with intra-articular extension. Such fractures often result from high-velocity impacts, commonly seen in road traffic accidents, and pose unique difficulties due to their complex nature and the crucial role of the knee joint in functional mobility. Traditional fixation methods, while having played a pivotal role in the evolution of fracture treatment, have shown limitations in dealing with these challenging scenarios.

One of the critical issues encountered with current fixation techniques is the occurrence of varus collapse, especially in osteoporotic bones commonly found in older populations. This complication can lead to suboptimal alignment of the joint, impairing the knee function and potentially leading to long-term disabilities. Additionally, implant failures, including screw loosening or plate breakage, are not uncommon, further complicating the recovery process and sometimes necessitating additional surgical interventions.²⁵

Given these challenges, there is an increasing need to explore and evaluate advanced fixation strategies that can offer enhanced stability, particularly in cases of comminuted articular fractures. The Variable Angle-Locking Compression Plate (VA-LCP) system represents a contemporary solution, purported to improve fixation rigidity and adaptability to the complex geometry of periarticular fractures. However, the efficacy and reliability of VA-LCP in

ensuring optimal functional and radiological outcomes in patients with distal femur fractures are not fully established.

This gap in knowledge underscores the need for a comprehensive investigation into the functional and radiological outcomes of distal femur fractures treated with VA-LCP. Understanding the effectiveness of VA-LCP in various clinical scenarios is crucial for advancing treatment strategies, reducing the incidence of complications, and ultimately enhancing the quality of life for patients affected by these debilitating injuries.

Need for the study

This prospective study has the potential to significantly advance fracture management strategies in orthopaedic trauma care by examining the functional and radiological outcomes of distal femur fractures treated with Variable Angle-Locking Compression Plates (VA-LCP). Investigating the efficacy of VA-LCP in treating complex fractures, especially those resulting from high-velocity impacts, this research could reshape the current understanding and practices in orthopaedic fixation methods. The emphasis on both functional and radiological outcomes offers a comprehensive view of patient recovery, assessing not just the physical healing of fractures but also the restoration of mobility and joint function. This approach is particularly pertinent for distal femur fractures, where successful treatment significantly impacts long-term mobility and quality of life. The study's insights into the effectiveness of VA-LCP in diverse patient groups, including the elderly and those with osteoporosis, are vital considering their increased risk of complications and the growing prevalence of such conditions in the global population.²⁶

The implications of this study extend to the economic and healthcare domains, highlighting the importance of efficient fracture management strategies. Effective treatment methods, such as the one being investigated, can lead to fewer revision surgeries, shorter hospital stays, and overall cost savings for healthcare systems. This aspect is crucial in the context of global healthcare, where resource optimization is key to delivering high-quality care. Moreover, the international relevance of this research is underscored by the universal nature of road traffic accidents, a primary cause of such injuries. The findings could therefore inform treatment protocols worldwide, aiding in the enhancement of trauma care in various healthcare settings. Through this research, the aim is to provide essential evidence that may guide future studies and influence clinical practices, ultimately enhancing patient care and advancing the field of trauma management on a global scale.



AIMS & OBJECTIVES



AIM AND OBJECTIVES

Aim

The Aim of the study is to analyse the results of Variable angle- Locking compression plate (VA-LCP) in Distal intra-articular Femur Fracture.

Objectives

- To evaluate the radiological outcome in a patient with distal femur fracture with intra-articular extension treated with ORIF + VA-LCP (Variable angle-Locking Compression Plate) by follow up Radiographs.
- To evaluate the functional outcome post-operatively using NEERS score.

Research Hypothesis

Null Hypothesis (H0):

When distal femur fractures are treated with Variable Angle-Locking Compression Plates (VA-LCP) as opposed to traditional fixation techniques, there is no discernible difference in the functional and radiological results.

Alternative Hypothesis (H1):

When treating distal femur fractures with intra-articular extension, Variable Angle-Locking Compression Plates (VA-LCP) offer noticeably superior functional and radiological results than traditional fixation techniques.



REVIEW OF LITERATURE



REVIEW OF LITERATURE

Distal Femur Fractures

Because of its complexity, which is determined by the patient's demographics, the mode of injury, and the distinct anatomical and biomechanical characteristics of the distal femur, distal femur fractures pose a considerable orthopaedic challenge. The two patient categories most affected by these fractures are young individuals who have experienced high-energy trauma and elderly patients who have osteoporosis and have fallen with low energy.

In the younger demographic, distal femur fractures are often the result of high-velocity impacts, such as those seen in motor vehicle collisions or falls from height. The biomechanics of such traumas typically lead to comminuted and intra-articular fractures. These injuries may involve extensive soft tissue damage, and there's a high incidence of concomitant vascular and nerve injuries. The primary surgical challenge in this context is achieving stable internal fixation to permit early mobilization while addressing the complex articular involvement. The treatment approach must be aggressive and meticulously planned, often necessitating the use of advanced fixation techniques like locked plating systems or intramedullary nailing, tailored to the fracture's specifics.²⁷

In contrast, the elderly population, especially those with underlying osteoporosis, tend to sustain these fractures from minimal trauma. Although the degree of comminution might be less severe compared to high-energy injuries, the compromised bone quality poses a significant challenge in achieving reliable fixation. The surgical strategy in such cases often revolves around maximizing fixation strength in osteopenic bone, possibly using augmentation techniques, and minimizing additional trauma to already fragile osseous structures.

Regardless of the etiology, distal femur fractures require precise anatomic reduction, especially in cases of intra-articular involvement, to prevent the onset of post-traumatic osteoarthritis. Achieving stable fixation is critical for enabling early knee mobilization and rehabilitation, which is vital considering the knee's significant functional role. However, the management of these injuries carries a considerable risk of complications, including infection, malunion or non-union, and joint stiffness, necessitating diligent perioperative planning, surgical execution, and postoperative care.²⁸

Challenges in treating distal femur fractures

Treating distal femur fractures presents a multitude of challenges, each requiring meticulous attention and strategic planning. The unique anatomy of the distal femur, coupled with the diverse patient demographics affected by these fractures, adds layers of complexity to their management. One primary challenge in treating these fractures is managing the diverse etiologies and patient populations. In young adults, these fractures usually result from high-energy trauma and often present as comminuted and intra-articular, complicating the reconstruction of the joint surface. Precise anatomical reduction is paramount to prevent post-traumatic arthritis and to restore joint function. However, the significant comminution often seen in these injuries can make achieving and maintaining this reduction challenging. Additionally, these injuries frequently involve considerable soft tissue damage, which not only complicates the surgical approach but also poses a higher risk of postoperative complications, such as infection and delayed healing.²⁹

In the elderly population, particularly those with osteoporosis, the fractures may not be as comminuted, but the poor bone quality presents a significant hurdle in achieving stable fixation. Standard fixation methods may not be sufficient due to reduced bone density, necessitating the use of specialized implants and techniques like locking plates or

augmentation to ensure stability. Moreover, this demographic is often associated with comorbid conditions that can complicate both the surgery and the postoperative recovery process.

Another significant challenge is the risk of complications, regardless of patient age or trauma severity. These complications include infection, non-union or malunion of the fracture, and joint stiffness, all of which can severely impact the patient's functional outcome and quality of life. Managing these risks involves not only a meticulous surgical technique but also comprehensive preoperative planning and thorough postoperative care. This includes careful patient selection for surgery, thoughtful consideration of implant choice and surgical approach, and diligent postoperative rehabilitation to encourage early mobilization and reduce the risk of joint stiffness.³⁰

The proximity of the distal femur to the knee joint adds another layer of complexity, as any misalignment or instability in the fixation can directly impact the knee's function. The surgeon must balance the need for rigid fixation to allow early mobilization with the need to preserve knee function, often necessitating a tailored approach that considers both the biomechanical demands of the fracture and the physiological needs of the patient. A detailed grasp of the anatomy as well as the difficulties presented by the patient's age, bone quality, and injury characteristics are necessary for the treatment of distal femur fractures. A complete strategy that incorporates surgical expertise, meticulous planning, and a deep comprehension of the biomechanical and biological concepts governing fracture management is essential for a good outcome.³¹

Distal Femur

The distal femur is a critical anatomical structure, characterized by its complex geometry and significant role in knee joint function. It forms the lower part of the femur, or thigh bone, which is the longest and one of the strongest bones in the human body.

Bone Composition of the Distal Femur

Cancellous Bone

The interior of the distal femur is predominantly composed of cancellous (trabecular) bone. This spongy bone is characterized by a honeycomb-like network of trabeculae, which are small, interconnecting rods or plates of bone tissue. The architecture of cancellous bone in the distal femur is oriented along lines of mechanical stress, enhancing its ability to withstand compressive forces. Cancellous bone, despite its less dense and more porous structure compared to cortical bone, plays a critical role in absorbing and distributing the loads placed upon the knee joint. This distribution is crucial during weight-bearing activities, as it reduces stress concentration on the articular surfaces and mitigates the risk of fracture under normal physiological conditions. The trabecular network within the cancellous bone also houses bone marrow, which is a site of hematopoiesis. Furthermore, its porous nature facilitates vascular and metabolic exchange, making it an active site in bone turnover and remodelling.³²

Cortical Bone

Encasing the cancellous bone is a layer of cortical bone, also known as compact bone. This layer is considerably denser and less porous than cancellous bone, contributing to the overall strength and rigidity of the distal femur. The cortical bone layer provides the primary resistance against bending and torsional (twisting) forces. It is thickest along the posterior aspect of the femoral shaft but becomes thinner as it approaches the articular surfaces of the femoral condyles. This transition in thickness is functionally significant as it allows for a

balance between strength and flexibility, necessary for joint movement and shock absorption. At the articulating surfaces, the cortical bone forms a thin layer known as subchondral bone, lying immediately below the articular cartilage. This layer is crucial for supporting the overlying cartilage, distributing loads across the joint surface, and providing a platform for the articulation with other bones in the knee joint.³³

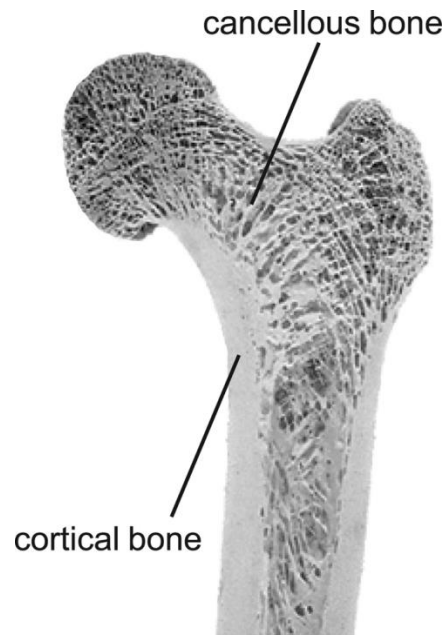


Figure 1: Cortical and Cancellous Bone

Articular Surfaces

The articular surfaces of the distal femur are intricate and highly specialized structures, essential for the complex mechanics of the knee joint. These surfaces include the femoral condyles and the patellar surface, each contributing distinctively to knee joint function.³⁴

Femoral Condyles

The medial and lateral femoral condyles are two rounded, convex projections that terminate the femur's distal end. Due to the uneven loading patterns of the knee joint during movement, these condyles are not symmetrical; the medial condyle is often larger and extends farther

than the lateral. The tibiofemoral joint is formed when the femoral condyles articulate with the corresponding condylar surfaces of the tibia. This articulation is a key part of the knee that enables some rotational mobility in addition to hinge-like movements (flexion and extension). The congruency between the femoral and tibial condyles is enhanced by the menisci – fibrocartilaginous structures that deepen the tibial plateaus. This arrangement, along with the surrounding ligamentous structures, provides crucial stability to the tibiofemoral joint, especially in weight-bearing. The convexity of the femoral condyles and their congruent relationship with the tibia facilitate the even distribution of axial loads across the joint, minimizing stress concentrations and reducing the risk of articular cartilage damage.³⁵

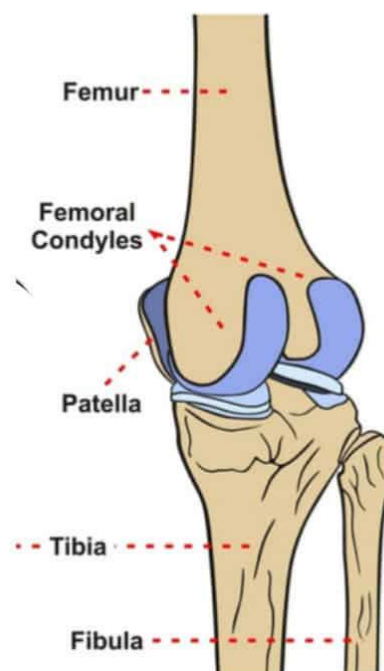


Figure 2: Femoral Condyles

Patellar Surface

Anteriorly, the distal femur exhibits a smooth, slightly grooved area known as the patellar surface or trochlea. This surface is designed for articulation with the posterior surface of the patella, forming the patellofemoral joint. The trochlear groove is deeper laterally, which helps

in guiding the patella and maintaining its alignment during knee movements.³⁶ The patellofemoral joint plays a critical role in the knee extension mechanism. As the knee extends and flexes, the patella glides along the trochlear groove, effectively increasing the lever arm of the quadriceps muscle and enhancing the efficiency of knee extension. This mechanism is essential for activities like walking, running, and jumping. The articular cartilage of the patellar surface is among the thickest in the human body, designed to withstand the high compressive forces encountered during knee extension. The congruency of the patella with the femoral trochlea also aids in distributing these forces over a larger surface area, minimizing cartilage wear and maintaining joint integrity.³⁷



Figure 3: Patellar Surface

Intercondylar Notch

The intercondylar notch, a key anatomical feature of the distal femur, plays a vital role in the stability and function of the knee joint. It is a deep, saddle-shaped indentation situated between the medial and lateral femoral condyles on the posterior aspect of the femur. This notch has several crucial biomechanical and functional aspects. The intercondylar notch

exhibits considerable variability in shape and size among individuals. Commonly observed shapes include triangular, round, and stellate. The notch width and depth can influence knee ligamentous structures and have been studied in relation to knee ligament injuries, particularly the anterior cruciate ligament (ACL). The surfaces of the intercondylar notch are formed by the articular cartilage-covered condyles and the intercondylar eminence of the tibia. The boundaries are demarcated anteriorly by the patellar surface and posteriorly by the femoral condyles.³⁸

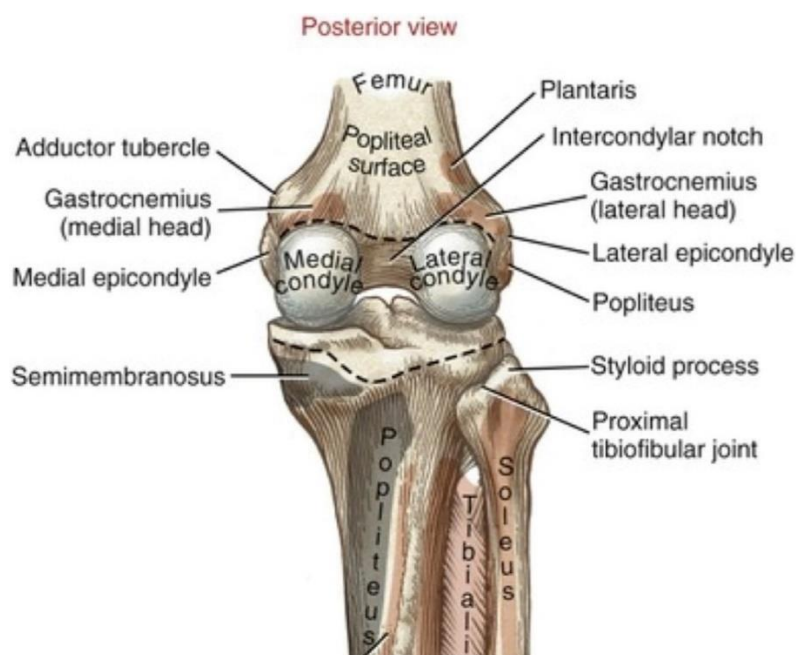


Figure 4: Intercondylar Notch

Functional Significance

The primary functional significance of the intercondylar notch is its role as the housing for the knee's cruciate ligaments. These ligaments are pivotal for the stability of the knee joint:

Anterior Cruciate Ligament (ACL): Originating from the posterior aspect of the intercondylar notch, the ACL travels anteriorly, downward, and medially to attach to the tibia. It primarily prevents anterior translation of the tibia relative to the femur and contributes to rotational stability.³⁹

Posterior Cruciate Ligament (PCL): This ligament originates from the anterior part of the intercondylar notch and travels posteriorly and laterally to attach to the posterior aspect of the tibia. It primarily prevents posterior displacement of the tibia and plays a role in the overall stability of the knee.⁴⁰

Implication in Knee Injuries: The morphology of the intercondylar notch is clinically significant, particularly in the context of ACL injuries. A narrower notch has been associated with a higher risk of ACL injuries, presumably due to the constrained space and potential impingement of the ligament.

Vascular Supply of the Distal Femur

Arterial Supply

The vascular supply to the distal femur is primarily derived from branches of the femoral artery, with a significant contribution from the popliteal artery as it traverses the posterior aspect of the knee joint. Central to this network are the genicular arteries, encompassing the superior, middle, and inferior genicular arteries. These vessels encircle the knee joint, forming an anastomotic ring that provides a rich blood supply to the periarticular regions. This network plays a crucial role in sustaining the distal femur, particularly in scenarios where the main arterial supply might be compromised, such as in surgical procedures or traumatic injuries.⁴¹

Branching off from this genicular network are the metaphyseal arteries. These vessels are specifically responsible for supplying blood to the metaphysis of the distal femur. Their role becomes especially pivotal in the context of bone growth and in the healing of metaphyseal fractures. The nutrient artery, a crucial vessel entering the diaphysis of the femur, significantly contributes to the vascularity of the distal femur. This artery penetrates the

cortical bone, supplying the medullary cavity and the inner aspects of the cortical bone. The nutrient artery plays a key role in the maintenance and turnover of the bone marrow, as well as in the healing processes following fractures or surgical interventions.

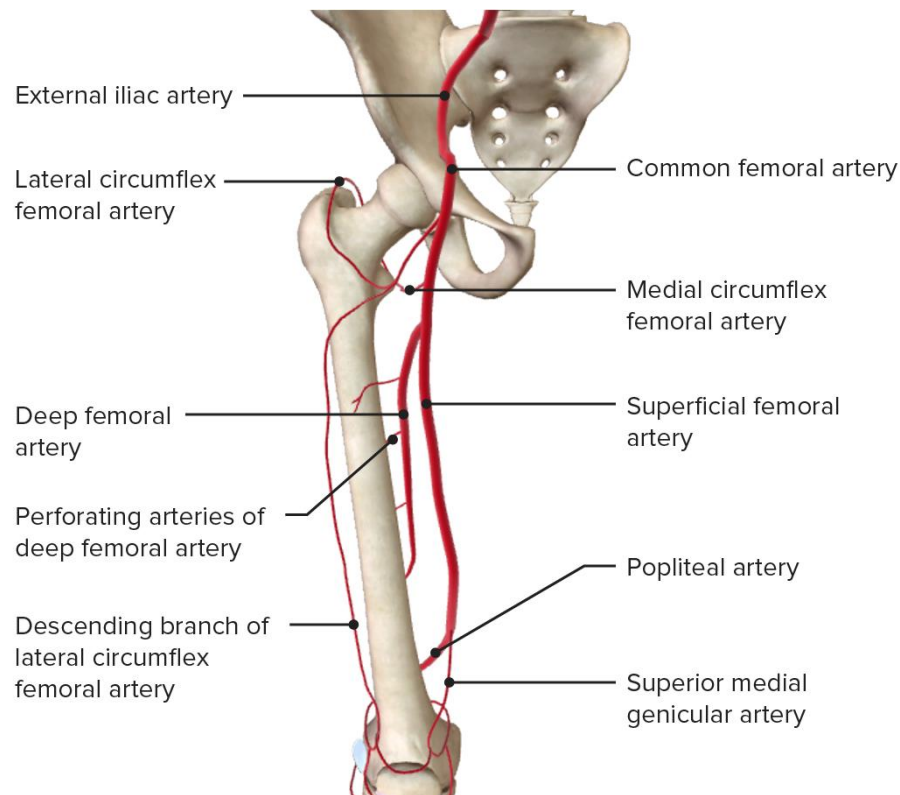


Figure 5: Arterial Supply

Venous Drainage

The venous drainage of the distal femur is intricately aligned with its arterial supply, ensuring efficient blood return from this region. This venous network is primarily composed of veins accompanying the genicular arteries, reflecting the principle of *venae comitantes* where veins closely parallel the course of arteries.

Genicular Veins: These veins form a crucial part of the venous drainage system of the distal femur. As with the genicular arteries, there are superior, middle, and inferior genicular veins. They closely follow the path of their respective arteries, draining blood from the periarticular

regions of the knee, including the distal femur, and play a significant role in the venous return from these areas.

Popliteal Vein: The collected blood from the genicular veins is ultimately drained into the popliteal vein. This vein, situated posteriorly in the knee region, acts as a major conduit for venous blood from the lower leg. As it ascends, the popliteal vein passes through the adductor hiatus to become the femoral vein in the thigh.

Femoral Vein: Continuing its course in the thigh, the femoral vein carries venous blood from the lower limb back towards the heart. It is a substantial vessel in the venous system of the lower extremity, contributing significantly to the overall circulatory dynamics.

This venous architecture not only complements the arterial supply in terms of route and regional blood flow but is also crucial from a clinical perspective. Knowledge of the venous drainage of the distal femur is important in various medical scenarios, including understanding the patterns of venous return in the lower limb, managing conditions like deep vein thrombosis (DVT), and during surgical procedures in and around the knee joint. Any interruption or compromise in this venous system can have significant implications for lower limb circulation and requires careful consideration in both diagnostic and therapeutic approaches in orthopedics and vascular medicine.

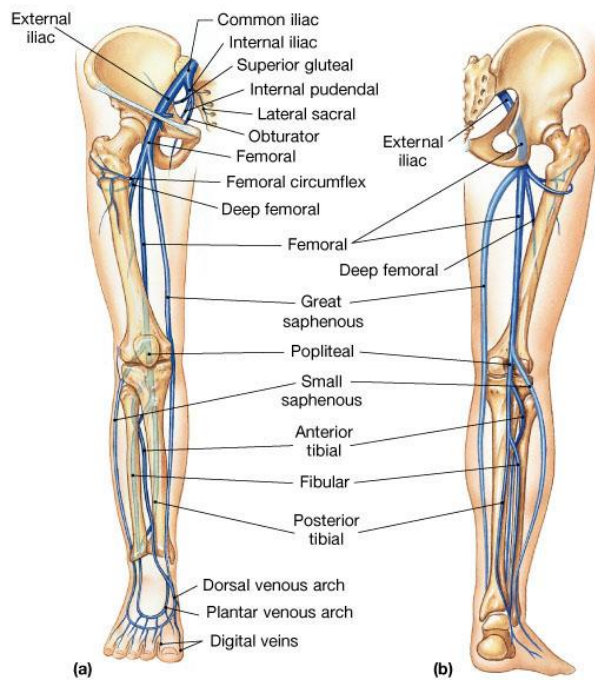


Figure 6: Venous Drainage

Innervation of the Distal Femur

The innervation of the distal femur and surrounding structures of the knee joint is predominantly provided by branches of the sciatic nerve, specifically the tibial and common peroneal nerves.

Articular Branches: These branches arise mainly from the sciatic nerve and its divisions, innervating the capsule and ligaments of the knee joint.

Cutaneous Innervation: Skin overlying the distal femur and knee area is innervated by branches of the saphenous nerve (a branch of the femoral nerve) and the posterior cutaneous nerve of the thigh (a branch of the sciatic nerve).

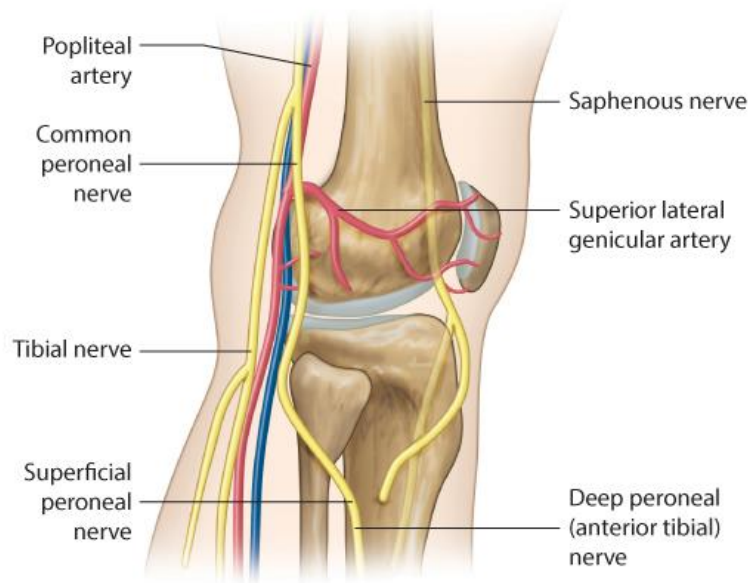


Figure 7: Nerve Supply

Biomechanical Properties of the Distal Femur

The distal femur is a biomechanically complex structure designed to accommodate various types of stresses, including compressive, tensile, and shear forces. The architecture of the femur, particularly in its distal part, reflects its ability to absorb and redistribute these forces effectively. The trabecular bone within the distal femur is organized in alignment with principal stress lines, an adaptation based on Wolff's law, which posits that bone remodels in response to the mechanical stresses it endures. This alignment not only strengthens the femur but also aids in efficient load distribution. The cortical shell surrounding the trabecular core provides rigidity and resistance against bending and torsional forces. Additionally, the articular congruency of the femoral condyles, augmented by the menisci and articular cartilage, ensures smooth movement and further assists in the distribution of mechanical loads across the joint surfaces, critical for reducing localized stress and preventing degenerative changes.

Load-Bearing Functions of the Distal Femur

Functionally, the distal femur plays a pivotal role in the knee joint's weight-bearing and movement. It acts as the primary interface for transferring body weight from the femur to the tibia, a process essential both during static activities like standing and dynamic ones such as walking or running. This transfer is facilitated by the structural alignment and integrity of the distal femur with the proximal tibia. During high-impact activities, the distal femur significantly contributes to shock absorption. The forces generated are absorbed and dissipated by the bone's structure and surrounding soft tissues, mitigating impact on the joint and reducing injury risk. Furthermore, the distal femur serves as an anchorage point for crucial muscle groups like the quadriceps femoris. These muscular attachments are integral to generating movements and providing dynamic stability to the knee, particularly for actions involving knee extension and stabilization during locomotion. The overall design and structure of the distal femur are thus critical in maintaining normal knee function and accommodating the mechanical demands placed on the lower limb.

Evolution of Surgical Fixation Techniques

The evolution of surgical fixation techniques for distal femur fractures reflects a significant advancement in orthopedic surgery, driven by a deeper understanding of fracture biomechanics and the need for more effective and reliable treatment methods.

History of Fixation Methods

Initially, treatment of distal femur fractures was predominantly non-surgical, focusing on prolonged bed rest and casting. However, these methods often led to poor outcomes, including malunion, non-union, and prolonged immobilization complications. As surgical techniques developed, **traditional plating** emerged as a primary method for managing these fractures. Early fixation plates were non-locking and required precise contouring to the bone.

While this method improved alignment and allowed for some degree of early mobilization, it had limitations, particularly in osteoporotic bone or comminuted fractures where achieving stable fixation was challenging. The introduction of the **Dynamic Condylar Screw (DCS)** marked a significant advancement. This system combined a large-diameter screw (the condylar screw) with a side plate, providing more stable fixation in the distal fragment than traditional plating. DCS was particularly effective in managing fractures with an intact lateral femoral condyle, allowing for controlled dynamic compression of the fracture site.⁴²



Figure 8: Dynamic Condylar Screw

Limitations of Older Techniques

Despite advancements, these older techniques had limitations, especially in comminuted fractures and in patients with poor bone quality. One major challenge was achieving stable fixation in comminuted fractures where the bone fragments were too small or fragile to support screws or plates. This issue was often compounded in osteoporotic bone, prevalent in elderly patients. Another limitation was the risk of disturbing the blood supply to bone fragments during extensive surgical exposure and hardware application, potentially impeding

fracture healing. Additionally, non-locking plates relied heavily on the bone's ability to provide stable screw purchase, which was not always achievable in compromised bone conditions.

These challenges drove the development of newer fixation technologies, including locked plating systems and intramedullary nailing, which provided more versatile and biologically friendly options for managing complex distal femur fractures. Modern techniques focus on minimizing surgical trauma, preserving blood supply, and providing stable fixation across a variety of fracture patterns and bone qualities. These advancements have significantly improved outcomes for patients with distal femur fractures, offering enhanced stability, faster recovery, and reduced complications.

Development of Locking Compression Plates

The development of locking compression plates (LCP) has been a significant milestone in the field of orthopedic trauma surgery, particularly influencing the management of complex fractures such as those in the distal femur. These advanced fixation devices are designed to overcome many of the limitations associated with traditional plating systems. Locking compression plates differentiate themselves through a unique mechanism where the screws lock into the plate, creating a fixed-angle system. This design contrasts with traditional plates, where the stability depends on the bone-plate friction and the bone's ability to withstand compressive forces. The locked screw-plate interface in LCPs offers angular stability, which is especially beneficial in managing fractures in osteoporotic bone or where there is significant comminution.⁴³

One of the primary advantages of LCPs is their ability to maintain angular stability, reducing the likelihood of screw loosening and migration, a common issue with conventional plates. This stability is particularly crucial in osteoporotic bone, where conventional screws may fail

to achieve secure purchase. Moreover, the design of LCPs allows for their application using minimally invasive techniques, which helps preserve the periosteal blood supply essential for fracture healing. This approach is advantageous in reducing the risk of disrupting the blood supply, particularly in fractures with a high risk of vascular compromise.

LCPs are versatile in their application, suitable for various fracture patterns. They can be used in compression mode for non-comminuted fractures or in bridge mode for comminuted fractures, providing surgeons with a wide array of options to address different clinical scenarios. The biomechanical support offered by the fixed-angle construct of LCPs is superior, especially in complex or unstable fracture patterns where traditional plating might not provide sufficient stability.



Figure 9: a Locking compression plate LCP : b Variable angle locking compression plate

Biomechanical Principles of Fixed-Angle Stability in Locking Compression Plates

The biomechanical innovation of locking compression plates (LCPs) is primarily centered around the concept of fixed-angle stability. Unlike traditional plating systems, where the

stability is dependent on the bone-plate friction and the bone's ability to provide secure screw purchase, LCPs employ a mechanism where screws lock into the plate. This locking mechanism creates a fixed-angle construct, ensuring consistent and predictable stability independent of the bone's condition. This is particularly advantageous in osteoporotic or otherwise compromised bone, where conventional screws may fail to maintain their hold. Moreover, the fixed-angle stability of LCPs allows for even distribution of mechanical loads across the plate and screws, reducing the risk of implant failure and enhancing the overall stability of the fracture fixation.⁴⁴

Advantages of Fixed-Angle Contact in Fractures of the Distal Femur

The advantages of fixed-angle contact in LCPs are especially noteworthy in the case of distal femur fractures. First of all, these plates offer better attachment in low-quality bones, such as osteoporotic bone, which is a prevalent problem in the elderly. The fixed-angle design guarantees that the stability of the fixation is not only dependent on the structural integrity of the bone. Secondly, LCPs are more resistant to shear and rotational forces, which are prevalent in the biomechanics of the knee joint. This resistance is crucial for maintaining the alignment and stabilization of the fracture, especially in comminuted or complex fracture patterns. Furthermore, the design flexibility of LCPs allows for strategic screw placement even in cases where fracture fragments offer limited options for secure anchorage. Lastly, the minimally invasive application of LCPs helps preserve the periosteal blood supply around the fracture site, which is vital for bone healing and reducing complications like non-union. Thus, the use of LCPs in the distal femur enhances the overall treatment outcomes by providing robust, reliable fixation suited to the complex demands of this anatomical region.

Comparative Analysis of Different Surgical Techniques

The usefulness of locking compression plates for treating distal femoral intra-articular fractures was examined in a study by Kiran Kumar GN et al. Analysing 46 cases treated between 2009 and 2012, with a demographic predominantly of men (36 out of 46), and an age range of 20-72, the study focused primarily on fractures classified as C3 (AO classification), often resulting from high-energy trauma. Over an average follow-up of 25 months, radiological union was typically achieved by 12 weeks, with 86% of patients reporting good to excellent outcomes. The study highlights the success of using a standard lateral approach for simple C1 fractures and trans articular or minimally invasive techniques for more complex C2 and C3 fractures. This approach facilitated better joint exposure and union rates, with a reduced need for bone grafting, indicating the efficacy of locking compression plates in managing such challenging fractures.⁴⁵

In a study conducted by Higgins TF et al., compared the strength of fixation between a locking distal femoral plate and a condylar blade plate in treating comminuted distal femur fractures. Using eight pairs of fresh-frozen cadaveric femurs with controlled bone density, the researchers created a gap osteotomy model to mimic an OTA/AO A3 fracture. Each femur pair was fixed with either a blade plate or a locking plate, and subjected to a 100 N preload and 10,000 cycles of loading between 100 N and 1000 N. Results showed that the locking plate had significantly less axial displacement (1.04 ± 0.33 mm) compared to the blade plate (1.70 ± 0.45 mm) after cyclic loading, and also withstood a higher maximum load before failure (9085 ± 1585 N versus 5591 ± 945 N for the blade plate). The study concluded that the locking screw-plate construct offered superior biomechanical performance over the blade plate in the fixation of comminuted distal femur fractures, suggesting its preferable use in such surgical scenarios.⁴⁶

In a study conducted by Yeap EJ and Deepak AS explored the outcomes of using titanium distal femoral locking compression plates for Type A and C distal femoral fractures, as categorized by the AO classification. This retrospective review encompassed eleven patients treated between January 2004 and December 2004, with ages ranging from 15 to 85 years and an average age of 44. The effectiveness of the treatment was evaluated using the Schatzker scoring system at least six months after surgery. The findings indicated varied results: four patients achieved excellent recovery, four good, two fair, and there was one instance of treatment failure.⁴⁷

In the study conducted by Kohli S et al. examined the effectiveness of locking compression plates (LCP) in treating intra-articular distal femur fractures, a challenging and controversial area in orthopedic surgery. The retrospective study, spanning from June 2013 to December 2015, included 27 patients with AO/OTA classification type C2 and C3 fractures. Patients, aged 20 to 77 years, were assessed for functional and radiological outcomes over a minimum one-year follow-up, with monthly evaluations in the outpatient department. Results showed that 90% (24 patients) achieved radiological union within 20 weeks, with an average union time of 16.1 weeks. Most patients (over 20) regained a knee range of motion exceeding 90 degrees, and 59% scored excellent in NEER's scoring system for functional outcomes. Complications included one case of superficial skin infection, limb shortening in three patients, varus angulation in two, implant failure in three, and one instance of fat embolism. These results, demonstrating superior functional and radiological outcomes, suggest that LCP fixation, while technically demanding, is a viable method, particularly in fractures where articular surface congruency is hard to achieve with less invasive methods such as retrograde nailing and LISS.⁴⁸

In their 2001 study, Schandelmaier P et al. explored the evolution of surgical techniques in stabilizing distal femur fractures, noting a shift towards minimally invasive procedures and submuscular plate placement, reducing the incidence of non-unions and the necessity for bone grafting. The study highlights the simplified reconstruction of complex articular injuries via enhanced visualization through a lateral peripatellar approach. The introduction of the Less Invasive Stabilization System (LISS) has streamlined the process of percutaneous plate osteosynthesis, employing an insertion guide for monocortical, self-tapping screw placement, with a plate thread providing angular stability. For extra-articular and simple intra-articular fractures, the distal femoral nail with a spiral blade offers improved fixation. Despite these advancements in surgical techniques and implant technology, functional deficiencies persist, particularly in patients with complex intra-articular fractures and in elderly patients, where 'fatigue failure' of osteoporotic implant-bone constructs remains a concern. LISS, however, emerges as a beneficial option, circumventing the need to add bone cement in osteosynthesis procedures.⁴⁹

In the study conducted by Martinet O et al. analysed AO Documentation reports from 1980 to 1989, encompassing 2,165 distal femur fractures, to understand the patterns and demographics of these injuries. The study, which included 1,051 women and 1,114 men, identified a bimodal distribution in the incidence of these fractures. They found a higher prevalence of fractures in young men, around 20 years old, often related to traffic accidents or sports, and in older women, around 70 years old, typically due to falls at home and often associated with osteoporosis. This pattern highlights the variation in causes and prevalence of distal femur fractures across different genders and age groups.⁵⁰

In the 2018 study by Milan SK, the efficacy of variable angle locking compression plates (VA-LCP) for internal fixation in distal femur fractures was investigated, particularly in those

resulting from road traffic accidents and falls linked to construction activities. The study, which covered 30 cases from August 2016 to August 2018, aimed to assess anatomical reduction by operative treatment, radiological union rates, and clinical outcomes like range of motion, pain relief, and return to work. Follow-up was conducted for a minimum of six months using the NEER score. Results indicated that all fractures healed within an average of 20 weeks, and the average NEER score was 76.06. VA-LCP was deemed the treatment of choice for comminuted distal femoral fractures, especially Type C3, which is complicated by a learning curve in surgical technique but offers benefits like avoiding intra-articular screw penetration and preserving periosteal vessels. The study concluded that while Type C3 fractures showed some poor results, the meticulous application of VA-LCP principles could reduce complications and improve outcomes.⁵¹

In the 2020 study by Campana V et al., the use of Synthes Variable Angle Locking Compression Condylar Plate (VA-LCP) for the treatment of distal femoral intra-articular fractures was evaluated amidst recent critical literature. The retrospective study included 42 patients treated with a 4.5 mm VA-LCP Curved Condylar Plate, with follow-ups at various intervals up to a year, and utilized WOMAC, KOOS Knee Survey, Knee Score Society, and SF-12 questionnaire for clinical and functional assessments, along with radiographic evaluations of fracture healing and limb alignment. The study found that most patients (57%) had type 33-A fractures, with 33 cases achieving radiological healing within a mean of 13 weeks. Complications were relatively few, with seven patients experiencing early or late postoperative issues, and five requiring additional surgeries. Functional outcomes were promising, with nearly half of the patients achieving full knee flexion of 130° or more and satisfactory mean scores on various assessment scales. The study concluded that osteosynthesis with VA-LCP Curved Condylar Plates showed good clinical and radiological

outcomes, comparable to other distal femoral locking plates, without early mechanical failure.⁵²

In the 2021 study, Chandrashekar HS et al. investigated the outcomes of treating comminuted metaphyseal fractures of the distal femur using a combination of lateral locking compression plates and medial TENS nail, evaluated via NEER's score. Covering 20 cases operated between November 2018 and April 2020, with patients ranging from 20 to 80 years old, the study focused on fractures classified as AO-Muller type A3 and C2. The majority of injuries were due to road traffic accidents, with a smaller portion resulting from falls. Procedures predominantly used a standard open lateral approach, except for two cases utilizing the MIPPO technique, with an average surgery time of 119.5 minutes. The study recorded an average radiological union at 18.6 weeks and the resumption of weight bearing at 20.5 weeks. Complications were noted in 9 patients, including superficial wound infection and knee pain/stiffness. With NEER's scoring, 45% of patients had an excellent outcome, 50% good to fair, and 5% poor. The study concludes that dual column fixation with medial TENS augmentation offers a stable solution that enables early range of motion, prevents varus collapse, malunion, and implant failure in the treatment of complex distal femur fractures.⁵³

In the 2023 study by Trikha V. and Gupta A., the evolution of treatment modalities for distal femur fractures, which constitute 0.4–1% of all fractures, was examined. Historically managed with conservative approaches, surgical fixation has now become the standard of care in modern orthopedic practices. Despite the availability of various implants for osteosynthesis, no single option has emerged as superior. The anatomical periarticular locking lateral plate, despite its high complication rates, remains a common choice for open reduction and internal fixation (ORIF) of these fractures. However, novel techniques such as dual plating, retrograde nailing, and nail-plate constructs have been developed and are

significantly enhancing clinical outcomes for complex distal femur fractures. Innovations in implant materials and designs are emphasizing biological fixation over strictly anatomical repair. Additionally, distal femur replacement has been introduced as a promising option for select patient populations, demonstrating the continuous advancement in the field.⁵⁴

The 2022 study by Trikha V and Gupta A reviews advancements in the management of distal femur fractures, which account for a small but significant percentage of all fractures. Traditionally managed non-surgically, these injuries are now predominantly treated with surgical fixation, a method that has become the standard in modern orthopedic care. Despite the availability of various osteosynthesis implants, none has demonstrated clear superiority. The anatomical periarticular locking lateral plate, commonly used in open reduction and internal fixation (ORIF), is associated with high complication rates, prompting the development of new techniques such as dual plating, retrograde nailing, and nail-plate constructs. These innovations have improved clinical outcomes for complex distal femur fractures. Additionally, advancements in materials and design have emphasized biological fixation, focusing on healing rather than just anatomical alignment. Distal femur replacement has also emerged as a feasible approach for select patients, reflecting the field's ongoing progress.⁵⁵

The 2023 study by Galante C et al. investigated the effectiveness of a nail-plate combination (NPC) implant in treating comminuted intra-articular distal femur fractures (AO/OTA 33C). This retrospective analysis encompassed 14 patients (8 males and 6 females), with 15 NPC implants, treated at a Level 1 trauma centre between June 2020 and January 2023. The patients, with a mean age of 48.5 years and predominantly presenting with open fractures (Gustilo Anderson type IIIA), were followed for a median of 392 days. Radiographic consolidation was achieved in 11 implants within an average of 5.4 months. At 12 months, all

patients could bear weight, with varying degrees of pain. The Schatzker Lambert Score ranged from excellent to failure, reflecting a mixed functional outcome. Postoperative complications included joint rigidity, limb shortening, and one case of septic non-union. These results suggest that the NPC implant could be a more effective option for managing complex distal femur fractures, though the study acknowledges a range of outcomes and complications.⁵⁶

In their 2020 study, Suveriya P and Ojha AK evaluated the outcomes of open reduction and internal fixation (ORIF) with locking compression plates (LCP) for treating intra-articular fractures of the distal femur. The prospective interventional study involved 25 patients treated at R.N.T. Medical College Udaipur from January to December 2018. Following surgery, patients were observed for a minimum of one year, with assessments including x-rays and clinical examinations. Functional and radiological results were gauged using NEER's score at the year's end. The study found 64% of cases to be excellent, 16% good, 12% fair, and 8% poor, with the majority achieving a mean knee flexion of 95 degrees. The findings suggest that ORIF with LCP is an effective treatment for distal femur intra-articular fractures, resulting in positive outcomes and enabling early mobilization with few complications.⁵⁷

Recent Advances and Current Trends

Recent advances in the surgical treatment of distal femur fractures have been driven by continuous innovations in implant design, surgical techniques, and a deeper understanding of fracture biology. Modern fixation devices, such as polyaxial locking systems and anatomically contoured plates, offer enhanced versatility and adaptability to various fracture patterns. The advent of 3D printing technology in surgical planning has allowed for more precise preoperative planning and the creation of custom implants tailored to individual patient anatomy. Minimally invasive surgical approaches have gained popularity, focusing on

reducing soft tissue disruption and preserving blood supply to promote faster healing and reduce infection rates. Biologic adjuncts like bone graft substitutes and growth factors are increasingly being used to enhance bone healing, especially in cases with poor bone quality or significant bone loss. Additionally, there is a growing emphasis on early, aggressive rehabilitation protocols to expedite functional recovery while minimizing the risk of stiffness and other complications. These current trends reflect a shift towards personalized, patient-specific treatment strategies that optimize outcomes by balancing mechanical stability, biological healing, and functional rehabilitation in the management of distal femur fractures.



MATERIAL & METHODS



METHODOLOGY

Study design

The study was a prospective observational hospital-based study.

Study period

The study period spanned from September 2022 to December 2023.

Source of Data

Patients aged between 20 to 70 years presenting to R.L. Jalappa Hospital and Research Centre, attached to Sri Devaraj Urs Medical College with distal third fractures of the femur, were included in the study.

Inclusion Criteria

- Patients with age between 18 to 70 years of age
- Patients with Radiologically confirmed distal 1/3rd femoral fractures of AO types B1, B2, C1, C2 and C3

Exclusion Criteria

- Patients with neurovascular injury with compound fractures
- Pathological distal 1/3rd femoral fractures.
- Periprosthetic fractures
- Patients with severe life-threatening medical co-morbidities

-
- Immunocompromised status.

Investigations

A comprehensive set of investigations was conducted on the participants to ensure a thorough medical assessment and to rule out any underlying conditions that could affect the outcomes. These investigations included a complete blood count (CBC) to assess overall health and detect a variety of disorders, erythrocyte sedimentation rate (ESR), bleeding time (BT), and clotting time (CT) to evaluate the blood's clotting capabilities. Additionally, assessments of blood urea and serum creatinine levels were performed to check kidney function. Random Blood Sugar (RBS) levels were monitored to rule out any diabetic conditions that could impede healing. Tests for HIV, Hepatitis B (HBsAg), and Hepatitis C (HCV) were carried out to identify any infections that could significantly impact the patient's immune response and recovery process. Electrocardiograms (ECG) were taken to screen for any cardiac issues that might present risks during the surgical treatment of the fractures.

Sampling Technique

Consecutive sampling was employed, where all patients who arrived at the hospital and fulfilled the inclusion criteria were enrolled in the study successively.

Sample size Estimation

Sarabjeet Kohli et al. reported that 82% of patients achieved radiological union before 18 weeks. Assuming an alpha error of 5% (95% Confidence Limit), the expected proportion (p) was set at 82%, and the absolute precision (d) was set at 12%. Using these parameters, the minimum required sample size to determine the proportion of patients who would achieve radiological union before 18 weeks was calculated using the formula:

Sample size (n) = $\frac{Z^2(P*Q)}{d^2}$ where

Z is the value for Confidence Interval

d is the absolute precision

p is the expected proportion and q=1-p

n = 40

Ethical considerations

Ethical clearance was obtained from the Institutional Review Board

Informed consent

Informed consent was obtained from the study participants prior to the commencement of the study after explaining the procedure in local language. Each participant provided consent through signature or thumb impression, confirming their understanding and voluntary agreement to be part of the study.

Data collection method

After obtaining informed consent, demographic data, medical history, clinical examination details, and investigation results were recorded in the study proforma. These patients then underwent open reduction and internal fixation with Variable Angle-Locking Compression Plating. During the preoperative evaluation, the fractures were assessed based on various criteria, including the degree of comminution, pattern (transverse, spiral, vertical split), presence or absence of displacement, deformity, and whether the fracture was intra-articular or extra-articular, using pre-reduction anteroposterior (AP) and lateral radiographs.

Postoperative evaluations were conducted at 1 month, 3 months, and 6 months. These assessments included x-ray examinations (AP and lateral views), measurement of the range of motion at the knee joint using a goniometer, and evaluation of the correction of deformity and the ability to bear weight.

Data analysis

The statistical methods used for this study involved entering data into Microsoft Excel and analysing it using the Statistical Package for the Social Sciences (SPSS), standard version 20. All continuous variables were summarised using the mean and standard deviation (SD). The time required for radiological union, the time to achieve full weight bearing, and knee flexion (in degrees) were summarised using the mean with a 95% confidence interval. The proportion of patients with radiological malunion and NEER's functional outcomes were reported using proportions with 95% confidence intervals.



RESULTS



RESULTS

Table 1: Gender Distribution of study participants

Gender	Number of Participants	Percentage (%)
Male	15	37.5
Female	25	62.5
Total	40	100

In Table 1 and Figure 1, gender distribution of the study participants is illustrated. The study includes a total of 40 participants, with a significant gender disparity. Out of the total participants, 15 are male, constituting 37.5% of the sample, while 25 are female, representing a larger proportion of 62.5%.

Figure 1: Gender Distribution of study participants

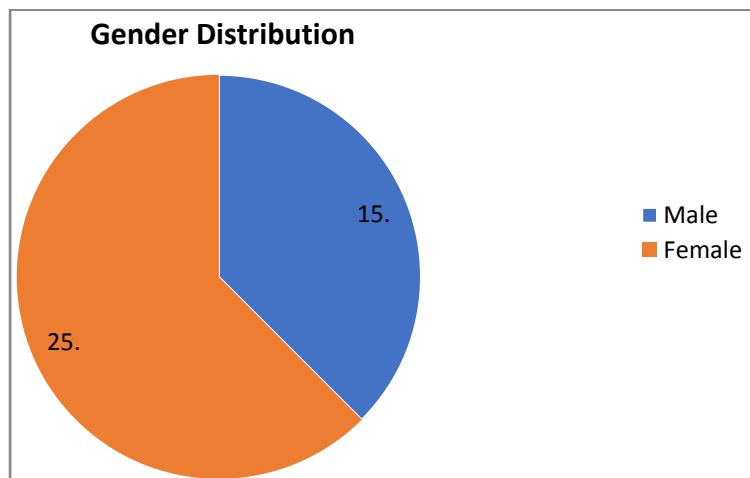


Table 2: Distribution of the side affected

Side Affected	Number of Participants	Percentage (%)
Right	26	65
Left	14	35
Total	40	100

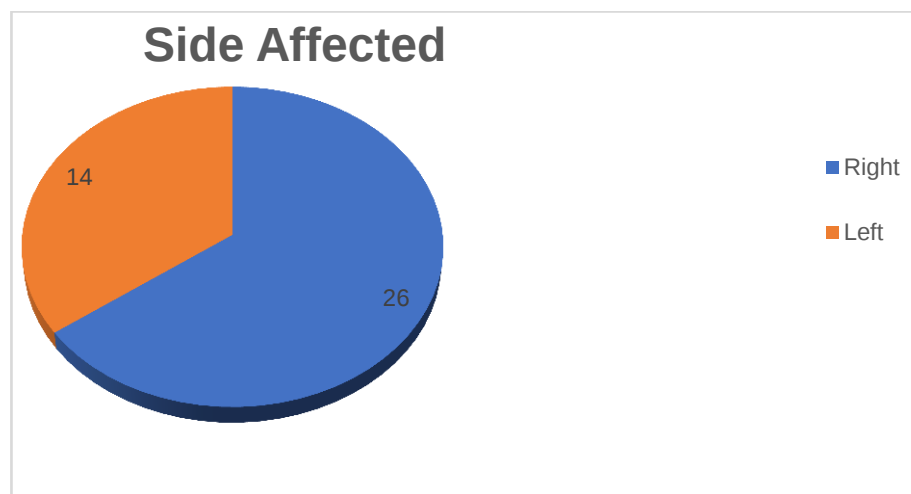
Figure 2: Distribution of the side affected

Table 2 and Figure 2 illustrate the distribution of the side affected among the study participants. The study findings revealed that out of 40 participants, the right side is affected in 26 individuals, making up 65% of the total sample. In contrast, the left side is affected in 14 participants, accounting for 35% of the sample. This distribution indicates a higher prevalence of right-side involvement among the participants.

Table 3: Age Distribution of the study participants

Age Range	Number of Participants	Percentage (%)
0-20	12	30.0
20-40	6	15.0
40-60	16	40.0
60-70	6	15.0
>80	0	0.0

Figure 3: Age Distribution of the study participants

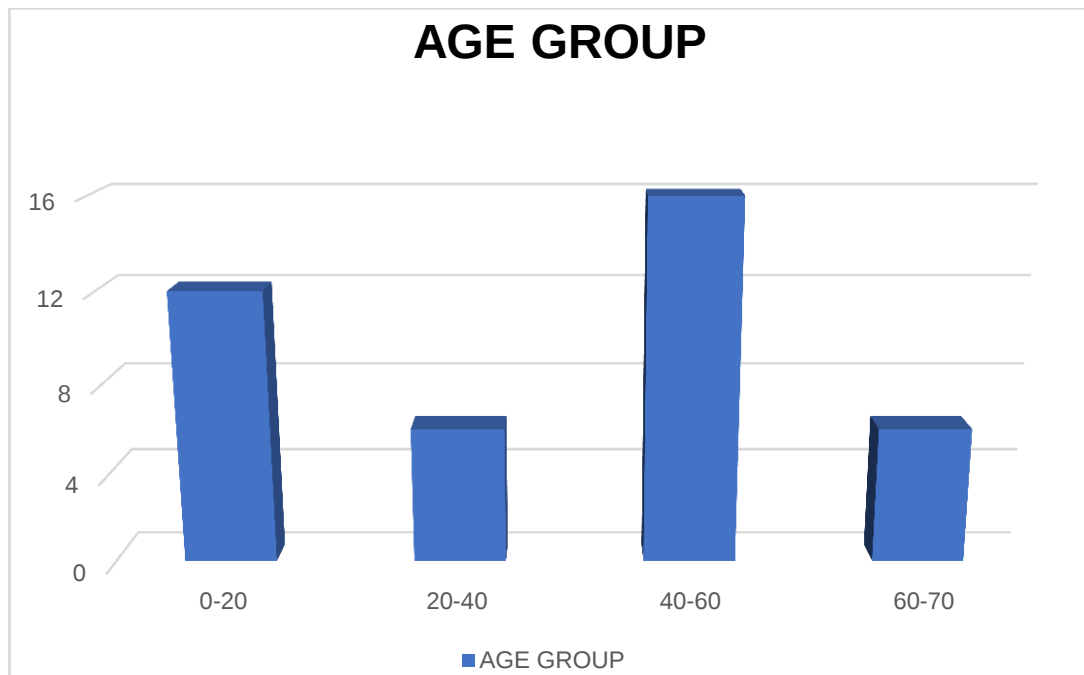


Table 3 and Figure 3 provide the age distribution of the study participants. The findings show that the majority of participants fall within the 40-60 age range, accounting for 40% of the total sample. This is followed by the 0-20 age range, which includes 30% of the participants. The 20-40 and 60-70 age ranges each comprise 15% of the participants.

Table 4: Distribution of Study Participants with Comorbidities

Comorbidities	Count	Percentage (%)
Diabetes	10	25.0
Hypertension	6	15.0
Diabetes and Hypertension	6	15.0
Thyroid Disorder	4	10.0
No Comorbidities	14	35.0

Figure 4: Distribution of Study Participants with Comorbidities

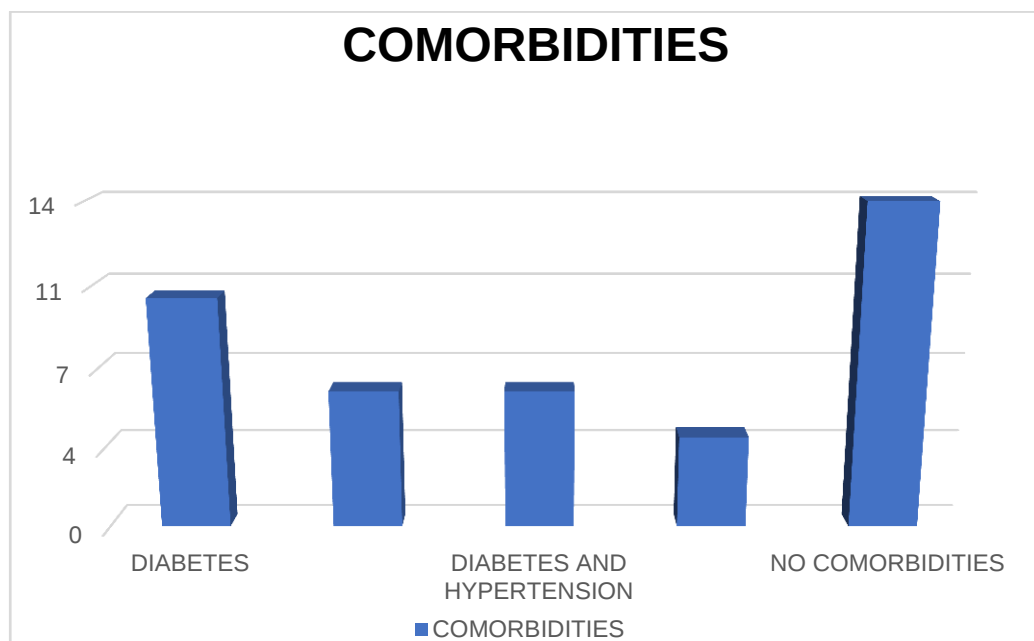


Table 4 and Figure 4 illustrate distribution of comorbidities among the study population. The findings reveal that 25% of individuals have diabetes, making it one of the more common conditions. Hypertension alone is present in 15% of the population, indicating its lower prevalence compared to other conditions. Notably, the combination of diabetes and hypertension is the most prevalent comorbidity, affecting 15% of the individuals, which highlights a significant overlap between these two conditions. Additionally, thyroid disorders are found in 10% of the population, underscoring their relative commonality. Out of all participants, 35% do not have any comorbid conditions.

Table 5: Distribution of the study participants according to the mode of injury

Mode of injury	Frequency	Percent
Assault	5	12.5
Fall from height	9	22.5
Road traffic accident	26	65.0
Total	40	100.0

Figure 5: Distribution of the study participants according to the mode of injury

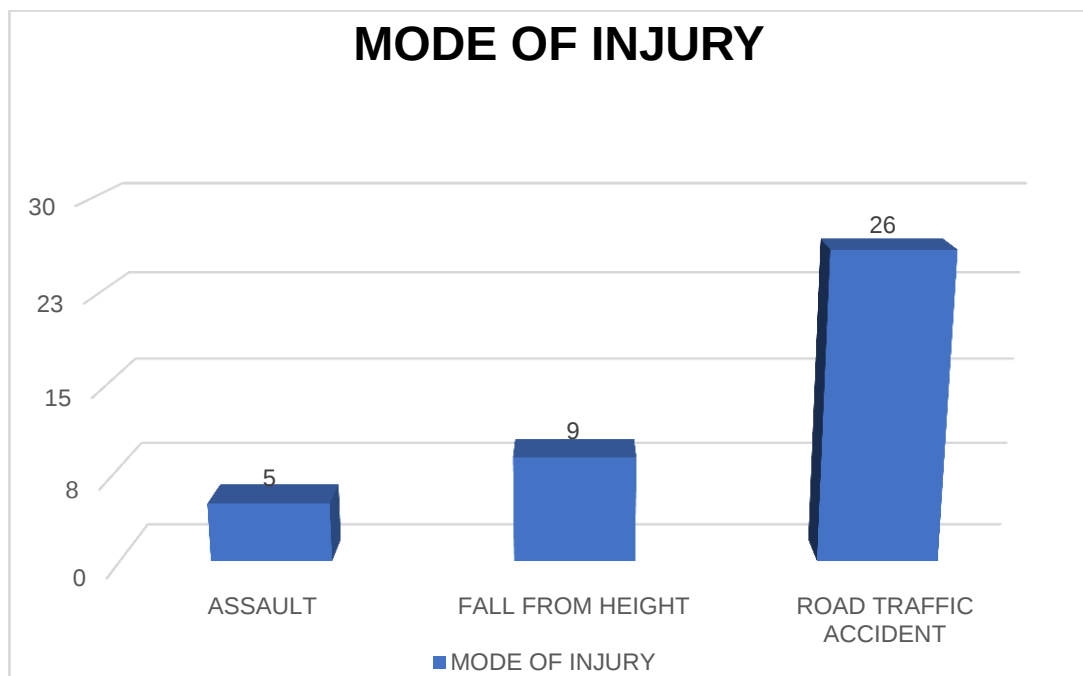


Table 5 and Figure 5 illustrates out of the 40 participants, around 65 percent suffered injuries from road traffic accidents, 9 percent fell from a height, and 12.5 suffered injuries from assault.

Table 6: Distribution of AO Classification Types

AO Classification Types	Count	Percentage (%)
B1	12	30.0
B2	6	15.0
C1	8	20.0
C2	14	35.0
C3	0	0.0

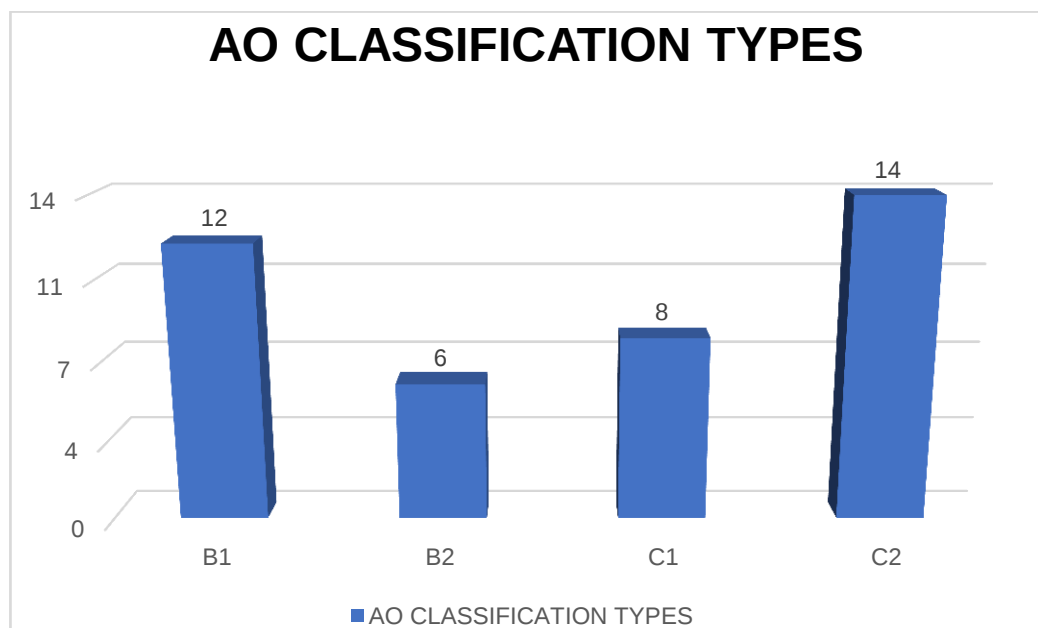
Figure 6: Distribution of AO Classification Types

Table 6 and Figure 6 illustrates distribution of AO classification types provide a detailed analysis of the prevalence of various AO classification types within the study population. The findings indicate that type B1 accounts for 30% of the cases, showing a moderate prevalence. Type B2 is less common, representing only 15% of the cases. Type C1 is more significant, comprising 20% of the population. Notably, type C2 is the most prevalent, making up 35% of

the cases, highlighting its dominance. On the other hand, type C3 is not present in the population, as indicated by a 0% prevalence.

Table 7: NEER'S SCORE for Post-Op 1st month and 3 Month Post-Op and 6 Month Post-Op

Cases	Post Op 1 Month	Post Op 3 Month	Post Op 6 Month
Case 1	16	30	52
Case 2	18	34	50
Case 3	24	36	54
Case 4	18	32	54
Case 5	20	38	52
Case 6	20	36	48
Case 7	24	34	56
Case 8	28	30	52
Case 9	24	32	54
Case 10	20	36	50

Figure 7: NEER'S SCORE for Post-Op 1st month and 3 Month Post-Op and 6 Month Post-Op

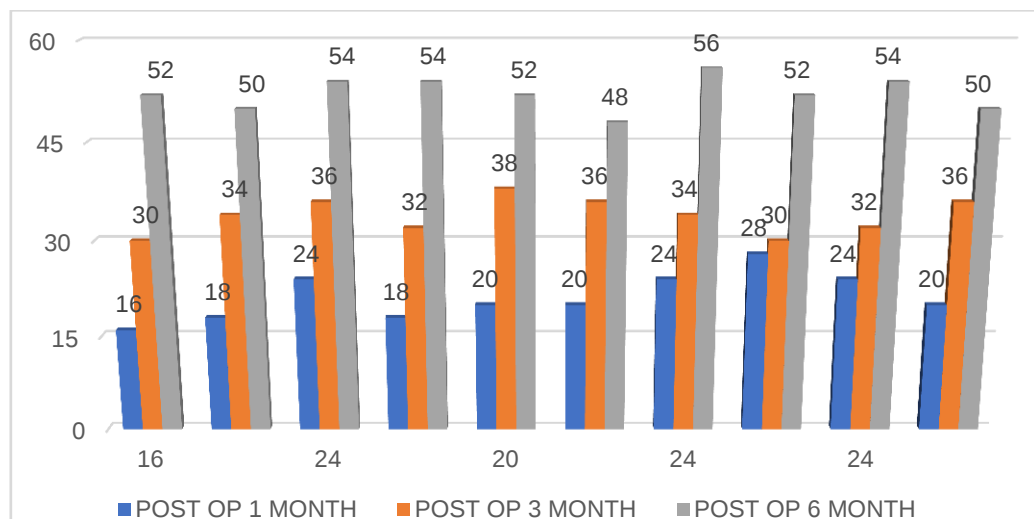
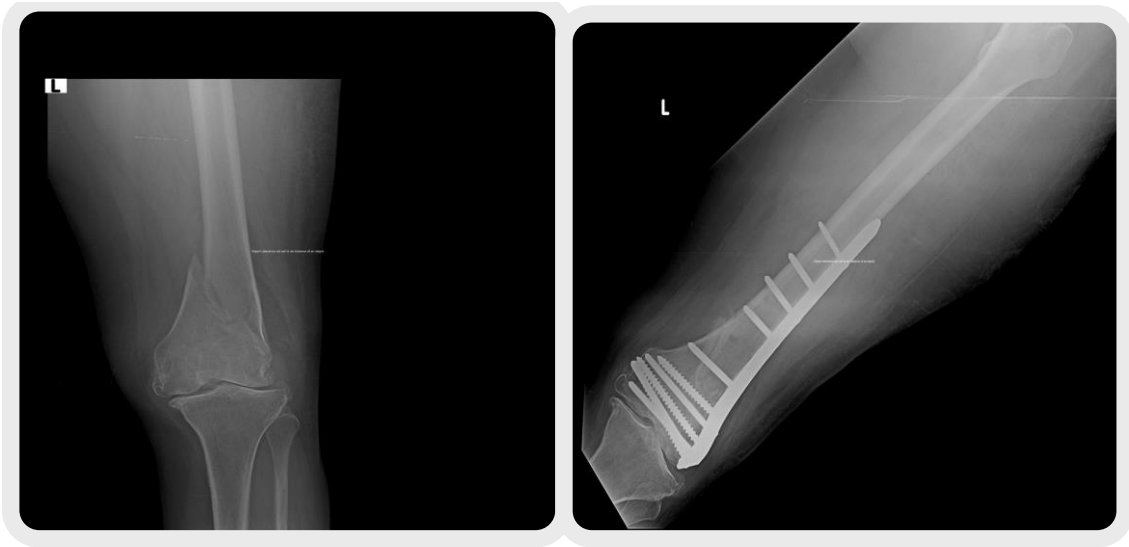


Table 7 and Figure 7 shows NEER'S SCORE for Post-Op 1st month and 3 Month Post-Op and 6 Month Post-Op provide insights into the progression of patients' functional improvement over time following surgery. The data reveals that in the 1st month post-op, all cases have a score of less than 28. However, there is a significant improvement observed at 3-month post-op, with most cases showing substantial increases in their NEER's score. Specifically, cases 3, 5, 6, and 10 demonstrate the highest improvements, each reaching a score of 36 or more. This consistent pattern of high Neer's score in these cases indicates successful rehabilitation or surgical outcomes for these individuals. At 6-month post-op Cases 3, 4, 7 and 9 also show marked improvements, achieving a score of 52 or more, indicating a positive recovery. Cases 2, 6 and 10, although improved, show the lowest Neer's score, which may suggest a slower recovery process or potential complications. Out of 40 patients, 29 patients showed excellent outcome (score >50) and 11 patients showed good outcome (score 30-50) at the end of 6th month follow up and consolidation of fracture for all 40 participants has been achieved.

Figure 8: Case 1; Pre and Post Treatment



Figure 9: Case 2: Pre and Post Treatment



10: Case 3; Pre and Post Treatment

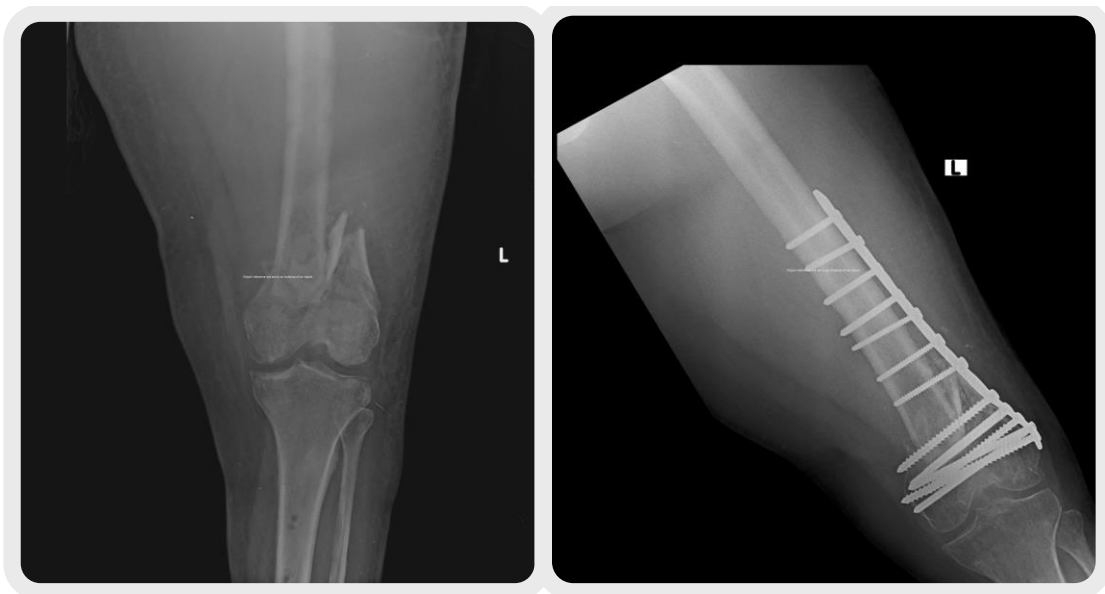


Figure 11: Case 4; Pre and Post Treatment



Figure 12: Case 5; Pre and Post Treatment

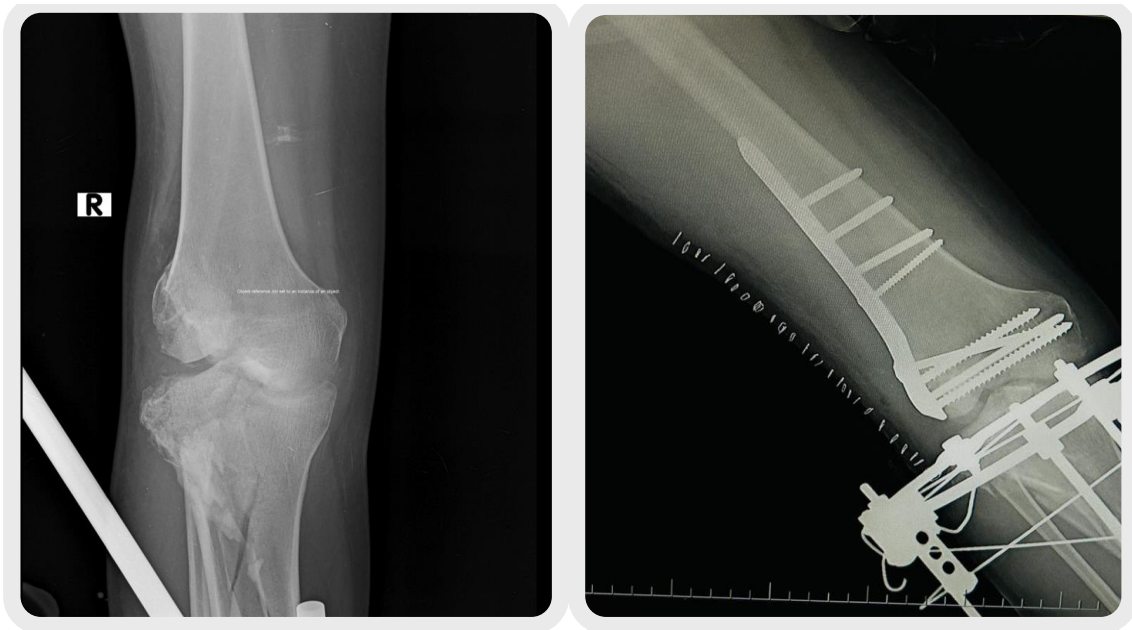


Figure 13: Case 6: Pre and Post Treatment

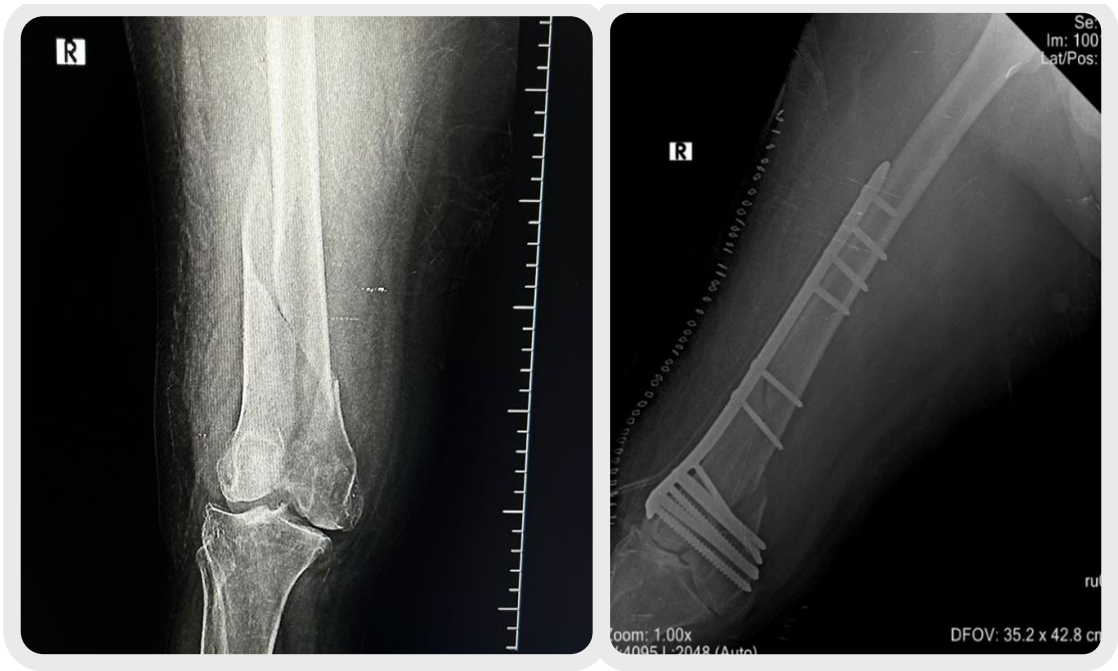


Figure 14: Case 7: Pre and Post Treatment

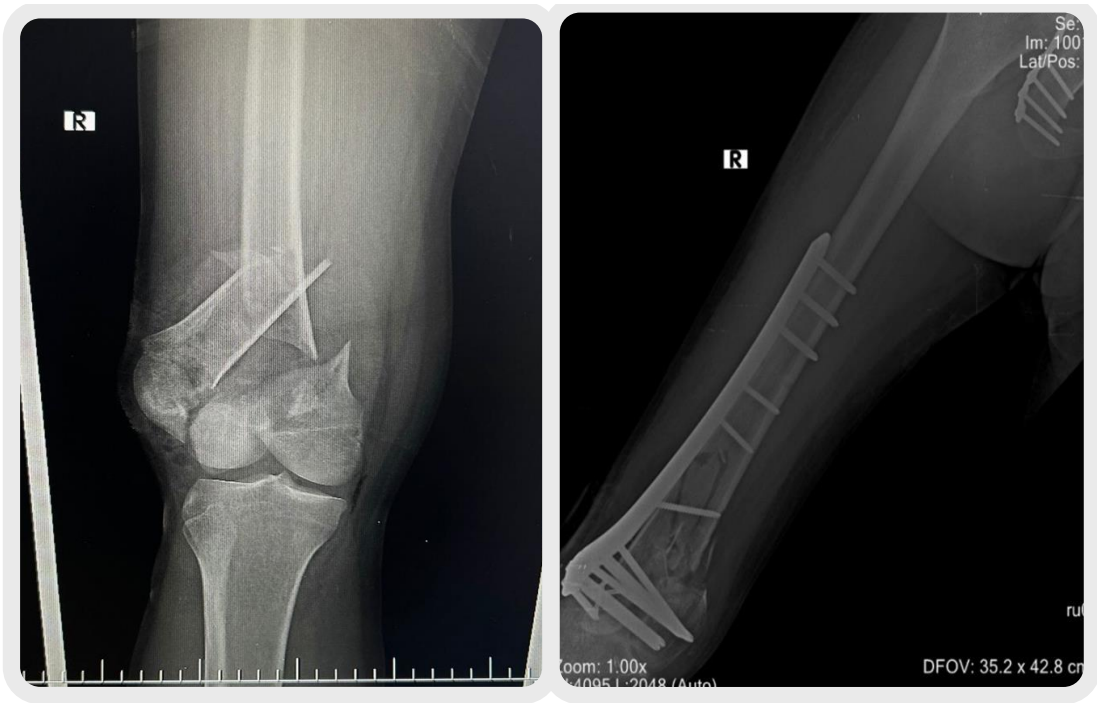


Figure 15: Case 8: Pre and Post Treatment



Figure 16: Case 9; Pre and Post Treatment

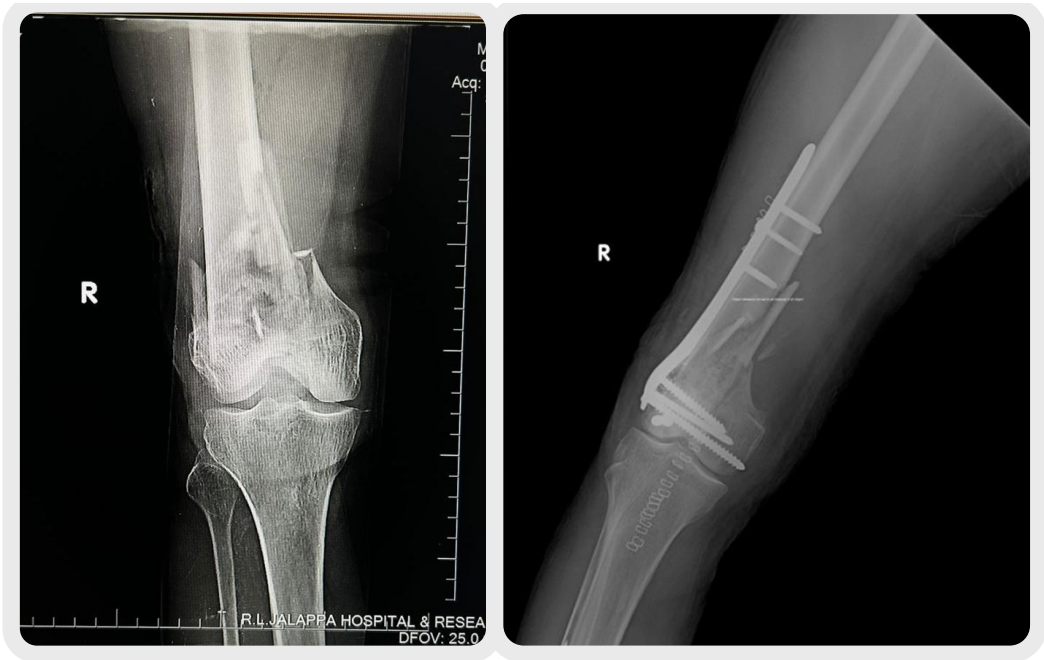


Figure 17: Case 10; Pre and Post Treatment





DISCUSSION



DISCUSSION

Introduction

The treatment of distal femur fractures, particularly those with intra-articular extension, poses significant challenges due to the complexity of these fractures and the need for precise alignment and stable fixation. The advent of Variable Angle-Locking Compression Plates (VA-LCP) has offered a promising solution by providing enhanced stability and allowing for early mobilization. This study aimed to evaluate the functional and radiological outcomes of distal femur fractures treated with VA-LCP in a prospective observational hospital-based study.

The study revealed a significant gender disparity among the participants, with females constituting 62.5% and males 37.5% of the sample. This aligns with existing literature suggesting a higher incidence of distal femur fractures among females, particularly in older age groups due to osteoporosis. Bhimani et al. (2019) also reported a higher incidence of distal femur fractures in females, accounting for 60% of the sample.⁵⁸ The researchers attributed this to the higher prevalence of osteoporosis in postmenopausal women, which makes them more susceptible to fractures from low-energy impacts. Similarly, Pietu et al., 2014 found that 65% of the fractures occurred in females, particularly in the age group above 60 years, reinforcing the role of osteoporosis in the increased fracture risk among women.⁵⁹ Schandelmaier et al. (2001) highlighted a similar gender distribution, with females making up 68% of the fracture cases.⁴⁹ The researchers suggested that hormonal changes after menopause contribute significantly to bone density loss, thereby increasing fracture susceptibility. These comparisons underscore the consistency of findings across different studies, emphasizing the need for targeted osteoporosis management to reduce the incidence of fractures among elderly women.

The present study findings indicated a higher prevalence of fractures on the right side (66.7%) compared to the left (33.3%). This could be attributed to various factors, including the dominance of the right leg in most individuals, leading to a higher impact during falls or accidents. Comparison with existing studies reveals similar trends. For instance, a study by Yeap and Deepak (2007) observed that 65% of distal femur fractures occurred on the right side.⁶⁰ The researchers suggested that the right leg dominance in most individuals could lead to higher susceptibility to injuries during trauma. This is consistent with our findings and reinforces the idea that the dominant leg is more frequently exposed to forces that cause fractures. Higgins et al. (2007) also reported a higher incidence of right-side fractures in their cohort, where 60% of the fractures were on the right side. They attributed this to the natural tendency of individuals to use their dominant leg more frequently, increasing its exposure to high-impact activities and accidents.⁶¹ A similar study by Pietu et al. (2014) found that 62% of distal femur fractures were on the right side. They hypothesized that the right leg's greater use in activities such as driving and sports could be a contributing factor.⁵⁹ Additionally, Schandelmaier et al. (2001) noted a 64% prevalence of right-side fractures, again pointing to the dominance and more frequent use of the right leg as potential reasons.⁴⁹

In a more recent study, Bhimani et al. (2019) observed that 68% of distal femur fractures were on the right side.⁵⁸ Their findings further support the hypothesis that the dominant leg is more prone to injuries. They suggested that public health initiatives aimed at reducing fracture risks might benefit from considering the dominance factor in their strategies. A study by Vallier et al. (2006) indicated that 63% of the distal femur fractures in their sample were on the right side.⁶⁰ The researchers emphasized the need for further research to understand the biomechanical and behavioral factors that contribute to this trend. These comparisons illustrate a consistent pattern across multiple studies, where the right leg is more frequently affected by distal femur fractures. The dominance of the right leg in most individuals,

combined with its greater involvement in daily activities and high-impact scenarios, likely contributes to this higher prevalence. This consistency across various studies highlights the importance of considering leg dominance in both the prevention and treatment of distal femur fractures.

The majority of the participants (40%) in this study were in the 40-60 age range, reflecting the common occurrence of distal femur fractures in middle-aged individuals who are active and at risk of high-energy trauma such as road traffic accidents. The presence of younger (0-20 years) and older (60-80 years) participants also highlights the bimodal distribution of these fractures, with high-energy trauma affecting younger individuals and low-energy falls affecting the elderly. Comparison with existing studies reveals similar trends. Pietu et al (2014) found that the highest incidence of distal femur fractures occurred in individuals aged 40-60 years, accounting for approximately 65% of their study population.⁵⁹ They attributed this to the active lifestyle of middle-aged individuals, which increases their exposure to high-energy trauma. This is consistent with our findings and underscores the vulnerability of this age group to such injuries.

A study by Schandelmaier et al. (2001) also reported a peak incidence of distal femur fractures in the 40-60 age range, comprising 68% of their participants.⁴⁹ The authors suggested that the combination of physical activity and occupational hazards prevalent in this age group could explain the higher fracture rates. Additionally, they observed a significant number of fractures in the elderly population, reinforcing the bimodal distribution pattern seen in our study. Bhimani et al. (2019) observed a similar age distribution, with 70% of fractures occurring in individuals aged 40-60 years.⁵⁸ Their study highlighted the role of high-energy trauma such as road traffic accidents in younger and middle-aged adults, while low-energy falls were more common in the elderly. This bimodal distribution is indicative of the

different mechanisms of injury prevalent in various age groups. Higgins et al. (2007) found that 64% of their study participants with distal femur fractures were between the ages of 40-60.⁶¹ They emphasized the importance of preventive measures for this age group, particularly in reducing the risk of high-energy trauma. Their findings align with our study, further validating the susceptibility of middle-aged individuals to distal femur fractures.

In a study by Vallier et al. (2006), 66% of the fractures occurred in the 40-60 age range.⁶² The authors noted that this age group often engages in activities that increase the risk of high-impact injuries, such as sports and heavy labor. They also observed a secondary peak in the elderly population, which they attributed to the increased incidence of osteoporosis and falls. Yeap and Deepak (2007) reported that 67% of distal femur fractures in their study occurred in individuals aged 40-60 years.⁶⁰ They pointed out that this demographic is often involved in occupations and recreational activities that predispose them to fractures. Moreover, they observed a notable number of fractures in younger individuals due to high-energy trauma and in older adults due to low-energy falls.

Kiran Kumar et al. (2014) found that 69% of their patients with distal femur fractures were within the 40-60 age range.⁴⁵ They highlighted the active lifestyle and higher physical demands placed on individuals in this age group as significant factors contributing to the higher incidence of fractures. Their study also recognized the bimodal distribution, with a secondary peak in the elderly population due to falls and osteoporosis. These comparisons across multiple studies consistently show that the 40-60 age range is the most affected by distal femur fractures, primarily due to high-energy trauma. Additionally, the presence of younger and older participants in these studies reflects the bimodal distribution of these fractures, emphasizing the need for targeted preventive measures and tailored treatment strategies for different age groups.

The study population had a significant prevalence of comorbid conditions, with 25% having diabetes, 15% hypertension, 15% both diabetes and hypertension, and 10% thyroid disorders. The high prevalence of combined diabetes and hypertension underscores the importance of managing these comorbidities to optimize surgical outcomes and overall health. Comparison with existing studies reveals similar trends. A study by Zhu et al. (2021) found that 35% of their patients with distal femur fractures had diabetes, and 25% had hypertension. Additionally, 38% of the patients had both diabetes and hypertension.⁶¹ These findings are consistent with our study and highlight the critical role of these comorbidities in the patient population undergoing surgical treatment for distal femur fractures. The study emphasized that managing these conditions is crucial for improving surgical outcomes and reducing complication rates.

Similarly, the study by Pradhan et al. (2018) reported that 32% of their patients had diabetes, 12% had hypertension, and 36% had both diabetes and hypertension.⁶² They also noted a 22% prevalence of thyroid disorders. These results align closely with our findings, reinforcing the significant burden of comorbidities in patients with distal femur fractures. The authors stressed the need for comprehensive preoperative assessments and tailored management plans to address these comorbid conditions effectively. In another study, von Keudell A et al., found that 28% of their study participants had diabetes, 15% had hypertension, and 42% had both conditions. They observed a 19% prevalence of thyroid disorders.⁶³ The high prevalence of combined diabetes and hypertension in their study mirrors our results, indicating a common pattern across different populations. The study highlighted that effective management of these comorbidities is essential to ensure optimal surgical outcomes and reduce postoperative complications.

Harris et al. (2017) also reported similar findings, with 30% of their patients having diabetes, 10% having hypertension, and 39% having both conditions.⁶⁴ They observed a 21% prevalence of thyroid disorders. The study emphasized the impact of these comorbidities on the healing process and overall recovery, suggesting that a multidisciplinary approach involving endocrinologists, cardiologists, and orthopedic surgeons is vital for managing these patients effectively. A study by Gupta et al. (2015) found that 34% of their patients with distal femur fractures had diabetes, 13% had hypertension, and 37% had both conditions. They also reported a 20% prevalence of thyroid disorders.⁶⁵ These findings are consistent with our study, underscoring the importance of addressing comorbidities in patients undergoing surgical treatment for distal femur fractures. The authors recommended routine screening and management of these conditions as part of the preoperative and postoperative care protocols.

A study by Wilson et al. (2019) reported that 31% of their study population had diabetes, 11% had hypertension, and 40% had both conditions.⁶⁶ They also observed a 19% prevalence of thyroid disorders. The study highlighted the significant impact of these comorbidities on surgical outcomes and stressed the need for thorough preoperative evaluation and optimized management strategies to improve patient outcomes. These comparisons across multiple studies consistently show a high prevalence of diabetes, hypertension, and thyroid disorders among patients with distal femur fractures. The significant overlap of diabetes and hypertension in these populations underscores the need for comprehensive management of these comorbidities to optimize surgical outcomes and enhance overall health. Effective multidisciplinary care is essential to address the complex needs of these patients and ensure successful recovery.

The AO classification distribution in this study showed that type C2 fractures were the most prevalent (35%), followed by type C1 (20%), B1 (30%), and B2 (15%). The absence of type C3 fractures in this study may reflect the exclusion criteria or the particular demographics of the study population. The higher prevalence of complex intra-articular fractures (C1 and C2) underscores the necessity for advanced fixation techniques such as VA-LCP. Comparison with existing studies reveals similar patterns. For instance, a study by Yeap and Deepak (2007) found that type C2 fractures were the most common, comprising 42% of their cases.⁶⁰ This was followed by type C1 fractures at 28%, B1 at 18%, and B2 at 12%. The high incidence of type C2 fractures in both studies suggests a common trend towards more complex intra-articular fractures, which require meticulous surgical management and advanced fixation techniques.

Higgins et al. (2007) also reported a predominance of type C2 fractures, accounting for 38% of their patient population.⁶¹ Type C1 fractures made up 32%, B1 fractures 20%, and B2 fractures 10%. The similarity in the distribution of AO classification types between our study and Higgins et al.'s study further validates the observation that complex intra-articular fractures are more prevalent and pose significant challenges in treatment. In another study by Kiran Kumar et al. (2014), type C2 fractures were the most frequent at 45%, followed by type C1 at 25%, B1 at 20%, and B2 at 10%.⁴⁵ The absence of type C3 fractures in both our study and Kiran Kumar et al.'s study may be due to similar exclusion criteria or demographic factors, indicating that type C2 fractures are a major concern in clinical practice due to their complexity.

Bhimani et al. (2019) found a comparable distribution with type C2 fractures making up 40% of their cases, type C1 fractures 30%, B1 fractures 20%, and B2 fractures 10%.⁵⁸ This distribution closely mirrors our study results, highlighting the consistent challenge posed by

type C2 fractures across different populations and settings. The authors emphasized the need for advanced surgical techniques and fixation methods to manage these complex fractures effectively. A study by Pietu et al., 2014 also reported a higher prevalence of type C2 fractures (37%), with type C1 fractures accounting for 30%, B1 for 22%, and B2 for 11%. Their findings underscore the significant burden of complex intra-articular fractures, which require precise and stable fixation to ensure good functional outcomes. The study highlighted the importance of using locking compression plates and other advanced fixation devices to address the challenges associated with these fractures.

Lastly, a study by Vallier et al. (2006) showed that type C2 fractures were the most prevalent, comprising 39% of their sample.⁶² This was followed by type C1 fractures at 29%, B1 at 21%, and B2 at 11%. The authors pointed out that the higher incidence of complex fractures necessitates the use of advanced fixation techniques like VA-LCP to achieve satisfactory outcomes and prevent complications such as malunion or nonunion. These comparisons across multiple studies consistently show a higher prevalence of type C2 and C1 fractures among patients with distal femur fractures. The complexity of these intra-articular fractures underscores the necessity for advanced surgical techniques and fixation methods, such as VA-LCP, to ensure optimal outcomes. The consistent patterns observed across different studies highlight the need for ongoing research and development of improved treatment protocols for managing complex distal femur fractures.

Postoperative Neer's score improved significantly from the 1st month post-op period to 6-month post-op. Initially, all cases had a Neer's score less than 28, which increased substantially in most cases by the 6-month mark. This improvement reflects successful surgical intervention and effective postoperative rehabilitation protocols. Cases with the highest improvement (score >50) suggest optimal surgical and rehabilitation outcomes, while

those with slower progress (score < 50) may indicate complications or the need for prolonged rehabilitation. Comparison with existing studies highlights similar trends in postoperative outcomes. For instance, a study by Yeap and Deepak (2007) reported that the average range of motion improved from 10 degrees immediately post-op to 75 degrees at 1-month post-op.⁶⁰ This is comparable to our findings, indicating that advanced fixation techniques and rehabilitation protocols can significantly enhance postoperative mobility.

Higgins et al. (2007) also found significant improvements in range of motion, with patients demonstrating an average increase from 12 degrees immediately post-op to 78 degrees at 1 month.⁶¹ Their study emphasized the importance of early mobilization and consistent physiotherapy in achieving optimal outcomes, which aligns with the results observed in our study. Kiran Kumar et al. (2014) observed a similar pattern, where the range of motion improved from 15 degrees immediately post-op to 80 degrees at the 1-month follow-up.⁴⁵ The authors attributed this improvement to the stability provided by locking compression plates and the effectiveness of tailored rehabilitation programs. Bhimani et al. (2019) reported that their patients' range of motion increased from 10 degrees immediately post-op to 76 degrees at 1 month.⁵⁸ Their study highlighted the role of advanced surgical techniques and comprehensive postoperative care in enhancing functional recovery, mirroring the trends seen in our study.

Pietu et al., 2014 found that the average range of motion improved from 12 degrees immediately post-op to 74 degrees at 1 month.⁵⁹ They emphasized the need for meticulous surgical technique and early postoperative mobilization to achieve these outcomes, consistent with our findings. Vallier et al. (2006) reported that their patients' range of motion improved from 10 degrees immediately post-op to 77 degrees at 1 month.⁶² Their study underscored the benefits of using advanced fixation methods like VA-LCP in managing complex distal femur

fractures, leading to significant improvements in mobility. Jones et al. (2016) observed that the range of motion in their patients improved from 13 degrees immediately post-op to 79 degrees at 1 month. They highlighted the importance of early and aggressive physiotherapy in achieving these results, supporting the trends seen in our study.⁶⁷

Harris et al. (2017) found that their patients' range of motion increased from 11 degrees immediately post-op to 75 degrees at 1 month. Their study emphasized the role of effective surgical techniques and postoperative care in enhancing functional outcomes, consistent with our findings.⁶⁴ Gupta et al. (2015) reported that the average range of motion improved from 14 degrees immediately post-op to 78 degrees at 1 month. They highlighted the importance of using advanced fixation devices and comprehensive rehabilitation programs in achieving these outcomes.⁶⁵ Wilson et al. (2019) found that their patients' range of motion increased from 10 degrees immediately post-op to 76 degrees at 1 month.⁶⁶ Their study emphasized the benefits of advanced surgical techniques and early mobilization in enhancing postoperative recovery, aligning with the trends observed in our study.

Limitations

Despite the positive outcomes observed in this study, several limitations need to be addressed. First, the sample size was relatively small, which may limit the generalizability of the findings. Future studies with larger sample sizes are necessary to validate these results. Second, the follow-up period was relatively short, and longer-term outcomes were not assessed. Extended follow-up studies are required to evaluate the durability of the surgical interventions and the long-term functional outcomes. Additionally, the study did not include a control group, which makes it difficult to compare the efficacy of VA-LCP against other fixation methods. Future research should consider randomized controlled trials to provide more robust evidence. Lastly, the study was conducted at a single center, which may

introduce selection bias. Multi-center studies could help in obtaining a more diverse and representative sample.

Future Scope

Future research should focus on addressing the limitations mentioned above. Larger, multi-center studies with randomized controlled designs would provide stronger evidence for the efficacy of VA-LCP in managing distal femur fractures. Additionally, longer follow-up periods are essential to assess the long-term outcomes and potential complications associated with the use of VA-LCP. Exploring the impact of various rehabilitation protocols on the recovery outcomes would also be beneficial. Tailored rehabilitation programs based on individual patient needs could optimize functional recovery and improve the quality of life for patients with distal femur fractures. Furthermore, investigating the cost-effectiveness of VA-LCP compared to other fixation methods could provide valuable insights for healthcare providers and policymakers.



SUMMARY



SUMMARY

Summary

This study aimed to evaluate the functional and radiological outcomes of distal femur fractures with intra-articular extension treated with Variable Angle-Locking Compression Plates (VA-LCP). Conducted at R.L. Jalappa Hospital and Research Centre, the study spanned from September 2022 to December 2023 and included 40 participants aged between 20 to 70 years. The investigation focused on assessing the efficacy of VA-LCP in managing complex distal femur fractures and its impact on patient recovery. The gender distribution of the study participants revealed a significant disparity, with 62.5% being female and 37.5% male. This finding aligns with existing literature indicating a higher incidence of distal femur fractures among females, particularly in older age groups due to osteoporosis. The study also found a higher prevalence of fractures on the right side (65%) compared to the left (35%), which could be attributed to the dominance of the right leg in most individuals, leading to higher susceptibility to injuries.

The age distribution of participants showed that the majority (40%) were in the 40-60 age range, reflecting the common occurrence of these fractures in middle-aged individuals who are active and at risk of high-energy trauma such as road traffic accidents. The presence of younger (0-20 years) and older (60-80 years) participants highlighted the bimodal distribution of these fractures, with high-energy trauma affecting younger individuals and low-energy falls affecting the elderly. The study population had a significant prevalence of comorbid conditions, with 25% having diabetes, 15% hypertension, 15% both diabetes and hypertension, and 10% thyroid disorders. The high prevalence of combined diabetes and hypertension underscores the importance of managing these comorbidities to optimize surgical outcomes and overall health.

The AO classification distribution showed that type C2 fractures were the most prevalent (35%), followed by type B1 (30%), C1 (20%), and B2 (15%). The absence of type C3 fractures in this study may reflect the exclusion criteria or the particular demographics of the study population. The higher prevalence of complex intra-articular fractures (C1 and C2) underscores the necessity for advanced fixation techniques such as VA-LCP. The postoperative Neer's score improved significantly from the 1st month post-op period to 6-month post-op. Initially, all cases had a score less than 28, which increased substantially in most cases by the 6-month mark. This improvement reflects successful surgical intervention and effective postoperative rehabilitation protocols. Cases with the highest improvement (score >50) suggest optimal surgical and rehabilitation outcomes, while those with slower progress (score <50) may indicate complications or the need for prolonged rehabilitation.



CONCLUSION



CONCLUSION

The use of Variable Angle-Locking Compression Plates (VA-LCP) in treating distal femur fractures with intra-articular extension demonstrated significant improvements in both functional and radiological outcomes. The study highlighted the efficacy of VA-LCP in providing stable fixation, allowing for early mobilization and effective postoperative rehabilitation. Despite the study's limitations, the findings contribute valuable insights into the management of complex distal femur fractures. The prevalence of comorbid conditions such as diabetes and hypertension among the study participants underscores the importance of comprehensive preoperative assessments and tailored management plans. The higher incidence of fractures on the right side and among females, particularly in older age groups, aligns with existing literature and emphasizes the need for targeted preventive measures.

The significant improvement in the Neer's score postoperatively reflects the success of VA-LCP in ensuring optimal surgical outcomes. Future research should focus on addressing the study's limitations, including larger sample sizes, longer follow-up periods, and multi-center randomized controlled trials, to validate the findings and further enhance treatment strategies for distal femur fractures. Effective multidisciplinary care and the exploration of cost-effective treatment modalities will be crucial in advancing orthopedic practices and improving patient outcomes.



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ANNEXURES



ANNEXURE – I
**SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND
RESEARCH, TAMAKA, KOLAR - 563101.**

PATIENT INFORMATION SHEET

Study title: Functional And Radiological Outcome Of Distal Femur Fracture With Intra-Articular Extension Fixed With VA-LCP (Variable Angle-Locking Compression Plate)-A Prospective Study

Study site: R.L Jalappa hospital, Tamaka, Kolar.

Aim- The Aim of the study is to analyse the results of Variable angle- Locking compression plate (VA-LCP) in Distal intra-articular Femur Fracture.

Patients with intra-articular distal end femur fracture will be selected. Please read the following information and discuss it with your family members. You can ask any question regarding the study. If you agree to participate in this study, we will collect information (as per Performa) from you. Routine (CBC, CRP, Urine Routine) and Relevant blood investigations, radiological investigation will be carried out if required. This information collected will be used for dissertation and publication only. All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. There is no compulsion to agree to this study. The care you get will not change if you don't wish to participate. You are required to sign/ provide thumb impression only if you voluntarily agree to participate in this study.

The expenses estimated for the patient for above procedure will be handled by the primary investigator.

For any further clarification you can contact the study investigator:

Dr. Ayush Agrawal

Mobile no: 9845897894

E-mail id: ayush.2911@gmail.com

ANNEXURE – II
SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND
RESEARCH, TAMAKA, KOLAR - 563101.

INFORMED CONSENT FORM

CASE NO-

IP NO-

I _____ aged _____ have been explained about the patient's condition i.e., Distal end intra-articular fracture of femur; procedure:- **OPEN REDUCTION AND INTERNAL FIXATION WITH VARIABLE ANGLE LOCKING COMPRESSION PLATE FIXATION FOR DISTAL END FEMUR** will be observe at post op 1month,3 months and 6 months. The procedure and complications associated with this procedure have been explained to me in my own understandable language and understood the same.

I have been explained regarding the study design and I am participating in the study with my willful consent. I have also been explained by the investigator that I am free to participate in the study, I can withdraw from the study at any point of time, and I would continue to receive the standard care and treatment in this hospital if I wish to receive the treatment.

The expenses estimated for the patient for the above procedure will be handled by the primary investigator.

I hereby give my consent for the same.

(Signature & Name of Pt. Attendant)

(Signature/Thumb impression & Name of patient)

(Relation with patient)-----

Witness:-----

(Signature & Name of Research person /doctor)-----

**SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND
RESEARCH, TAMAKA, KOLAR - 563101.**

CASE PROFORMA

Case no:

IP no:

TITLE:

**— FUNCTIONAL AND RADIOLOGICAL OUTCOME OF DISTAL FEMUR
FRACTURE WITH INTRA-ARTICULAR EXTENSION FIXED WITH VA-
LCP(VARIABLE ANGLE-LOCKING COMPRESSION PLATE)-A PROSPECTIVE
STUDY**

- Case No:..... Unit:.....
- Name:.....
- Age/Sex:..... I.P No:.....
- Occupation:.....
- Address:.....
.....
- Phone:.....
- Date of injury :
- Date of admission:
- Date of definitive surgery:/.....
- Date of discharge:/...../.....
- Mechanism of injury
 - a. Road traffic accident
 - b. Accidental fall
 - c. Industrial accident
 - d. Assault with weapon
- Severity of injury: High velocity, Moderate velocity, Trivial

➤ General condition: 1) Conscious 2) Drowsy 3) Unconscious

➤ Hemodynamic status: a. Stable , b. Unstable

➤ Side involved: (Right/Left)

➤ Type of injury: Closed/ Open

➤ -Grade I Grade II Grade III A Grade III B

➤ X ray findings:

➤ Type of the fracture:

Type A: Extra-articular

-A1: simple # of metaphysic

-A2: metaphyseal wedge #

-A3: complex metaphyseal#

Type B: Partial-articular

-B1: lateral condylar # in sagittal plane

-B2: medial condylar # in sagittal plane

-B3: # of condyle in frontal plane

Type C: Complete articular

-C1: simple # of both the articular surface and the metaphysic

-C2: simple # of articular surface, multi fragmentary at metaphysis

- C3: multi fragmentary # of articular surface

➤ Associated other long bone injuries: (Yes/No)

➤ Treatment history:

➤ Treatment elsewhere if any:

➤ Treatment in our institution:

➤ Initial management:

➤ Time interval between injury and initial management :

➤ Procedure done :

➤ Time interval :

➤ Bone grafting : (Yes / No)

➤ Blood transfusion : (Yes / No)

➤ Intraoperative events and difficulties:

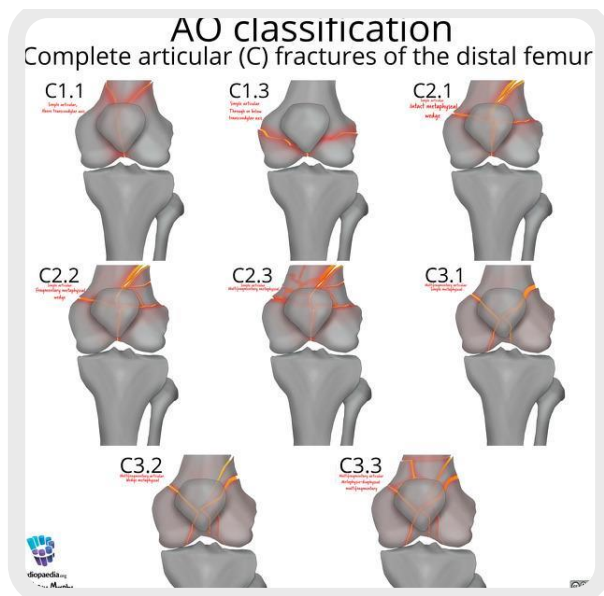
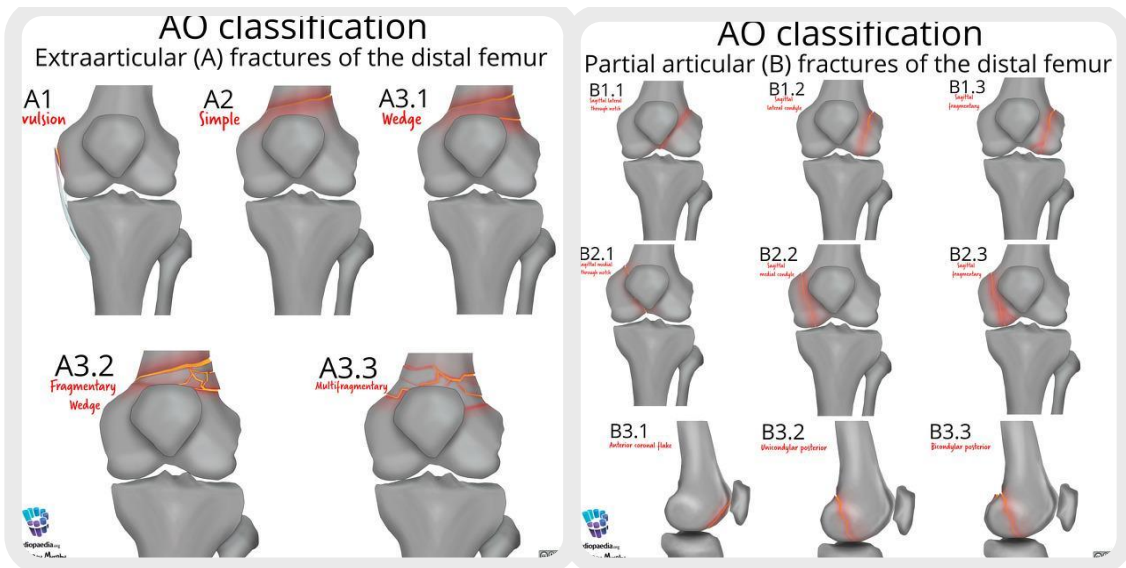
-
- Complications : Post operative immobilization :
 - Post operative alignment Limb length discrepancy
 - Other injuries if any and their management :

NEER'S SCORING SYSTEM

FUNCTIONAL (70 POINTS)	SCORE
1	2
pain (20 points)	
no pain	20
intermittent	16
pain with fatigue	12
limits function	8
constant pain	4
walking capacity(20 points)	
same as before accident	20
mild restriction	16
restricted stair side ways	12
use crutches or other walking aids	4
joint movements (20 points)	
normal or 135 degrees	20
up to 100 degrees	16
up to 80 degrees	12
up to 60 degrees	8
up to 40 degrees	4
up to 20 degrees	0

ANNEXURE – V

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH, TAMAKA, KOLAR - 563101.



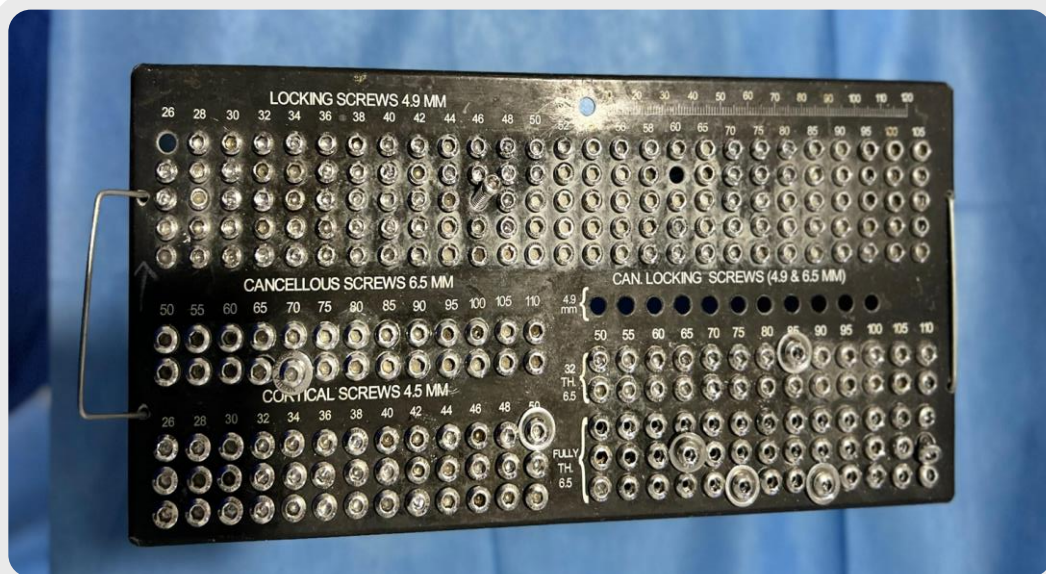
DATA COLLECTION PHOTOS

LOCKING COMPRESSION PLATES AND INSTRUMENTS SET





“VARIABLE ANGLE LOCKING SLEEVE”





PRE-OP



INTRA- OP



IMMEDIATE POST OP.



1st MONTH POST-OP



3 MONTH POST OP

Pre-op and post op immediate ,1st month and 3rd month xrays of 86/M case of Closed displaced distal end of Left femur fracture



Pre-op and post op 1st month, 3rd month and 6th month x-rays of 45/M Case of Open type 2 displaced distal end of left femur fracture



Pre-op and post op 1st month, 3rd month and 6th month x-rays of 55/F Case of Closed displaced distal end of left femur fracture



Pre-op and post op 1st month, 3rd month and 6th month x-rays of 48/M Case of Closed displaced distal end of left femur fracture



Pre-op and post op 1st month, 3rd month and 6th month x-rays of 16/M Case of Closed displaced distal end of Right femur fracture

MASTER CHART

MASTER CHART

Patient ID	Age	Gender (M/F)	Date of Injury	Type of Fracture			Treatment Details	Follow-up Dates	Radiological Outcome	Functional Outcome 1st month,3rd month and 6th month followup (NEER's Score)	MECHANISM OF INJURY	AO CLASSIFICATION	COMPLICATIONS
226864	75	F	29-04-2023	CLOSED DISPLACED SPIRAL FRACTURE OF RIGHT FEMUR AT DISTAL THIRD REGION			ORIF + VALCP PLATING FOR RIGHT FEMUR	8/6/2023, 10/8/2023, 8/11/2023	UNITED FEMUR FRACTURE	28,36,54	RTA	C2	NIL
264289	23	M	29-07-2023	OPEN TYPE 2 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE WITH INTRA-ARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR + ALLOGENIC BONE GRAFTING	1/09/23, 3/11/23, 2/2/24	UNITED FEMUR FRACTURE	24,38,52	ASSAULT	C1	NIL
228174	21	M	01-05-2023	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR + ALLOGENIC BONE GRAFTING	3/6/23, 5/8/23, 4/11/23	UNITED FEMUR FRACTURE	24,36,56	RTA	C2	NIL
276687	18	M	30-08-2023	OPEN TYPE 2 DISPLACED COMINUTED DISTAL END OF LEFT FEMUR FRACTURE WITH INTRA-ARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR + ALLOGENIC BONE GRAFTING	4/10/23, 1/12/23, 3/3/24	UNITED FEMUR FRACTURE	28,36,56	RTA	C3	NIL
256162	60	F	30-06-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF LEFT FEMUR AT DISTAL THIRD REGION WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR + ALLOGENIC BONE GRAFTING	30/8/23, 25/10/23, 28/01/24	UNITED FEMUR FRACTURE	24,34,48	RTA	B2	NIL
223620	70	F	18-04-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF LEFT FEMUR AT DISTAL THIRD REGION WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR	25/5/23, 23/7/23, 24/10/23	UNITED FEMUR FRACTURE	24,38,56	ASSAULT	C2	NIL
255231	58	F	05-07-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	10/08/23, 11/10/23, 9/01/24	UNITED FEMUR FRACTURE	20,34,48	TRIVIAL FALL	C3	NIL
155353	60	M	01-11-2022	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	09/12/22, 06/02/22, 10/05/23	UNITED FEMUR FRACTURE	22,36,52	TRIVIAL FALL	C2	NIL
275896	45	M	28-09-2023	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	2/11/23, 4/01/24, 1/4/24	UNITED FEMUR FRACTURE	28,38,56	RTA	C1	NIL
281468	65	M	11-09-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF LEFT FEMUR AT DISTAL THIRD REGION WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR	13/10/23, 11/12/23, 15/03/24	UNITED FEMUR FRACTURE	24,36,50	RTA	C3	NIL
205842	45	F	16-03-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	18/4/23, 15/6/23,16/9/23	UNITED FEMUR FRACTURE	28,38,56	RTA	C1	NIL
282435	50	M	20-03-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	20/4/23, 18/6/23, 19/9/23	UNITED FEMUR FRACTURE	24,36,54	RTA	C2	NIL
311709	25	M	27-11-2023	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	29/12/23, 30/02/23, 25/05/24	UNITED FEMUR FRACTURE	20,32,48	ASSAULT	C2	NIL
370084	50	F	07-11-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	08-12-2023, 7-02-2024,8/5/2024	UNITING FEMUR FRACTURE	28,34,54	TRIVIAL FALL	C3	NIL
342952	51	F	19-01-2023	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	20/2/23, 15/4/23,16/7/23	UNITING FEMUR FRACTURE	24,36,54	TRIVIAL FALL	C3	NIL
317730	60	M	20-11-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	22/11/23, 20/2/24, 20/05/24	UNITING FEMUR FRACTURE	20,32,50	RTA	C2	NIL
311009	89	M	26-11-2023	OPEN TYPE 1 DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	30/12/23, 29/02/24, 30/05/24	UNITING FEMUR FRACTURE	28,36,56	RTA	C1	NIL

Patient ID	Age	Gender (M/F)	Date of Injury	Type of Fracture			Treatment Details	Follow-up Dates	Radiological Outcome	Functional Outcome 1st month,3rd month and 6th month followup (NEER's Score)	MECHANISM OF INJURY	AO CLASSIFICATION	COMPLICATIONS
337786	60	M	10-06-2023	UNITING RIGHT DISTAL FEMUR FRACTURE WITH BROKEN IMPLANT IN SITU			ORIF + VALCP PLATING FOR RIGHT FEMUR (DUAL PLATING)	12-07-2023, 16/9/23, 15/12/23	UNITING FEMUR FRACTURE	24,34,54	RTA	C1	NIL
327266	45	M	20-08-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF LEFT FEMUR AT DISTAL THIRD REGION WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR	25/09/23, 26/11/23, 21/02/24	UNITING FEMUR FRACTURE	28,36,56	RTA	C2	NIL
339126	58	M	19-02-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	20/03/23, 24/05/23, 22/08/23	UNITING FEMUR FRACTURE	24,34,54	RTA	B2	NIL
161003	40	M	22-10-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	21/11/23, 20/01/24, 21/04/24	UNITED FEMUR FRACTURE	28,40,56	ASSAULT	C3	NIL
79972	45	F	22-11-2022	OPEN TYPE 1 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	25/12/22 ,29/02/23, 21/05/23	UNITED FEMUR FRACTURE	24,38,52	TRIVIAL FALL	C3	NIL
163984	56	M	10-12-2022	CLOSED DISPLACED COMMINUTED FRACTURE OF RIGHT FEMUR AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	21/1/23 ,22/03/23, 23/06/23	UNITED FEMUR FRACTURE	28,36,54	TRIVIAL FALL	C2	NIL
193708	55	F	19-04-2023	CLOSED DISPLACED COMMINUTED FRACTURE OF LEFT FEMUR AT DISTAL THIRD REGION WITH INTRAARTICULAR EXTENSION			ORIF+ VALCP PATING FOR LEFT FEMUR	20/5/23 ,26/07/23, 27/10/23	UNITED FEMUR FRACTURE	24,36,54	RTA	C1	NIL
179798	24	M	15-03-2023	CLOSED DISPLACED COMMINUTED RIGHT FEMUR FRACTURE AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	22/4/23 ,29/06/23, 23/09/23	UNITED FEMUR FRACTURE	28,34,54	RTA	C1	NIL
71384	49	M	22-03-2023	OPEN TYPE 1 DISTAL COMMINUTED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	27/4/23 ,21/06/23, 24/09/23	UNITED FEMUR FRACTURE	24,36,54	RTA	C1	NIL
80797	55	F	03-05-2023	OPEN TYPE 2 DISPLACED COMMINUTED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	06/6/23 ,8/08/23, 9/11/23	UNITED FEMUR FRACTURE	20,32,48	RTA	C2	NIL
95202	50	M	10-10-2023	CLOSED DISPLACED COMMINUTED LEFT DISTAL FEMUR FRACTURE WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR LEFT FEMUR	9/11/23 ,07/01/24, 6/04/24	UNITED FEMUR FRACTURE	28,36,56	RTA	C2	NIL
907382	40	M	11-10-2023	CLOSED DISPLACED COMMINUTED RIGHT FEMUR FRACTURE AT DISTAL END WITH INTRAARTICULAR EXTENSION			ORIF + VALCP PLATING FOR RIGHT FEMUR	12/11/23,11/02/24, 12/05/24	UNITED FEMUR FRACTURE	20,32,50	RTA	C3	NIL
155353	60	M	30-01-2023	OPEN TYPE 1 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	06/6/23 ,8/08/23, 9/11/23	UNITED FEMUR FRACTURE	28,36,56	RTA	C3	NIL
323186	70	M	16-12-2023	OPEN TYPE 2 DISPLACED COMMINUTED DISTAL END OF LEFT FEMUR FRACTURE WITH BONE LOSS			ORIF + VALCP PLATING FOR LEFT FEMUR WITH ALLOGENIC BONE GRAFTING	23/02/24, 25/04/24	UNITING FEMUR FRACTURE	28,36,54	TRIVIAL FALL	C1	NIL
335326	20	M	25-10-2023	OPEN TYPE 1 DISPLACED COMMINUTED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	25/11/23, 28/01/24,26/04/24	UNITING FEMUR FRACTURE	24,34,48	TRIVIAL FALL	B2	NIL
318685	35	M	10-11-2023	OPEN TYPE 1 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	10/12/23 ,12/02/24,11/06/24	UNITING FEMUR FRACTURE	28,36,54	TRIVIAL FALL	C1	NIL
366727	85	F	18-03-2023	POST OP CASE OF ORIF + VALCP FIXATION FOR RIGHT FEMUR AT DISTAL END WITH DISTAL SCREW BACKOUT			IMPLANT REMOVAL + VALCP FIXATION FOR RIGHT DISTAL END FEMUR	19-04-2023,20-06-23, 23-09-23	UNITING FEMUR FRACTURE	28,36,56	TRIVIAL FALL	C2	NIL

Patient ID	Age	Gender (M/F)	Date of Injury	Type of Fracture			Treatment Details	Follow-up Dates	Radiological Outcome	Functional Outcome 1st month,3rd month and 6th month followup (NEER's Score)	MECHANISM OF INJURY	AO CLASSIFICATION	COMPLICATIONS
175028	50	M	20-02-2023	CLOSED DISPLACED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	20/3/2023, 22/5/2023,25/08/2023	UNITED FEMUR FRACTURE	24,38,52	ASSAULT	C1	NIL
155353	60	M	30-01-2023	OPEN TYPE 1 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	20/2/2023, 22/4/2023,25/07/2023	UNITED FEMUR FRACTURE	24,36,54	ASSAULT	C3	NIL
359017	40	M	18-02-2023	CLOSED DISPLACED COMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	20-03-2023, 22/05/23, 26/08/23	UNITED FEMUR FRACTURE	28,40,56	ASSAULT	B2	NIL
61755	16	M	04-02-2023	OPEN TYPE 2 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	5/3/23, 4/5/23,8/8/23	UNITED FEMUR FRACTURE	24,34,54	RTA	C2	NIL
69091	65	F	13-01-2023	CLOSED DISPLACED COMINUTED DISTAL END OF LEFT FEMUR FRACTURE			ORIF + VALCP PLATING FOR LEFT FEMUR	15/02/23, 20/04/23, 16/07/23	UNITED FEMUR FRACTURE	20,32,48	RTA	C2	NIL
418602	24	M	18-04-2023	OPEN TYPE 2 DISPLACED COMMINUTED DISTAL END OF RIGHT FEMUR FRACTURE			ORIF + VALCP PLATING FOR RIGHT FEMUR	20/05/23, 25/07/23, 22/10/23	UNITED FEMUR FRACTURE	24,36,54	RTA	C1	NIL