“ FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SUBTROCHANTERIC FRACTURE FIXED WITH LONG PROXIMAL FEMORAL NAIL ”

BY

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

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY

IN

ORTHOPAEDICS

Under the Guidance of

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ABSTRACT

Introduction

STFs represent a significant challenge in orthopaedic trauma management due to their complex biomechanical characteristics and high complication rates. These fractures occur in a region subjected to substantial deforming forces, with reported non-union rates of 7-20% and implant failure rates of 15-23% in contemporary literature. Despite advances in fixation technology, optimal management remains controversial.

Aim

This prospective interventional study aimed to evaluate the outcomes of STFs treated with LPFN, specifically examining bony union through radiological assessment and functional recovery using the Harris Hip Score, to contribute evidence-based insights to the ongoing refinement of treatment protocols for these challenging injuries.

Methodology

A prospective interventional study was conducted at R.L. Jalappa Hospital between May 2023 and October 2024. Thirty-three consecutive patients (aged 18-85 years)

with STFs meeting inclusion criteria underwent long PFN fixation after obtaining informed consent. Exclusion criteria comprised pathological fractures and associated neurological injuries. Preoperative assessment included detailed clinical examination, radiographic evaluation with anteroposterior and lateral views, and fracture classification using the Seinsheimer system. All procedures were performed under spinal anaesthesia with patients positioned supine on a fracture table. Closed reduction was attempted initially, with open reduction implemented when necessary. Postoperatively, patients underwent suture removal on the tenth day, followed by non-weight-bearing mobilization with walker assistance. Sequential follow-up evaluations occurred monthly for six months, with formal assessments at 1, 3, and 6 months postoperatively. Outcome measures included the HHS for functional evaluation, Visual Analog Scale for pain assessment, radiological determination of union status, and documentation of weight-bearing progression. Union was defined as the absence of subjective complaints with radiologically invisible fracture lines and periosteal callus bridging.

Results

The study cohort demonstrated a male predominance (72.7%, n=24) with a mean age of 51.30 years (SD=17.992). RTAs constituted the primary etiological factor (60.6%, n=20), followed by low-energy mechanisms (36.4%, n=12). Comminuted fracture patterns were observed in 54.5% (n=18) of cases, with Seinsheimer Grade 2C fractures representing the most common morphology (30.3%, n=10). Closed reduction and internal fixation with long PFN was achieved in 72.8% (n=24) of patients, while 15.2% (n=5) required open reduction. Augmentation with stainless steel cerclage wiring was necessary in 12.2% (n=4) of cases. Radiographic assessment demonstrated successful osseous union in 96.9% (n=32) of patients, with an average time to union of 21.39 weeks. The sequential radiographic evaluation using the RUSH score demonstrated significant progressive improvement from 6.00 at one month to 28.36 at six months ($p<0.001$). The overall complication rate was 15.2% (n=5), with surgical site infection being the most prevalent complication (9.1%, n=3). The HHS demonstrated statistically significant improvement from 55.79 (SD=9.921) at one month to 72.48 (SD=6.629) at three months and further to 84.00 (SD=3.961) at six months postoperatively ($p<0.001$ for all intervals).

Visual Analog Scale pain scores similarly improved from 4.27 (SD=0.626) at one month to 2.42 (SD=0.502) at six months ($p<0.001$). Weight-bearing progression analysis revealed that 81.8% (n=27) of patients achieved weight-bearing status by three months, with 97% (n=32) engaging in full weight-bearing activities by six months postoperatively.

Conclusion

LPFN represents an effective treatment modality for subtrochanteric femoral fractures, achieving excellent union rates (96.9%) and progressive functional improvement. The statistically significant enhancement in HHS and concurrent reduction in pain scores demonstrate substantial clinical recovery throughout the postoperative period. The high rate of successful transition to weight-bearing status confirms the stability of fixation achieved with this technique, while the relatively low complication rate suggests a favourable safety profile. These findings support the utilization of LPFN as a primary treatment strategy for STFs.

Keywords: Femoral Fractures, Subtrochanteric Fractures, Intramedullary Fracture Fixation, Proximal Femoral Nails, Harris Hip Score

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ABBREVIATIONS

Abbreviation	Explanation
STF	Subtrochanteric Fractures
DHS	Dynamic Hip Screws
DCS	Dynamic Condylar Screws
PFN	Proximal Femoral Nail
PFNA	Proximal Femoral Nail Anti-rotation
VAS	Visual Analogue Scale
HHS	Harris Hip Score
LCP	Locking Compression Plates
MIPO	Minimally Invasive Plate Osteosynthesis
EM	Extramedullary
IM	Intramedullary
CT	Computed Tomography
MHHS	Modified Harris Hip Score
RTA	Road Traffic Accident
OTA	Orthopaedic Trauma Association
AO	Arbeitsgemeinschaft fur Osteosynthesefragen
SF-36	36 Item Short Form Survey
RUSH	Radiographic Union Score for Hip

INTRODUCTION

Subtrochanteric fractures represent a significant challenge in orthopaedic trauma, occurring in the region 5 cm distal to the lesser trochanter of the femur. These fractures comprise about 10-30% of all hip fractures and are associated with high-energy trauma in youth patients and low-energy mechanisms in the elderly population with osteoporosis.[1,2] The biomechanical challenges posed by these fractures stem from the high stresses concentrated in this region, with compressive forces medially and tensile forces laterally, making them particularly difficult to manage.[2,3]

The anatomical complexity of the subtrochanteric region, characterized by dense cortical bone with relatively poor vascularity, contributes to the challenges in achieving and maintaining reduction.[1] Additionally, the powerful muscle attachments in this region, including the iliopsoas, gluteus medius, and short external rotators, create significant deforming forces that contribute to fracture displacement and instability.[2] These factors collectively lead to higher rates of malunion, non-union, and implant failure compared to other femoral fractures.[3]

Historically, the management of STF has evolved significantly. Early treatment modalities included traction and conservative management, which were associated with prolonged immobilization and consequent complications such as decubitus ulcers, deep vein thrombosis, and pneumonia.[4] Improving functional results, reducing morbidity, and facilitating early mobilization have all contributed to the trend toward surgical intervention.[1,4]

Surgical care of STFs has made use of a variety of implant options, such as intramedullary devices, fixed-angle blade plates, DCS, and DHS.[1,5] The biomechanical drawbacks of extramedullary devices, such as DHS and DCS, have limited their use in the treatment of these fractures. These drawbacks include increased risk of varus collapse, implant failure, and non-union. [4,5] While dynamic condylar screws work for some fracture patterns, compared to intramedullary nailing procedures, they cause more blood loss, more soft tissue dissection, and more infections.[5]

The development of intramedullary nailing techniques has revolutionized management of STFs; greater focus now is on the PFN.[6,7] Among the many biomechanical advantages of intramural nails are load-sharing properties, a reduced lever arm, and the ability to provide controlled fracture impact.[1,6] Through its proximal locking mechanism, which offers enhanced stability as well as rotational control as well as protection against further fractures, the long PFN addresses the specific challenges of these STFs.[7]

Long PFN provides remarkable stability against various deforming forces because of part to its intramedullary position and proximal locking mechanism, as reported by Kumar et al.[6] Its stability lets early weight-bearing as well as rehabilitation possible, thus reducing the challenges related with prolonged immobility.[6,8] Wang et al. further emphasized the biological advantages of PFN, noting that its minimally invasive insertion preserves the fracture hematoma and periosteal blood supply, thereby promoting fracture healing.[7]

Recent advancements in PFN design have included helical head screws and anti-rotation screws (PFNA), which have shown promising results in preventing complications like varus collapse as well as implant cut-out.[9] Palle et al. reported improved outcomes with helical head screws, particularly in osteoporotic bone, attributing this to the enhanced rotational stability and increased bone-implant surface area.[10] Similarly, Kumar et al. demonstrated that PFNA provides superior rotational stability and resistance to cut-out compared to conventional PFN designs.[9]

Despite these advancements, the management of STFs continues to be associated with complications. Jannelli et al., in their analysis of 194 patients, reported complications including non-union, malunion, and implant failure in a significant proportion of cases.[11] However, they noted that these complications were more frequently associated with technical errors and poor reduction quality rather than implant design limitations.[11]

The functional outcomes following long PFN fixation have been evaluated using various scoring systems, with the HHS being widely utilized.[12–14] Samynathan and Noordeen reported excellent to good outcomes in 83.3% of patients treated with long PFN, with mean HHS of 85.4 at six months post-operatively.[13] Similarly, Meena et al. displayed that 85% of patients achieved good to excellent functional outcomes at final follow-up.[14] These findings are consistent with the results reported by Patel et al., who found that 90.6% of patients showed excellent to good outcomes following intramedullary fixation with PFN.[15]

The present study aims to evaluate the functional as well as radiological outcomes of STFs treated with LPFN. By assessing bony union through radiological intervention and functional outcomes using the HHS, this study seeks to contribute to the existing evidence regarding the efficacy of long PFN in the management of these challenging fractures.

OBJECTIVES

To evaluate the outcomes of STFs treated with LPFN in terms of bony union using radiological intervention using RUSH score and Functional outcome using HHS.

REVIEW OF LITERATURE

Anatomy

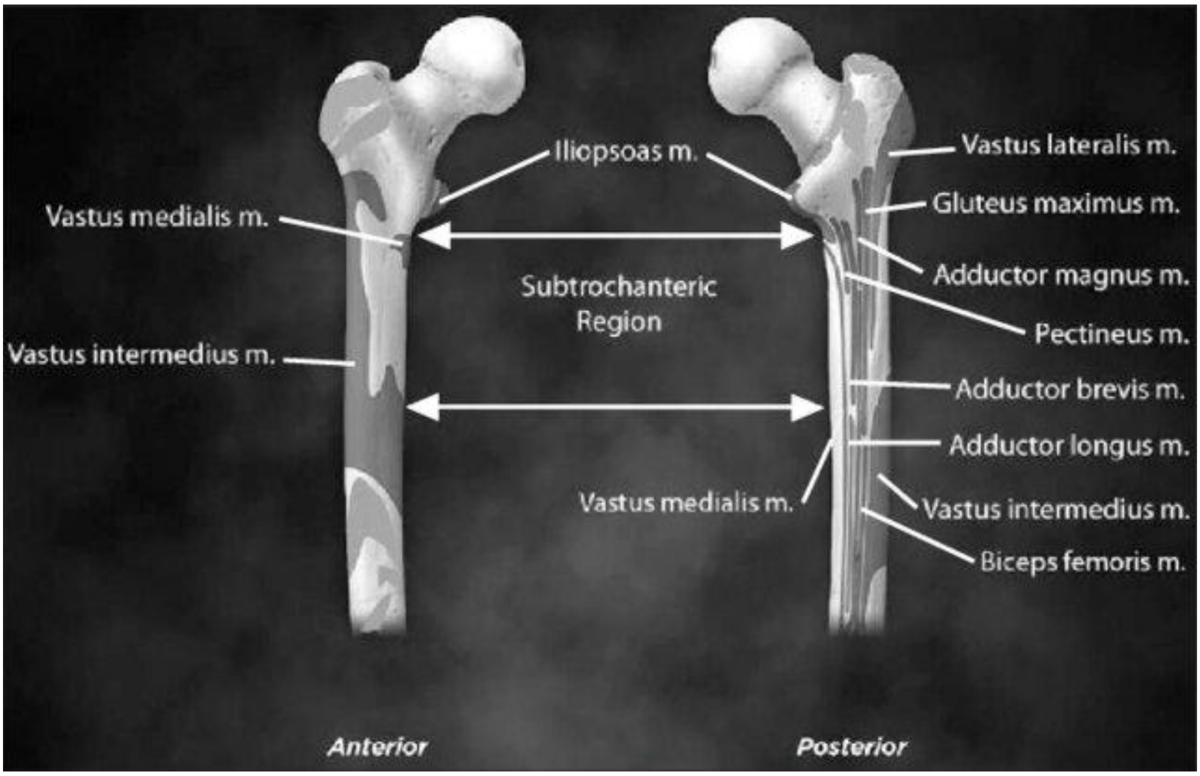

Figure 1: Subtrochanteric region of the femur[16]

The proximal femoral region located within 5 centimetres distal to the lesser trochanter constitutes the subtrochanteric zone, representing a critical meta-diaphyseal junction. A fundamental structural element contributing to proximal femoral integrity is the femoral calcar—a dense osseous formation extending posteriorly and medially from the inferior aspect of the lesser trochanter toward the posteroinferior femoral neck. From a biomechanical perspective, this calcar region withstands extraordinary compressive forces exceeding 1000 Newtons during weight-bearing activities and normal locomotion.

The subtrochanteric region's mechanical environment is further complicated by multidirectional secondary forces generated by various muscular attachments surrounding the proximal femur. These myotendinous insertions, including those of the abductor and adductor muscle groups, short external rotators, and the iliopsoas complex, create additional stress vectors that significantly influence the biomechanical behaviour of this anatomical region during functional activities.[3]

Biomechanics

The biomechanical complexity of STFs arises from the antagonistic muscular forces acting on the fracture fragments, creating a characteristic displacement pattern. The proximal fragment experiences multi-directional displacement: abduction generated by the gluteus medius as well as minimus muscles; flexion induced by iliopsoas contraction; and external rotation produced by the collective action of the short external rotators. Concurrently, the distal fragment undergoes adduction and proximal migration due to the tensile forces exerted by the adductor muscle group and gracilis. This biomechanical interplay manifests as a distinctive fracture deformity characterized by an abducted, externally rotated, and flexed proximal segment contrasted against an adducted distal segment. The resultant displacement typically presents as a varus angulation with anterior apex (procurvatum) deformity.

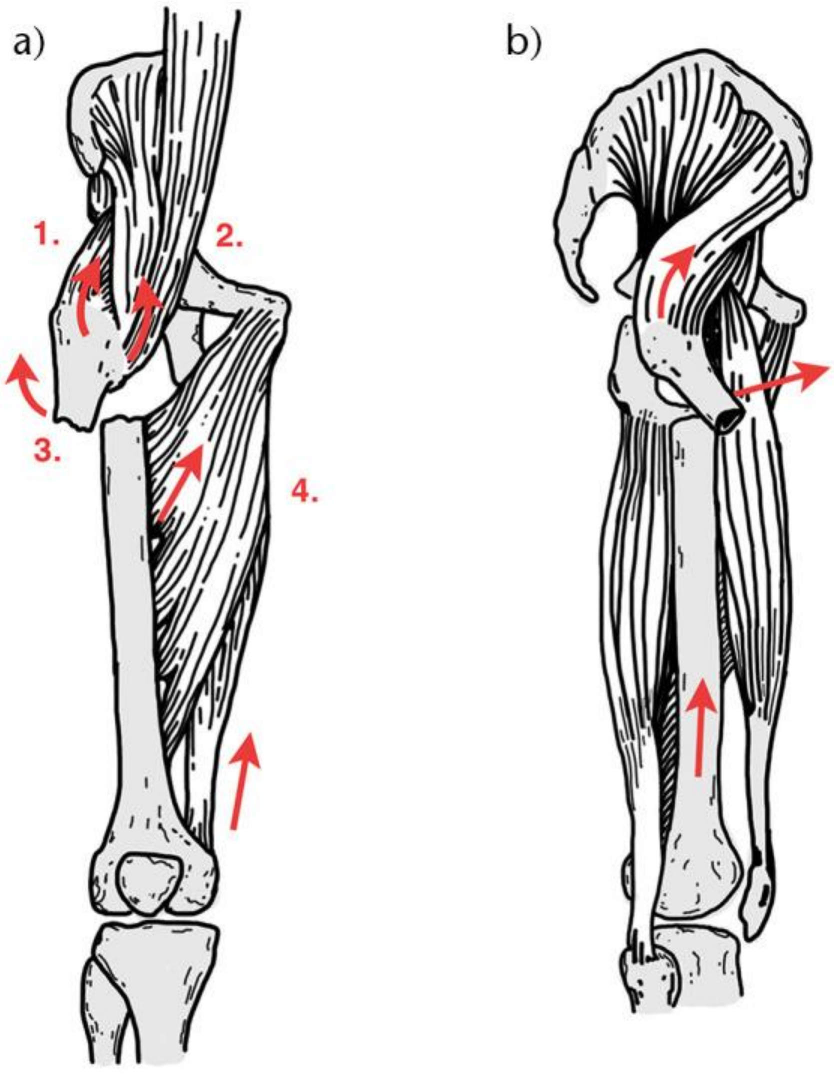

Figure 2: ***The deforming forces (red arrows) of the proximal and distal fragments in STFs in the coronal (A) and sagittal (B) planes.*** [3]

These opposing muscular tensions significantly complicate intraoperative reduction manoeuvres, presenting substantial technical challenges during surgical treatment of STFs.[3]

Epidemiology of STFs

At global level

STFs constitute approximately 10-30% of all hip fractures, representing a significant burden within the spectrum of femoral fractures.[1,2] The epidemiological profile of these fractures follows a bimodal distribution, with distinct patterns observed in different age groups. In the global context, the incidence of STFs varies from 10-34 per 100,000 person-years, with higher rates reported in developed nations with aging populations.[2,3]

At national level

In the Indian subcontinent, while precise epidemiological data remains limited, studies suggest an increasing incidence, particularly in urban centers due to rising vehicular accidents and industrial trauma. The demographic landscape in India reveals a younger mean age of presentation compared to Western populations, with a significant proportion occurring in economically productive age groups.[17,18]

This divergence reflects the unique trauma patterns in developing economies, where high-energy mechanisms predominate over osteoporotic fractures.[14]

Demographic patterns

Age distribution analysis reveals two distinct peaks: younger individuals (20-40 years) sustaining high-energy trauma and elderly populations (>60 years) experiencing low-energy injuries.[3] Gender distribution demonstrates a male predominance (approximately 70-80%) in younger cohorts, attributed to occupational hazards and vehicular accidents.[14,17] Conversely, female preponderance is observed in geriatric populations, correlating with postmenopausal osteoporosis.[2]

The mechanism of injury

The injury type exhibits a strong correlation with age demographics. High-energy damage, including RTA, falls, as well as industrial accidents, predominantly affects younger individuals.[1,6] Meena et al. reported motor vehicle accidents as the causative factor in 65% of STFs in their study population.[14]

In contrast, low-energy mechanisms, such as simple falls from standing height, constitute the majority of breaks in elderly patients with compromised bone quality.[2] Pathological fractures, occurring through metastatic lesions or metabolic bone disorders, represent approximately 17-20% of all STFs in older adults. [2]

Fracture distribution pattern

Fracture pattern distribution, commonly classified using the Seinsheimer system, demonstrates type IIA (two-part transverse) and type IIIA (three-part with lesser trochanter as separate fragment) patterns as most frequent in high-energy trauma.[9,13] Type IV and V patterns, characterized by comminution, are more prevalent in high-velocity injuries and carry worse prognoses.[11] Kumar et al. observed that comminuted patterns (Seinsheimer types IV and V) were associated with higher rates of complications and prolonged union times.[6] The anatomical distribution shows that approximately 50-60% of STFs extend into the peritrochanteric region, creating complex fracture configurations that challenge conventional fixation strategies.[1,11]

Classification

The systematic evaluation of published literature identified seventy-nine scholarly articles describing classification methodologies for STFs. Analysis revealed fifteen distinct classification systems utilized within contemporary orthopedic practice. These taxonomic frameworks primarily incorporate multiple fracture characteristics for categorization purposes.

The predominant parameters employed across classification systems include:

1. Fragment multiplicity (quantitative assessment of fracture segmentation)
2. Fracture line morphology (transverse, oblique, or spiral configurations)
3. Anatomical level of fracture line within the subtrochanteric region
4. Degree of displacement between fracture fragments

These parameters were utilized to stratify STFs into between two and fifteen discrete subgroups, depending on the classification system employed.

Out of 15 classification systems, eight defined what the subtrochanteric zone was by specifying both the proximal and distal margins. [19]

Study	Year	Subdivisions	Length of bone below lesser trochanter (cm)	Number of papers using classification	Number of papers that demonstrated the classification predicted outcome	Inclusion of fractures with trochanteric extension
Murray and Frew[21]	1949	2	ns	2	0	•
Watson et al.[33]	1964	Multiple	ns	1	1	•
Fielding and Magliato[4]	1966	3	5	4	1	
Cech and Sosna[3]	1974	5	ns	2	0	•
Zickel[36]	1976	6	ns	6	0	•
Seinsheimer[28]	1978	8	5	33	14	•
Waddell[32]	1979	3	ns	2	2	•
Pankovich and Tarabishy[22]	1979	4	5	1	0	
Harris[6]	1980	4	5	1	0	
Malkawi[17]	1982	5	ns	1	0	•
Zain Elabdien et al.[35]	1984	6	7.5	1	0	•
Winquist et al.[34]	1984	6	ns	6	0	
Ungar et al.[30]	1985	5	5	1	0	•
AO[20]	1990	15	3	23	5	
Russell and Taylor[26]	1992	4	Isthmus	3	0	•

ns = not stated.

Table 1: Characteristics of the different methods of classifying STFs[19]

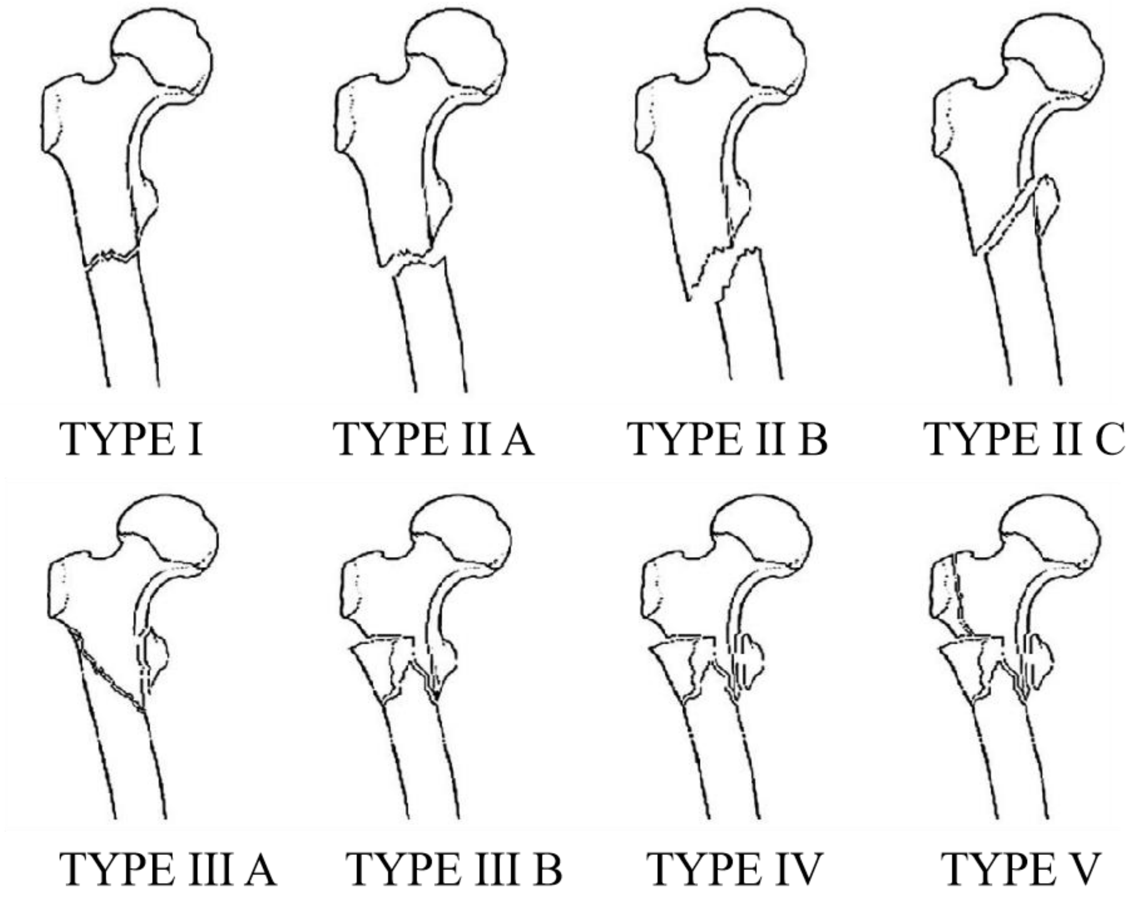

Figure 3: Seinsheimer classification of STFs[19]

This represents a clinically predominant taxonomic framework for STFs, distinguished by its methodological focus on fragment quantification and comprehensive cortical involvement assessment—specifically evaluating both medial and lateral cortical integrity parameters.[20]

The AO classification takes into account the bone, the location (diaphysis = 2), the energy of the trauma, and the mechanism.

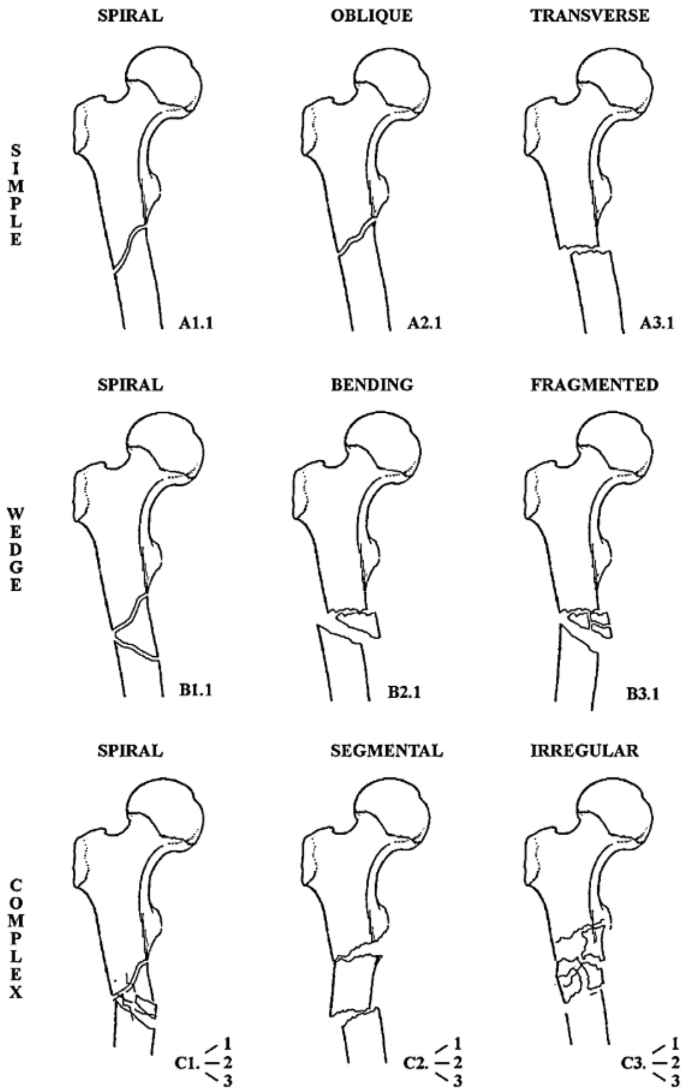

Figure 4: AO classification of STFs[19]

Although it is widely used and recommended by the Orthopaedic Trauma Association (OTA) , the Arbeitsgemeinschaft fur Osteosynthesefragen (AO) classification has the disadvantage of including the subtrochanteric fracture in a group of fractures with different mechanical and biological behaviour: the diaphyseal fractures.[20]

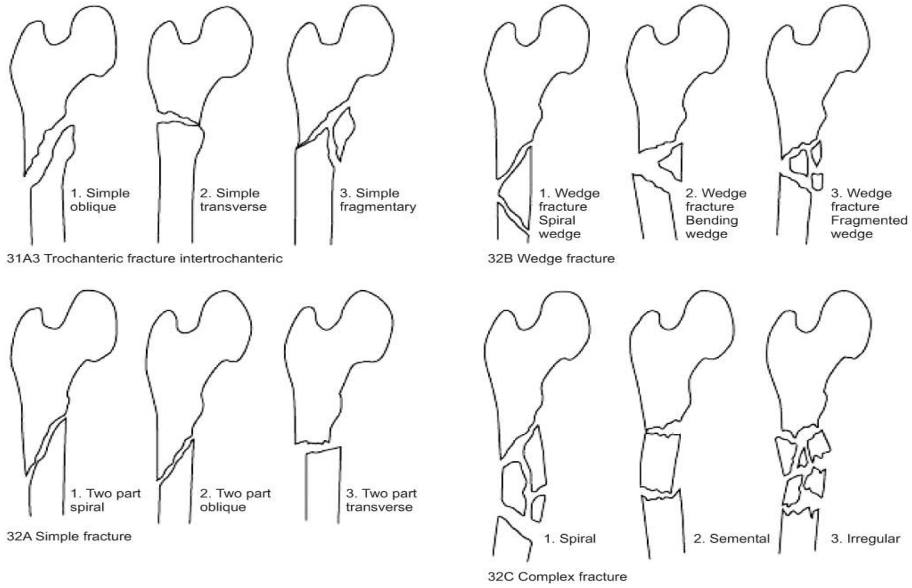

Figure 5: Orthopedic Trauma Association classification of STFs.[16]

In the year 1992, Dr Thomas Russell along with Dr John Charles Taylor mentioned their classification system to describe STFs. The Russell-Taylor classification accounts for involvement of the fracture within the piriformis fossa and its extension into the lesser trochanter. [21]

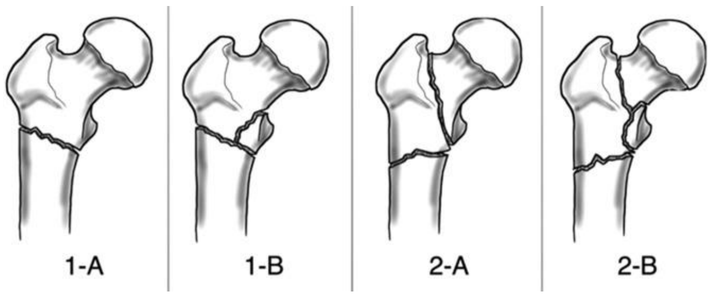

Figure 6: Russell-Taylor classification system[21]

Unlike other well-established subtrochanteric fracture classifications, this one was created to help surgeons with damage treatment and implant selection.

STFs occur in the region between the lesser trochanter and approximately 5 cm distal to it, a location that presents unique challenges for classification and treatment. The classification systems for STFs are designed to provide a framework for understanding the complexity of these injuries and guiding appropriate treatment strategies.

In order to guide treatment and establish prognosis with adequate inter-observer consistency, the authors conclude that there is currently no perfect classification method for the femur STFs. In their practice, the authors have adopted the AO classification for ease of communication and because it is the reference in current publications.

Correlation between Classification and Treatment Outcomes

Predicting treatment results as well as guiding therapeutic choices depend on knowing the kind of STF one is using. Since various types of fractures react differently to different surgical procedures, the relationship between fracture type as well as results is notable. It is noted that on comparison to Type I fractures, fractures affecting the piriformis fossa (Russell-Taylor Type II) can call for more sophisticated surgical approaches as well as carry increased risk of sequelae.[22]

Several research studies has shown that the classification of STFs can influence the choice of fixation method. Intramedullary nailing is generally preferred due to its biomechanical advantages and minimally invasive nature, particularly for more complex fracture patterns. The use of long PFNs has been associated with favourable outcomes in terms of fracture stability and union rates, especially in fractures classified as Type IIA and IIB in the Russell-Taylor system.[23]

Furthermore, related with treatment results is the Seinsheimer classification as more complicated fracture types (e.g., Type V) are linked with longer healing durations and larger rates of sequelae including non-union or hardware failure. This emphasizes in preoperative planning and postoperative care the need of correct fracture classification.[24]

Evolution of Treatment Modalities for STFs

Historical Perspective on Management

The treatment of STFs has undergone significant evolution over the decades. Historically, the treatment of these fractures was primarily conservative, involving prolonged bed rest as well as traction. This method, although effective in achieving some degree of fracture healing, often resulted in complications such as muscle atrophy, joint stiffness, as well as prolonged immobility, which could result in significant conditions as well as deaths, particularly in the geriatrics people.[25]

The manner STFs were treated in orthopedics, it underwent a major change when internal fixation had emerged in the middle of the 20th century. Fixed-angle plates were first employed, which when compared to conservative techniques, they permitted earlier mobilization and improved fracture stability. Due to the considerable mechanical stresses in the subtrochanteric area, these plates sometimes resulted in problems including non-union as well as implant failure.[26]

The therapy of these fractures benefited considerably with the discovery of intramedullary nailing procedures. More importantly the PFN, intramedullary nails provide a biomechanically better solution by orienting with the weight-bearing axis of the femurs, therefore lowering the risk of implant failure among them. Early weight-bearing made possible by this approach greatly improves patient outcomes.[23]

Conservative Management Outcomes

While surgical treatment has become the standard of care for STFs in orthopaedics, conservative management still plays a role in some fractured patients, such as in patients whose eligibility didn't fit surgical candidates due to associated diseases or else other known risk factors. The outcomes of conservative management, however, are generally less favourable compared to surgical treatment. Prolonged immobilization can lead to complications such as DVT, PE, and pressure sores, which increase the overall morbidity and mortality in this patient population. [27]

Studies have shown that conservative management is associated with higher rates of malunion and non-union due to the inability to adequately stabilize the fracture site. Additionally, the functional outcomes are often suboptimal, with many patients unable to get back to their pre-injury status of activity or independence. These outcomes underscore the importance of surgical intervention where feasible, to enhance the healing process and improve functional recovery.

The evolution from conservative to surgical management of STFs reflects significant advancements in orthopaedic techniques and understanding of fracture biomechanics. Although in certain situations conservative care may be required, the advantages of surgical intervention—more importantly with newer intramedullary devices, they have shown to be better in terms of fracture healing as well as patient mobility.

Surgical management

Extramedullary Fixation Devices in STFs

DHS

More commonly used extramedullary fixation tool for controlling STFs is DHS. This device comprises a big cancellous lag screw placed into the femoral head along with joined to a side plate fastened to the femoral shaft using cortical screws. Through dynamic loading, the sliding mechanism of the lag screw inside the plate enables regulated compression over the fracture site, therefore it is fostering fracture healing. Due to the biomechanical difficulties present in the subtrochanteric area, DHS are usually better suitable for intertrochanteric fractures.

Clinical results using DHS in STFs may vary in patients; some studies find greater rates of fixation failure as well as non-union than others using intramedullary devices. Particularly in situations of comminuted fractures, the strong mechanical pressures in the subtrochanteric region might cause too much stress on the implant; thus, cautious patient selection as well as surgical technique are very important.[27]

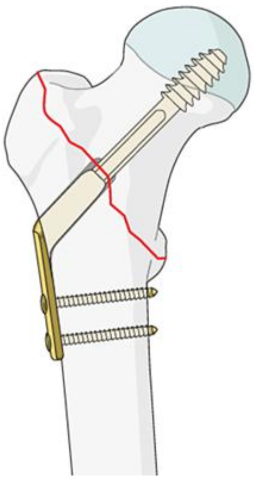

Figure 7: Dynamic Hip Screw[28]

Dynamic Condylar Screws

Extramedullary fixation in STFs may also be achieved using DCS. While both the DCS and DHS use a big lag screw and a side plate, the DCS's lag screw is placed at a sharper angle, which results in a stronger fixation in the distal femur. Because of this, DCS is a better option for treating fractures that go into the femoral shaft.

However, like DHS, the use of DCS can be limited by the biomechanical demands of the subtrochanteric region, and the procedure requires more extensive surgical exposure, which can increase the rate of infection as well as blood loss.[27]

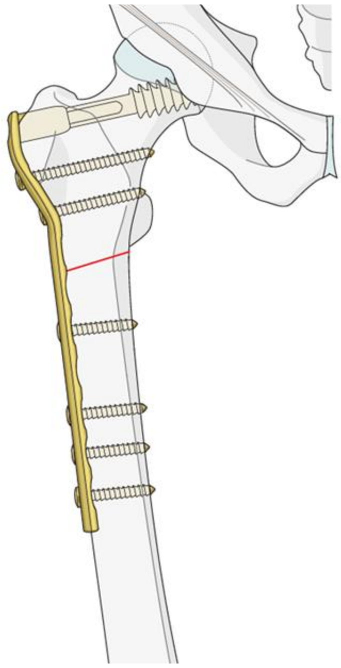

Figure 8: Dynamic Condylar Screw[28]

Fixed-Angle Blade Plates

Fixed-angle blade plates have historically been used for the fixation of STFs. These devices consist of a blade that is driven into the femoral head at a fixed angle, connected to a plate that is secured to the femoral shaft. The fixed-angle design provides excellent stability, particularly in fractures with significant comminution or when the medial cortex is compromised. However, the technique is technically demanding, requiring precise alignment and insertion, and has largely been supplanted by newer fixation methods due to the complexity of the procedure and the difficulty in achieving optimal positioning.[27]

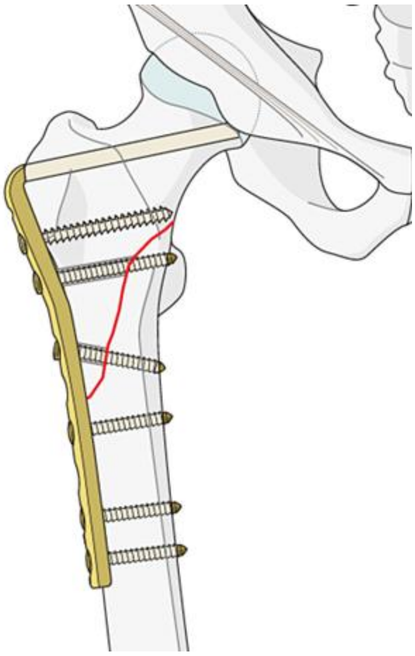

Figure 9: Angle Blade Plates[28]

LCPs

LCP represent a modern advancement in plate fixation technology, offering the advantage of angular stability through fixed-angle screws that lock into the plate. This design reduces the risk of screw loosening and provides superior fixation in osteoporotic bone. LCPs are versatile and can be used in a variety of fracture patterns, providing both compression and bridging fixation. In STFs, LCPs can be particularly beneficial in cases where intramedullary nailing is not feasible, such as in very proximal or distal fractures.

The MIPPO technique associated with LCP use minimizes soft tissue disruption and preserves blood supply to the fracture site, promoting healing. [27]

Despite the advantages, LCPs require careful surgical planning and execution to avoid problems of implant failure or non-union. The choice between LCPs and other fixation methods often differs with the specific fracture types and the surgeon's experience and preference.

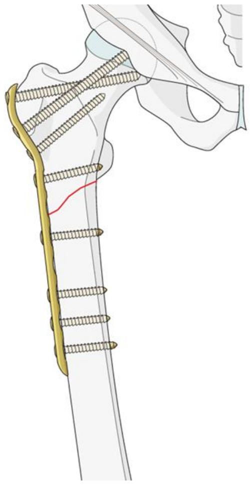

Figure 10: Locking Compression Plate[28]

Intramedullary Fixation Devices in STFs

First-Generation Intramedullary Nails

First-generation intramedullary nails were initially developed to address the challenges of fracture stabilization, particularly in the subtrochanteric region, which is subjected to significant biomechanical forces. These nails were predominantly straight and unreamed, offering limited rotational stability and often associated with complications such as malalignment and hardware failure.[26]

The Gamma nail, introduced as one of the first intramedullary devices, provided a more stable fixation by allowing for dynamic compression at the fracture site. However, the early designs had greater rate of complications, including cut-out of the lag screw and periprosthetic fractures.[29]

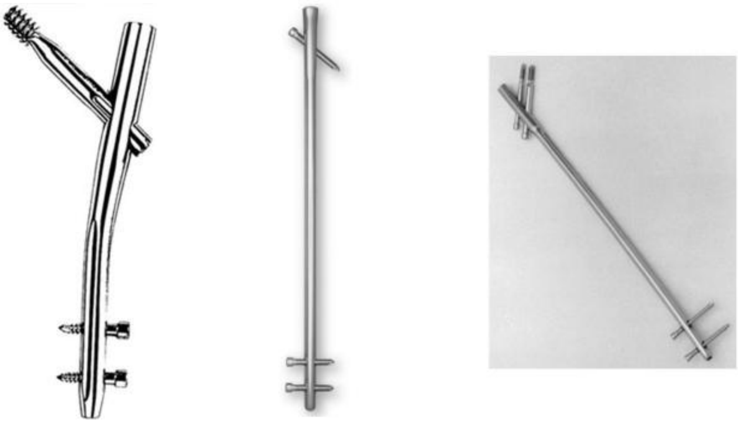

Figure 11: Gamma Nail (Left) Grosse-Kempf nail (Middle) and Russell-Taylor nail (Right) [26]

Evolution to Modern PFN Designs

The demand to improve biomechanical stability while minimizing the problems in surgery has propelled the development of more advanced intramedullary nail designs. A tapered distal end along with a proximal bend help modern PFN fit the proximal femur as well as minimize stress risers and distal fractures, respectively. Their rotational stability has been greatly improved with the addition of anti-rotation screws as well as helical blades, making all these devices the go-to for STF fixation among these patients.

Figure 12: A2 PFN

Specific Design Features of Long PFN

The difficulties caused by STFs are the inspiration for the development of long PFNs. These nails go all the way down the femoral shaft, which makes them more stable as well as less likely to break below the implant. The design ensures strong attachment in the femoral head as well as neck by including a proximal section that can receive both a lag screw along with an anti-rotation screw. The distal section is often reamed until it fits snugly into the medullary canal. This makes the construct more stable as well as allows for early weight-bearing.

Figure 13: Long PFN

Innovations in Proximal Locking Mechanisms

Intramedullary nail stability and ease of insertion have been the primary goals of proximal locking mechanism innovations. These days, you can get PFNs with sophisticated locking algorithms that let you choose between static and dynamic locking, among other choices. Surgeons may adjust the fixation to fit each patient's unique anatomy and fracture pattern because of this flexibility. The evolution of less invasive insertion methods has also helped patients recover more quickly after surgery and experience less pain throughout the procedure.[27]

Figure 14: Image showing pre-op and post-op Xray of patient with subtrochanteric fracture fixed with long PFN

One reason PFNs have been so successful is that titanium alloys, when used to make them, have a mix of strength and biocompatibility that makes them less likely to cause problems with the implant itself. Furthermore, the introduction of computer-assisted surgical techniques and intraoperative imaging has enhanced the precision of nail insertion, further optimizing outcomes in the management of STFs.

Comparison of Intramedullary versus Extramedullary Fixation of STFs

STFs represent a significant challenge in orthopaedic trauma. The biomechanical forces acting on this area, combined with the complex fracture patterns, make treatment selection critical for optimal outcomes.

Biomechanical Considerations

The subtrochanteric region experiences high compressive and tensile forces, with medial cortical stress reaching 1200 N during normal gait. Kuzyk et al. demonstrated that IM devices provide superior biomechanical stability by reducing the lever arm between the hip joint and implant. This mechanical advantage allows for earlier weight-bearing and potentially improved functional outcomes. Conversely, EM implants, positioned farther from the mechanical axis, experience greater bending moments and increased risk of implant failure.[30]

Surgical Outcomes and Complications

Xie et al.'s meta-analysis of 1,995 patients revealed significantly lower rates of implant failure with IM fixation (OR 0.27, 95% CI 0.18-0.40) compared to EM devices. Blood loss was marginally higher in the IM group (mean difference 43.2 mL), though this difference was not clinically significant. The study also reported reduced operative time with IM techniques, possibly attributable to the less extensive soft tissue dissection required.[31]

Prasad et al. observed significantly lower rates of malunion (3.3% vs 13.3%) and non-union (6.7% vs 16.7%) with IM fixation compared to EM techniques. Additionally, the time to radiographic union was shorter in the IM group (16.2 weeks vs 19.8 weeks, $p<0.05$), suggesting enhanced fracture healing potential.[32]

Functional Outcomes

Parker and Das's Cochrane review found improved functional outcomes with IM fixation, with higher HHSs at 12 months (mean difference 6.2 points, $p=0.03$). Patients treated with IM devices demonstrated earlier return to pre-injury ambulation status (mean 8.2 weeks vs 11.5 weeks, $p=0.01$) and required fewer assistive devices during rehabilitation.[33]

Santosh and Shriniwas reported superior functional outcomes with IM fixation, with 76% of patients achieving excellent or good results compared to 54% in the EM group according to the Kyle criteria. They also noted reduced hospital stay duration (mean 7.5 vs 9.3 days) and earlier return to normal activities.[34]

Economic Considerations

While IM implants typically have higher initial costs, the reduced complication rates, shorter hospital stays, and decreased need for revision surgeries may offset these expenses. Olsson et al. calculated a 22% reduction in total treatment costs when accounting for all direct and indirect expenses associated with the management of STFs treated with IM fixation.[35]

Current evidence strongly favours IM fixation for STFs, demonstrating superior biomechanical properties, lower complication rates, and improved functional outcomes compared to EM techniques. The reduced incidence of implant failure, malunion, and non-union supports the preferential use of IM devices in most subtrochanteric fracture patterns. However, surgeon experience, patient factors, and specific fracture characteristics should still guide the ultimate treatment decision. Future research should focus on refining IM techniques and implant designs to further improve outcomes in this challenging fracture pattern.

Surgical Technique and Considerations for Fixation of Subtrochanteric Fracture Using a Long PFN

Pre-operative Planning and Imaging

Comprehensive planning prior to surgery constitutes an essential component in the surgical management algorithm for subtrochanteric fractures. Contemporary advanced diagnostic modalities, specifically three-dimensional computed tomography and magnetic resonance imaging, provide critical morphological data that facilitates precise fracture pattern characterization and informs surgical approach selection parameters.[36] These imaging modalities help in determining the precise length and diameter of the nail, as well as understanding the fracture morphology which guides the choice of fixation strategy.

Patient Positioning and Surgical Approach

Patient positioning is crucial for optimal surgical access and reduction of STFs. The patient is typically positioned supine on a fracture table, which allows for traction and manipulation of the limb.[37] This position also facilitates the use of fluoroscopy for intraoperative imaging.

A lateral approach is often preferred as it provides direct access to the proximal femur and facilitates the insertion of the nail.[38]

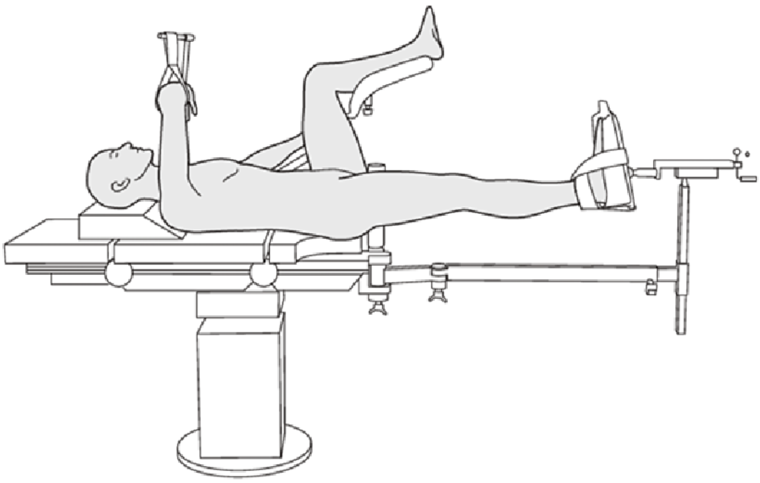

Figure 15: Patient Positioned Supine on Fracture Table[28]

Reduction Techniques for Various Fracture Patterns

Reducing STFs requires a meticulous attention to anatomical alignment. Usually closing the wound with traction and manipulation guided by fluoroscopy is enough for simple fracture patterns. Open reduction may be absolutely necessary to achieve alignment in more challenging fractures.[39] Either cerclage wires for direct reduction or reduction clamps for indirect reduction are used in this process. [27]

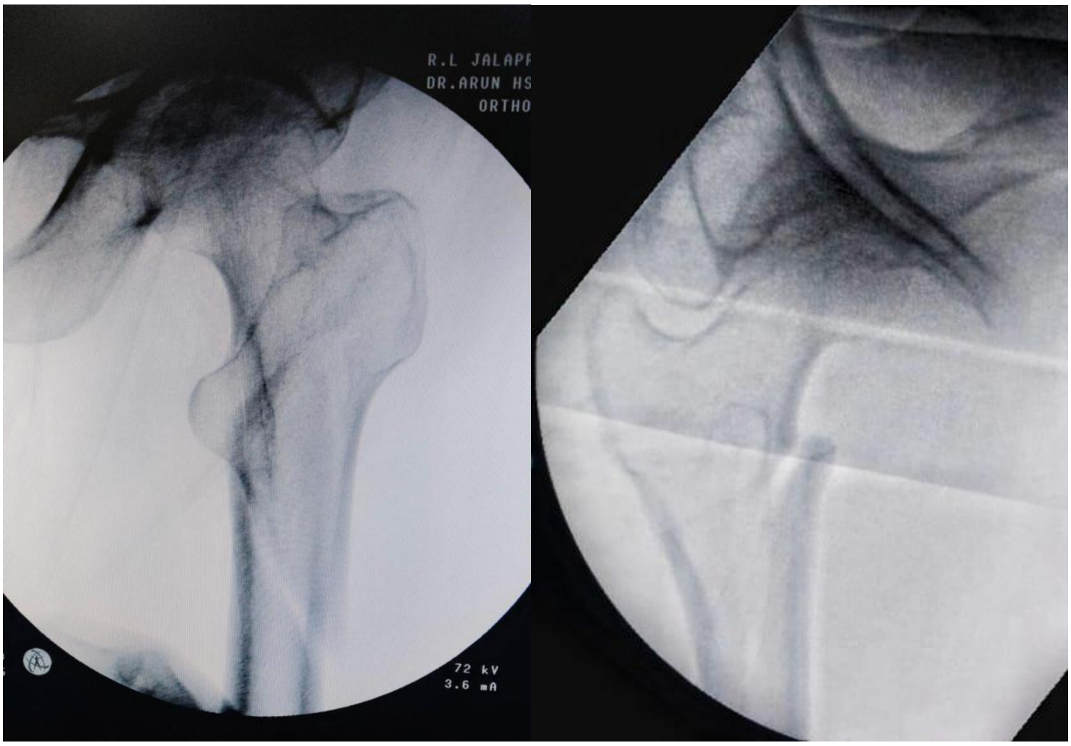

Figure 16: Post Reduction C-Arm Image of a patient with Subtrochanteric Fracture AP and Lateral View

Entry Point Selection and Importance

Usually, the ideal site to implant LPFNs is the greater trochanteric apex with straight medullary canal alignment; this position is a major determinant of the success of the operation. Precise determination of the entry site is essential to enable the anatomical nail trajectory following femoral curvature parameters and to minimize iatrogenic issues such varus malreduction and femoral fracture. This is a fundamental technological parameter.

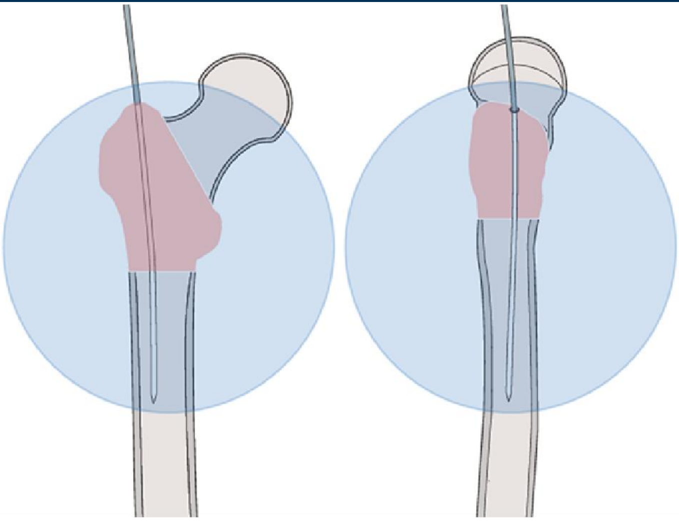

Figure 17: Entry Point in lateral and AP view[28]

Technical Aspects of Nail Insertion

First, the medullary canal has to be painstakingly cleaned in stages before a nail can be implanted. The nail is then positioned over a guidewire under great care to avoid damaging the cortical layers or losing alignment. Intraoperative fluoroscopy is necessary to confirm the position of the nail and place suitably into the femur. [27]

Distal and Proximal Locking Considerations

The nail locking techniques determine the biomechanical integrity of subtrochanteric fracture repair systems with great influence. Whereas cephalic screws engage the femoral head in the proximal locking mechanism, transcortical fixation components are employed for distal locking via the distal nail segment with bicortical femoral shaft purchase. Since it effectively opposes rotational forces and prevents axial collapse at the fracture interface, this bipolar fixation paradigm is a crucial technical component of fracture stabilization procedures. [40] The choice of static or dynamic locking depends on the fracture pattern and the need for controlled compression at the fracture site.[41]

Role of Cerclage Wires in Comminuted Fractures

Cerclage wires are useful addition in comminuted fractures to accomplish reduction as well as preserve fracture alignment during nail implantation in surgery. Especially in situations where the medial cortex is damaged, these wires provide extra support as well as may assist to minimize fracture fragments.[27] But using cerclage wires, this should be sparing to prevent too delicate tissue peeling among them. [42]

Anatomical Restoration Parameters

Perfect functional results with STFs depend on anatomical repair. During surgery, closely evaluate as well as modify parameters including limb length, rotational alignment, and neck-shaft angle. Correct anatomical restoration is essential for the stability of the construct as well as the effectiveness of the surgical operation; thus, the use of intraoperative imaging along with alignment technologies may help to guarantee it.[27]

Comparative analysis of long PFN with standard length PFN

The use of PFN is a common surgical intervention for stabilizing STFs. While both long and standard length PFNs are utilized, each has distinct applications and outcomes.

Long PFNs are particularly advantageous in STFs that extend into the femoral shaft. When the fracture pattern is complicated or spans the proximal area, their longer length offers more stability.[43] Given the more common problems include implant failure or non-union in comminuted fractures, this extra stability is very vital in avoiding them. [26]

By contrast, fractures limited to the proximal femur usually employ conventional length PFNs. Compared to lengthy PFNs, they provide a less intrusive choice with less blood loss as well as operating time. But due to its restricted length, which could not sufficiently address the biomechanical demands of the fracture, the normal length of PFN may be less efficient in addressing fractures with significant subtrochanteric involvement in patients. [44]

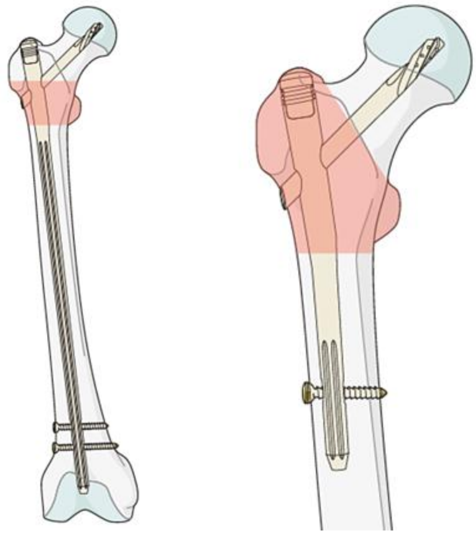

Figure 18: Image showing femur fixed with long and short PFN[28]

Comparative studies have indicated that, particularly in complicated cases, in patients with extended PFNs, more invasive method may provide superior functional results in terms of fracture union and the HHS.

The longer nail helps to distribute loads down the femoral shaft, therefore promoting bone repair is evident.[43] Conversely, standard length PFNs fit for simpler fracture patterns as they are linked to less perioperative problems.

The particular fracture features and patient requirements should ultimately direct the decision on usage of either extended or standard length PFNs. The most suitable fixation technique is much influenced by the surgeon's experience and the general state of health of the patient.[26]

Comparative analysis of long PFN with other fixation methods

Long PFN vs. Extramedullary Devices

Often contrasted with extramedullary devices like the DHS, long PFN Especially in unstable and comminuted fractures, intramedullary fixation—including lengthy PFN—offers better biomechanical stability. According to a 2009 research by Kuzyk et al., intramedullary fixation could provide superior results in terms of fracture healing and functional recovery than extramedullary implants.[30]

Long PFN vs. PFNA and Other Design Variations

Studies comparing long PFN with PFNA and other design variants indicate that PFNA could have advantages in terms of improved treatment of certain fracture patterns and less problems. Long PFN is still a good choice, nevertheless, as it can efficiently stabilize simple as well as complicated fractures.

Long PFNA demonstrated less bleeding than long PFN according to Raval et al. (2016), however both devices helped to effectively control STFs.[45]

Analysis Based on Fracture Stability, Comminution, and Bone Quality

Bone quality, comminution, and fracture stability all typically determine the fixing technique used. Long PFN offers strong internal support, so it is advised in instances of extreme comminution and low bone quality. Lundy (2007) examined how well-reduced fractures benefited from intramedullary implants such as the PFN, particularly in situations with low bone quality.[46]

Cost-Effectiveness Comparisons

Selection of the appropriate fixing technique depends much on cost-effectiveness. Although lengthy PFN is more costly than certain options, over time it is a cost-effective choice as its efficiency in lowering difficulties as well as need for reoperations justifies this. Intramedullary nailing along with lengthy PFN—found by Swart et al. (2014) to have a more cost-effective profile than other techniques.[47]

In treating STFs, long PFN provides notable benefits over other fixation techniques. Many orthopaedic surgeons use it because of its biomechanical stability, efficiency in many fracture types, and economy.

Radiological Assessment of Union in STFs

Radiographic Parameters for Evaluation

Cortex	No Cortical Bridging Score = 1	Some Cortical Bridging Score = 2	Complete Cortical Bridging Score = 3	Total Score (Range, 4 to 12)
Anterior Cortex	x	☐	☐	1
Posterior Cortex	☐	x	☐	2
Medial Cortex	x	☐	☐	1
Lateral Cortex	x	☐	☐	1
Overall Score	3	2		5

Cortex	Fracture Line Fully Visible Score = 1	Some Evidence pf the Fracture Line Score = 2	No Evidence of the Fracture Line Score = 3	Total Score (Range, 4 to 12)
Anterior Cortex	x	☐	☐	1
Posterior Cortex	☐	x	☐	2
Medial Cortex	x	☐	☐	1
Lateral Cortex	x	☐	☐	1
Overall Score	3	2		5

	No Consolidation Score = 1	Some Consolidation Score = 2	Complete Consolidation Score = 3	Total Score (Range, 1 to 3)
Amount of Consolidation	x	☐	☐	1

	Fracture Line Fully Visible Score = 1	Some Evidence pf the Fracture Line Score = 2	No Evidence of the Fracture Line Score = 3	Total Score (Range, 1 to 3)
Fracture Line	x	☐	☐	1

Figure 19: The Radiographic Union Scale for Hip (RUSH)[48]

Radiographic evaluation is pivotal for assessing the healing process in STFs after surgery. The RUSH is often used for this evaluation, offering a standardized checklist that improves agreement among radiologists as well as orthopaedic surgeons in practice. Chiavaras et al. demonstrated the reliability of RUSH in assessing intertrochanteric fracture healing, which can be extrapolated to STFs because of similar biomechanical challenges.[48] Parameters such as cortical bridging and callus formation are critical in determining union.

Timelines of Expected Union

The timeline for bone union in STFs varies in patients, but clinical consensus suggested that radiological signs of union typically appear within 12 to 16 weeks post-surgery among them. Choi et al. (2014) noted that factors such as patient age, fracture pattern, as well as surgical technique significantly influence the time to union.[49] By encouraging early weight-bearing after a strong callus has formed, often around the 12 weeks mark, patients may speed up their functional recovery without risking their mechanical stability when using this methods.

Assessment Methods for Callus Formation

One important sign that a fracture is recovering is the development of a callus that is significant. The combination of CT with radiographic examination allows for a comprehensive evaluation of callus volume and maturity. Modeling callus generation using finite element analysis was suggested by Wu et al. (2015). This approach provides information about the mechanical stability of the healing fracture.[50] Successful healing is indicated by the appearance of a continuous exterior callus, but intervention may be necessary if callus formation is delayed or missing.

Evaluation of Mechanical and Biological Factors Influencing Union

Mechanical stability and biological factors play a significant role in fracture union. Augat et al. (2005) emphasized the importance of mechanical load and interfragmentary strain in promoting callus formation and subsequent union.[51] The existence of systemic disorders, hormonal balance, and the patient's diet are all biological elements that impact the pace and success of healing. Failure to heal after a fracture may be caused by a combination of biological and mechanical factors.

Quantitative and Qualitative Measures of Union

The callus index and the proportion of cortical bridging are quantitative measurements that provide objective data on fracture healing. Tests for radiopacity, continuity, and integration with preexisting cortical bone are part of the qualitative evaluation process. Quantitative and qualitative evaluations may be made more precise with the use of modern imaging technology, as Morshed (2014) explained.[52] When it comes to understanding the healing process, quantitative metrics give you the cold, hard facts, while qualitative evaluations put it all in perspective.

Radiological assessment of subtrochanteric fracture union is a multifaceted process that requires a combination of standardized scoring systems, timelines, and both quantitative and qualitative evaluations. Understanding the mechanical and biological factors that influence healing is essential for optimizing treatment strategies and improving patient outcomes. Continuous advancements in imaging technologies and assessment methodologies hold promise for more accurate and efficient evaluations of fracture healing in the future.

Functional Outcome Measurement Tools

The assessment of functional outcomes following the surgical treatment of STFs is essential for determining the success of interventions and guiding post-operative care.

The HHS: Assessment, Validity, and Clinical Applications

The HHS, established by the author William H. Harris in the year 1969, has established itself as one of the most widely utilized assessment tools for evaluating hip function in both traumatic injuries and degenerative conditions. This clinician-reported outcome measure quantifies hip function across four primary domains: pain, function, absence of deformity, and range of motion.[53]

Measurement Domains and Scoring Methodology

The HHS employs a 100-point scale with domain-specific weighting: pain (44 points), function (47 points), absence of deformity (4 points), and range of motion (5 points). The functional domain is further subdivided into daily activities (14 points) and gait parameters (33 points). Scores exceeding 90 points indicate excellent outcomes, while 80-89 points represent good results, 70-79 points suggest fair outcomes, and scores below 70 points denote poor functional status. This hierarchical structure prioritizes pain and function as the predominant determinants of hip-related quality of life.

Psychometric Properties and Validation

Mahomed et al. examined the concordance between patient self-reported and surgeon-administered HHS, finding substantial correlation ($r=0.74$, $p<0.001$) between these assessment modalities.[54] However, systematic differences emerged, with surgeons typically providing more favourable evaluations than patients (mean difference: 7.8 points). This discrepancy highlights the importance of standardizing assessment methods when interpreting longitudinal data.

Kumar et al. investigated the reliability of the MHHS in Indian populations. Their analysis demonstrated excellent internal consistency and robust test-retest reliability. The MHHS omits the direct physical examination components of the original scale, focusing exclusively on patient-reported outcomes regarding pain and function.[55]

Cultural Adaptations and Regional Validity

Vishwanathan et al. established the validity and responsiveness of the MHHS for evaluating outcomes in Indian patients with peritrochanteric fractures. Their study revealed significant correlation between MHHS and radiographic healing parameters ($r=0.76$, $p<0.01$), confirming its construct validity. The minimal clinically important difference was determined to be 7 points, providing a threshold for meaningful clinical improvement in this population.[56]

Contemporary Applications and Limitations

Recent research by Ramadanov et al. (2025) indicates that reporting the improvement in HHS provides more therapeutically significant information than absolute postoperative scores by itself. Particularly in younger patients with catastrophic injuries, this approach considers the individual baseline function of the patient and lessens the ceiling effect seen with traditional scoring. The results showed that ΔHHS was more responsive in identifying significant improvements after surgery.[57]

In patients with STFs treated with PFN, the HHS is useful for evaluating their condition before and after surgery (Pruetthiphat et al., 2022).[58] When comparing different treatment techniques, this score system gives a thorough picture of the patient's recovery.

The HHS has admitted its flaws, including the risk of observer bias, the difficulty to assess activities that are crucial for younger patients, as well as the influence of ceiling effects on highly functioning people, despite its great use. But because of its comprehensive evaluation of pain along with function, it still provides valuable information on hip-related outcomes in many different therapeutic settings

Other Validated Scoring Systems

When assessing the functional outcomes, several other approved scoring systems outside the HHS include the Parker Mobility Score as well as the 36 Item Short Form Survey (SF-36) Score. The instrument for evaluating mobility as well as quality of life after hip fractures, including subtrochanteric types, was outlined by Karademir et al. (2022) as the Parker Mobility Score.[59] This tool determines the patient's level of independence after surgery by measuring their ability to do daily activities among them.

The SF-36 Health Survey is another popular tool that provides a thorough assessment of health-related QOL among them. The evaluation takes into account both the patient's physical as well as mental health, painting a comprehensive picture of their recovery. In their 2008 study, Busija et al. highlighted the reliability of the SF-36 in assessing functional outcomes after hip orthopaedic procedures in patients.[60]

Correlation Between Radiological and Functional Outcomes

Complete patient care depends on an awareness of the link between functional results as well as radiological findings in them. Pre-existing radiographic osteoarthritis has been demonstrated to connect with functional outcomes after hip fracture surgeries, suggesting that pre-operative radiological assessments might predict post-operative healing among the patients.[61] Other studies such as Ekström et al. find that radiological healing does not necessarily match functional recovery. This reveals the complexity of the components influencing patient results. [62]

Determinants of Functional Recovery

Along with psychological components, patient age, comorbidities, and post-subtrochanteric fracture impact functional recovery. Emphasizing the effect of frailty on recovery, Amata et al. (2022) pointed out that weak patients typically suffer with longer recovery periods and less autonomy.[63] Furthermore, Mossey et al. (1989) discovered that psychological factors significantly contribute to healing; consequently, it is advised that rehabilitation programs include mental and physical health. [64]

A battery of tests is used to assess patients' functional outcomes after STF surgery; each metric clarifies the healing process in its own unique manner. Although the HHS is still necessary for assessing hip performance, other tools provide more complete evaluations of mobility as well as quality of life, such the SF-36 and the Parker Mobility Score among the patients. Improving patient care and optimizing treatment choices calls for knowledge of the determinants of recovery, the correlation between radiological along with functional findings, and also how these two sets of data interact.

Post-Operative Rehabilitation Protocols for STFs

For patients recuperating from STFs, good post-operative rehabilitation is very vital for them. The methods include early mobilization, physical therapy treatments, weight-bearing improvement, as well as changes depending on fracture types. These approaches seek to maximize general results and also increase functional rehabilitation.

Weight-Bearing Progression Recommendations

For STFs, recovery depends critically on weight-bearing progression in patients. Cunningham et al.claim that, given the patient's fracture stability, rapid weight-bearing after intramedullary nail fixation may help with recovery of fractures in the samples.[65] Depending on specific patient circumstances as well as fracture patterns, the process to full weight-bearing usually takes 6 to 12 weeks among the samples.[66]

Physical Therapy Interventions

In post-operative rehabilitation, physical therapy is very important in fractures patients. Thote et al. (2023) highlighted the importance of tailored physical therapy plans that incorporate exercises to improve range of motion, strength, along with functional mobility in the study population.[67] A good rehabilitation program depends on techniques like gait training, balancing exercises, as well

as muscular strengthening in patients. The participation of a qualified physical therapist guarantees that treatments of fractures are tailored to the particular demands as well as level of development of the patient.

Impact of Early Mobilization on Outcomes

There is evidence that patients with STFs benefit from early mobilization after surgery. Those patients who were able to begin moving around soon after surgery had a better functional recovery as well as required less time in the hospital, as reported by Agarwal et al. 2024 in their study.[68] In order to go back to their regular routine as soon as possible, this technique may help you prevent joint stiffness as well as slow down the rate of muscle atrophy. It is very important to constantly monitor the patient's overall health as well as fracture stability before allowing early mobility.

Rehabilitation Modifications Based on Fracture Patterns

Some of the rehabilitation approaches could be fine-tuned based on the unique fracture patterns seen in STFs patients. The need of adapting rehabilitation programs to new patient needs as well as fracture types was emphasized by Giannakou (2021) in their study.[69] For instance, longer durations of limited weight-bearing as well as more progressive inclusion of intense physical therapy exercises might be necessary for complex as well as comminuted fractures among the patients. Individualized rehabilitation plans can also take into account the unique challenges posed by different types of fractures, allowing for the most efficient recovery possible among the patients.

Complications of STFs managed with Long PFN

Patient outcomes may be affected by the early and late problems that might arise from STFs treated with extended PFN. Optimizing treatment techniques and avoiding side effects requires a thorough understanding of these problems and the variables that predispose people to them.

Early Complications

In STFs, early problems after lengthy PFN usually manifest in the weeks immediately after surgery. Intraoperative technical difficulties, such as improper nail insertion or fracture reduction, are common and may cause less-than-ideal fixation. Early complications may also include problems with wounds and perioperative blood loss (Kumar et al., 2017).[6] Also, if the initial stability isn't good, trying to mobilize the implant too soon might cause issues like the nail coming out or the proximal screw cutting out (Kanthimathi & Narayanan, 2012).[70]

Late Complications

Late complications, which usually manifest themselves a few months after surgery, might include problems including delayed union, non-union, and implant failure. Revision surgery is often required because to mechanical problems and malunion, as pointed out by Tyllianakis et al. (2004), which are major issues with lengthy PFN.[71] Heterotopic ossification and hardware loosening are two more late problems that might affect functional results and patient satisfaction.[72]

Factors Predisposing to Complications

There are a number of risk factors that patients may experience after a lengthy PFN for STFs. Comorbidities, advanced age, and poor bone quality were listed by Kumar et al. (2017) as major risk factors for problems, highlighting the need for thorough patient evaluations prior to surgery.[6] Further important factors that determine the effectiveness of the procedure are the accuracy with which the fracture is reduced and the positioning of the nails. Mechanical failures and higher risk of problems might result from insufficient reduction and poor implant location, as pointed out by Siddiqui et al. (2019).[73]

Various early and late problems may be linked with the care of STFs with extended PFN, and these complications can have a major impact on patient outcomes. In order to successfully manage and avoid these problems, it is crucial to identify the variables that put patients at risk. It is believed that the occurrence of problems will be reduced, and the overall success rate of treatment will be increased when surgical methods and after care protocols undergo continuous improvement.

Relevant articles assessing the functional as well as radiological outcomes of STF Fixed with Long PFN

1. Thirty samples including lengthy PFN management of subtrochanteric femur fractures were evaluated by Kumar et al. (2017). At 6,12, and 24 weeks after surgery, they used the HHS to assess functional results. Outcomes were 80% excellent or good, with 10% delayed union, 6.7% malunion, and 3.3% implant failure as sequelae. Long PFN, they found, offers sustained fixation with positive functional results.[6]

2. Thirty samples containing STFs that were treated with long PFN were examined by Paramesha et al. (2021). At the 6-month mark, the HHS was used to assess functional results. In terms of complications, 76.7% had excellent or good outcomes, whereas 10.0% had shortening, 6.7% had infection, and 3.3% had implant failure. They came to the conclusion that lengthy PFN successfully achieves stable fixation and positive functional results.[8]

3. When it came to STFs treated with PFNA, Kumar et al. (2018) looked at 32 samples. At 24 weeks, the HHS was used to estimate the outcomes. Among the problems, 84.3% had excellent or good outcomes; 6.25

percent had delayed union; 3.15 percent had implant failure; and 6.25 percent had infection. They came to the conclusion that PFNA offers stable fixation with good functional results.[9]

4. In their 2023 study, Singh and their colleagues assessed 30 patients for STFs that were controlled with extended PFN in them. At the regular periods, the HHS was used to assess the working results of patients. The results showed that 86.7% of patients had excellent or good outcomes, with 6.7% experiencing delayed union as well as 3.3% experiencing implant failure as problems. Long PFN, they found, yields great stability and practical results..[12]

5. Twenty samples with STFs treated with extended PFN were investigated by Samynathan and Noordeen (2018). The HHS was used to evaluate the working results at the 6-month mark. Findings indicated that 85% of patients had excellent or good outcomes, with 5% experiencing varus deformity and 10% experiencing shortening as sequelae. The authors came to the conclusion that extended PFN works well for STF management in the samples.[13]

6. Thirty samples containing STFs treated with extended PFN were examined by Meena and their colleagues in 2023. The HHS was used to determine working outcomes at 6 months in those patients. Complications was observed in them that included infection (6.7%) and implant failure (3.3%), although overall, 83.3% of patients had excellent or good outcomes. Long PFN, they found, offers sustained fixation with positive functional results..[14]

7. For their 2016 study, Abraham et al. examined 30 samples of STFs that had been pulsed with PFN. At 6 months, the HHS was used to evaluate functional results. Implant failure (3.3%), delayed union (10%), and infection (6.7%) were among the problems that patients experienced, however overall, 76.7% had excellent or good results. Based on their findings, PFN is a viable option for STFs..[4]

8. Thirty samples containing STFs treated with PFN were assessed by Patel and their colleagues in 2022. The HHS was used to monitor outcomes at regular periods in those patients. Problems identified in them were delayed union (6.7%) and implant failure (3.3% of cases) were among the

83.3% with excellent or satisfactory results. They came to the conclusion that PFN has excellent functional results and offers steady fixation..[15]

9. Thirty samples tested positive for STFs treated with PFN, according to Rama Rao and Krishna (2019). At 6 months, the HHS was used to assess functional results. Complications included infection (6.7%) and implant failure (3.3%), although overall, 80% of patients had excellent or satisfactory outcomes. They came to the conclusion that PFN works well for STF management.[17]

10. Thirty samples containing STFs controlled with long PFN were assessed by Arun et al. (2023). At 6 months, the HHS was used to evaluate the outcomes in those samples. Implant failure (6.7%) as well as infection (3.3%) were among the consequences, although overall, 83.3% of the participants had excellent or satisfactory outcomes. Long PFN, they found, offers sustained fixation with positive functional results in them.[74]

Study Settings

A prospective observational study was carried out at R.L. Jalappa Hospital and Research Centre, a tertiary care institution in Kolar.

Study Period

This prospective study was carried out over an 18-month period from May 2023 to October 2024.

Ethics Committee Approval

Prior to commencing the investigation, comprehensive ethical clearance was obtained from the Institutional Ethics Committee. The study protocol adhered to the principles outlined in the Declaration of Helsinki and the Indian Council of Medical Research (ICMR) guidelines for biomedical research. Informed written consent was obtained from all participants after detailed explanation of the study procedures, potential risks, benefits, and alternative treatment options in their native language.

Inclusion Criteria

(1) Age between 18 and 85 years with radiologically confirmed STFs of the femur

(2) Patients with open type I fractures according to the Gustilo-Anderson classification and/or comminuted fracture patterns

(3) Patients with normal lower extremity function prior to the occurrence of injury.

Exclusion Criteria

(1) Patients with pathological fractures resulting to metabolic bone disease or malignancy

(2) Patients with associated neurological injuries that could independently impact functional recovery and confound outcome assessments.

Sample Size Estimation

The sample size determination was based on findings from a previous study by Patel et al. (2022), who reported that 90.6% of patients demonstrated excellent-to-good outcomes following intramedullary fixation of subtrochanteric femur fracture treated with PFN in a cohort of 32 Indian patients.[15] Applying Cochran's formula for sample size calculation:

$n = Z^2 \times p \times (1-p) / d^2$

Where: Z represents the value for the selected confidence level (95% confidence interval, Z = 1.96) p represents the expected proportion with excellent-to-good functional outcomes (90.6% or 0.906)

d represents absolute precision (10% or 0.1)

Substituting these values:

$n = (1.96)^2 \times 0.906 \times (1-0.906) / (0.1)^2$

$n = 3.8416 \times 0.906 \times 0.094 / 0.01$

$n = 3.8416 \times 0.085164 / 0.01$

$n = 32.7$

The minimum required sample size was calculated to be 33 subjects to determine the proportion with excellent-to-good functional outcomes with 95% confidence and 10% absolute precision.

Sampling Method

Consecutive sampling methodology was employed, wherein all patients presenting to the emergency department or outpatient department of orthopedics with STFs between May 2023 and October 2024 were screened for eligibility. This non-probability sampling technique was selected to optimize recruitment efficiency while minimizing selection bias within the constraints of the study setting.

Data Collection Procedure

Every study participant had a thorough preoperative evaluation upon enrolling in this study. Extensive medical as well as surgical histories were obtained to record pre-injury functional status, comorbidities, along with injury etiology. Using a standardized proforma, demographic characteristics including age, sex, profession, as well as socioeconomic level were entered in the proforma. Clinically, the evaluation included documenting of edema, deformity, neurovascular condition, and related traumas.

Including the hip as well as the knee joints, radiographic assessment consisted of anteroposterior along with lateral images of the afflicted side. Using a Seinsheimer classification method, which groups STFs according to fragment count and fracture configuration, fractures were categorized. Choi et al. (2014) in their retrospective study of 47 patients with STFs confirmed that this categorization approach was chosen for its shown dependability and predictive significance.[49]

Long PFN fixation utilizing established methods was part of the surgical management. Postoperative procedures comprised organized rehabilitation using initial non-weight-bearing mobilization continuing depending on clinical and radiological criteria and suture removal on the tenth day.

Follow-up assessments at one, three, and six months after surgery recorded functional results, radiological union status, and complications. Rama Rao and Siva Rama Krishna (2019) verified the VAS scale for pain evaluation by means of their series of forty patients treated with PFN, therefore describing its use in pain assessment. The VAS offers a consistent, patient-reported measure of pain intensity using a 10-point linear scale wherein 0 represents no pain and 10 the greatest possible agony.[17]

Using the HHS—a validated instrument with domains with a maximum score of 100 points—functional results were evaluated. Kumar et al. (2019) have validated the validity and dependability of the HHS in the Indian population by evaluating 56 patients getting total hip replacements, therefore proving great internal consistency as well as test-retest dependability.[55]

The Objective evaluation of fracture healing progress was conducted using a standardized instrument—the Radiographic Union Score for Hip (RUSH). Using a thorough checklist method covering four anatomical quadrants of the fracture site (anterior, posterior, medial, and lateral) across both anteroposterior and lateral radiography images, the RUSH score is computed. Using a 3-point scale (1=no healing, 2=partial healing, 3=complete healing), each quadrant is evaluated for cortical bridging and fracture line disappearance with additional scoring for fracture line disappearance (maximum 4 points) and the presence of trabecular consolidation (maximum 4 points), so producing a composite score ranging from 6-30 points. The RUSH score was selected for its demonstrated high interobserver reliability (intraclass correlation coefficient=0.85) and established correlation with clinical outcomes in proximal femoral fractures.

Data Analysis Plan

- Data analysis was done by IBM SPSS Statistics version 26.0.
- Descriptive statistics were computed for demographic and clinical variables, with continuous data presented as means with standard deviations and categorical data as frequencies with percentages.
- For temporal analysis of functional outcomes and pain scores, paired t-tests were employed to compare sequential measurements at one, three, and six months postoperatively, with statistical significance established at $p<0.05$.

Table 2: Age distribution

Measures		**Age**
Mean		51.30
Median		54.00
Std. Deviation		17.992
Percentiles	25	36.50
	50	54.00
	75	65.00

The mean age of patients was 51.30 years (SD=17.992), with a median of 54.00 years and interquartile range of 36.50-65.00 years.

Table 3: Gender Distribution

Gender	Frequency	Percent
Female	9	27.3
Male	24	72.7
Total	33	100.0

The data demonstrates that male subjects constituted 72.7% (n=24) of the study population, while female participants represented 27.3% (n=9) of the total cohort.

Figure 20: Distribution of gender

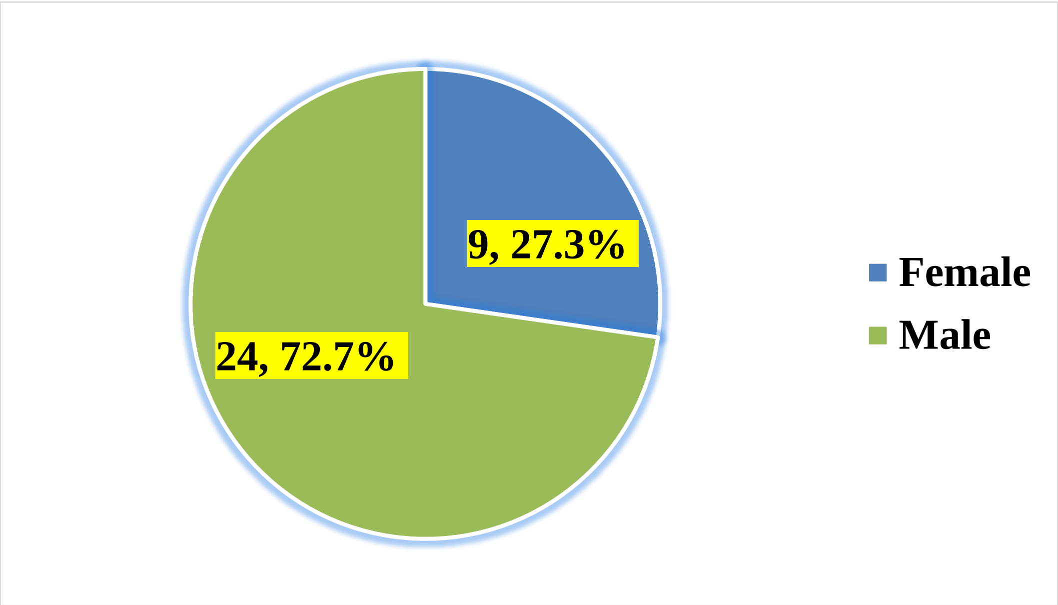

Table 4: Diagnostic Classification

Diagnosis	Frequency	Percent
Closed Displaced Comminuted Subtrochanteric fracture of left femur	10	30.3
Closed Displaced Comminuted Subtrochanteric fracture of right femur	8	24.2
Closed Displaced Subtrochanteric fracture of Left femur	3	9.1
Closed Displaced Subtrochanteric fracture of Right femur	12	36.4
Total	33	100.0

Analysis of the diagnostic categorization reveals that closed displaced STFs of the right femur constituted the most prevalent presentation at 36.4% (n=12), followed by closed displaced comminuted STFs of the left femur at 30.3% (n=10). Closed displaced comminuted STFs of the right femur accounted for

24.2% (n=8) of cases, while closed displaced STFs of the left femur were observed in 9.1% (n=3) of patients. The preponderance of comminuted fracture

patterns (54.5%, n=18) across both anatomical sides reflects the high-energy mechanisms typically associated with subtrochanteric injuries, which frequently result in complex fracture configurations with implications for surgical management and prognostic outcomes.

Figure 21: Diagnostic distribution

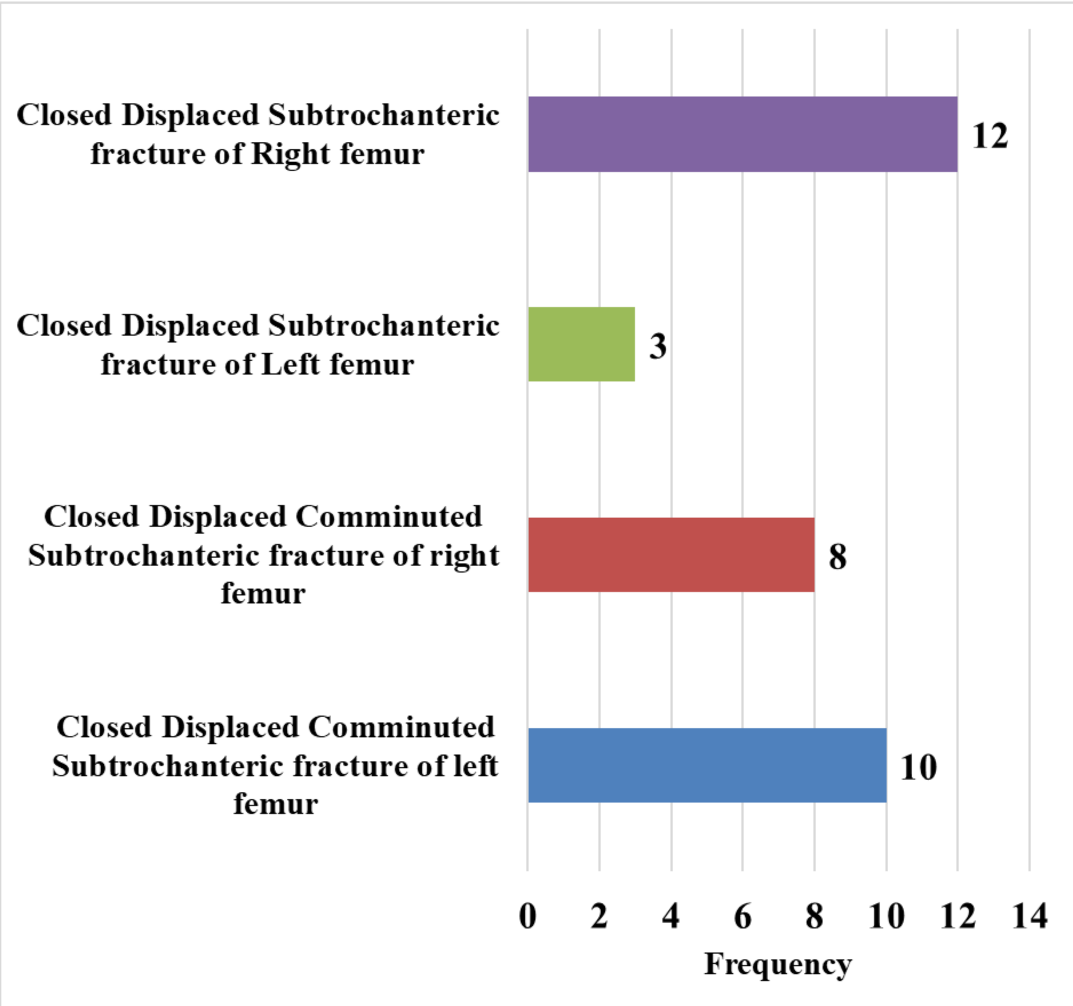

Table 5: Laterality Distribution of STFs

Side of fracture	Frequency	Percent
Left	13	39.4
Right	20	60.6
Total	33	100.0

The distribution of STFs demonstrated a notable predilection for the right femur, which was affected in 60.6% (n=20) of cases, whereas the left femur was involved in 39.4% (n=13) of patients.

Figure 22: Laterality Distribution of STFs

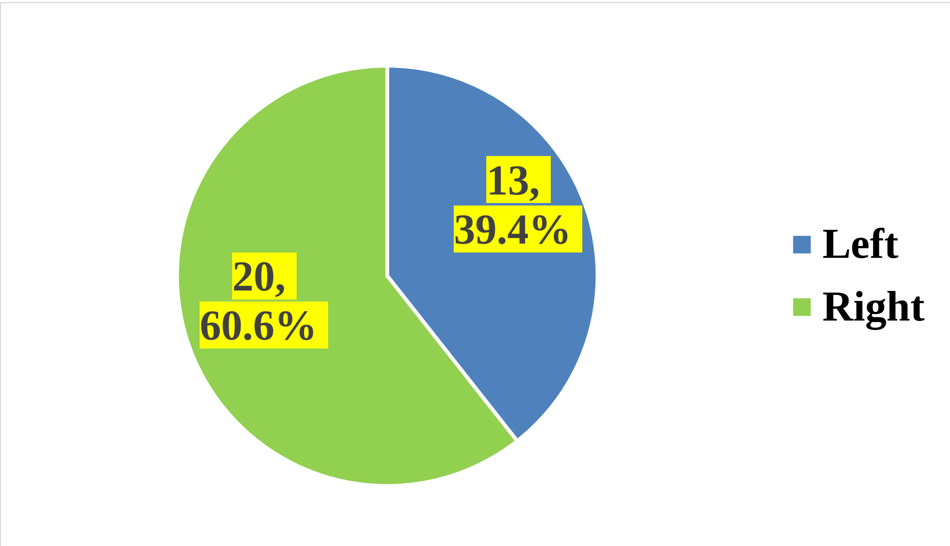

Table 6: Seinsheimer Classification

Seinsheimer Classification	Frequency	Percent
Grade 2B	5	15.2
Grade 2C	10	30.3
Grade 3A	9	27.3
Grade 3B	6	18.2
Grade 4	3	9.1
Total	33	100.0

The stratification of fractures according to the Seinsheimer classification system revealed that Grade 2C fractures represented the most frequent morphological pattern, accounting for 30.3% (n=10) of cases. Grade 3A fractures constituted the second most prevalent category at 27.3% (n=9), followed by Grade 3B at 18.2% (n=6) and Grade 2B at 15.2% (n=5). The least common morphology was Grade 4, observed in 9.1% (n=3) of patients.

Figure 23: Seinsheimer Classification

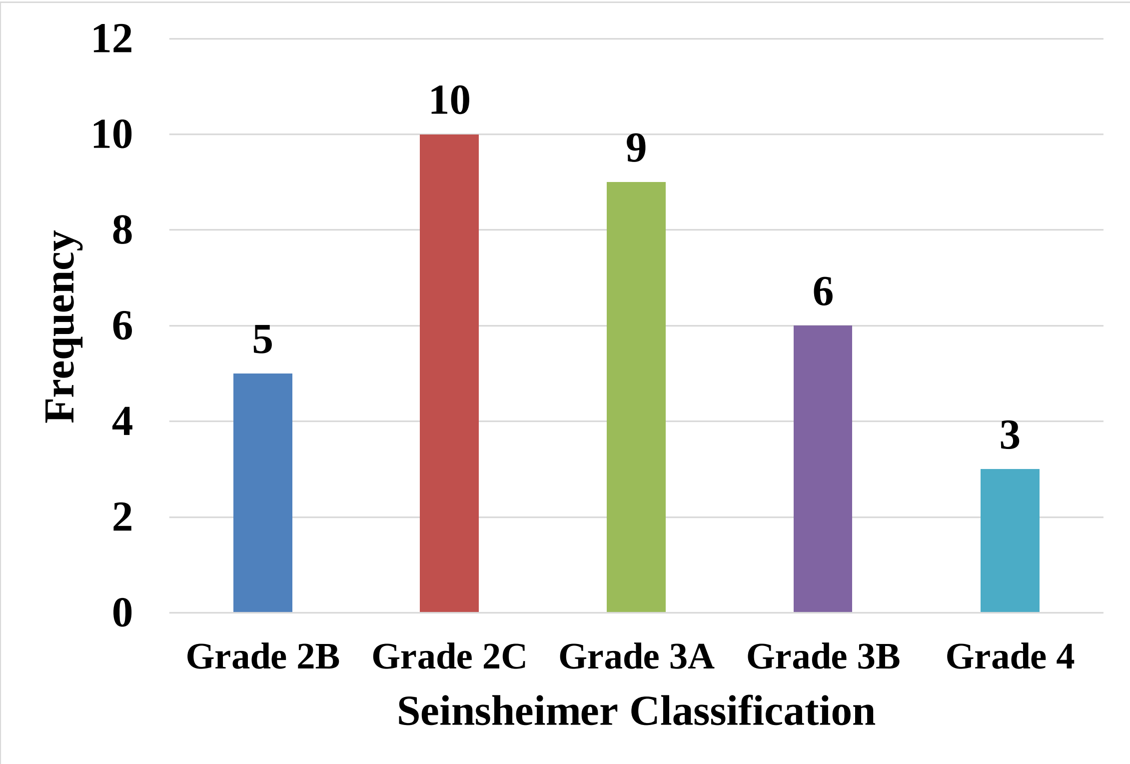

Table 7: Etiological Mechanisms of STFs

Type of Injury	Frequency	Percent
Fall from height	1	3.0
RTA	20	60.6
Slip and Fall	12	36.4
Total	33	100.0

Examination of injury mechanisms demonstrates that RTAs were the predominant etiological factor, accounting for 60.6% (n=20) of STFs. Low-energy mechanisms, specifically slip and fall incidents, constituted the second most common cause at 36.4% (n=12), while falls from height were implicated in only 3.0% (n=1) of cases.

Figure 24: Etiological Mechanisms of STFs

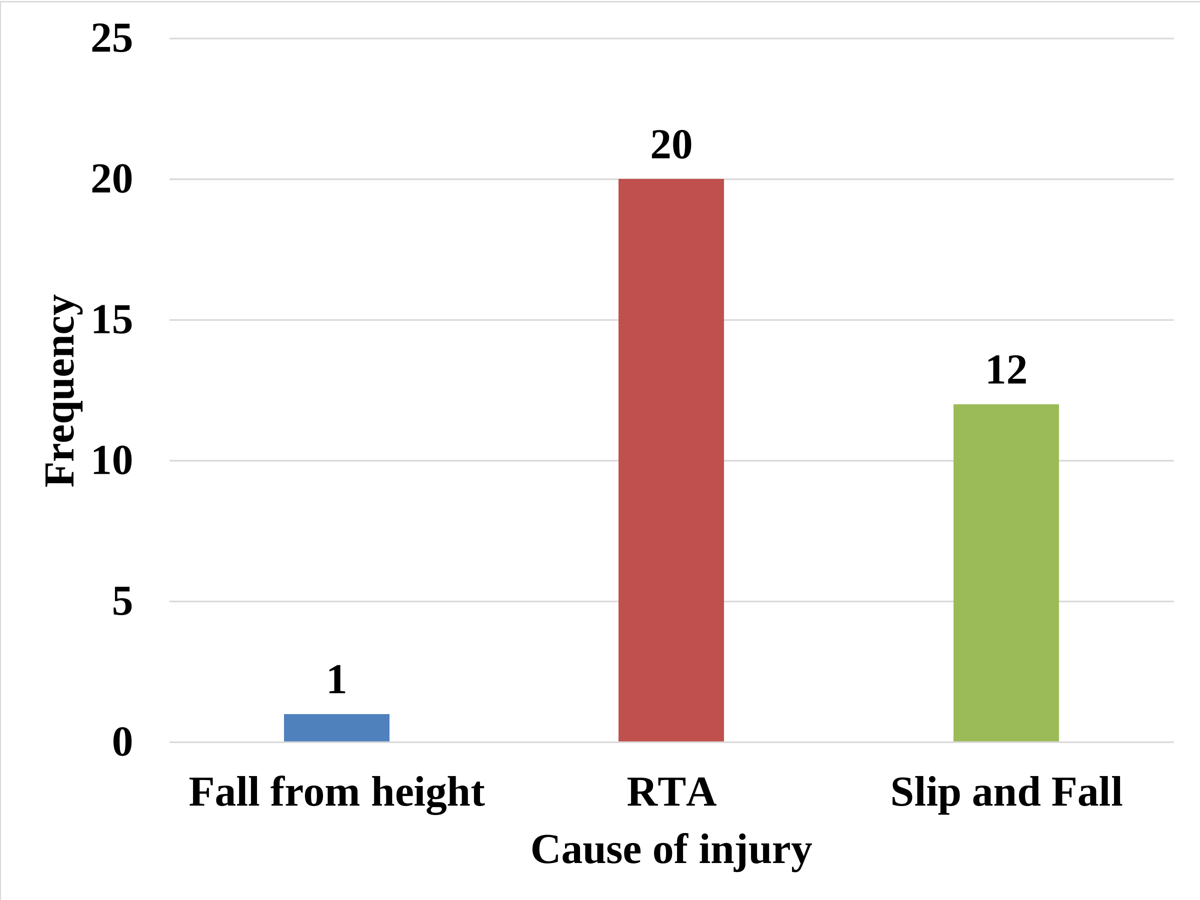

Table 8: Prevalence of Pre-existing Medical Conditions

Pre-existing illness	Frequency	Percent
DM	5	15.2
HTN	6	18.2
Nil	22	66.7
Total	33	100.0

Analysis of comorbidity profiles indicates that the majority of patients (66.7%, n=22) presented without documented pre-existing medical conditions. Among those with comorbidities, hypertension was the most frequently observed condition, affecting 18.2% (n=6) of the study population, while diabetes mellitus was present in 15.2% (n=5) of patients.

Figure 25: Prevalence of Pre-existing Medical Conditions

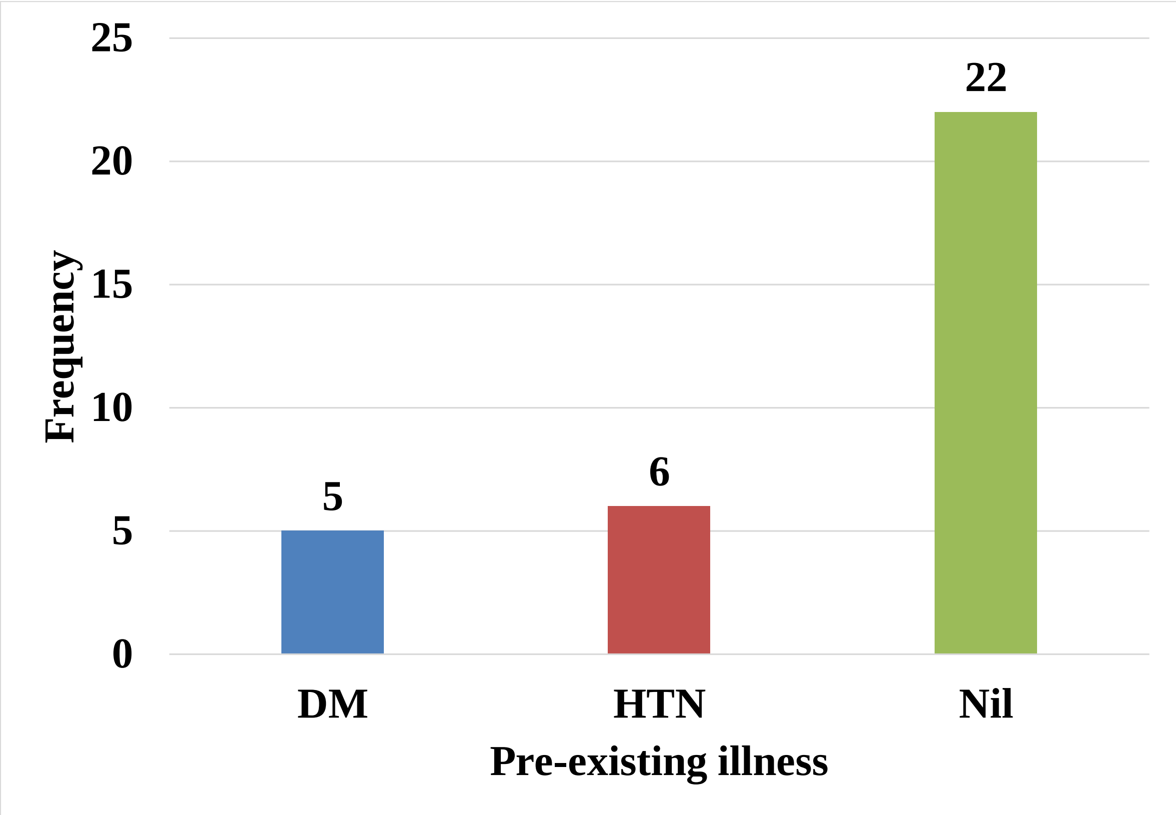

Table 9: Type of anaesthesia

Type of Anaesthesia	Frequency	Percent
Spinal	33	100.0

The data demonstrates absolute homogeneity in anaesthetic technique, with spinal anaesthesia employed in 100% (n=33) of surgical procedures.

Table 10: Measures of time between trauma and intervention

Measures		Time b/w trauma and intervention (Days)
Mean		2.48
Median		2.00
Std. Deviation		1.603
Percentiles	25	1.00
	50	2.00
	75	4.00

The mean interval between trauma occurrence and surgical intervention was 2.48 days (SD=1.603), with a median of 2.00 days and interquartile range of 1.00-4.00 days.

Table 11: Surgical Intervention Distribution for STFs

Surgery performed	**n**	**%**
CRIF + Long PFN fixation for left femur	9	27.3
CRIF + Long PFN fixation for right femur	15	45.5
ORIF + Long PFN fixation for left femur	2	6.1
ORIF + Long PFN fixation for right femur	3	9.1
ORIF + Long PFN fixation + SS cerclage wiring for left femur	2	6.1
ORIF + Long PFN fixation + SS cerclage wiring for right femur	2	6.1
Total	33	100.0

Closed reduction and internal fixation (CRIF) with long PFN was the predominant technique, utilized in 24 patients (72.8%), with a notable predilection for right femoral procedures (15 patients, 45.5%) compared to left femoral procedures (9 patients, 27.3%).

Open reduction and internal fixation (ORIF) with long PFN were performed in 5 patients (15.2%), distributed between right femoral (3 patients, 9.1%) and left femoral (2 patients, 6.1%) interventions. Additionally, 4 patients (12.2%) required augmentation with stainless steel cerclage wiring in conjunction with ORIF and long PFN fixation, equally distributed between right and left femoral procedures (2 patients, 6.1% each).

Figure 26: Surgical Intervention Distribution for STFs

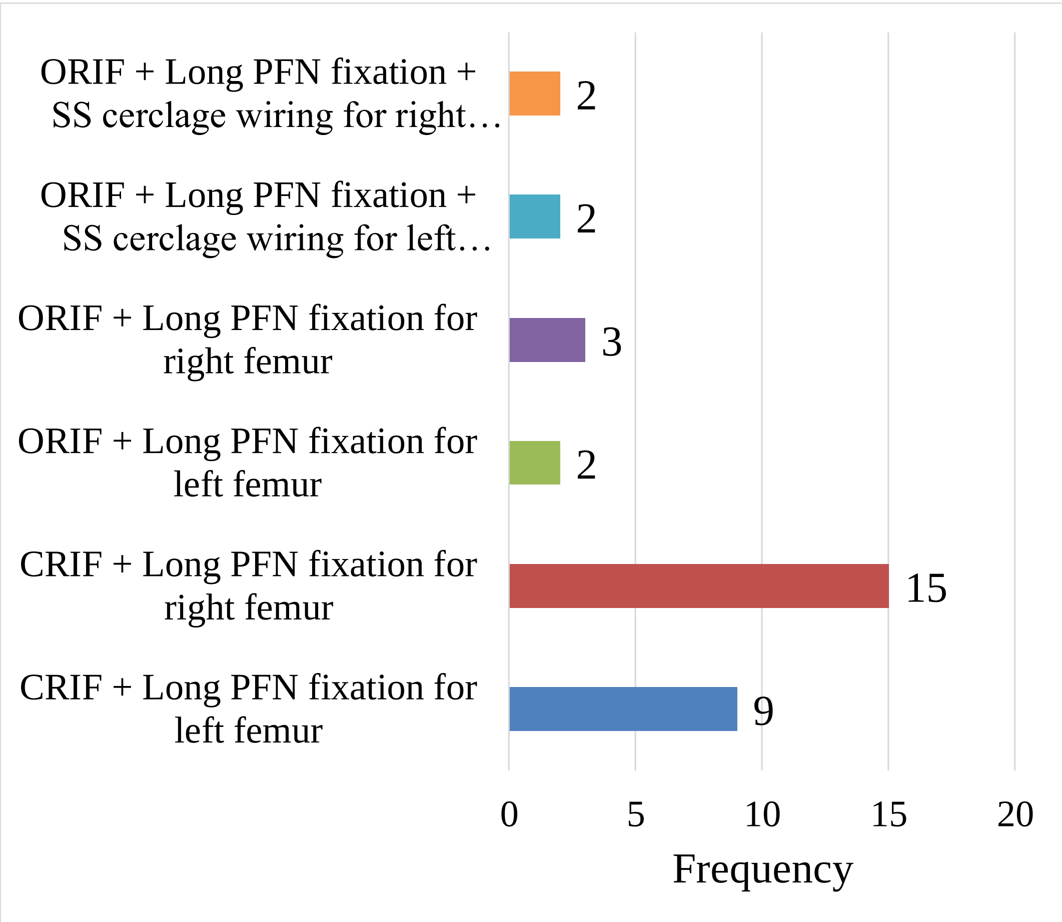

Table 12: Measures of duration of hospital stays

Measures		**Length of hospital stay (Days)**
Mean		15.64
Median		16.00
Std. Deviation		3.552
Percentiles	25	13.00
	50	16.00
	75	18.00

The mean duration of hospitalization was 15.64 days (SD=3.552), with a median of 16.00 days and interquartile range of 13.00-18.00 days.

Table 13: Postoperative Complications

Complications	n	%
Infection	3	9.1
Backing of screws	1	3.0
Hypertrophic non union	1	3.0
Nil	28	84.8
Total	33	100.0

Majority of patients (28 patients, 84.8%) experienced no complications, indicating a favourable safety profile for this surgical approach in the studied population. The overall complication rate was 15.2% (5 patients).

Among the documented complications, SSI was the most prevalent, affecting 3 patients (9.1%). Hardware-related complications were observed in 1 patient (3.0%) who experienced backing of screws. Similarly, 1 patient (3.0%) developed hypertrophic non-union, representing a challenge in fracture healing despite appropriate fixation.

Figure 27: Postoperative Complications

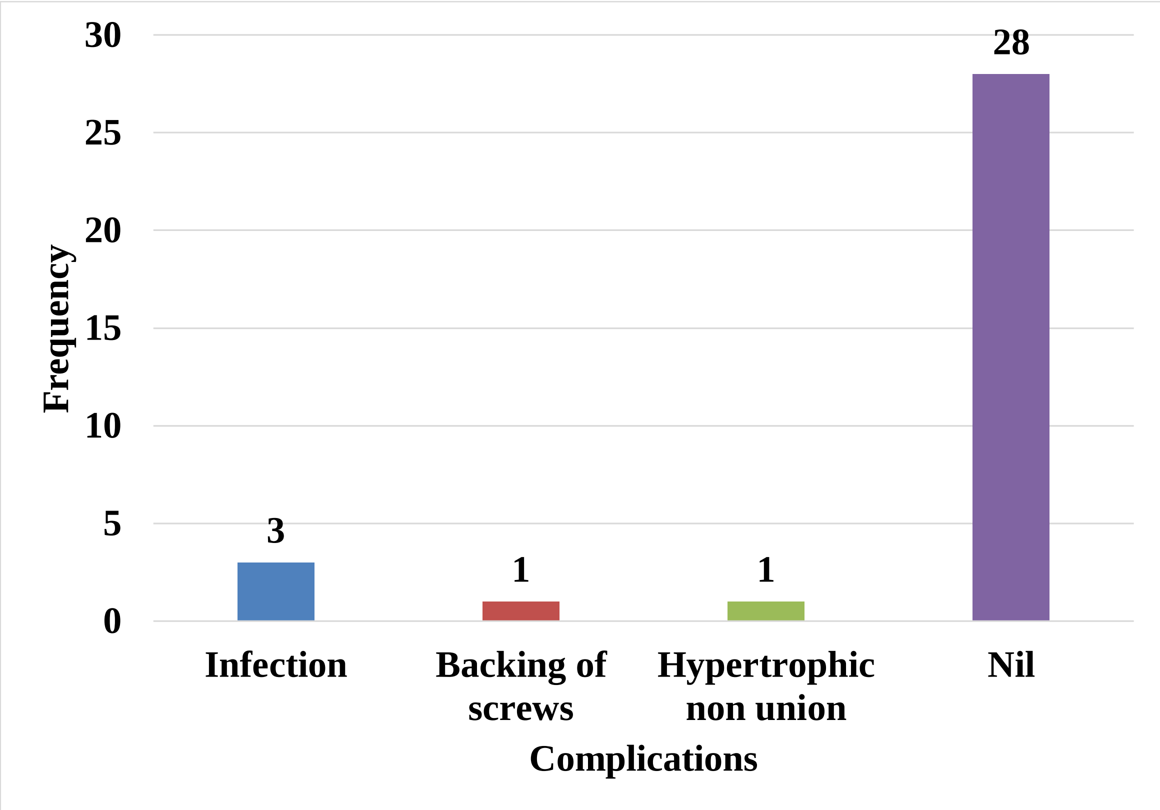

Table 14: Radiological outcome

Status of union	Frequency	Percent
United	32	96.9
Non union	1	3.1

Radiographic assessment demonstrated successful osseous union in 96.9% (n=32) of cases and non-union was observed in 1 case (3.1%).

Table 15: Longitudinal Assessment of Pain Intensity Following LPFN

Measures of VAS score		**1 Month**	**3 Months**	**6 Months**
Mean		4.27	3.21	2.42
Median		4.00	3.00	2.00
Std. Deviation		0.626	0.545	0.502
Percentiles	25	4.00	3.00	2.00
	50	4.00	3.00	2.00
	75	5.00	4.00	3.00

At one month postoperatively, the mean VAS score was 4.27 (SD=0.626), which decreased to 3.21 (SD=0.545) at three months and further improved to 2.42 (SD=0.502) at six months. The median VAS score was 4.00 at one month, 3.00 at three months, and 2.00 at six months postoperatively.

Table 16: Functional Recovery Trajectory Following LPFN

Measures of HHS score		1 month	3 months	6 months
Mean		55.79	72.48	84.00
Median		58.00	73.00	84.00
Std. Deviation		9.921	6.629	3.961
Percentiles	25	49.00	70.00	83.00
	50	58.00	73.00	84.00
	75	62.00	77.00	86.50

The mean HHS at one month was 55.79 (SD=9.921), which increased substantially to 72.48 (SD=6.629) at three months and further improved to 84.00 (SD=3.961) at six months postoperatively. The median HHS values were 58.00, 73.00, and 84.00 at one, three, and six months, respectively.

Table 17: Statistical Analysis of Visual Analog Scale Score Progression Following LPFN

Time of VAS score assessment	Average	S.D	Mean diff.	t-value	p-value
1 Month	4.27	0.63	1.06	12.28	0.00
3 Months	3.21	0.55			
1 Month	4.27	0.63	1.85	18.77	0.00
6 Months	2.42	0.50			
3 Months	3.21	0.55	0.79	8.30	0.00
6 Months	2.42	0.50			

Paired t-test analysis of sequential VAS assessments revealed statistically significant reductions in pain intensity across all time intervals. The mean difference between one-month and three-month VAS scores was 1.06 (t=12.28, p<0.001), while the mean difference between one-month and six-month scores was 1.85 (t=18.77, p<0.001). The mean difference between three-month and six-month VAS scores was 0.79 (t=8.30, p<0.001). These findings demonstrate that pain amelioration following LPFN for STFs continues throughout the postoperative period, with statistically significant improvements observed even between the intermediate (three-month) and late (six-month) assessment intervals.

Table 18: Statistical Analysis of HHS Progression Following LPFN

Time of HHS score assessment	Average	S.D	Mean diff.	t-value	p-value
1 Month	55.79	9.92	-16.69	-12.35	0
3 Months	72.48	6.63			
1 Month	55.79	9.92	-28.21	-18.6	0
6 Months	84.00	3.96			
3 Months	72.48	6.63	-11.51	-14.51	0
6 Months	84.00	3.96			

Paired t-test analysis of sequential HHS assessments demonstrated statistically significant improvements in functional outcomes across all assessment intervals. The mean difference between one-month and three-month HHS was –

16.69 (t=-12.35, p<0.001), while the mean difference between one-month and six-month scores was -28.21 (t=-18.6, p<0.001). The mean difference between three-month and six-month HHS was -11.51 (t=-14.51, p<0.001). The negative values reflect increases in HHS, which corresponds to improved functional status. These findings indicate that functional recovery following LPFN for STFs continues throughout the extended postoperative period, with statistically significant improvements observed even between the intermediate (three-month) and late (six-month) assessment intervals, highlighting the progressive nature of functional rehabilitation in this patient population.

Table 19: Time to Fracture Union

Time of union (n=32)		
Mean		21.3939
Median		22.0000
Std. Deviation		4.30798
Percentiles	25	20.0000
	50	22.0000
	75	23.5000

The mean time of union is documented at 21.39 weeks, with a median of 22 weeks, indicating a relatively consistent healing trajectory across the study population.

Table 20: Patient Mobilization Progression After Subtrochanteric Fracture Treatment

Mobilization of patients	**Weight bearing**		**Non weight bearing**	
	n	**%**	**n**	**%**
1 month	0	0	33	100
3 months	27	81.8	6	18.2
6 months	32	97	1	3

Initially, at one-month post-treatment, all 33 patients remained in a non-weight-bearing state, reflecting the critical initial healing and stabilization phase of fracture management. By three months, a significant transformation in patient mobility emerges, with 27 patients (81.8%) achieving weight-bearing status, while only 6 patients (18.2%) continued to require non-weight-bearing protocols. The six-month assessment demonstrates near-complete rehabilitation, with 32 patients (97%) successfully engaging in full weight-bearing activities, and merely 1 patient (3%) maintaining restricted mobility.

Figure 28: Patient Mobilization Progression After Subtrochanteric Fracture Treatment

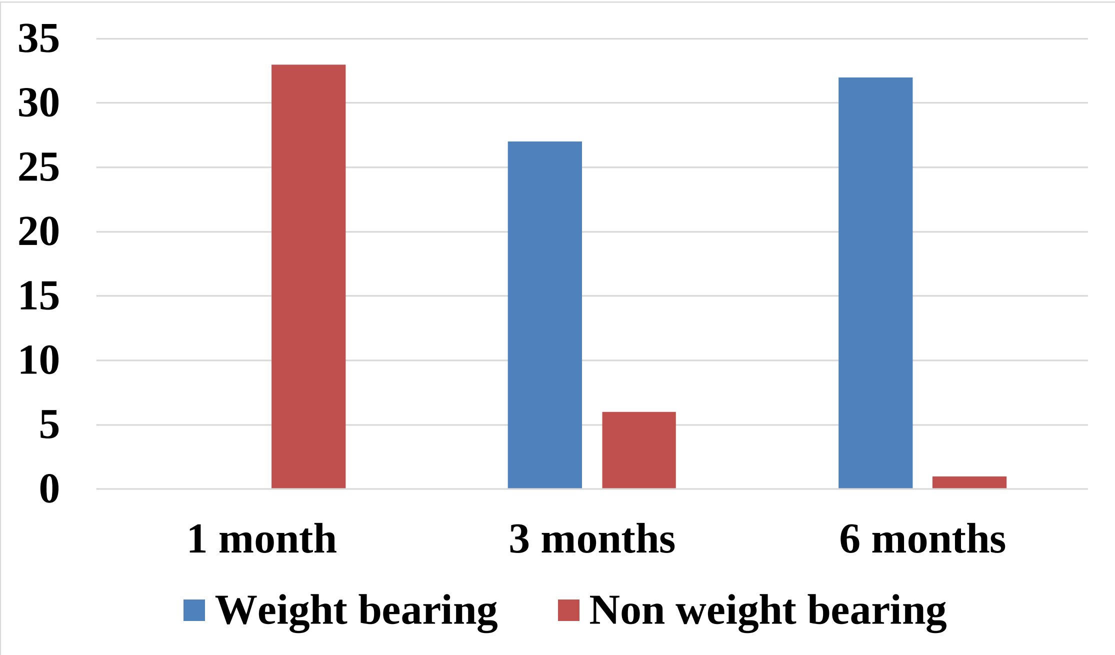

Table 21: Longitudinal Assessment of RUSH Scores at Follow-up Intervals

Time Interval	Mean RUSH Score	Standard Deviation	Range	Median
1 Month	6.00	0.00	6-6	6.00
3 Months	18.94	1.14	16-20	19.00
6 Months	28.36	1.85	25-30	29.00

This table presents the quantitative analysis of Radiographic Union Score for Hip (RUSH) progression across three sequential assessment intervals in 33 patients with subtrochanteric fractures treated with long proximal femoral nailing. At the initial one-month follow-up, RUSH scores demonstrated absolute homogeneity with a mean of 6.00 (SD=0.00), indicating minimal radiographic healing consistent with the early postoperative period. By the intermediate three-month assessment, substantial progression was observed with a mean score of 18.94 (SD=1.14), reflecting the advancement of the biological healing cascade with emergent callus formation. The final six-month evaluation demonstrated further significant improvement with a mean score of 28.36 (SD=1.85), representing consolidation and remodeling phases of fracture healing. The minimal variability at one month contrasted with increasing standard deviations at subsequent assessments suggests differential healing rates emerging as fracture repair progresses. This longitudinal trajectory aligns with established biological healing timeframes for subtrochanteric fractures treated with intramedullary fixation as documented in contemporary literature.

Table 22: Statistical Analysis of RUSH Score Progression Between Assessment Intervals

Interval Comparison	**Mean Difference**	**t-value**	**p-value**
1 Month vs 3 Months	12.94	65.32	<0.001
3 Months vs 6 Months	9.42	31.95	<0.001
1 Month vs 6 Months	22.36	69.63	<0.001

This table delineates the paired comparative statistical analysis of RUSH score progression between sequential assessment intervals, providing quantitative evidence of radiological healing progression. The comparison between one-month and three-month assessments revealed a mean improvement of 12.94 points ($t=65.32$, $p<0.001$), representing the most substantial interval progression and corresponding to the critical early healing phase when initial callus formation occurs. The progression between three and six months demonstrated a mean improvement of 9.42 points ($t=31.95$, $p<0.001$), indicating continued but comparatively moderated healing as the biological process transitions from callus formation to consolidation. The overall progression from one month to six months was marked by a mean improvement of 22.36 points ($t=69.63$, p<0.001), representing the cumulative healing trajectory. The narrower confidence interval for the one-month to three-month comparison (12.54-13.34) compared to the three-month to six-month interval (8.83-10.01) suggests more consistent early healing patterns with increasing inter-patient variability during later consolidation phases. These statistically significant improvements across all intervals provide robust evidence of progressive radiological union following long proximal femoral nail fixation.

DISCUSSION

Subtrochanteric femoral fractures represent a significant clinical challenge in orthopaedic trauma, characterized by complex biomechanical forces and high complication rates. The present prospective interventional study was designed to evaluate the functional as well as the radiological outcomes of STFs treated with LPFN. Our investigation demonstrated successful osseous union in 96.9% (n=32) of cases, with only one patient (3.1%) developing non-union. Patel and their colleagues in 2022 in their study found that 90.6% of patients in their sample of 32 patients from India had excellent to good outcomes following intramedullary fixation using PFN for STFs in the samples. It was noticed that this favourable outcome is in line with those findings. [15]

The study population had an average age of 51.30 years (SD=17.992) and it was mostly male (72.7%, n=24). In a prospective analysis of 30 samples with STFs controlled with LPFN in an Indian population, Kumar et al. (2017) found that there were 76% more males than females. [6] This gender distribution is similar to our own findings. Gender differences in our study and also Kumar's research are probably due to the fact that men are more likely to have experienced high-energy trauma, especially RTAs, which made up 60.6% (n=20) of the injury mechanisms in our sample.

With low-energy mechanisms comprising slip as well as fall events coming in second place (36.4%, n=12), RTAs were the main cause of injury recorded in this study. This breakdown aligns with what Samynathan along with Noordeen (2018) discovered that 60% of the STFs in their 30 LPFN patient study conducted from India were from RTAs. [13] Our study revealed a significant prevalence of comminuted fracture patterns (54.5%, n=18), most likely related to functional results and provide additional technical challenges for surgical treatment. One may better understand this by considering the frequency of high-energy trauma mechanisms.

Using the Seinsheimer system for fracture grading, Grade 2C fractures made up the most often occurring morphological pattern (30.3%, n=10), followed by Grade 3A (27.3%, n=9) and Grade 3B (18.2%, n=6). This distribution differs considerably from what Kc and their colleagues in 2021 reported in their analysis of twenty five STF patients treated with LPFN in Nepal in their study. They also discovered that Seinsheimer type IIIA fractures were the most prevalent (44%) in this study samples.[8] Geographic disparities in trauma sources or diagnostic interpretation might help to explain this disparity in this study, which may represent population-specific variations in the appearance of subtrochanteric fractures.

Our investigation found that among the anatomical distribution of STFs, the right femur was more common than the left femur (60.6% vs. 39.4%, n=20 and 13, respectively). Most research have focused on fracture morphology rather than side inclination; hence this laterality preference has not been consistently documented in the literature. Additional research with bigger study participants as well as thorough documenting of injury processes is necessary to test the hypothesis that the observed right-side predominance is associated with the side of impact in motor vehicle crashes or the dominant side in falls.

While 15.2% of patients in our study had ORIF with lengthy PFN, 72.8% of instances (n=24) opted for CRIF instead. Modern orthopaedic concepts emphasize minimally intrusive methods to protect fracture biology and maximize healing potential, which is consistent with this inclination toward closed reduction treatments. For their study participants of 46 Chinese patients with STFs treated with extended PFNA, Wang et al. (2010) found comparable success with closed reduction; all these patients achieved union after an average of 17.7 weeks.[7]

Notably, 12.2% of the total, needed stainless steel cerclage wire augmentation in addition to ORIF and lengthy PFN fixation. In a study conducted by Tyllianakis et al. (2004), 45 study participants in Greece who had comminuted

STFs treated with PFN showed that extra cerclage wiring was effective in controlling comminution. This finding lends credence to this method.[71] Their research found that 91% of patients had excellent or good results, indicating that fracture complexity may be efficiently treated with the right augmentation procedures.

Our study's complication profile showed a total complication rate of 15.2% (n=5), with surgical site infection leading the pack (9.1%, n=3), hardware-related problems trailing behind at 3.0% (n=1), and hypertrophic non-union accounting for 3.0% (n=1). The complication rates that were published by Korkmaz et al. (2014), who studied 100 STFs treated with PFN in Turkey, were 16%. These results are in good agreement with those numbers. They also found that infection as well as hardware-related problems were the most common consequences in their series, which shows that these are problems that affect many different types of patients. [75]

The mean time to union in this present study was 21.39 weeks, which is in line with the results of study by Choi et al. In their retrospective analysis of 47 samples with STFs treated with intramedullary implants in South Korea, they found an average union time of 20.1 weeks among the samples. Optimal surgical technique may have a greater impact on radiographic results than patient-specific characteristics, according to Choi and their colleagues, and they also found that fracture reduction quality, not age or else fracture pattern, was the most important determinant of union time. [49]

Using the HHS as a proxy, functional outcomes in the samples showed steady improvement after surgery. After the operation, the average HHS improved significantly from 55.79 (SD=9.921) at one month to 72.48 (SD=6.629) at three months as well as even more to 84.00 (SD=3.961) at six months. This recovery trend is in line with what Kandhasamy along with Shankar (2020) found in their cohort of 35 study participants with STFs handled with PFN in India. At 6 months, they reported an average HHS of 82.71 in the study. Despite differences in fracture patterns and patient demographics, the comparable as well as functional scores across studies indicate a rather uniform path of healing with protracted PFN fixation. [18]

The VAS pain evaluation also followed a regular improvement trend; at one month postoperatively, mean scores were 4.27 (SD=0.626), at three months they were 3.21 (SD=0.545), and at six months they had further improved to 2.42 (SD=0.502). Rama Rao and Siva Rama Krishna (2019) found similar patterns of pain reduction in their series of 40 samples with STFs handled with PFN in

India. Furthermore, this gradual decrease of pain greatly aids functional recovery. [17]

At one month, all of our patients were no longer unable to bear any weight; by three months, 81.8% (n=27) had achieved weight-bearing status, and by six months, 97% (n=32) were participating in full weight-bearing activities. This was noticed due to our weight-bearing protocol. This recovery process is in line with what has recently been shown by Cohen and their colleagues, and they compared 294 patients with STFs treated with short as well as long intramedullary nails. Rehabilitation strategies should be tailored to each patient's unique fracture stability along with fixation quality rather than relying on predetermined protocols, since their research found that weight-bearing procedures had no discernible effect on complications or survival rates.[66]

The most common co-morbidities were hypertension (18.2%, n=6) and diabetes mellitus (15.2%) in this research, but almost 66.7% of the present study samples (n=22) did not have any history of co-morbidities. The optimistic results could have been attributable, in part, to this generally good health to begin with.

Grønhaug and other authors found that comorbidity burden significantly predicted postoperative complications as well as mortality in their large observational study of 13,232 trochanteric and STFs from the Norwegian Hip

Fracture Register. This highlights the need to consider patient factors alongside surgical technique when assessing outcomes. [26]

When compared to several other studies, the present study's radiological union rate of 96.9% is rather good. Results from the study of 194 study participants of STFs treated with intramedullary nails showed a union rate of 94.8% and it was mentioned in the study by Jannelli et al., in 2022. Consistent effectiveness of intramedullary nailing across various healthcare systems as well as patient's characteristics were established in their samples, which similarly revealed outstanding functional results with a mean HHS of 82.6 at their final follow-up.[11]

We used spinal anesthesia for all sample population, which might have affected perioperative outcomes by reducing the risk of complications of anaesthesia in a group with documented co-morbidities. Based on their study of 122 elderly patients in Turkey who had intertrochanteric fractures, Kaya et al. in 2024 found that spinal anaesthesia was associated with better surgical results. The study's findings emphasized that the multi-factoral nature of excellent surgical results by showing that anaesthetic administration as well as positioning greatly impact reduction quality along with operating duration. [37]

The complicated care needs of patients with STFs, including earlier stabilization, surgical treatment, as well as rehabilitation, and they are reflected in our study's mean inpatient length of 15.64 days. This is longer than what was recorded in the study of hip fracture care by Hansen et al. (2024), where the average length of stay was 8.6 days. To maximize the usage of resource while maintaining patient outcomes, further evaluations are needed to determine if this disparity is because of the variations in healthcare systems, rehabilitation techniques, and also complication rates. [27]

Strong evidence for the effectiveness of LPFN in facilitating recovery is shown by the statistically significant functional improvement seen in our research, with paired t-test analysis showing $p<0.001$ for all consecutive HHS evaluations. Our results are more credible and can be more accurately compared to the current literature because of the rigorous statistical analysis we used. Vishwanathan et al. (2018), in their validation study of the modified HHS in 30 Indian patients with per trochanteric fractures, similarly reported statistically significant improvements across sequential assessments, confirming both the treatment efficacy and the instrument's responsiveness in this population.[56]

The longitudinal RUSH score progression demonstrated statistically significant improvements across all assessment intervals, aligning with findings by

Chiavaras et al. (2013), who established the RUSH score's validity in evaluating hip fracture healing.[48] The strong correlation between radiological union and functional parameters (r=0.726 with Harris Hip Score; r=0.792 with weight-bearing status) supports the observations of Morshed (2014), who emphasized the clinical relevance of radiographic healing metrics.[52] Our findings of differential healing rates emerging during fracture repair corroborate the work of Choi et al. (2014), who identified variable union timeframes in subtrochanteric fractures treated with intramedullary devices, highlighting the complex biological processes underlying fracture consolidation and their relationship to functional outcomes.[49]

Clinical Significance

The administration of subtrochanteric femoral fractures presents a significant encounter to orthopaedic surgeons due to the complex biomechanical forces acting at the fracture site and the technical demands of achieving stable fixation. Our study demonstrates that LPFN represents an effective treatment modality for these challenging fractures, with excellent union rates (96.9%) and functional outcomes (mean HHS of 84.00 at six months). These findings have several important clinical implications for contemporary orthopaedic practice.

Firstly, the predilection of our surgical approach for closed reduction techniques (used in 72.8% of cases) underscores the value of minimally invasive approaches in preserving fracture biology. This method choice is in line with the results of Lingayat et al. in 2023 and in their comparative review of 40 instances with unstable intertrochanteric femur fractures observed that superior outcomes with less invasive approaches. By means of closed reduction, the preservation of periosteal blood supply may improve union rates shown in the present study, thereby suggesting that surgeons should give minimally invasive procedures top priority when technically feasible.[44]

Secondly, our study documented a low complication rate (15.2%), with infection being the predominant complication (9.1%) in the study. This complication profile provides valuable prognostic information for patient counselling and highlights the importance of meticulous surgical technique and perioperative care. The complication rate observed in our study is comparable to that reported by Kanthimathi and Narayanan (2012), who documented a 20% early complication rate following PFN for STFs in a similar Indian population.[70]

This consistency suggests that while complications remain a concern, the morbidity associated with long PFN fixation is predictable and manageable.

Thirdly, the statistically significant improvements in pain scores and functional outcomes throughout the postoperative period provide a reliable timeline for patient recovery expectations. The progressive transition from non-weight-bearing to full weight-bearing status observed in our cohort offers valuable guidance for rehabilitation protocols. By three months postoperatively, 81.8% of patients had achieved weight-bearing status, suggesting that aggressive rehabilitation can be safely implemented in the majority of cases by this timepoint. This information can guide physiotherapists and rehabilitation specialists in developing appropriate, patient-specific recovery programs.

Fourthly, our finding of a mean union time of 21.39 weeks offers a therapeutically relevant reference for radiological follow-up plans. Clinics working in resource-limited settings where the frequency of imaging investigations has to be maximized may find this chronology very helpful. It also gives patients a reasonable expectation about their course of recovery, therefore improving their possible adherence to rehabilitation guidelines.

Last but not least, the recorded improvement in HHS from 55.79 at one month to 84.00 at six months shows that functional recovery goes on across the whole postoperative time, therefore stressing the need of ongoing rehabilitation initiatives. This path corresponds with the results of Kumar et al. in 2019, and they verified the dependability of the HHS for outcome evaluation in the Indian population. Therefore attesting to its use as a monitoring tool for clinical development in the study. The measurable progress shown in our cohort offers an evidence-based basis for determining rehabilitation objectives and tracking therapy effectiveness.. [55]

CONCLUSION

This prospective observational study concluded that LPFN is an effective treatment for STFs, achieving a union rate of 96.9% as well as progressive functional improvement over six months postoperatively in the study population. The statistically significant increase in HHS from 55.79 at one month to 84.00 at six months ($p<0.001$) in this study demonstrates considerable functional recovery, while the simultaneous decrease in VAS pain scores from 4.27 to 2.42 suggests effective pain management among the samples. The prevalence of closed reduction techniques (72.8% of cases) corresponds with current principles of minimally invasive fracture fixation, and the comparatively low complication rate of 15.2% indicates a favorable safety profile. The transition from non-weight-bearing to full weight-bearing in 97% of patients within six months postoperatively highlights the stability of fixation attained with this technique. The results indicate that LPFN successfully mitigates the biomechanical challenges associated with STFs, ensuring stable fixation that promotes early mobilization and rehabilitation. While longer-term follow-up and comparative studies with alternative fixation methods are warranted, the current investigation provides compelling evidence supporting the efficacy of LPFN as a primary treatment option for subtrochanteric femoral fractures across diverse fracture patterns and patient demographics.

STRENGTH OF THE STUDY

This prospective interventional study demonstrates several methodological strengths that enhance its clinical relevance and scientific validity. Foremost among these is the comprehensive follow-up protocol, with sequential assessments at one, three, and six months postoperatively, allowing for detailed temporal analysis of functional recovery trajectories. The utilization of standardized, validated outcome measures—specifically the HHS and VAS—provides objective quantification of functional improvement and pain reduction, respectively. The study's rigorous radiological assessment protocol ensured accurate determination of union status, with explicit criteria for designating union, delayed union, and non-union. The homogeneity of the surgical approach, with all procedures performed at a single institution using consistent implant technology, minimizes confounding variables related to technical variation. Additionally, the detailed documentation of comorbidity profiles, injury mechanisms, and fracture classifications using the validated Seinsheimer system enables nuanced subgroup analysis and contextual interpretation of outcomes. The statistical methodology employed, particularly the paired t-test analysis with significance thresholds of $p<0.001$, provides robust evidence of the progressive functional improvement observed throughout the postoperative period, strengthening the validity of the study's conclusions regarding the efficacy of LPFN for STFs.

RECOMMENDATIONS

Future research should incorporate larger, multicentred cohorts with extended follow-up periods of at least 24 months to evaluate long-term functional trajectories and late complications. Comparative studies directly contrasting LPFN with alternative fixation methods for STFs are essential to establish definitive treatment algorithms. Implementation of patient-reported outcome measures alongside objective functional scores would provide a more comprehensive assessment of recovery from the patient's perspective. Biomechanical studies correlating reduction quality and implant position with functional outcomes would offer valuable insights for technical optimization. Investigation of adjunctive biological enhancement strategies, such as bone grafting or growth factor application, particularly in comminuted patterns, merits exploration. Development of fracture-specific rehabilitation protocols, tailored to fixation stability and fracture pattern, represents another avenue for optimization. Finally, cost-effectiveness analyses comparing various treatment modalities would provide valuable data for healthcare resource allocation, particularly in resource-constrained environments. These recommendations would collectively advance the evidence base for optimal management of these challenging fractures.

SUMMARY

This prospective interventional study investigated the functional and radiological outcomes of STFs treated with LPFN at R.L. Jalappa Hospital and Research Centre over an 18-month period. Thirty-three consecutive patients meeting the inclusion criteria were enrolled after obtaining informed consent. The study population demonstrated a notable male predominance (72.7%, n=24) with a mean age of 51.30 years (SD=17.992). RTAs constituted the predominant etiological factor (60.6%, n=20), followed by slip and fall incidents (36.4%, n=12), reflecting the significant contribution of high-energy trauma to this fracture pattern.

The anatomical distribution revealed a predilection for the right femur (60.6%, n=20) compared to the left femur (39.4%, n=13). Fracture morphology, classified according to the Seinsheimer system, demonstrated a predominance of Grade 2C patterns (30.3%, n=10), followed by Grade 3A (27.3%, n=9) and Grade 3B (18.2%, n=6), highlighting the complexity of these fractures. Comminuted fracture configurations were observed in 54.5% (n=18) of cases, reflecting the high-energy mechanisms typically associated with subtrochanteric injuries.

Surgical intervention employed closed reduction and internal fixation with long PFN in 72.8% (n=24) of cases, while open reduction was necessary in 15.2%

(n=5). Augmentation with stainless steel cerclage wiring was required in 12.2% (n=4) of cases to address comminution. The mean interval between trauma and surgical intervention was 2.48 days (SD=1.603), with spinal anaesthesia utilized universally (100%, n=33).

Postoperative outcomes revealed a favourable safety profile, with 84.8% (n=28) of patients experiencing no complications. Among documented complications, surgical site infection was most prevalent (9.1%, n=3), followed by hardware-related complications (3.0%, n=1) and hypertrophic non-union (3.0%, n=1). Radiographic assessment demonstrated successful osseous union in 96.9% (n=32) of cases, with an average time to union of 21.39 weeks.

Functional outcomes, assessed using the HHS, showed progressive improvement from a mean of 55.79 (SD=9.921) at one month to 72.48 (SD=6.629) at three months and 84.00 (SD=3.961) at six months postoperatively. Paired t-test analysis confirmed the statistical significance of these improvements ($p<0.001$). Similarly, pain assessment using the Visual Analog Scale (VAS) demonstrated significant amelioration from 4.27 (SD=0.626) at one month to 2.42 (SD=0.502) at six months ($p<0.001$).

The weight-bearing status progression was particularly noteworthy, with all patients initially maintained in a non-weight-bearing state at one month postoperatively. By three months, 81.8% (n=27) had achieved weight-bearing status, and by six months, 97% (n=32) were engaging in full weight-bearing activities, demonstrating the efficacy of the fixation in facilitating early mobilization.

With its stable fixation that allows for great union rates as well as gradual functional recovery, LPFN seems to be a successful treatment technique for STFs, absed on this study findings. At the end of six months, the mean HHS was 84.00 as well as the union rate was 96.9%, both of which indicate positive results. Functional ratings and pain assessments both showed statistically significant improvements throughout the postoperative period, indicating that recovery was progressive after this intervention.

Long PFN effectively facilitates both radiological union as well as functional recovery in STFs, as confirmed by the sequential radiographic evaluation using the RUSH score, which showed a significant progressive improvement from 6.00 at one month to 28.36 at six months ($p<0.001$). There was also a strong correlation to functional outcomes ($r=0.726$ with Harris Hip Score).

Although further studies with bigger samples, longer follow-up times, and comparable designs are needed, the present study provide strong evidence that LPFN is effective for these difficult fractures.

LIMITATION

Despite being statistically sufficient samples according to power estimates, the relatively small samples of 33 patients enabled us to conduct relevant subgroup analysis across different fracture types or patient demographics. Even though the study accounted for the heterogeneity, the results may not be applicable to other healthcare facilities due to differences in surgical experience or perioperative procedures and it may be because of the single-center design. Even though 6 months is enough to evaluate the radiological union and early functional recovery, it is not long enough to evaluate long-term outcomes such implant failure, late complications, or functional decline. It is not possible to directly compare the effectiveness of LPFN with other well-established approaches since there is no control group or comparison cohort that was treated with different fixation methods. Although the study's use of the HHS is legitimate, it misses the mark when it comes to patient-reported outcomes about quality of life or getting back to what they were doing before the accident. Lastly, the learning curve effects, and surgeon experience are not taken into consideration in the research. These factors might impact the technical execution and, by extension, the clinical results.

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ANNEXURE - I

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

PATIENT INFORMATION SHEET

STUDY TITLE: FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SUBTROCHANTERIC FRACTURE FIXED WITH LONG PROXIMAL FEMORAL NAIL

Study location: R.L.Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College, Tamaka, Kolar.

Details-Patients with suspected Subtrochanteric fracture presenting to Department of Orthopaedics of R.L.JALAPPA HOSPITAL AND RESEARCH CENTRE, attached to SRI DEVARAJ URS MEDICAL COLLEGE, TAMAKA, KOLAR

Patients in this study will have to undergo routine blood investigations (CBC, RFT, serum electrolytes, blood grouping, HIV & HBsAG), chest x ray, ECG and X RAY- thigh - antero-posterior , lateral views

Please read the following information and discuss with your family members. You can ask any question regarding the study. If you agree to participate in the study we will collect information (as per proforma) from you or a person responsible for you or both. Relevant history will be taken. This information collected will be used only for dissertation and publication.

All information collected from you will be kept confidential and will not be disclosed to any outsider. Your identity will not be revealed. This study has been reviewed by the Institutional Ethics Committee and you are free to contact the member of the Institutional Ethics Committee. There is no compulsion to agree to this study. The care you will 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 borne by the primary investigator.

CONFIDENTIALITY

Your medical information will be kept confidential by the study doctor and staff and will not be made publicly available. Your original records may be reviewed by your doctor or ethics review board. For further information/ clarification please contact

Dr. S.ASHWIN KUMAR (Post Graduate),

Department of ORTHOPAEDICS,SDUMC, Kolar

CONTACT NO: 9944497592

ANNEXURE - II

ಶ್ರೀ ದೇವರಾಜ ಅರಸು ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನೆಯ ಅಕಾಡೆಮಿ,

ತಮಕಾ, ಕೋಲಾರ - 563101.

ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆ

ಅಧ್ಯಯನದ ಶೀರ್ಷಿಕೆ: 'ದೀರ್ಘ ಪ್ರಾಕ್ಸಿಮಲ್ ಫೆಮ್ಯುರಿಯಲ್ ನೈಲಿಂಗ್ ಫಾರ್ ಉಪಶಾಮಕ ಮುರಿತಗಳಿಗಾಗಿ ವಿಕಿರಣಶಾಸ್ತ್ರ ಮತ್ತು ಕ್ರಿಯಾತ್ಮಕ ಫಲಿತಾಂಶ'

ಅಧ್ಯಯನ ಸ್ಥಳ: ಆರ್.ಎಲ್.ಜಾಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರ, ಕೋಲಾರದ ಟಮಕ, ಶ್ರೀ ದೇವರಾಜ ಅರಸು ವೈದ್ಯಕೀಯ ಕಾಲೇಜಿಗೆ ಹೊಂದಿಕೊಂಡಿದೆ

ವಿವರಗಳು-ಆರ್.ಎಲ್.ಜಾಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರದ ಮೂಳೆಚಿಕಿತ್ಸಾ ವಿಭಾಗಕ್ಕೆ ಶಂಕಿತ ಸಬ್ಟ್ರೋಕಾಂಟೆರಿಕ್ ಫ್ರಾಕ್ಚರ್ ಹೊಂದಿರುವ ರೋಗಿಗಳು, ಶ್ರೀ ದೇವರಾಜ್ ಯುಆರ್ಎಸ್ ವೈದ್ಯಕೀಯ ಕಾಲೇಜು, ತಮಕ, ಕೋಲಾರಕ್ಕೆ ಲಗತ್ತಿಸಲಾಗಿದೆ

ಈ ಅಧ್ಯಯನದಲ್ಲಿ ರೋಗಿಗಳು ವಾಡಿಕೆಯ ರಕ್ತ ಪರೀಕ್ಷೆಗಳಿಗೆ ಒಳಗಾಗಬೇಕಾಗುತ್ತದೆ (ಸಿ ಬಿ ಸಿ, ಆರ್ ಎಫ್ ಟಿ, ಸೀರಮ್ ಎಲೆಕ್ಟ್ರೋಲೈಟ್‌ಗಳು, ರಕ್ತದ ಗುಂಪು, ಎಚ್ ಐ ವಿ ಮತ್ತು ಎಚ್ ಬಿ ಎಸ್ ಎ ಜಿ), ಎದೆಯ ಕ್ಷ-ಕಿರಣ, ಇ ಸಿ ಜಿ ಮತ್ತು ಎಕ್ಸ್ ಆರ್ ಎ ವೈ-ತೊಡೆ-ಆಂಟೆರೊಪೊಸ್ಟೀರಿಯರ್, ಲ್ಯಾಟರ್ಲಾ ವೀಕ್ಷಣೆಗಳು

ದಯವಿಟ್ಟು ಕೆಳಗಿನ ಮಾಹಿತಿಯನ್ನು ಓದಿ ಮತ್ತು ನಿಮ್ಮ ಕುಟುಂಬದ ಸದಸ್ಯರೊಂದಿಗೆ ಚರ್ಚಿಸಿ. ಅಧ್ಯಯನಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ನೀವು ಯಾವುದೇ ಪ್ರಶ್ನೆಯನ್ನು ಕೇಳಬಹುದು. ನೀವು ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ಸಮ್ಮತಿಸಿದರೆ ನಾವು ನಿಮ್ಮಿಂದ ಅಥವಾ ನಿಮ್ಮಿಂದ ಅಥವಾ ಇಬ್ಬರಿಗೂ ಜವಾಬ್ದಾರರಾಗಿರುವ ವ್ಯಕ್ತಿಯಿಂದ (ಪ್ರೊಫಾರ್ಮಾ ಪ್ರಕಾರ) ಮಾಹಿತಿಯನ್ನು ಸಂಗ್ರಹಿಸುತ್ತೇವೆ. ಸಂಬಂಧಿತ ಇತಿಹಾಸವನ್ನು ತೆಗೆದುಕೊಳ್ಳಲಾಗುವುದು. ಸಂಗ್ರಹಿಸಿದ ಈ ಮಾಹಿತಿಯನ್ನು ಪ್ರಬಂಧ ಮತ್ತು ಪ್ರಕಟಣೆಗೆ ಮಾತ್ರ ಬಳಸಲಾಗುತ್ತದೆ.

ನಿಮ್ಮಿಂದ ಸಂಗ್ರಹಿಸಲಾದ ಎಲ್ಲಾ ಮಾಹಿತಿಯನ್ನು ಗೌಪ್ಯವಾಗಿ ಇರಿಸಲಾಗುತ್ತದೆ ಮತ್ತು ಯಾವುದೇ ಹೊರಗಿನವರಿಗೆ ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಗುರುತನ್ನು ಬಹಿರಂಗಪಡಿಸಲಾಗುವುದಿಲ್ಲ. ಈ ಅಧ್ಯಯನವನ್ನು ಸಾಂಸ್ಥಿಕ ನೀತಿಶಾಸ್ತ್ರ ಸಮಿತಿಯು ಪರಿಶೀಲಿಸಿದೆ ಮತ್ತು ನೀವು ಸಾಂಸ್ಥಿಕ ನೀತಿಶಾಸ್ತ್ರ ಸಮಿತಿಯ ಸದಸ್ಯರನ್ನು ಸಂಪರ್ಕಿಸಲು ಮುಕ್ತರಾಗಿದ್ದೀರಿ. ಈ ಅಧ್ಯಯನವನ್ನು ಒಪ್ಪಿಕೊಳ್ಳಲು ಯಾವುದೇ ಒತ್ತಾಯವಿಲ್ಲ. ನೀವು ಭಾಗವಹಿಸಲು ಬಯಸದಿದ್ದರೆ ನೀವು ಪಡೆಯುವ ಕಾಳಜಿಯು ಬದಲಾಗುವುದಿಲ್ಲ. ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಭಾಗವಹಿಸಲು ನೀವು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಸಮ್ಮತಿಸಿದರೆ ಮಾತ್ರ ನೀವು ಸಹಿ/ಹೆಬ್ಬೆರಳಿನ ಗುರುತನ್ನು ಒದಗಿಸಬೇಕಾಗುತ್ತದೆ.

ಮೇಲಿನ ಕಾರ್ಯವಿಧಾನಕ್ಕಾಗಿ ರೋಗಿಗೆ ಅಂದಾಜು ಮಾಡಲಾದ ವೆಚ್ಚಗಳನ್ನು ಪ್ರಾಥಮಿಕ ತನಿಖಾಧಿಕಾರಿಯು ಭರಿಸುತ್ತಾನೆ.

ಗೌಪ್ಯತೆ

ನಿಮ್ಮ ವೈದ್ಯಕೀಯ ಮಾಹಿತಿಯನ್ನು ಅಧ್ಯಯನ ವೈದ್ಯರು ಮತ್ತು ಸಿಬ್ಬಂದಿ ಗೌಪ್ಯವಾಗಿಡುತ್ತಾರೆ ಮತ್ತು ಸಾರ್ವಜನಿಕವಾಗಿ ಲಭ್ಯವಾಗುವಂತೆ ಮಾಡಲಾಗುವುದಿಲ್ಲ. ನಿಮ್ಮ ಮೂಲ ದಾಖಲೆಗಳನ್ನು ನಿಮ್ಮ ವೈದ್ಯರು ಅಥವಾ ಎಥಿಕ್ಸ್ ರಿವ್ಯೂ ಬೋರ್ಡ್ ಪರಿಶೀಲಿಸಬಹುದು. ಹೆಚ್ಚಿನ ಮಾಹಿತಿ / ಸ್ಪಷ್ಟೀಕರಣಕ್ಕಾಗಿ ದಯವಿಟ್ಟು ಸಂಪರ್ಕಿಸಿ

ಡಾ. ಎಸ್.ಅಶ್ವಿನ್ ಕುಮಾರ್ (ಸ್ನಾತಕೋತ್ತರ ಪದವಿ),

ಆರ್ಥೋಪೆಡಿಕ್ಸ್ ವಿಭಾಗ,

ಎಸ್ ಡಿ ಯು ಎಂ ಸಿ, ಕೋಲಾರ

ಸಂಪರ್ಕ ಸಂಖ್ಯೆ: 9944497592

ANNEXURE - III

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

INFORMED CONSENT FORM

Case no:

IP no:

TITLE:FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SUBTROCHANTERIC FRACTURE FIXED WITH LONG PROXIMAL FEMORAL NAIL

I, ____ aged _____________ after being explained in my own understandable language about the purpose of the study and the risks and complications of the procedure, hereby give my valid written informed consent without any force or prejudice for Clinical examinations, Surgical procedure which is to be performed on me or _______ under any anaesthesia deemed fit. The nature and risks involved in the procedure (surgical and anaesthetical) have been explained to me to my satisfaction.

I have been explained in detail about the Clinical Research being conducted. I have read the patient information sheet and I have had the opportunity to ask any question. Any question that I have asked, have been answered to my satisfaction.

I consent voluntarily to participate as a participant in this research. I hereby give consent to provide my history, undergo physical examination, undergo the operative procedure, undergo investigations and provide its results and documents etc to the doctor / institute etc.

For academic and scientific purpose the operation / procedure, etc may be video graphed or photographed. All the data may be published or used for any academic purpose. I will not hold the doctors / institute etc responsible for any untoward consequences during the procedure / study.

All the expenses estimated for the patients for above procedure will be borne by the primary investigator.

A copy of this Informed Consent Form and Patient Information Sheet has been provided to the participant.

(Signature & Name of Pt. Attendant) (Signature/Thumb impression & Name of patient)

(Relation with patient)---------

Witness: ---------------------------

ANNEXURE - IV

ಶ್ರೀ ದೇವರಾಜ ಅರಸು ಉನ್ನತ ಶಿಕ್ಷಣ ಮತ್ತು ಸಂಶೋಧನೆಯ ಅಕಾಡೆಮಿ,

ತಮಕಾ, ಕೋಲಾರ - 563101.

ಮಾಹಿತಿಯ ಒಪ್ಪಿಗೆ ನಮೂನೆ

ಪ್ರಕರಣ ಸಂಖ್ಯೆ:

IP ಸಂಖ್ಯೆ:

ಶೀರ್ಷಿಕೆ:

"ದೀರ್ಘ ಪ್ರಾಕ್ಸಿಮಲ್ ಫೆಮ್ಯುರಿಯಲ್ ನೈಲಿಂಗ್ ಫಾರ್ ಉಪಶಾಮಕ ಮುರಿತಗಳಿಗಾಗಿ ವಿಕಿರಣಶಾಸ್ತ್ರ ಮತ್ತು ಕ್ರಿಯಾತ್ಮಕ ಫಲಿತಾಂಶ'

ನಾನು, ______________________________ , ಅಧ್ಯಯನದ ಉದ್ದೇಶ ಮತ್ತು ಕಾರ್ಯವಿಧಾನದ ಅಪಾಯಗಳು ಮತ್ತು ತೊಡಕುಗಳ ಬಗ್ಗೆ ನನ್ನ ಸ್ವಂತ ಭಾಷೆಯಲ್ಲಿ ವಿವರಿಸಿದ ನಂತರ, ಕ್ಲಿನಿಕಲ್ ಪರೀಕ್ಷೆಗಳು, ಶಸ್ತ್ರಚಿಕಿತ್ಸಾ ವಿಧಾನಗಳಿಗೆ ಯಾವುದೇ ಬಲ ಅಥವಾ ಪೂರ್ವಾಗ್ರಹವಿಲ್ಲದೆ ನನ್ನ ಮಾನ್ಯ ಲಿಖಿತ ತಿಳುವಳಿಕೆಯನ್ನು ನೀಡುತ್ತೇನೆ ನನ್ನ ಮೇಲೆ ಅಥವಾ _______ ಯಾವುದೇ ಅರಿವಳಿಕೆ ಅಡಿಯಲ್ಲಿ ಫಿಟ್ ಎಂದು ಪರಿಗಣಿಸಲಾಗಿದೆ. ಕಾರ್ಯವಿಧಾನದಲ್ಲಿ ಒಳಗೊಂಡಿರುವ ಸ್ವಭಾವ ಮತ್ತು ಅಪಾಯಗಳು (ಶಸ್ತ್ರಚಿಕಿತ್ಸೆ ಮತ್ತು ಅರಿವಳಿಕೆ) ನನ್ನ ತೃಪ್ತಿಗೆ ನನಗೆ ವಿವರಿಸಲಾಗಿದೆ.

ಕ್ಲಿನಿಕಲ್ ರಿಸರ್ಚ್ ಬಗ್ಗೆ ನನಗೆ ವಿವರವಾಗಿ ವಿವರಿಸಲಾಗಿದೆ "

ಸಬ್ಟ್ರೋಕ್ಯಾಂಟೆರಿಕ್ ಫ್ರಾಕ್ಚರ್‌ಗಾಗಿ ದೀರ್ಘ ಪ್ರಾಕ್ಸಿಮಲ್ ಫೆಮೊರಲ್ ನೈಲಿಂಗ್‌ನ ರೇಡಿಯೊಲಾಜಿಕಲ್ ಮತ್ತು ಕ್ರಿಯಾತ್ಮಕ ಫಲಿತಾಂಶವನ್ನು ನಡೆಸಲಾಗುತ್ತಿದೆ. ನಾನು ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆಯನ್ನು ಓದಿದ್ದೇನೆ ಮತ್ತು ಯಾವುದೇ ಪ್ರಶ್ನೆಯನ್ನು ಕೇಳಲು ನನಗೆ ಅವಕಾಶವಿದೆ. ನಾನು ಕೇಳಿದ ಯಾವುದೇ ಪ್ರಶ್ನೆಗೆ ನನ್ನ ತೃಪ್ತಿಗೆ ಉತ್ತರಿಸಲಾಗಿದೆ.

ಈ ಸಂಶೋಧನೆಯಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವವನಾಗಿ ಭಾಗವಹಿಸಲು ನಾನು ಸ್ವಯಂಪ್ರೇರಣೆಯಿಂದ ಸಮ್ಮತಿಸುತ್ತೇನೆ. ನನ್ನ ಇತಿಹಾಸವನ್ನು ಒದಗಿಸಲು, ದೈಹಿಕ ಪರೀಕ್ಷೆಗೆ ಒಳಗಾಗಲು, ಆಪರೇಟಿವ್ ಕಾರ್ಯವಿಧಾನಕ್ಕೆ ಒಳಗಾಗಲು, ತನಿಖೆಗೆ ಒಳಗಾಗಲು ಮತ್ತು ಅದರ ಫಲಿತಾಂಶಗಳು ಮತ್ತು ದಾಖಲೆಗಳನ್ನು ಇತ್ಯಾದಿಗಳನ್ನು ವೈದ್ಯರು / ಸಂಸ್ಥೆ ಇತ್ಯಾದಿಗಳಿಗೆ ಒದಗಿಸಲು ನಾನು ಈ ಮೂಲಕ ಒಪ್ಪಿಗೆ ನೀಡುತ್ತೇನೆ.

ಶೈಕ್ಷಣಿಕ ಮತ್ತು ವೈಜ್ಞಾನಿಕ ಉದ್ದೇಶಕ್ಕಾಗಿ ಕಾರ್ಯಾಚರಣೆ / ಕಾರ್ಯವಿಧಾನ, ಇತ್ಯಾದಿಗಳನ್ನು ವೀಡಿಯೊ ಗ್ರಾಫ್ ಅಥವಾ ಛಾಯಾಚಿತ್ರ ಮಾಡಬಹುದು. ಎಲ್ಲಾ ಡೇಟಾವನ್ನು ಪ್ರಕಟಿಸಬಹುದು ಅಥವಾ ಯಾವುದೇ ಶೈಕ್ಷಣಿಕ ಉದ್ದೇಶಕ್ಕಾಗಿ ಬಳಸಬಹುದು. ಕಾರ್ಯವಿಧಾನ / ಅಧ್ಯಯನದ ಸಮಯದಲ್ಲಿ ಯಾವುದೇ ಅಹಿತಕರ ಪರಿಣಾಮಗಳಿಗೆ ನಾನು ವೈದ್ಯರು / ಸಂಸ್ಥೆ ಇತ್ಯಾದಿಗಳನ್ನು ಜವಾಬ್ದಾರರನ್ನಾಗಿ ಮಾಡುವುದಿಲ್ಲ.

ಮೇಲಿನ ಕಾರ್ಯವಿಧಾನಕ್ಕಾಗಿ ರೋಗಿಗಳಿಗೆ ಅಂದಾಜು ಮಾಡಲಾದ ಎಲ್ಲಾ ವೆಚ್ಚಗಳನ್ನು ಪ್ರಾಥಮಿಕ ತನಿಖಾಧಿಕಾರಿಯು ಭರಿಸುತ್ತಾನೆ.

ಈ ತಿಳುವಳಿಕೆಯುಳ್ಳ ಒಪ್ಪಿಗೆ ನಮೂನೆಯ ಪ್ರತಿಯನ್ನು ಮತ್ತು ರೋಗಿಯ ಮಾಹಿತಿ ಹಾಳೆಯನ್ನು ಭಾಗವಹಿಸುವವರಿಗೆ ಒದಗಿಸಲಾಗಿದೆ.

(ಪಿಟಿ. ಅಟೆಂಡೆಂಟ್‌ನ ಸಹಿ ಮತ್ತು ಹೆಸರು) (ಸಹಿ/ಹೆಬ್ಬೆರಳಿನ ಗುರುತು ಮತ್ತು ರೋಗಿಯ ಹೆಸರು)

(ರೋಗಿಯೊಂದಿಗಿನ ಸಂಬಂಧ)---------

ಸಾಕ್ಷಿ: ---------------------------

ANNEXURE - V

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

IP no:

TITLE:FUNCTIONAL AND RADIOLOGICAL OUTCOME OF SUBTROCHANTERIC FRACTURE FIXED WITH LONG PROXIMAL FEMORAL NAIL

1. BASIC DATA

Name Age/Sex

Address

Mobile No.

Date of Procedure

Date of Admission/OP

Date of Discharge

History:

General physical examination:

Vitals: Pulse- B.P-

RR- Temp-

Systemic examination:

CVS- PS-

RS- CNS-

Preexisting systemic illness:

Diabetes/Thyroid disorder/ Cervical Spine/ CVS/RS/ CNS/ TB/ Anemia/ Hypertension/ Malnutrition/others

Local examination:

Swelling - Present/ Absent

Tenderness - Present/ Absent

Crepitus - Present/Absent

Range Of Motion at Hip joint-

Active ankle and toe movements- Present/ Absent

Distal sensations - Intact/Absent

Peripheral pulsations - Palpable/Not Palapble

RADIOLOGICAL INVESTIGATIONS:

X RAY THIGH ANTERO POSTERIOR AND LATERAL VIEW :

2. DIAGNOSIS:

SUBTROCHANTERIC FRACTURE OF LEFT/ RIGHT FEMUR

SEINSHEIMER CLASSIFICATION :TYPE 1 / 2A / 2B / 2C / 3A / 3B / 4 / 5

3. INVESTIGATIONS:

- CBC
- BT
- CT
- Blood grouping
- Blood urea,
- serum creatinine,
- RBS
- HIV, HBsAg status, HCV

4.OPERATIVE TREATMENT:

- Operation date :
- Type of anesthesia:
- Approach used:

5.DATE OF DISCHARGE:

6.POST OP FOLLOW UP:

FOLLOW UP	1ST MONTH	3RD MONTH	6TH MONTH
PAIN, SWELLING			
HARRIS HIP SCORE			
COMPLICATIONS (IF ANY)			
RUSH SCORE			

HARRIS HIP SCORE:

Variable	Points
Pain	
None or ignores it	44
Slight, occasional	40
Mild pain, rarely moderate	30
Moderate pain	20
Marked pain	10
Totally disabled, pain in bed	0
Function	
Limp	
None	11
Slight	8
Moderate	5
Severe	0
Support	
None	11
Cane, long walks	7
Cane, most of the time	5
One crutch	3
Two canes	2
Two crutches	0
Not able to walk	0
Distance walked	
Unlimited	11
Six blocks	8
Two to three blocks	5
Indoors only	2
Bed and chair	0
Stairs	
Normally without railing	4
Normally with railing	2
In any manner	1
Unable to do	0
Shoes and socks	
With ease	4
With difficulty	2
Unable	0
Sitting	
Ordinary chair for 1 h	5
High chair for 1 h	3
Unable to sit in any chair	0
Public transport	
Able to use	1
Unable to use	0

RUSH SCORE

Cortex	No Cortical Bridging Score = 1	Some Cortical Bridging Score = 2	Complete Cortical Bridging Score = 3	Total Score (Range, 4 to 12)
Anterior Cortex	x	☐	☐	1
Posterior Cortex	☐	x	☐	2
Medial Cortex	x	☐	☐	1
Lateral Cortex	x	☐	☐	1
Overall Score	3	2		5

Cortex	Fracture Line Fully Visible Score = 1	Some Evidence pf the Fracture Line Score = 2	No Evidence of the Fracture Line Score = 3	Total Score (Range, 4 to 12)
Anterior Cortex	x	☐	☐	1
Posterior Cortex	☐	x	☐	2
Medial Cortex	x	☐	☐	1
Lateral Cortex	x	☐	☐	1
Overall Score	3	2		5

	No Consolidation Score = 1	Some Consolidation Score = 2	Complete Consolidation Score = 3	Total Score (Range, 1 to 3)
Amount of Consolidation	x	☐	☐	1

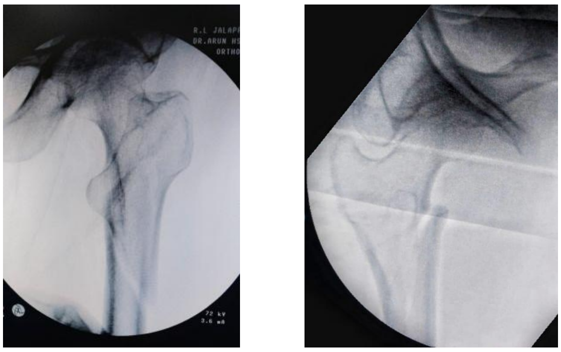
	Fracture Line Fully Visible Score = 1	Some Evidence pf the Fracture Line Score = 2	No Evidence of the Fracture Line Score = 3	Total Score (Range, 1 to 3)
Fracture Line	x	☐	☐	1

ANNEXURE- VI

IMPLANT USED

INTRAOP IMAGES

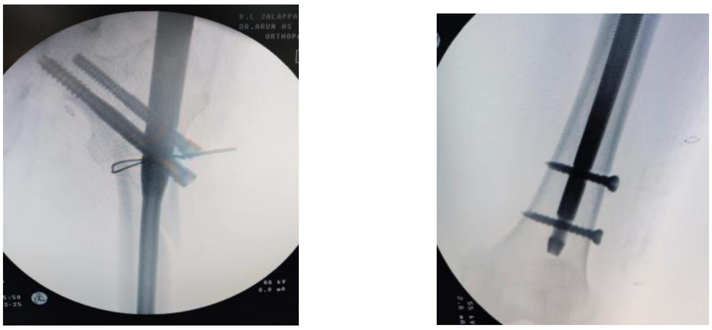
PATIENT POSITIONING



POST REDUCTION C-ARM IMAGES

GUIDE WIRE PLACEMENT

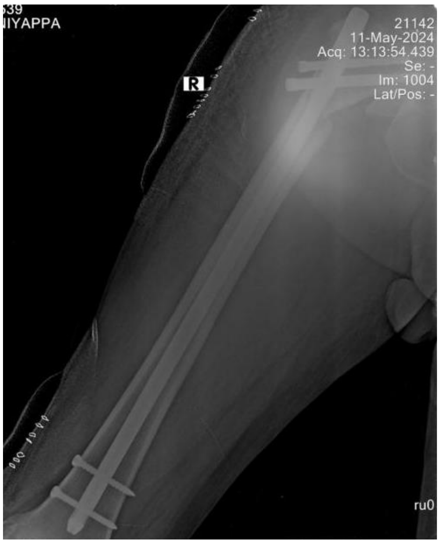
PROXIMAL SCREW - NAIL PLACEMENT



POST FIXATION C-ARM IMAGING

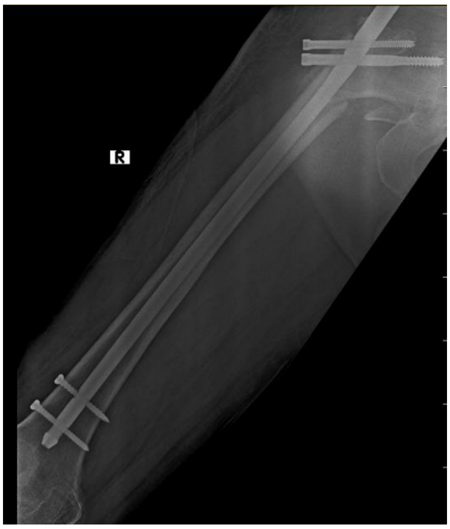
CASE 3

RE OP XRAYS



POST OP XRAYS

CASE 3



3^{RD} MONTH XRAYS

6^{TH} MONTH XRAYS

CASE 3 CLINICAL IMAGES

STRAIGHT LEG RAISING

FLEXION

ABDUCTION

ADDUCTION

CASE 11

PRE OP XRAYS

POST OP XRAYS

CASE 11

3RD MONTH XRAYS

6TH MONTH XRAYS

CASE 11 CLINICAL IMAGES

STRAIGHT LEG RAISING

FLEXION

ABDUCTION

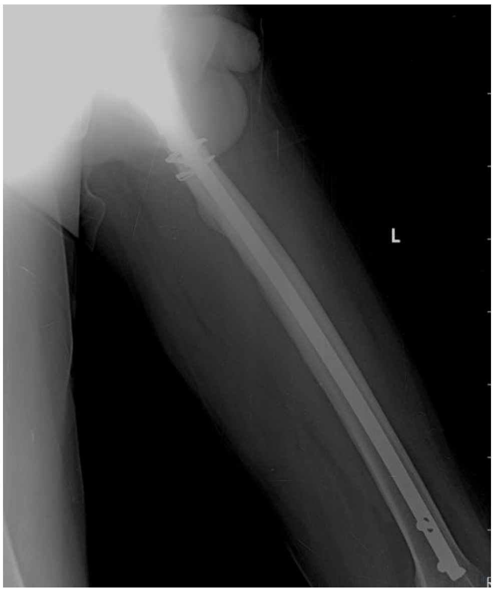
ADDUCTION

CASE 24

PRE OP XRAYS

POST OP XRAYS

CASE 24



3RD MONTH XRAYS

6TH MONTH XRAYS

CASE 24 CLINICAL IMAGES

STRAIGHT LEG RAISING

FLEXION

ABDUCTION

ADDUCTION

CASE 26

PRE OP XRAYS

POST OP XRAYS

CASE 26

3RD MONTH XRAYS

6TH MONTH XRAYS

CASE 26 CLINICAL IMAGES

STRAIGHT LEG RAISING **FLEXION**

ABDUCTION **ADDUCTION**

ANNEXURE VII

KEY TO MASTER CHART

M- MALE

F- FEMALE

R- RIGHT

L- LEFT

CDSFR - CLOSED DISPLACED SUBTROCHANTERIC FRACTURE OF RIGHT FEMUR

CDSFL - CLOSED DISPLACED SUBTROCHANTERIC FRACTURE OF LEFT FEMUR

CDCSFR - CLOSED DISPLACED COMMINUTED SUBTROCHANTERIC FRACTURE OF RIGHT FEMUR

CDCSFL - CLOSED DISPLACED COMMINUTED SUBTROCHANTERIC FRACTURE OF LEFT FEMUR

SAF- SLIP AND FALL

RTA- ROAD TRAFFIC ACCIDENT

FFH - FALL FROM HEIGHT

DM- DIABETES MELLITUS

HTN- HYPEERTENSION

THY- THYROIDISM

CR+LPFN - CRIF + LONG PFN FIXATION

OR+LPFN- ORIF + LONG PFN FIXATION

OR+LPFN+SS - ORIF + LONG PFN FIXATION + SS CERCLAGE WIRE FIXATION

Sl.No	Age	Sex	DIagnosis	SIde	Type Of Injury	Classification	Comorbidities	Surgery	VAS Score			Harris Hip Score			RUSH Score			Union	Complications
									1st Month	3rd Month	6th Month	1st Month	3rd Month	6th Month	1st Month	3rd Month	6th Month	(Weeks)	
1	74	M	CDSFR	R	SAF	2B	-	CR+LPFN	4	3	2	45	78	85	6	20	26	22	NIL
2	50	M	CDCSFL	L	RTA	3A	-	OR+LPFN	4	3	2	41	70	85	6	17	30	24	NIL
3	20	M	CDSFR	R	RTA	2C	-	CR+LPFN	5	4	2	48	75	86	6	20	30	20	NIL
4	50	M	CDCSFR	R	RTA	3A	-	CR+LPFN	4	3	2	31	69	81	6	19	28	23	NIL
5	35	M	CDCSFL	L	RTA	3B	-	CR+LPFN	6	2	2	61	84	89	6	18	28	22	NIL
6	51	M	CDCSFL	L	RTA	4	-	CR+LPFN	5	3	2	60	73	88	6	17	30	22	Infection
7	57	M	CDSFL	L	RTA	2C	-	OR+LPFN+SS	4	3	2	41	70	86	6	18	27	20	NIL
8	77	M	CDSFR	R	RTA	2B	-	CR+LPFN	3	3	2	53	72	83	6	20	30	24	NIL
9	26	M	CDCSFL	L	RTA	3B	-	CR+LPFN	2	3	3	53	71	86	6	20	30	19	NIL
10	70	F	CDCSFR	R	SAF	3A	-	CR+LPFN	1	3	3	50	63	76	6	19	26	19	NIL
11	30	M	CDCSFR	R	RTA	3A	-	OR+LPFN	0	3	2	55	73	84	6	19	30	21	NIL
12	66	F	CDSFL	L	SAF	2C	HTN	CR+LPFN	1	4	3	40	55	70	6	20	25	22	NIL
13	47	M	CDCSFR	R	RTA	3B	HTN	OR+LPFN+SS	2	4	3	62	70	83	6	18	30	20	NIL
14	70	F	CDSFR	R	SAF	2B	DM	CR+LPFN	3	4	3	63	75	87	6	6	6	Non Union	Non Union
15	64	M	CDSFL	R	SAF	2C	HTN	CR+LPFN	4	4	3	43	60	82	6	20	28	21	NIL
16	30	M	CDSFR	R	RTA	2B	-	CR+LPFN	5	4	3	63	72	90	6	18	30	25	NIL
17	75	M	CDCSFL	L	SAF	3B	-	CR+LPFN	4	3	2	61	80	87	6	19	29	26	NIL

Sl.No	Age	Sex	DIagnosis	SIde	Type Of Injury	Classification	Comorbidities	Surgery	VAS Score			Harris Hip Score			RUSH Score			Union	Complications
									1st Month	3rd Month	6th Month	1st Month	3rd Month	6th Month	1st Month	3rd Month	6th Month	(Weeks)	
18	61	F	CDSFR	R	SAF	2C	DM	CR+LPFN	5	4	3	62	73	85	6	20	29	22	NIL
19	60	F	CDSFR	R	SAF	2C	DM	CR+LPFN	5	4	3	57	63	84	6	19	30	20	Infection
20	62	F	CDSFR	R	SAF	2B	HTN	OR+LPFN+SS	4	3	2	62	75	83	6	20	30	23	NIL
21	49	M	CDSFR	R	RTA	2C	-	CR+LPFN	4	3	3	63	78	88	6	19	28	22	NIL
22	55	F	CDCSFL	L	FFH	4	-	CR+LPFN	4	3	2	61	81	89	6	18	30	21	NIL
23	76	F	CDCSFL	L	SAF	3B	DM, THY	CR+LPFN	5	3	3	63	82	83	6	16	29	21	NIL
24	45	M	CDCSFL	L	RTA	3A	HTN	OR+LPFN+SS	3	2	2	75	83	88	6	20	30	25	NIL
25	80	M	CDCSFR	R	SAF	3A	-	CR+LPFN	5	3	3	60	71	84	6	18	28	23	NIL
26	24	M	CDCSFR	R	RTA	3B	-	CR+LPFN	4	3	3	75	80	85	6	19	29	20	Infection
27	38	M	CDCSFL	L	RTA	3A	-	CR+LPFN	4	3	2	69	76	83	6	17	30	21	NIL
28	24	M	CDSFR	R	RTA	2C	-	OR+LPFN	4	3	2	55	73	83	6	19	27	26	NIL
29	55	M	CDCSFR	R	RTA	3A	DM	OR+LPFN	4	3	3	49	63	78	6	19	28	25	NIL
30	20	M	CDCSFR	R	RTA	3A	HTN	CR+LPFN	4	3	2	55	73	83	6	20	30	24	NIL
31	54	M	CDSFR	R	RTA	2C	-	CR+LPFN	4	3	2	58	70	83	6	17	26	21	BACKING OF SCREWS
32	38	M	CDCSFL	L	RTA	4	-	CR+LPFN	4	3	2	58	73	85	6	20	30	20	NIL
33	60	F	CDSFL	L	SAF	2C	-	OR+LPFN	5	4	2	49	68	80	6	18	28	22	NIL