ORIGINAL RESEARCH

Utilization of Locking Compression Plates in the Management of Proximal Tibial Fractures

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ABSTRACT

Background:The treatment of proximal tibia fractures has historically posed challenges due to the anteromedial surface's subcutaneous location. Contemporary focus has shifted significantly towards addressing the condition of the soft tissue envelope. This study aims to assess the union of proximal tibia fractures treated with a Locking Compression Plate, examining the clinical outcomes, including knee range of movements and complications associated with this particular treatment approach.**Methods**:A prospective study spanning one year was conducted on 60 patients with proximal tibial fractures treated using locking compression plates. The study included both male and female participants aged 20 to 70, undergoing treatment with locking compression plates for intra-articular and extraarticular fractures of the proximal tibia. Exclusions comprised type II and Type III open fractures (Gustilo Anderson), pathological fractures, and individuals with severe comorbidities. The study received approval from the ethics committee, and informed written consent was obtained from all participants. Subsequently, data was systematically collected from the enrolled patients.**Results**:The predominant age group in the study was 31-40 years, comprising the majority of patients (30%). The study demonstrated a significant male preponderance, with 80% of participants being male, while female patients constituted 20% of the study group. The most prevalent cause of fractures was Road Traffic Accidents. According to the AO classification system, 3.3% of patients were classified as type A1, 13.3% as type A2, 30% as type A3, 16.7% as type C1, 30% as type C2, and 6.7% astype C3.**Conclusion**:The findings of this study lead to the conclusion that Open Reduction and Internal Fixation (ORIF) with Locking Compression Plate (LCP) emerges as a favorable implant choice for proximal tibia fractures, even in challenging fracture scenarios.

Keywords:Proximal Tibial, Fractures, Locking Compression Plate

INTRODUCTION

Fractures involving the proximal tibia pose unique challenges in the realm of orthopedic treatment, primarily due to the subcutaneous positioning of its anteromedial surface. These fractures frequently present not only with significant damage to the bone but also involve soft tissues, contributing to a higher occurrence of open fractures compared to other long bones.[1] The consequences of these injuries often manifest as malunion, non-union, and infections, collectively leading to substantial and enduring disability for affected individuals.In recent times, the medical community has increasingly recognized the critical role of the soft tissue envelope in the management of proximal tibia fractures. This heightened awareness has prompted the development and adoption of surgical approaches that prioritize the preservation and care of soft tissues. Additionally, advancements in minimally invasive techniques have played a pivotal role in improving overall outcomes for patients grappling with these complex fractures.Proximal tibia fractures typically fall into two broad categories: high-energy fractures and low-energy fractures. High-energy fractures often result from traumatic incidents such as high-speed accidents or falls from significant heights.[2,3] These fractures typically occur due to direct axial compression, frequently accompanied by a valgus (more common) or varus moment and indirect shear forces. On the other hand, low-energy fractures may be observed in elderly patients with osteoporotic bone, and these fractures often manifest as depressed-type fractures.The surgical objective in treating proximal tibia fractures is to meticulously restore the congruency of the articular surfaces of the tibial condyles. This strategic approach not only addresses

the immediate structural concerns but also aims to facilitate the patient's ability to regain a functional and painless range of motion in the knee joint over time.[4]In summary, the contemporary management of proximal tibia fractures integrates a comprehensive understanding of both bone and soft tissue dynamics. By prioritizing soft tissue considerations and embracing evolving surgical techniques, clinicians strive to navigate the complexities of these fractures, ultimately enhancing the prospects for successful recovery and improved long-term functionality for affected individuals.The insights gleaned from various clinical studies have illuminated a persistent challenge associated with the utilization of rigid conventional plates in orthopedic procedures—namely, the tendency for the bone beneath these plates to exhibit characteristics of thinness and atrophy. This inherent quality renders the bone susceptible to secondary displacement, primarily due to the inadequacy of buttressing, thereby increasing the vulnerability to secondary fractures post plate removal. Moreover, the interruption of vascular supply, a consequence of using conventional plates, often results in a protracted period for the union of the fracture site.In response to these limitations and aiming to usher in a new era of surgical techniques, the concept of biological fixation gained prominence, giving rise to minimally invasive plate osteosynthesis (MIPO).[5] MIPO represented a departure from conventional approaches by prioritizing a more biologically friendly fixation method. However, the implementation of MIPO came with its own set of challenges. Conventional plates necessitated meticulous contouring to ensure precise placement for optimal fixation. Compounding this complexity was the issue of poor fixation encountered in patients with osteoporosis, adding an additional layer of intricacy to the surgical process.In the pursuit of overcoming these challenges and further refining the principles of biological fixation, the introduction of internal fixators, exemplified by PC-fix I and later PC fix II, marked a significant step forward. These internal fixators represented an evolution in the approach to fracture stabilization, deviating from traditional plate fixation methods.[6]As our understanding of the intricacies of biological fixation deepened, this knowledge propelled further innovation in plate design, ultimately leading to the development of the less invasive stabilizing system (LISS). The LISS represents a cutting-edge approach in orthopedic surgery, characterized by its emphasis on less invasive procedures while prioritizing stability. This innovative system reflects the ongoing commitment within the medical community to continually refine and improve fixation techniques, with the overarching goal of optimizing patient outcomes and expediting the healing process for fractures. The journey from conventional plates to internal fixators and, ultimately, to the LISS underscores the dynamic nature of orthopedic advancements and the unwavering pursuit of enhanced patient care.

MATERIALS AND METHODS

In a comprehensive prospective study, 60 patients with proximal tibial fractures were subjected to meticulous investigation and treatment using locking compression plates. A rigorous follow-up protocol was established, involving regular clinical examinations and X-rays. The imaging was initiated immediately post-operation, with subsequent assessments conducted at regular intervals until fracture union, and a final evaluation at one year post-surgery.The study encompassed patients of both genders within the age range of 20 to 70 years, who underwent treatment with locking compression plates for intra-articular and extraarticular fractures of the proximal tibia. Exclusions were made for type II and Type III open fractures (Gustilo Anderson), pathological fractures, and individuals with severe comorbidities. Ethical considerations were paramount, with the study obtaining approval from the ethics committee, and participants providing informed written consent.The data collection process was meticulous, commencing with the recording of information upon admission. This involved a comprehensive assessment of patients' medical history and thorough clinical examinations. Special attention was directed towards evaluating soft tissue injuries in all fractures, followed by a detailed radiological assessment of the fractures.[7,8] Prior to surgery, baseline blood investigations and X-rays were conducted, including Anteroposterior, lateral, and oblique views of the knee joint. Advanced imaging techniques such as C.T. and M.R.I were employed if deemed necessary.This methodical approach not only ensured a holistic understanding of each patient's condition but also laid the foundation for a comprehensive analysis of the efficacy of locking compression plates in the treatment of proximal tibial fractures. The integration of various diagnostic modalities and stringent follow-up procedures adds robustness to the study's findings and contributes valuable insights to the field of orthopedic research and clinical practice.Following the assessment of anesthesia fitness, surgical intervention was carried out using either anteromedial or anterolateral incisions, a crucial step in the comprehensive management of proximal tibial fractures. Subsequent to the surgery, patients underwent a carefully tailored postoperative care regimen. This included the administration of analgesics to alleviate pain, anti-inflammatory drugs to mitigate inflammation, and antibiotics to prevent potential infections. This multifaceted approach not only ensured the comfort of the patients but also played a pivotal role in expediting their mobilization.[9]Postoperatively, a strategic and progressive mobilization plan was implemented, facilitated by the judicious use of pain management medications. This approach aimed at

enhancing the recovery process, allowing patients to regain functional independence more swiftly. Regular and systematic assessments were conducted through postoperative X-rays at specified intervals—3, 6, 9, and 12 months post-surgery. These imaging assessments served as critical tools for evaluating the progression of fracture healing, alignment, and overall postoperative outcomes.The combination of surgical precision, postoperative pain management, and diligent follow-up through imaging contributed to a comprehensive and patient-centered approach. This method not only ensured the successful implementation of the chosen surgical technique but also facilitated optimal recovery, minimizing potential complications, and promoting long-term positive outcomes for individuals with proximal tibial fractures.

In cases where stable internal fixation was achieved, patients were mobilized 48 hours after drains were removed. Initially, the allowed range of motion was limited to 0-20 degrees for the first 2-3 days. Subsequently, from the 5th day onward, the range of motion was gradually increased, reaching 90 degrees after suture removal. In instances where there was uncertainty about stable fixation, external splinting (such as a Plaster of Paris slab) was provided for support, along with instructions for static quadriceps exercises.Daily passive motion exercises, including the temporary removal of the slab under careful supervision, were incorporated. The splint was then reapplied as needed. Partial weight-bearing was postponed until 6 weeks, and full weight-bearing was permitted between 12-15 weeks.

RESULTS

A prospective study was conducted to assess the surgical management of proximal tibial fractures using a locking compression plate. The majority of participants (30%) fell within the 31-40 age bracket. The study exhibited a notable male preponderance, with 80% of the participants being male, while female patients comprised 20% of the study cohort. Road Traffic Accidents emerged as the primary cause of fractures, accounting for 80%, whereas 20% of fractures resulted from falls from height (13.4%).In terms of laterality, the study indicated a slight right-sided predominance over the left side (56.7% vs. 43.3%). Among the patients, 66.7% sustained closed fractures, while 33.3% experienced open fractures.

Table1: Gender distribution

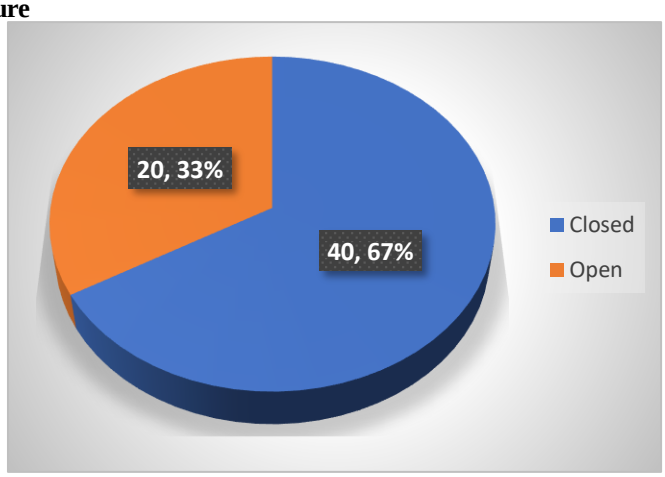
Gender	Percentage of Patients
Male	80%
Female	20%

Table2: Distribution of fractures among patients

Type of Fracture	Number of Patients	Percentage
Closed	40	66.7%
Open	20	33.3%

This table summarizes the distribution of fractures among the patients, indicating that 66.7% sustained closed fractures, while 33.3% sustained open fractures.

Figure1: Types of fracture



According to the AO classification system, 3.3% of patients fell into type A1, 13.3% in type A2, 30% in type A3, 16.7% in type C1, 30% in type C2, and 6.7% in type C3. The surgical approach included ORIF in 46 patients (76.7%) and MIPPO in 14 patients (23.3%). On average, the interval between injury and surgery was 2.8 days. Infections were observed in 8 patients (13.3%), and 2 patients (3.3%) experienced deep vein thrombosis (DVT). A late complication of extensor lag (100-150) occurred in 8 patients (13.3%).

Fracture union rates indicated that the majority (83.4%) were healed by 12-15 weeks, with 2 fractures (3.3%) uniting in less than 12 weeks and 8 fractures (13.3%) taking more than 15 weeks. Overall, 52 patients (86.7%) achieved excellent results with full, pain-free function, and 8 patients (13.3%) had good results.

Specifically, patients with A1 and A2 fractures had excellent outcomes, while the majority with A3 fractures also achieved excellent results, with a few having a good outcome. Among C1 fractures, 6 patients had excellent outcomes and 4 had good outcomes. All patients with C2 fractures achieved excellent results, while 2 out of 4 patients with C3 fractures had good outcomes, and the remaining patient had an excellent outcome. No significant association was found between the type of fracture and functional outcome (p=0.651), indicating that fractures of types A1, A2, A3, C1, C2, and C3 are suitable for fixation with a lateral locking plate.

Notably, post-operative complications were more prevalent in C-type fractures, with 4 patients experiencing infection in C1 fractures and 8 patients facing extensor lag in C2 fractures. This suggests that complications are more common in C-type fractures compared to other types.

DISCUSSION

Proximal tibia fractures pose a spectrum of challenges involving both soft tissue and bony injuries, often leading to lasting disabilities.[10] Managing these fractures is intricate due to factors such as comminution, instability, displacement, and extensive soft tissue damage. Treatment objectives focus on restoring joint congruity, limb alignment, ensuring knee stability, and achieving a functional range of knee motion. Nonoperative approaches face limitations, including difficulties in achieving adequate articular surface reduction and ineffective control over limb alignment. Moreover, prolonged hospitalization and recumbence associated with nonoperative methods are deemed less cost-effective in today's healthcare landscape.Proximal tibial fractures, among the most common intra-articular fractures, are on the rise, primarily attributable to road traffic accidents (RTAs). The surgical landscape for treating these fractures is evolving continually. Any knee joint-related fracture is of significant concern due to its potential for causing substantial morbidity and impacting overall quality of life. Consequently, managing proximal tibial fractures represents a considerable challenge for orthopedic surgeons.[11,12]In response to these challenges, researchers have developed innovative technologies, namely Minimally Invasive Plate Osteosynthesis (MIPO) and the Locking Compression Plate system. This prospective study was undertaken to assess the surgical management of proximal tibial fractures using the locking compression plate system, enrolling a total of 60 patients.

Examining preoperative factors is crucial in understanding the nuances of surgical outcomes. In our comprehensive study, we meticulously investigated several variables, including the age of the patient, gender, mode of injury, and the type of fracture. These factors were scrutinized to discern any potential correlation with the functional outcomes subsequent to surgery.[13]The age distribution within our patient cohort revealed noteworthy patterns. A substantial 30% of individuals fell within the age group of 31-40 years, indicating a notable representation in this demographic. Following closely were age groups of 41-50 years (23.3%) and 21-30 years (20%). Further analysis showed that 13.4% of patients were in the younger age bracket of 18-20 years, while 10% were between 51-60 years, and a smaller percentage (3.3%) constituted those over 60 years. Despite this diverse age distribution, our study did not unveil a significant impact of age on the functional outcome post-surgery.A parallel study conducted by Reddy JPK et al. exhibited similar age trends, with their average age noted at 41 years. The gender distribution in our study indicated a notable male preponderance, comprising 80% of the participants, whereas female patients constituted the remaining 20%.[14] This aligns with observations made by Reddy JPK et al., who reported a higher incidence of fractures in males (86.7%) in their study, linking it to the occupational and ambulant lifestyles commonly led by men. Interestingly, the gender of the patient did not emerge as a decisive factor influencing the functional outcome in our investigation.When delving into the mode of injury, our study spotlighted Road Traffic Accidents as the predominant cause of fractures (80%), with falls from height accounting for the remaining 20%. Despite the variation in the modes of injury, our findings underscored that the mode of injury did not exert a significant effect on the functional outcome postoperatively.In essence, our study, enriched by a diverse cohort and meticulous analysis of preoperative factors, provides valuable insights into the nuanced interplay between patient characteristics and surgical outcomes, contributing to the ongoing discourse on optimizing treatment strategies for proximal tibial fractures.The insights gleaned from studies conducted by Dendrinos GK et al., Barei DP et al., and Patil DG et al[15,16,17]. resonate with our own investigation, shedding light on crucial aspects of proximal tibia fractures. Notably, road traffic accidents emerged as the predominant mode of injury across these studies, a trend also observed in our cohort, where 93.3% of fractures were attributed to such accidents. Furthermore, a consistent observation across studies was the higher incidence of fractures on the right side, with our study corroborating this finding, albeit with a slight right-sided predominance (56.7% vs. 43.3%). Intriguingly, despite this asymmetry, our analysis revealed that the side (left or right) at which the patient sustained the

injury did not wield any discernible impact on the functional outcome.[18,19]

A significant proportion of our patients (66.7%) presented with closed fractures, while 33.3% experienced open fractures. Aligning with the AO classification system, our study exhibited a distribution of 3.3% type A1, 13.3% type A2, 30% type A3, 16.7% type C1, 30% type C2, and 6.7% type C3 fractures. This distribution closely mirrored the findings in the study by Reddy JPK et al., emphasizing the consistency in the classification of proximal tibia fractures across different cohorts.The interval between injury and surgery, a critical preoperative factor, varied within our patient group. For 33.3% of patients, surgery occurred in less than 2 days, 53.3% were operated on within 2-5 days, and 13.4% faced a delay of more than 5 days. Importantly, this variability in the injury-to-surgery interval, averaging 2.8 days, did not manifest as a determinant of the ultimate functional outcome, echoing the findings in the study by Reddy JPK et al.[20]The average range of motion postoperatively was noted at 114 degrees in our study. Remarkably, despite the diverse preoperative factors considered, including mode of injury, fracture type, and injury-to-surgery interval, these variables did not emerge as decisive factors influencing the final functional outcomes. The final knee flexion of 90 degrees, achieved by only 3.3% of patients, indicates the challenges associated with attaining optimal range of motion in proximal tibia fractures.In summation, the collective evidence from these studies underscores the complexity of proximal tibia fractures and the diverse factors influencing outcomes. The multidimensional nature of these injuries necessitates a nuanced approach, acknowledging the interplay of various elements in the quest for optimal functional recovery.

CONCLUSION

The findings from this study suggest that the utilization of Open Reduction and Internal Fixation (ORIF) with a Locking Compression Plate (LCP) serves as a favorable implant choice for managing proximal tibia fractures, even in challenging fracture scenarios. The stability and versatility offered by the LCP in addressing the complexities of these fractures make it a reliable option. However, a key takeaway from the study emphasizes the importance of being well-prepared with the necessary resources and expertise for potential revision surgery, should the need arise.While ORIF with LCP demonstrates effectiveness in achieving stable fixation and facilitating the healing process, acknowledging the potential for unforeseen complications or cases requiring reevaluation is essential. The recommendation for readiness in the "armamentarium for revision surgery" underscores the need for orthopedic surgeons to have a comprehensive set of tools, techniques, and strategies at their disposal. This proactive approach is in line with the dynamic nature of fracture management, where adaptability and preparedness for unforeseen challenges are paramount.In summary, the study supports the use of ORIF with LCP as a sound implant choice for proximal tibia fractures. However, the cautionary note about being prepared for potential revision surgery underscores the importance of a comprehensive and adaptable approach in orthopedic practice.

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