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Original Research

To assess the functional outcome of compound tibia metaphyseal fractures treated with Supracutaneous locking compression plate

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ABSTRACT

Aim: This study aimed to assess the functional outcomes of compound tibial metaphyseal fractures treated with a supracutaneous locking compression plate (LCP) as an external fixator.

Materials and Methods: This prospective, observational descriptive study was conducted at Pt. JNM Medical College and Dr. Bhim Rao Ambedkar Memorial Hospital, Raipur, with ethical approval from the Institutional Scientific and Ethical Committees. The study included 12 adult patients aged 18 to 65 years with compound fractures of the proximal and distal tibia. The patients were treated using supracutaneous LCP fixation, and functional outcomes were assessed using the Knee Society Score (KSS) and AOFAS (American Orthopaedic Foot and Ankle Society) score. Radiological healing was monitored through X-ray imaging.

Results: The study found that 60% of patients achieved excellent functional outcomes at the 6-month follow-up, with 25% showing good results. The average time for union was 6.5 months, and the most common complications included screw tract infection (25%) and knee stiffness (8.4%). The technique proved effective in preserving articular integrity and providing favorable outcomes, with the majority of patients achieving good to excellent scores.

Conclusion: Supracutaneous LCP fixation is an effective treatment for compound tibial fractures, offering promising functional outcomes and advantages over traditional external fixators. The technique helps preserve soft tissue integrity, is well-accepted by patients due to its low-profile design, and provides stable fixation. However, the presence of co-morbidities, such as smoking, may delay fracture healing. Despite a few complications, LCP fixation remains a reliable option for managing tibial fractures.

Keywords: Tibial fractures, Supracutaneous locking compression plate, Functional outcomes, External fixator,

Introduction

Tibia fractures are a common type of injury that affects long bones, with varying rates of occurrence across different regions of the world. Tibial shaft fractures account for approximately 37% of all long bone fractures in adults.[1] Surgery is the recommended treatment for tibial fractures, but the process is often complicated by issues such as skin breakdown and infection, especially due to the vulnerable subcutaneous anteromedial surface and the high-velocity trauma typically involved in these injuries.[2] As a result, efforts have been made to develop surgical techniques that stabilize these fractures with minimal invasiveness to protect both soft tissue and bone integrity. Open fractures of the tibia often require additional interventions and a higher number of surgical procedures. Metaphyseal fractures, occurring at both ends of the tibia, present a unique challenge for surgeons in choosing the appropriate implant and procedure, with a focus on minimizing further damage to already traumatized soft tissues.[3,4]

The use of Minimally Invasive Plate Osteosynthesis (MIPO) technology, coupled with low-profile anatomical locking compression plating, has shown promising results in reducing the risk of skin breakdown and infection.[5] In the treatment of compound tibial fractures, a common approach involves a two-stage regimen consisting of debridement and the application of an external fixator, followed by internal fixation once the soft tissue

condition allows. However, this traditional two-stage surgery leads to higher surgical costs, extended hospital stays, and an increased number of procedures.[6] As a result, the use of external fixation for interim stabilization of the fracture has been recommended.

A one-stage external plate fixation reduces both costs and surgical trauma.[7] In cases of open tibial fractures, the endosteal and periosteal blood supply is often significantly compromised, which is crucial for the healing process. Using a Locking Compression Plate (LCP) as an external device not only stabilizes the fracture but also helps preserve the tibial vascularity, promoting better healing.[8] Additionally, the frame is less likely to interfere with the contralateral leg during the swing phase of walking.

MATERIALS AND METHODS

This prospective, observational descriptive study was conducted at the Department of Orthopaedic Surgery in Pt. JNM Medical College and Dr. Bhim Rao Ambedkar Memorial Hospital, Raipur, and was approved by the Institutional Scientific and Ethical Committees. The study included adult patients aged 18 to 65 years who presented with compound fractures of the proximal and distal tibia. A total of 12 patients were enrolled during the time-bound study period, which lasted from February 2023 to August 2024. Data collection involved direct observation and patient interviews, with detailed documentation of clinical history, injury details, and physical examinations for each participant.

Inclusion Criteria

- Compound tibia fractures up to Grade IIIa, presenting within 3 weeks of injury.
- Age 18 years and above.
- AO fracture types: 41A, 41B1, 41C1, 41C2, 43A, 43B1, 43C1, 43C2.

Exclusion Criteria

- Polytrauma patients.
- Pathological fractures of the tibial shaft.
- Patients who had previously undergone surgery for the same bone.
- Patients presenting after three weeks of injury.
- Patients who did not provide consent to participate in the study.

Pre-Operative Workup

Upon admission, a comprehensive clinical examination was conducted, and a detailed patient history was obtained from both the patient and their attendants. Routine investigations were performed to evaluate the patient's fitness for surgery. The following information was collected for each patient: UHID number, IP number, patient's name, age, sex, occupation, address, phone number, date and mode of injury, fracture classification (AO classification), Gustilo and Anderson grade, soft tissue injury classification (Oestern and Tscherne classification), associated injuries, and any medical comorbidities.

Fracture Classification

The fractures were classified using the Gustilo and Anderson classification system, which categorizes open tibial fractures based on the severity of soft tissue damage. Type III fractures were further classified into three subcategories:

- **Grade IIIa:** Extensive soft-tissue laceration with adequate bone coverage and minimal periosteal stripping.
- **Grade IIIb:** Extensive soft-tissue injury with periosteal stripping and bone exposure, requiring soft-tissue flap closure.
- **Grade IIIc:** Fractures associated with neurological and vascular injury requiring repair.

Implants

In this study, pre-contoured locking compression plates (LCP) were used for both proximal and distal tibia fractures. LCPs work biomechanically by creating a fixed-angle device, locking the screws into the plate to provide stabilization while preserving soft tissue integrity and promoting fracture healing.

Surgical Procedure

The surgical procedure was carried out under general or spinal anesthesia, with the involved limb prepared and draped in a sterile manner. A preoperative antibiotic was administered according to the Gustilo and Anderson grade of the compound fracture, and a tourniquet was not used to allow adequate antibiotic perfusion. After performing debridement and wound wash, the fracture alignment was achieved before wound closure. The appropriate size of the LCP metaphyseal plate was selected based on the fracture location, and the plate was initially fixed to the proximal and distal fragments using K-wires under fluoroscopy guidance. The LCP was placed at a sufficient distance from the underlying skin to allow space for swelling and wound care. Bi-cortical screw fixation was done with locking screws, ensuring that at least 3 to 4 screws were placed in both the proximal and distal fracture fragments for stable fixation. Finally, wound dressing was applied, and the surgical site was monitored for complications.

Postoperative Protocol

Patients were followed up at 6 weeks, 3 months, and 6 months after surgery. Functional outcomes were assessed using the Knee Society Score (KSS) for proximal tibial fractures and the AOFAS (American Orthopaedic Foot and Ankle Society) score for distal tibial fractures. Both scores were calculated using an online scoring calculator. Radiological union was assessed through X-ray imaging in anteroposterior (AP) and lateral views at each follow-up visit.

Radiological Outcome

Radiological healing was assessed using a union scoring system, which evaluates the presence of callus formation across the four cortices (medial and lateral on the AP view, anterior and posterior on the lateral view). Each cortex was scored as follows:

- 1 point: Fracture line with no callus.
- 2 points: Callus present, but fracture line still visible.
- 3 points: Bridging callus with no fracture line.

The total score for all four cortices ranged from 4 to 12, with a score of ≥7 indicating radiographic fracture union. Fracture union was considered achieved when bony callus was evident in at least three cortices on the standard AP and lateral X-ray views.

Statistical Analysis

Data were analyzed using appropriate statistical methods. Descriptive statistics were used to summarize patient demographics, fracture classifications, and functional outcomes. The relationship between fracture healing and functional outcomes was evaluated through follow-up data.

Results

The study population consisted of 12 patients with compound fractures of the tibia. Regarding age group distribution, the majority of patients were in the 31-40 years range, comprising 50% (6 patients) of the sample. The 18-30 years group represented 25% (3 patients), while smaller proportions of patients were in the 41-50 years, 51-60 years, and 60-65 years age groups, each contributing 8.33% (1 patient each). In terms of gender, 83.33% (10 patients) were male, while 16.67% (2 patients) were female. The predominant mode of injury was road traffic accidents, accounting for 91.67% (11 patients), while 8.33% (1 patient) sustained fractures from a fall from stairs. The site of injury shows that proximal tibia fractures were more common, with 75% (9 patients) of cases, while distal tibia fractures made up 25% (3 patients). The side affected demonstrated that left leg fractures were predominant, with 58.33% (7 patients) of cases involving the left side. Soft tissue injury types were predominantly classified as Gustilo-Anderson Grade II (G-A II) in 41.67% (5 patients), followed by G-A IIIA in 33.33% (4 patients), and Oestern-Tscherne Grade III (O-T III) in 25% (3 patients). Regarding co-morbidities, 75% (9 patients) had no medical comorbidities, while 25% (3 patients) had associated conditions.The interval between trauma and surgery varied among the patients, with the shortest duration being 1 day for 4 patients, representing 33.33% of the sample. 6 days and 7 days were the most common durations, with 6 days observed in 2 patients (16.67%) and 7 days in 1 patient (8.33%). The average interval for surgery was generally between 1 to 6 days, with only a few patients experiencing a longer wait (2–3 days).At the 6-month follow-up, the functional outcomes were largely positive. The majority of patients, 60% (7 patients), achieved an excellent result, indicating full recovery or near-normal function. 25% (3 patients) showed good results, demonstrating some recovery but not to the extent of achieving full function. Only 8.4% (1 patient) had a fair outcome, with some residual disability, and another 8.4% (1 patient) had a poor result, indicating severe functional impairment. This suggests that most patients had a favorable recovery trajectory at the 6-month mark.The functional outcome scores at each follow-up (6th week, 3rd month, 6th month, and 8th month) showed improvement over time. In the 6th week, the patients demonstrated varying levels of knee function, with scores ranging from 29 to 68. By the 3rd month, the patients showed substantial improvement, with knee scores ranging from 40 to 68. By 6 months, the scores showed further improvement, with most patients achieving scores between 60 and 95, indicating a significant recovery in knee function. By 8 months, many patients reached their peak knee function, with scores ranging from 80 to 100, reflecting the effectiveness of the surgical intervention in promoting healing and recovery.The time taken for union varied across the patients, with most patients achieving union within 6 to 7 months. The average time for union was 6 months for the majority of patients (5 patients, 41.67%) and 7 months for 4 patients (33.33%). 5 months and 8 months were noted for 1 patient each (8.33% for each), suggesting some variability in healing times, likely due to the severity of fractures or other patient-specific factors. Complications were relatively few, with the most common being screw tract infection, which occurred in 25% (3 patients) of the cases. This may be associated with the nature of the surgery, where screws and plates are used to stabilize the fractures. Stiffness of the knee joint was another complication, observed in 8.4% (1 patient). This could be related to prolonged immobilization or other postoperative factors affecting joint mobility. These complications highlight the need for careful postoperative management to prevent infection and ensure proper joint function.

Table 1 Basic parameters of the patients

Category	Subcategory	Frequency	Percentage (%)
Age Group	18-30	3	25%
	31-40	6	50%
	41-50	1	8.33%
	51-60	1	8.33%
	60-65	1	8.33%

Gender	Male	10	83.33%
	Female	2	16.67%
Mode of Injury	Road traffic accident	11	91.67%
	Fall from stair	1	8.33%
Side Affected	Right	-	-
	Proximal tibia	2	16.67%
	Distal tibia	1	8.33%
	Left	-	-
	Proximal tibia	7	58.33%
	Distal tibia	2	16.67%
Site of Fracture	Proximal tibia	9	75%
	Distal tibia	3	25%
Soft Tissue Injury Type	G-A II	5	41.67%
	G-A IIIA	4	33.33%
	O-T III	3	25%
Co-Morbidity	Absent	9	75%
	Present	3	25%

Table 2: Interval Between Trauma and Surgery

Patient	Interval Between Fracture and Surgery
1	7 Days
2	6 Days
3	2 Days
4	1 Day
5	5 Days
6	6 Days
7	1 Day
8	1 Day
9	1 Day
10	2 Days
11	2 Days
12	3 Days

Table 3: Functional Outcome Score at 6th Month

Frequency	Percent	Result
7	60%	Excellent
1	8.4%	Fair
3	25%	Good
1	8.4%	Poor
12	100%	Total

Table 4: Functional Outcome Score at Each Follow-up

S.No.	6th Week	3rd Month	6th Month	8th Month
1	KneeScore 60, Function 0	KneeScore 65, Function 75	KneeScore 95, Function 100	-
2	KneeScore 60, Function 0	KneeScore 63, Function 25	KneeScore 75, Function 80	KneeScore 90, Function 90
3	AOFAS 47	AOFAS 68	AOFAS 81	AOFAS 81
4	KneeScore 29, Function 0	KneeScore 40, Function 0	KneeScore 60, Function 50	KneeScore 60, Function 50
5	KneeScore 45, Function 5	KneeScore 68, Function 55	KneeScore 93, Function 100	-
6	AOFAS 32	AOFAS 68	AOFAS 68	AOFAS 63
7	KneeScore 64, Function 0	KneeScore 68, Function 55	KneeScore 80, Function 75	KneeScore 80, Function 80
8	KneeScore 68, Function 5	KneeScore 63, Function 25	KneeScore 80, Function 80	-

9	KneeScore 45, Function 5	KneeScore 68, Function 55	KneeScore 93, Function 100	KneeScore 95, Function 100
10	KneeScore 68, Function 5	KneeScore 68, Function 55	KneeScore 93, Function 100	-
11	AOFAS 47	AOFAS 63	AOFAS 78	AOFAS 88
12	KneeScore 64, Function 5	KneeScore 68, Function 55	KneeScore 80, Function 75	KneeScore 80, Function 80

Table 5: Average Time Taken for Union

Average Time Taken for Union	No. of Cases
5 Months	1
6 Months	5
7 Months	4
8 Months	2

Table 6: Complications in Our Study

S.No.	Frequency	Complications
1	3 (25%)	Screw tract infection
2	1 (8.4%)	Stiffness of knee joint

CASENO1

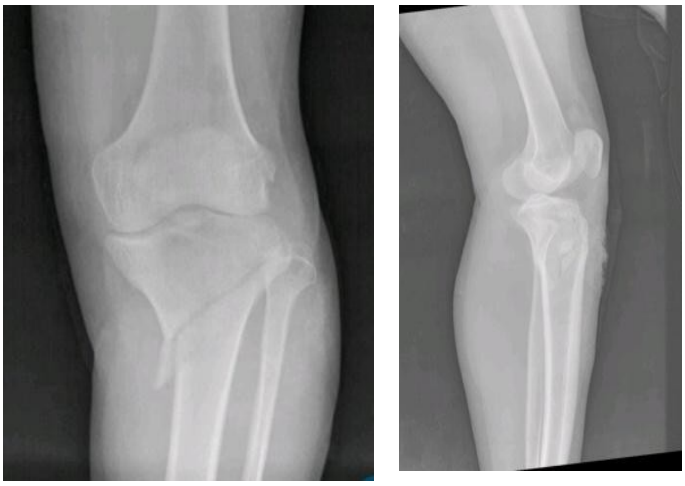

Figure-1.PreopX-rayshowingfractureproximaltibiaAPand Lat. view

Figure-2.Clinicalpictureshowing compound G-A grade II injury over Left Leg at

presentation

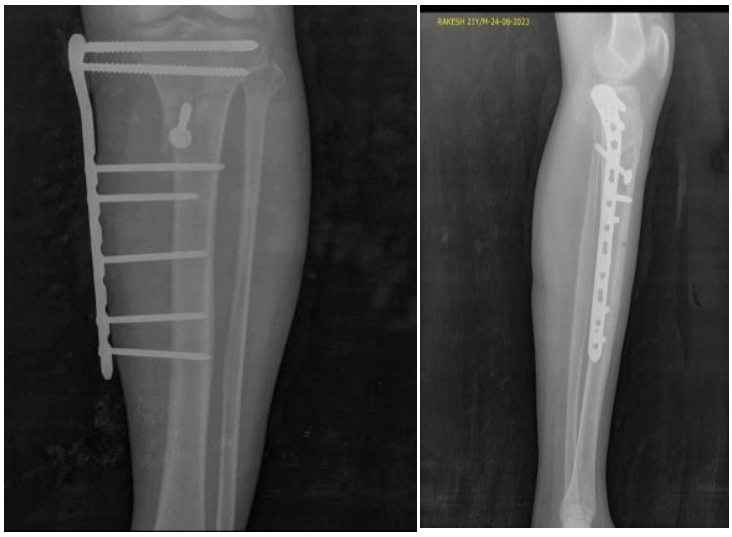

Figure-3 PostopX-rayAPandLat.viewat6th week

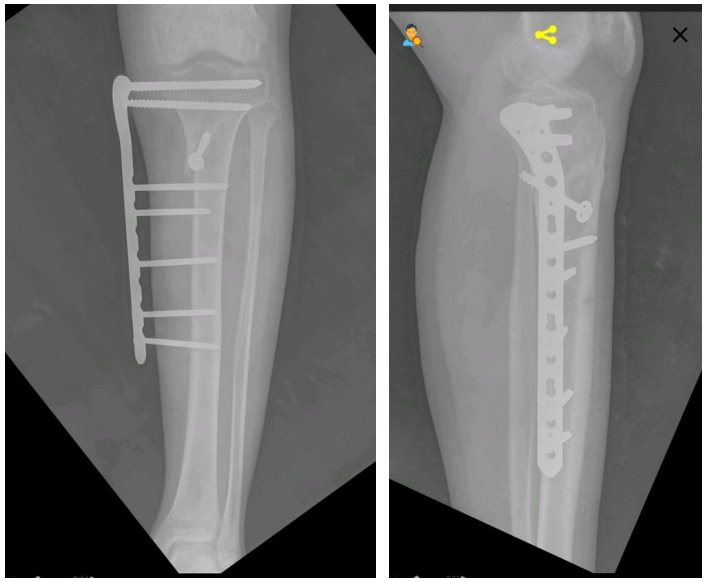

Figure-4 Postop X-ray AP and Lat. viewat3rdmonth

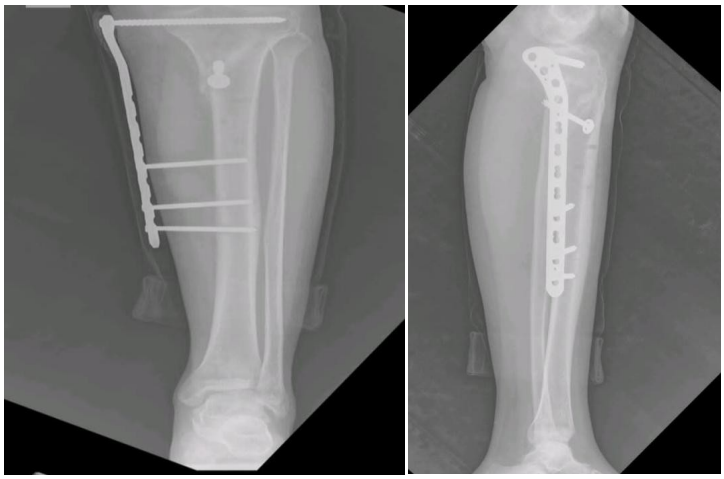

Figure-5 PostopX-rayAPandLat.viewat6thmonth

Figure- 6 PostopX-rayAPandLat.view post implant removal

Figure - 7 A clinical depiction of a patient performing daily activities with different levels of knee range of motion before implant removal

CASENO2

Figure-8.PreopX-rayshowingfractureproximaltibiaAP and Lat. view

Figure-9.Clinical picture showing compound O- T grade III injury over Right Leg

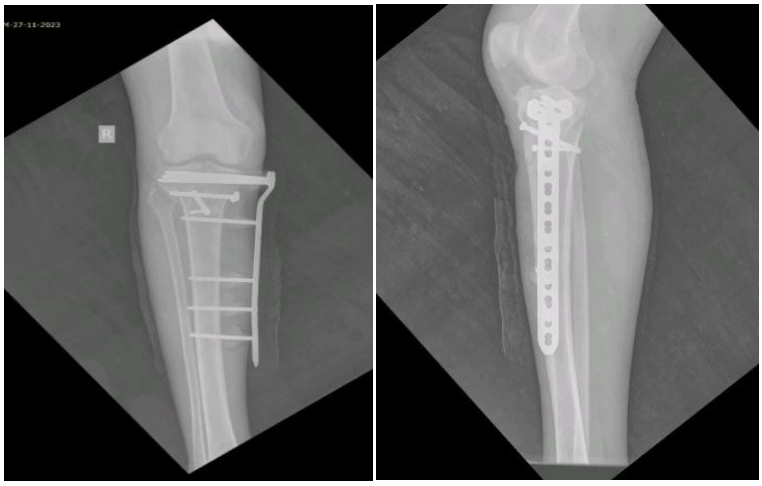

Figure-10.PostopX-ray APandLat.viewat6th week

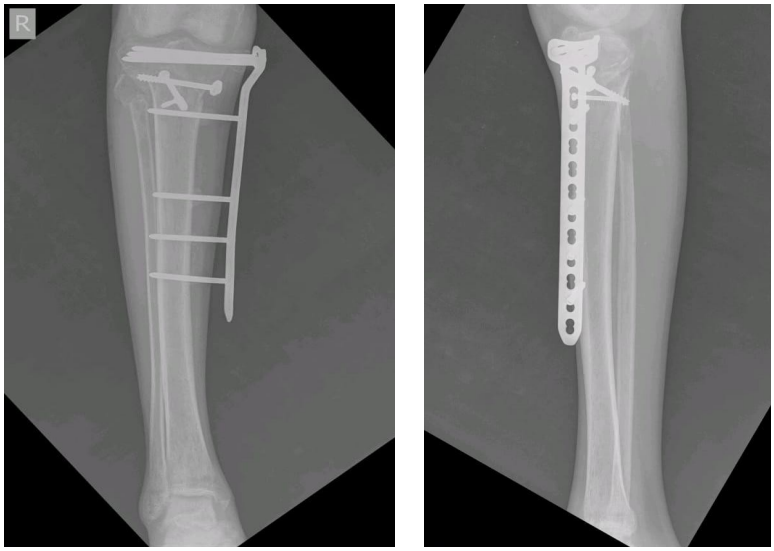

Figure-11.PostopX-rayAPandLat.viewat3rdmonth

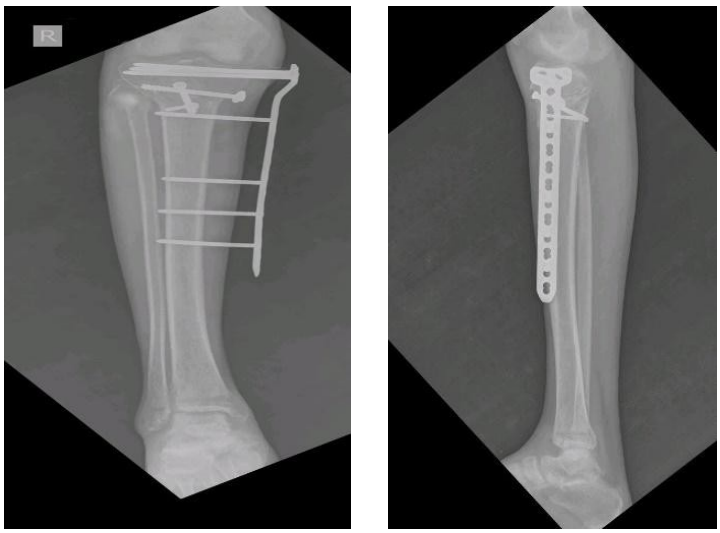

Figure-12.PostopX-rayAPandLat.viewat6thmonth

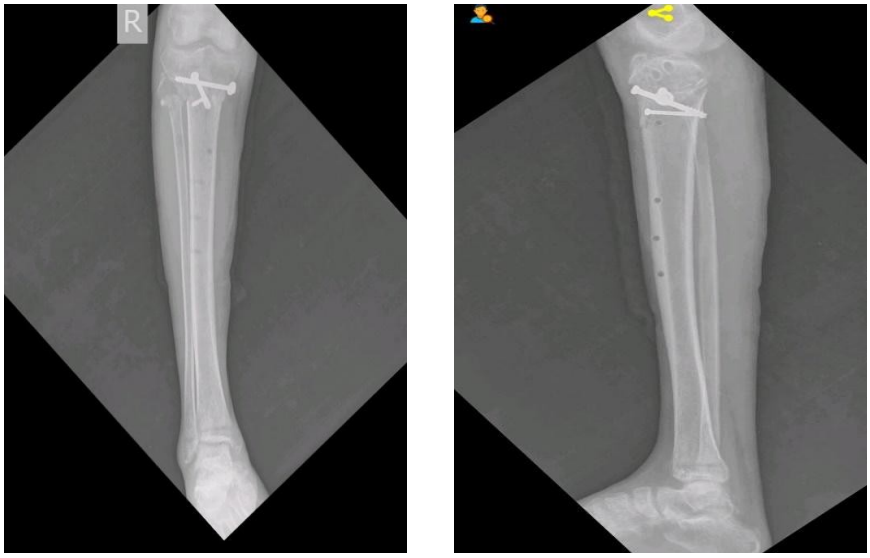

Figure-13.PostopX-rayAPandLat.view post implant

Figure-14. Clinical pictures showing functional range of motional knee joint before implant removal.

Discussion

The study population comprised 12 patients with a mean age of 37.6 years, which aligns with previous studies such as Shrinivas et al. (42 years) and Siddaram N Patil et al. (35 years), suggesting a consistent demographic of patients with compound tibial fractures. Most patients in our study were younger than 50 years, with 83.3% (10 out of 12) of the patients being under 50 years old. This trend is consistent with the higher prevalence of tibial fractures in younger individuals, who are more likely to be engaged in activities that involve a higher risk of high-velocity injuries, such as road traffic accidents (RTA) or sports. Similar trends were observed in the studies conducted by Shrinivas et al. and Siddaram N Patil et al., who also noted a younger demographic in their study populations.[9,10]Our study found a male predominance in compound periarticular tibial fractures, with a male-to-female ratio of 6:1. This finding is consistent with the trends reported in earlier studies, such as by Makelovet al. (5:1) and Sven A.F. Tulner et al. (6:1), demonstrating a clear male dominance in tibial fractures.[11,12] The higher incidence of these fractures in males could be attributed to their greater participation in activities that expose them to high-velocity injuries, particularly in younger age groups. Sports participation and risk-taking behaviors are more common in younger males, which may explain the observed sex disparity in the results. The findings also partially align with studies like Shrinivas et al., who reported a less pronounced male dominance (1.19:1), possibly due to differing study populations or methodologies.[13]The leading cause of injury in our study was road traffic accidents (RTA), accounting for 91.6% of cases. This aligns with several studies in developing countries, where high-speed collisions are common causes of tibial fractures. However, the findings diverge from studies conducted in developed nations, such as C.M. Court Brown et al.[14], where sports injuries were more prevalent (36.58%) compared to RTAs (31.7%). This discrepancy suggests a variation in injury patterns

based on geographic location and lifestyle factors. In developed countries, sports-related injuries may be more common due to higher levels of recreational and organized sports participation, whereas in our study, RTAs dominate due to higher vehicular traffic and road accidents in the region. These findings underscore the variability in the mode of injury depending on the socio-economic and environmental factors of the study population.Co-morbidities were present in 25% (3 out of 12) of our patients, including conditions like filariasis, HIV, and type I diabetes. One patient with a history of tobacco use and co-morbidities exhibited delayed fracture union (7-8 months), a finding that correlates with existing literature. For example, Sanjay N et al.42 demonstrated that smokers had significantly delayed fracture healing compared to non-smokers, with union taking over 48 weeks in smokers versus 24-28 weeks in non-smokers.[15] This study suggests that co-morbidities and lifestyle factors like smoking and chronic illnesses can contribute to delayed healing and slower recovery following fractures. The link between co-morbidity and delayed healing in compound tibial fractures warrants further investigation, as it could help refine treatment approaches for patients with these conditions.The functional outcomes in our study were promising, with 59% of patients achieving excellent results, 25% achieving good outcomes, 8% fair, and 8% poor (due to knee stiffness). These outcomes are comparable to previous studies. Bajoria RS et al.[16] reported similar results, with 50% excellent, 36% good, and 14% fair outcomes. Senghal Manik et al.[17] also reported high success rates, with 90% of patients achieving excellent outcomes using the Ketenjian and Shelton criteria. The high percentage of excellent outcomes in our study reflects the efficacy of Locking Compression Plate (LCP) fixation in treating compound periarticular tibial fractures, facilitating a functional recovery with minimal complications.The average time for radiological union in our study was 6.5 months, with a range of 5 to 8 months. This is consistent with findings from Biser Makelov et al.[11] (average union time of 5.6 months) and Segal et al.[18] (average union time of 5.5 months). These results demonstrate that LCP fixation provides effective stabilization and promotes bone healing in compound tibial fractures. Variations in healing times across studies may be attributed to differences in fracture type, patient demographics, and surgical technique.Complications in our study were observed in a small proportion of patients. The most common complication was **knee stiffness**, which occurred in 8.4% (1 patient). This was likely related to post-operative fibrosis and poor patient adherence to rehabilitation protocols. **Pin-tract infections** occurred in 25% (3 patients), a complication often associated with external fixation and poor personal hygiene. These infections were managed with appropriate antibiotics and resolved. Additionally, one patient experienced **implant impingement** during knee flexion beyond 90 degrees, which was resolved following implant removal. This suggests that implant placement should be carefully considered to avoid soft tissue impingement during deep knee bending. Our findings regarding knee stiffness and pin-tract infections are similar to those reported by Panda Shakti et al. (12.5%) and Seghal et al. (15%), but our study showed a higher rate of pin-tract infections.[19]

Conclusion

This study evaluated the functional outcomes of patients with compound metaphyseal tibial fractures treated using a supracutaneous locking compression plate (LCP) as an external fixator. The results show that this minimally invasive technique provides

excellent functional recovery, with most patients achieving good to excellent outcomes. The findings align with existing literature, which highlights the predominance of younger males and road traffic accidents as the leading cause of injury. The use of LCP offers advantages over traditional external fixators, preserving articular integrity and being more acceptable to patients due to its low-profile design. Co-morbidities, such as smoking, were found to potentially delay fracture healing, consistent with previous studies. Despite some complications, such as pin-tract infections and knee stiffness, LCP fixation remains a promising option for tibial fractures.

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