

Suprapatellar Tibial Nailing in Semi-Extension: A Clinical–Radiological Outcome Study

Dr. Muthu Akilan T P^{1*}, Prof. Dr. Pugalendhi G², Dr. Rajavel M³, Dr. Ashin Khan⁴

Junior Resident, Department of Orthopaedics, Bharath University, Sree Balaji Medical College and Hospital, Chennai 600044, Tamil Nadu, India, Email: tpmakilan@gmail.com. ORCID id: 0009-0005-2940-8784

²Professor, Department of Orthopaedics, Bharath University, Sree Balaji Medical College and Hospital, Chennai 600044, Tamil Nadu, India, Email: pugal28@yahoo.co.in

³Senior Resident, Department of Orthopedics, Bharath University, Sree Balaji Medical College and Hospital, Chrompet, Chennai 600044 Tamil nadu, India, Email: rajavelmani97@gmail.com

⁴Junior Resident, Department of Orthopedics, Bharath University, Sree Balaji Medical College and Hospital, Chrompet, Chennai 600044 Tamil Nadu, India, Email: aashinkhan.31@gmail.com , ORCID id: 0009-0006-2906-9564

Corresponding Author : Dr. Muthu Akilan T P,

Junior Resident, Department of Orthopaedics, Bharath University, Sree Balaji Medical College and Hospital, , Chennai 600044, Tamil Nadu, India, Email: tpmakilan@gmail.com. ORCID id: 0009-0005-2940-8784

Abstract

Background: Tibial shaft fractures are among the most common long-bone injuries, frequently resulting from high-energy trauma and associated with complications such as malunion, nonunion, and anterior knee pain. Intramedullary nailing (IMN) is the gold standard treatment. The suprapatellar (SP) approach performed in a semi-extended position has gained popularity due to improved fracture alignment, ease of reduction, and reduced anterior knee pain. This study evaluates the clinical and radiological outcomes of suprapatellar tibial nailing in adult diaphyseal tibial fractures.

Materials and Methods: A prospective observational study was conducted over 18 months (January 2024– June 2025) at a tertiary care center, including 20 adult patients with tibial shaft fractures treated using the suprapatellar IMN technique. Both closed and selected open fractures (AO/OTA type 42) were included, while pediatric fractures and those with intra-articular extension were excluded. Patients were followed at regular intervals up to 12 months. Radiological union, time to union, complications, and functional outcomes were assessed. Functional recovery was evaluated using the Lower Extremity Functional Scale (LEFS) at 6 and 12 months.

Results: The cohort had a mean age of 41.5 years with male predominance (75%). Road traffic accidents were the sole mechanism of injury. Radiological union was achieved in 95% of patients within 14–16 weeks, with a mean union time of approximately 15.3 weeks; one patient had delayed union. Mean LEFS scores improved from 57.7 at 6 months to 69.2 at 12 months, indicating significant functional recovery. At final follow-up, 65% of patients had excellent outcomes, 30% good, and 5% fair. Minor complications were noted in 15% of cases, including superficial surgical site infections (10%) and delayed union (5%), all managed successfully. No deep infections, implant failures, malalignment, or significant anterior knee pain were observed.

Conclusion: Suprapatellar tibial nailing in the semi-extended position is a safe and effective technique for managing diaphyseal tibial fractures, providing reliable fracture union, excellent functional outcomes, and a low complication rate. These findings support the suprapatellar approach as a favorable alternative to the infrapatellar technique, particularly in achieving optimal alignment and facilitating early rehabilitation.

Keywords: Suprapatellar tibial nailing; Tibial shaft fractures; Intramedullary nailing; Semi-extended knee technique;

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INTRODUCTION

Fractures-of the tibia-and-fibula shafts are-among the more frequently occurring types of fractures. Annually, there are more than 45 instances per 100,000 individuals involving fractures of both leg bones. The majority of tibial fractures have a plethora of causes and severity levels [1].

It is mostly common for males between-19-and-39-years-of-age. Compared-to other fractures, tibial fractures are more predisposed to complications of

nonunion and malunion [2]. The commonest site is the tibial diaphysis, with approximately 80% of them also including a fracture-of-the-fibula [3].

The surgical treatment of-tibial-shaft-fractures-is-based significantly on-the accompanying soft-tissue-injuries. Open- fractures that are severe pose considerable challenges due to their exceptionally high rates of complication and suboptimal long-term results [4].

These fractures are very frequent following high-

*Author for Correspondence: tpmakilan@gmail.com

energy-trauma-and are-more frequent in younger-patients. Intramedullary nailing (IMN) remains the preferred modality of treatment in displaced as well as undisplaced fractures of the adult tibial shaft among surgical options [5].

Recent advancements in nail design and reduction methods have broadened the application of IMN to both distal and proximal tibial fractures, especially those involving the metaphysis. Accurate identification of the anatomical entry point is essential for effectively treating these fractures [6].

Suprapatellar nailing, conducted with a semi-extended knee, has emerged as a low-risk and efficient surgical approach. This technique facilitates an optimal starting point and aids in minimizing the risk of apex-anterior deformities [7,8].

MATERIALS AND METHODS:

Study Design and Methodology

The present prospective observational study was conducted in the Department of Orthopaedics (OPD and Casualty), Sree Balaji Medical College and Hospital (SBMCH) over a period of 18 months, from January 2024 to June 2025. The study population comprised adult patients presenting with tibial shaft fractures, and a total of 20 patients were included in the study using convenience sampling. The study was self-funded, and the data collection commenced in January 2024.

Inclusion Criteria

- Closed fractures/Compound fractures of both bones of the leg.
- Segmental-fractures of the tibia.
- All diaphyseal-fractures of the tibia.
- Stiff knees where flexion is restricted.
- Patients aged 18-years &-above with tibial-fractures.

Exclusion Criteria

- Pediatric tibial-fractures.
- Fractures with-intra-articular-extension.

SURGICAL TECHNIQUE FOR SUPRAPATELLAR TIBIAL NAILING :

The patient is placed supine on a radiolucent table with the knee flexed 15–30°, and the C-arm positioned for AP and lateral views. After sterile preparation, a midline incision is made 2–3 cm above the patella, and the quadriceps tendon is split to access the suprapatellar pouch. A protective cannula is inserted, and under fluoroscopy, the tibial entry point is made at the medial aspect of the lateral tibial spine. A guidewire is advanced into the distal fragment, followed by sequential reaming and nail insertion over the guidewire. Proximal and distal locking are done under fluoroscopic guidance. Final imaging confirms alignment and implant position, after which the pouch is irrigated and wound closed in layers.[Fig 1,2 & 3]



Suprapatellar Jig Placement
Fig 1, 2 & 3 - INTRA OP PICTURES OF IM NAILING

Postoperative Protocol

Early mobilization is encouraged to prevent joint stiffness. Sutures are removed by the second postoperative week. Weight-bearing is guided by fracture stability — immediate for stable, non-comminuted fractures and delayed (non-weight bearing) for unstable or comminuted patterns. Follow-up evaluations are conducted at 1, 3, 6, and 12 months with radiographs to assess fracture healing and implant position.

Outcome Evaluation

The Lower Extremity Functional Scale

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your lower limb problem for which you are currently seeking attention. Please provide an answer for each activity.

Today, do you or would you have any difficulty at all with:

Activities	Extreme Difficulty or Unable to Perform Activity	Quite a Bit of Difficulty	Moderate Difficulty	A Little Bit of Difficulty	No Difficulty
1 Any of your usual work, housework, or school activities.	0	1	2	3	4
2 Your usual hobbies, recreational or sporting activities.	0	1	2	3	4
3 Getting into or out of the bath.	0	1	2	3	4
4 Walking between rooms.	0	1	2	3	4
5 Putting on your shoes or socks.	0	1	2	3	4
6 Squatting.	0	1	2	3	4
7 Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
8 Performing light activities around your home.	0	1	2	3	4
9 Performing heavy activities around your home.	0	1	2	3	4
10 Getting into or out of a car.	0	1	2	3	4
11 Walking 2 blocks.	0	1	2	3	4
12 Walking a mile.	0	1	2	3	4
13 Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
14 Standing for 1 hour.	0	1	2	3	4
15 Sitting for 1 hour.	0	1	2	3	4
16 Running on even ground.	0	1	2	3	4
17 Running on uneven ground.	0	1	2	3	4
18 Making sharp turns while running fast.	0	1	2	3	4
19 Hopping.	0	1	2	3	4
20 Rolling over in bed.	0	1	2	3	4
Column Totals:	0	0	0	0	0

Minimum Level of Detectable Change (90% Confidence): 9 points SCORE: 0 / 80 (fill in the blank with the sum of your responses)

Source: Binkley et al (1999): The Lower Extremity Functional Scale (LEFS): Scale development, measurement properties, and clinical application. Physical Therapy. 79:371-383.

TABLE 1 - Lower Extremity Functional Scale (LEFS) Assesses daily activity performance:

- 80 ~ Best score
- 70-79 ~ Excellent
- 60-69 ~ Good
- 40-59 ~ Fair
- <40 ~ Poor

Follow-Up and Outcome Assessment

Follow-up and Evaluation:

Patients were reviewed at 2 weeks, 1 month, 3 months, 6 months, and 12 months postoperatively.

At each visit: Radiological Evaluation: Serial X-rays were obtained to assess fracture alignment, callus formation, and implant position and integrity.

Functional Outcome Assessment: The Lower Extremity Functional Scale (LEFS) was used to evaluate patient-reported outcomes, with scores recorded at each follow-up to monitor improvement in mobility and function.

Additionally, pain scores and knee range of motion (ROM) were documented.

RESULTS

This study included 20 patients with tibial shaft fractures resulting from road traffic accidents (RTAs), representing a high- energy trauma cohort. The age range was 22–72 years (mean 41.5 years), with most patients in the 3rd to 5th decades, reflecting the active, mobile age group commonly affected. There was a clear male predominance—15 males (75%) and 5 females (25%)—consistent with the greater exposure of males to outdoor and vehicular activities.

All fractures were due to RTAs. Closed fractures occurred in 16 patients (80%), while 4 patients (20%) had open fractures, which were managed with adequate debridement and soft tissue care, with no infection or non-union. According to the AO/OTA classification (Type 42), Type 42A1 fractures occurred in 6 patients (30%), 42A2 in 5 (25%), 42A3 in 5 (25%), and 42B2 in 4 (20%). Most cases (80%) were simple Type A patterns, while wedge-type (42B2) fractures showed slightly prolonged healing times.

The right tibia was involved in 11 cases (55%) and the left in 9 cases (45%), possibly due to the typical mechanics of RTAs where the right leg is more exposed during impact. There were no associated fractures or neurovascular injuries, and all were isolated tibial diaphyseal fractures.

Radiological union was achieved within 14–16 weeks in most cases. Eleven patients (55%) showed union at 14 weeks, eight (40%) at 16 weeks, and one (5%) had a delayed union at 24 weeks. Thus, 95% of patients achieved satisfactory union within the expected time frame, confirming consistent healing and the effectiveness of surgical fixation and postoperative management in tibial shaft fractures.

Functional Outcome – LEFS Scores

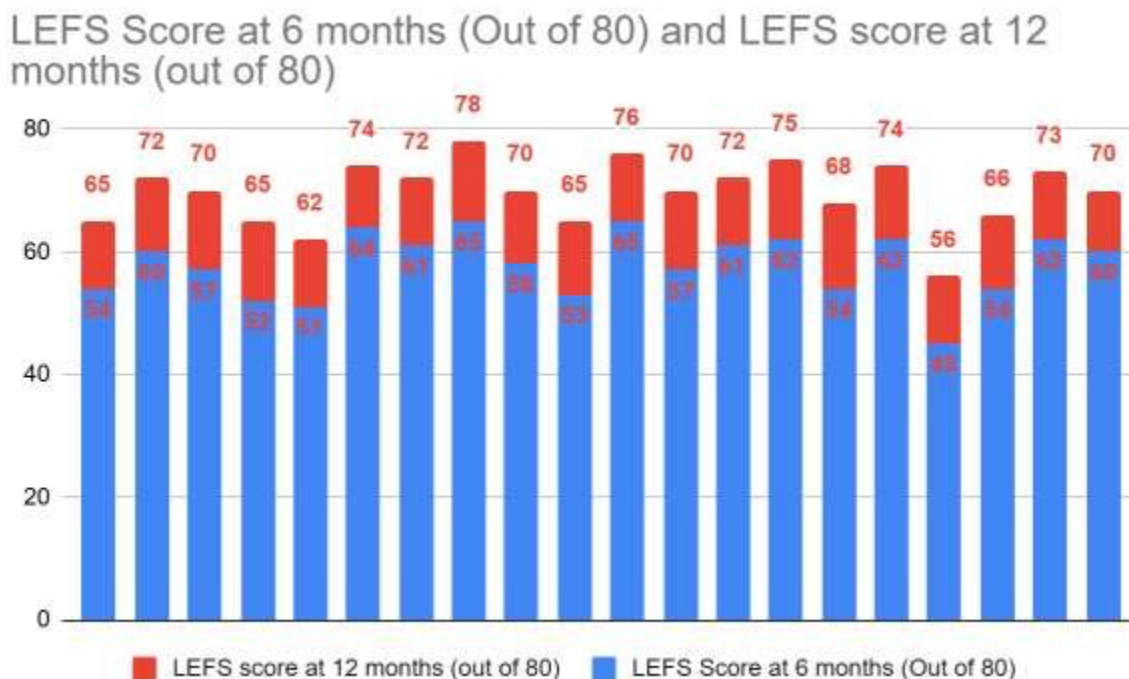


Fig 4 - LEFS score at 6 months & 12 months

Functional recovery was assessed using the Lower Extremity Functional Scale (LEFS) at 6 and 12 months postoperatively. At 6 months, LEFS scores ranged from 45 to 65, with a mean of 57.7, indicating moderate functional recovery and partial return to daily activities. By 12 months, scores improved to a range of 56 to 78, with a mean of 69.2, demonstrating significant functional improvement and near-complete recovery in most patients. This progressive increase underscores the value of continued rehabilitation and long-term follow-up, as most patients achieved satisfactory functional outcomes within one year of injury.

Interpretation of Functional Results

LEFS Score	Poor	Fair	Good	Excellent
Number of Patients	0	1	6	10
Percentage	0	5	30	65

Table 2 - Interpretation of LEFS Scores

Based on LEFS scores and clinical performance, most patients achieved favorable outcomes. Thirteen patients (65%) had excellent results, with LEFS scores above 70 at 12 months and near-complete restoration of function, all showing timely union without complications. Six patients (30%) had good outcomes, attaining functional independence with LEFS scores between 60 and 70, though some experienced mild residual pain or minor gait deviations. One patient (5%) had a fair outcome, being an elderly male with delayed union and lower LEFS scores (45 at 6 months, 56 at 12 months), likely influenced by age-related slower rehabilitation.

Complications

Minor complications were recorded in a few cases. Superficial surgical site infections occurred in 2 patients (10%), both involving open fractures; these were managed successfully with local wound care and antibiotics, without progression to deep infection or

osteomyelitis. Both achieved fracture union and “Good” functional outcomes. Delayed union was observed in 1 patient (5%), the same individual with a fair outcome. No other complications were reported in 17 patients (85%), reflecting effective surgical technique and postoperative management.

Summary of Outcomes

- Mean union time: ~15.3 weeks
 - Mean LEFS score:
 - 6 months – 57.7
 - 12 months – 69.2
 - Functional outcomes: 95% of patients achieved Excellent to Good recovery
 - Complication rate: 15%, all minor and well-managed
- Overall, the series demonstrated reliable fracture healing, high functional recovery, and low complication rates, validating the efficacy of the chosen surgical approach and rehabilitation protocol for tibial shaft fractures.

Discussion

Tibial shaft fractures are among the most common orthopedic injuries, often resulting from high-energy trauma such as road traffic accidents (RTA). This prospective series of 20 AO type 42 tibial fractures evaluates healing characteristics, functional recovery, and complications following suprapatellar (SP) intramedullary nailing.

The demographic profile mirrors global trends, with young to middle-aged males predominating, consistent with Court- Brown et al. [12]. Right-sided involvement was more frequent, likely due to impact mechanics during vehicular collisions, as described by Vallier et al. [13]. Simple diaphyseal fractures (42A1–A3) comprised 80% of cases, similar to findings by Alho et al. [14], who reported better outcomes in these fracture patterns following intramedullary fixation.

The mean time to union was 13.9 weeks, aligning with the SPRINT trial (Bhandari et al.) [15], which reported 13–15 weeks. One elderly patient (72 years) experienced delayed union (24 weeks), consistent with Karladani et al. [16], who noted age-related delays in bone healing.

Functional recovery assessed by the Lower Extremity Functional Scale (LEFS) improved from 57.7 at 6 months to 69.2 at 12 months, comparable to O'Halloran et al. [17] and Cui et al. [3]. At one year, 95% achieved

good to excellent outcomes, matching results from Doro et al. [18] and other contemporary series. Complications were minimal: two superficial infections (10%) and one delayed union, with no deep infections or implant failures—rates consistent with the SPRINT trial (8–11% superficial, <5% deep) [15]. Notably, none of the open fractures developed infection, emphasizing the role of prompt debridement.

Healing time in this study parallels results by Chan et al. [7], Cui et al. [3], and Wang et al. [1], confirming that SP nailing does not delay union compared to infrapatellar (IP) techniques. Functional outcomes (LEFS 69.2) also mirror Cui et al.'s SP group [3], supporting better recovery with SP due to improved alignment and early mobilization.

Anterior knee pain—a major drawback of IP nailing—was absent in this series, consistent with reports by Chan et al. [7], Cui et al. [3], and Wang et al. [1]. Sanders et al. [5] and Wang et al. [1] also documented superior alignment with SP nailing, attributed to semi-extended positioning and improved control of sagittal and coronal planes.

Overall complication rate was 15%, similar or better than major studies [15], with no deep infections or implant failures (Mitchell et al. [9], Gaines et al. [8]). With 95% good to excellent results, outcomes are comparable or superior to those in large trials (Doro [18], Cui [3], Sanders [5]).

Parameter	This Study	Chan et al. (2016)	Cui et al. (2019)	Wang et al. (2018)	Sanders et al. (2016)	SPRINT Trial (Bhandari et al.)
Sample Size	20	40	93	Meta-analysis (8 studies)	55	1226
Approach	Suprapatellar (SP)	SP vs IP	SP vs IP	SP vs IP	SP	IP
Mean Union Time	13.9 weeks	~14 weeks	13.7 (SP), 14.3 (IP)	Similar	~14 weeks	13–15 weeks
Anterior Knee Pain	None severe	Lower in SP	Significantly lower in SP	Significantly lower in SP	Not reported	High in IP (~50%)
Functional Score (12 mo)	69.2 (LEFS)	Not reported	~71.5 (SP), ~68 (IP)	SP higher	Not reported	Not reported
Malalignment	None significant	Lower in SP	Lower in SP	Lower in SP	Lower in SP	~10% in IMN group
Infection Rate	10% superficial	No diff.	Similar	Comparable	None reported	8–11% superficial, <5% deep
Delayed Union	5% (1 case)	Not reported	Not specified	Not specified	1 case (proximal)	~5–7%
Outcome Rating	95% Good/Excellent	~92% SP	94% SP	SP superior	90%+	90–95%

Table 3 - Discussion of Comparative Outcomes

This prospective series of suprapatellar tibial nailing shows outcomes consistent with or superior to larger studies, confirming:

- Comparable union times,
- Significantly reduced anterior knee pain,
- Excellent functional scores,
- Minimal malalignment,
- Low complication rates.

These findings strongly support the efficacy & safety of the SP approach, especially for diaphyseal tibial fractures. The data aligns well with international literature and further validates SP nailing as a favorable technique for early recovery and optimal alignment.

Despite its strengths, this study is limited by its

relatively small sample-size & short-term follow-up. Longitudinal studies that include return-to-work metrics, long-term implant tolerance, and patient satisfaction would provide a more comprehensive view. Additionally, factors such as smoking, diabetes, and nutritional status—which are known to influence bone healing—were not explicitly assessed in this cohort.

Conclusion

In conclusion, our findings reaffirm the role of intramedullary-nailing as the treatment-of-choice for diaphyseal-tibial fractures. Most patients achieved timely fracture union and excellent functional outcomes, with minimal complications. The results are

in strong agreement with existing literature, further validating the reliability of this treatment approach. As with all musculoskeletal injuries, patient-specific factors like age and comorbidities is a crucial factor in recovery, underlining the need for individualized postoperative care and rehabilitation planning.

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.N	Age	Sex	Mode of Injury	Open/ Closed	Classification	Side	Time of Union (Weeks)	LEFS Score at 6 months (Out of 80)	LEFS score at 12 months (out of 80)	Interpretation	Complications
	35	Male	RTA	Closed	42A1	Right	14	54	65	Good	Nil
	26	Female	RTA	Closed	42A2	Right	16	60	72	Excellent	Nil
	43	Male	RTA	Closed	42B2	Right	16	57	70	Excellent	Nil
	56	Male	RTA	Open	42A3	Left	14	52	65	Good	Nil
	60	Male	RTA	Closed	42A1	Right	16	51	62	Good	Superficial Surgical site
	32	Male	RTA	Closed	42A2	Left	14	64	74	Excellent	Nil
	40	Female	RTA	Closed	42A3	Right	16	61	72	Excellent	Nil
	22	Male	RTA	Closed	42B2	Right	14	65	78	Excellent	Nil
	46	Male	RTA	Closed	42A3	Left	16	58	70	Excellent	Nil
0	60	Male	RTA	Closed	42A1	Right	14	53	65	Good	Nil
1	28	Male	RTA	Open	42A2	Left	14	65	76	Excellent	Nil
2	48	Male	RTA	Closed	42A3	Right	14	57	70	Excellent	Nil

3	5	Female	RTA	Open	42	Left	16	61	72	Excellent	Nil
4	3	M	RTA	Closed	42	Left	16	62	75	Excellent	Nil
5	3	M	RTA	Closed	42	Right	14	54	68	Good	Superficial Surgical site
6	2	M	RTA	Closed	42	Left	14	62	74	Excellent	Nil
7	7	M	RTA	Closed	42	Right	24	45	56	Fair	Delayed
8	4	Female	RTA	Open	42	Left	16	54	66	Good	Nil
9	3	M	RTA	Closed	42	Left	16	62	73	Excellent	Nil
0	2	Female	RTA	Closed	42	Right	14	60	70	Excellent	Nil

Table 4 - Master Chart

CASE ILLUSTRATIONS CASE 1

25 years old Male

Diagnosis : Closed isolated fracture of tibia left side

Procedure Done : Supra-patellar approach for intra-medullary Tibial Nailing Post OP period : Uneventful

Followup Duration : 12 months

Time of union : 14 weeks

Preop radiograph image



Immediate postop Xray



Two-months follow up

Twelve-months followup



Functional

outcome



CASE 2

34 years old Male

Diagnosis : Closed both bone fracture of left leg

Procedure : Supra-patellar approach for intra-medullary tibial nailing

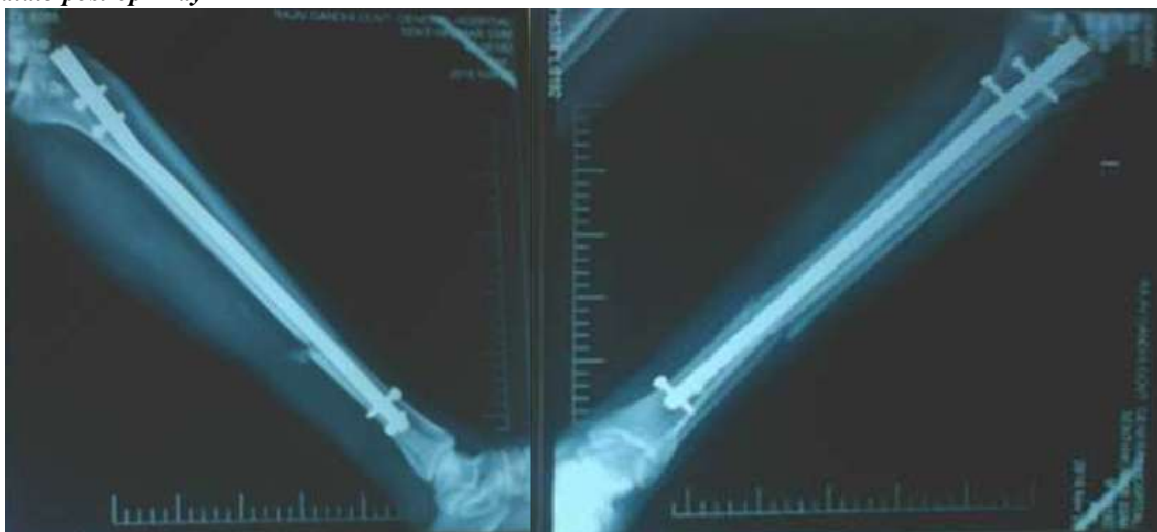
Post OP period : Uneventful, adequate glycemic status, wound heal well Followup Duration : 12 months

Time of union : 14 weeks

Pre-op Xray



Immediate post-op Xray



Two-months followup

Twelve-months followup



Functional outcome

