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Prospective study on functional and radiological outcome of suprapatellar approach for intramedullary nailing using semi extended knee position in tibial shaft fractures

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Abstract

Fractures of the tibia are one of the most common orthopedic injuries occurring most often in younger patients. Tibial fractures are frequently associated with high energy trauma mechanisms. Intramedullary nailing is one amongst the preferred treatment modalities for mid shaft tibial fractures. Standard Tibial nailing entry portals used are the infrapatellar and parapatellar approaches. Suprapatellar tibial nailing is a recent advance in the surgical technique for treatment of tibial shaft fractures. This method has shown reduced operative and fluoroscopy time and lesser pain incidence in previous studies. The semi extended position of the knee also allows for countering the deforming effect of the musculature pull of the quadriceps mechanism and also easier fluoroscopy imaging. The suprapatellar technique decreases the risk of perforation of posterior cortex by placing the starting point in line with the medullary canal. This technique also helps to reduce Varus and Valgus deformity by using the femoral trochlear groove as a guide to the starting point which maintains the mechanical axis of the lower extremity.

Objectives of the study: To assess Functional outcomes of suprapatellar approach in mid shaft tibial fractures by Lower extremity functional score (LEFS). To assess Radiological outcomes of suprapatellar approach in mid shaft tibial fractures by the Radiological Union in Tibia Score (RUST).

Study design: Prospective interventional study

Study period: October 2019 to May 2021

Source of data: Patients admitted with closed mid shaft tibial fractures as an inpatient in the Department of Orthopaedics, Victoria hospital and Bowring and Lady Curzon hospitals attached to BMCRI were included in the study satisfying the inclusion and exclusion criteria

Methodology: 20 patients with closed or open (type 1 and 2) mid shaft tibial fractures were treated using the suprapatellar approach. Functional outcome was measured using the Lower extremity functional score and radiological outcome was measured using the Radiological union in tibia score at immediate and last follow up intervals.

Results: Our study group comprised of 20 patients between the ages 20 to 60 years. LEFS showed a statistically significant improvement from 23.35 at 6 weeks to 69.25 at 12 months. In our study analysis out of 20 patients, 11 patients had excellent LEFS score, 7 patients had good LEFS score and 2 patients had fair LEFS score.

Also in our study 100% patients achieved union by 20 weeks with a mean RUST score of 7.4 at 6 weeks compared to a mean RUST score of 14.15 at 12 months.

Conclusion: Suprapatellar nailing has shown shorter fluoroscopy less manoeuvrability and operative time, excellent to fair functional outcome of lower limb and reduced incidence of valgus and varus malalignment postoperatively. Suprapatellar nailing is a promising technique of tibial fracture fixation with satisfactory radiological and functional outcomes postoperatively.

Keywords: Suprapatellar nail, lower extremity functional score (LEFS), radiological union scale in tibial fractures (RUST)

Introduction

Tibial fractures are quite common injuries caused by trauma and are highly referred to hospitals. Tibial fractures can immensely impact many areas in a patient's life like absence from working and unable to meet financial needs. This has shown to cause patients seeking alternative methods to meet their daily needs like depending on welfare or selling possessions.

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Tibial shaft fracture management has consistently been evolving with newer treatment methods being discovered [1]. Tibial nailing with the semi extended knee was begun to counteract post-operative procurvatum deformities that is a common problem in proximal third tibial shaft fractures. Earlier tibial nailing in the semi-extended knee position comprised of a knee arthrotomy in order to create the proximal tibial starting point. Recent technological advances have enabled surgeons to use instrumentation systems that allow for tibial nailing in the semi-extended position using a suprapatellar portal with nail insertion through the patellofemoral joint [2].

Suprapatellar nailing has shown a significantly shorter fluoroscopy time, less VAS pain score, better sagittal plane alignment and lower incidence of angular misalignment. For tibia nailing, suprapatellar technique can be superior to infrapatellar approach with lesser post-operative knee pain, better functional recovery, and improved fracture reduction. Meanwhile, no increased risk of postoperative complications was identified. More RCTs are required for further research [3].

Some studies have also shown no notable differences in pain, disability, or knee range of motion between suprapatellar and infrapatellar nail approaches after even 12 months of follow-up. Thus raising the need for larger trials to be conducted in this area [4].

Methodology

Inpatients of Hospitals attached to Bangalore Medical College and Research Institute with tibial diaphyseal fractures fulfilling the inclusion/exclusion criteria were taken into the study after obtaining written informed consent.

Demographic data, history, clinical examination and details of investigations and interventions were recorded in the study Performa.

From October 2019 to May 2021, patients with tibial diaphyseal fractures identified and operated with a suprapatellar approach with the knee in semi extension.

Patients were reviewed at immediate post-op, 6 weeks, 3 months, 6 months 9 months and 1 year post-operatively.

Study design: Prospective interventional study

Study Period: October 2019 to May 2021

Place: This study was carried out in Department of Orthopaedics in teaching hospital attached to Bangalore Medical College and Research Institute

Source of Data: Patients with mid shaft tibial fractures admitted under Department of Orthopaedics in teaching hospitals attached to Bangalore medical College and Research Institute.

Sample size: A sample size of 20 patients were included in this study

Inclusion criteria

1. Patients who are 18 years and above and willing to give written informed consent.
2. Patients with tibial diaphyseal fractures.
3. Closed and Gustilo Anderson type 1,2 and 3A open fractures
4. Patients who have attained skeletal maturity when assessed radio graphically

Exclusion criteria

1. Compound Grade IIIb, IIIc fractures
2. Segmental fractures of the tibia.

3. Pathological fracture
4. Co-morbid conditions not permitting major surgical procedures
5. Un-cooperative patients and patients not willing for surgery.

Ethical clearance: Approval for the study was obtained from the Institutional Ethics Committee of Bangalore Medical College and Research Institute.

Informed consent: Patients satisfying the inclusion criteria were explained about the nature of the study. Consent from patient and attenders was taken after explaining about the surgical treatment and prognosis in their own vernacular language.

Data collection: On admission a careful history was obtained from the patients and/or attendants about age, sex, details of the injury, duration were obtained through an interview. Patients were evaluated for any comorbidities and associated injuries and were addressed to. Patients were subjected to clinical and local examination. These findings were recorded on predesigned and pretested proforma.

Operative procedure [5]

The patient is placed in supine position on a radiolucent operating table and the knee is flexed to about 20 to 30 degrees and supported by a roll. The C-arm is brought in from the contralateral side.

The patella joint lines and tibial tubercle to enable correct placement of the guide wire and also because the leg is can be malrotated due to the fracture. A 1.5-cm to 2-cm vertical skin incision is made 1 cm above the superior pole of the patella. Blunt dissection is done to expose the quadriceps tendon, and the tendon is incised in the midline longitudinally.



Fig 1: Patient placed in supine position with semi extended knee

The cannula and trocar are now inserted beneath the patella through the patellofemoral joint up to the anterior edge of the tibia. The blunt trocar is replaced with multi holed guide pin sleeve. A 3.2 mm guide pin is drilled 5 to 6 cm into tibia through the central hole to obtain entry into medullary canal. Correct position of confirmed on both AP and lateral fluoroscopic imaging.



Fig 2: Incision over superior pole of patella



Fig 3: Entry gained through suprapatellar portal through trochar and protection sleeve

The ball tip guide wire is then passed through the opening into the medullary canal and past the fracture site into distal tibia. Reaming is commenced in sequential manner to widen the medullary canal. An essential prerequisite for reaming is that the fracture be reduced appropriately before reaming across the fracture site which can be done with the help of assistants, reduction clamps, K wires and blocking screws. Sequential Reaming with increments of 5mm size is done to about 1 to 1.5 mm larger than the planned nail diameter.



Fig 4: Reaming the medullary canal of tibia

Once the reaming process is complete the ball tip guide wire is exchanged for a plain guide wire. The nail is assembled onto the jig and passed over the guide wire across fracture site into distal tibia. Proximal locking is done first with the help of the targeting device followed by distal locking of the nail done by freehand technique under fluoroscopic guidance. In cases where the fracture needs to be compressed distal locking is done prior to proximal locking.



Fig 5: Passage of nail into medullary canal using custom made Jig

After confirming fracture reduction and nail and screw positions under fluoroscopy the knee joint is inspected and thoroughly washed with saline and wound is closed in layers.

Table 1: LEFS score at different follow-ups of patients studied

LEFS	Min-Max	Mean ± SD	Difference	t value	P value
6 weeks	14-31	23.35±3.81	-	-	-
3 months	22-38	31.50±4.87	-8.150	-13.214	<0.001**
6 months	35-69	54.10±9.36	-30.750	-19.554	<0.001**
9 months	45-74	63.40±8.15	-40.050	-31.638	<0.001**
12 months	52-79	69.25±8.15	-45.900	-32.249	<0.001**

In our study, there was a statistical improvement in LEFS at the end of year follow with an increase from a mean LEFS of 23.35 at 6 weeks to a mean LEFS of 69.25 at the end of 1 year follow up. Highest improvement was noted between 3 months to 6 months (31.50 to 54.10) as most patients had attained fracture union during this time period. There was not much improvement in LEFS after 6 months (54.10 to 69.25) as 100% of patients had attained fracture union.

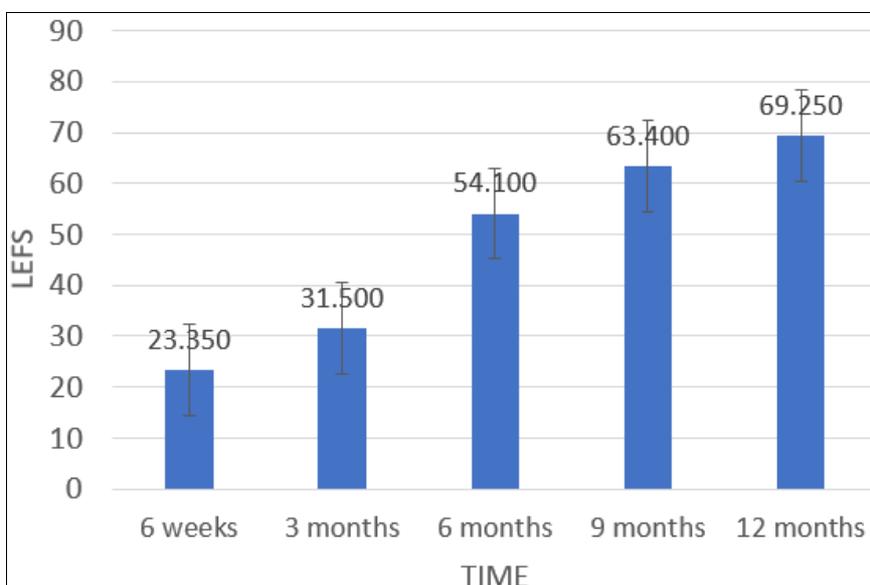


Chart 1: LEFS average at different follow up intervals

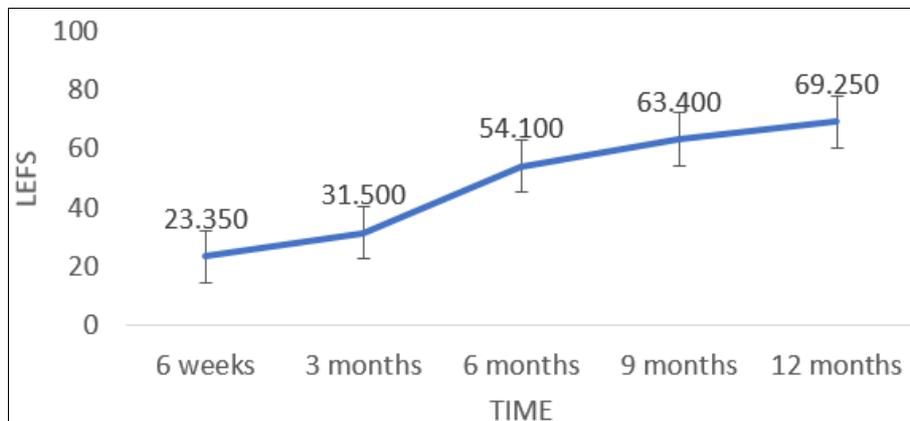


Chart 2: LEFS progression

Table 2: Number of patients as per LEFS at different follow up intervals

LEFS	6 weeks	3 months	6 months	9 months	12 months
< 40 (Poor)	20 (100%)	20 (100%)	1 (5%)	0	0
40 – 60 (Fair)	0	0	13 (65%)	6 (30%)	2 (10%)
60-70 (Good)	0	0	6 (30%)	7 (35%)	7 (35%)
70-80 (Excellent)	0	0	0	7 (35%)	11 (55%)
Total	20 (100%)	20 (100%)	20 (100%)	20 (100%)	20 (100%)

In our study 11 (55%) patients had excellent LEFS at end of 12 months, 7(35%) had good outcome, 2(10%) had fair outcome and none had poor outcome.

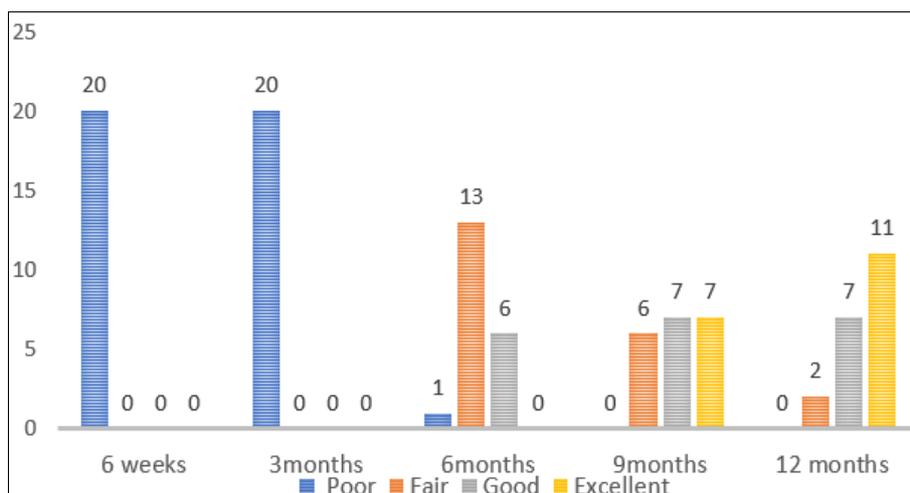


Chart 3: LEFS - Outcome with number of patients

Table 3: RUST scores at different follow up intervals

RUST	Min-Max	Mean ± SD	Difference	t value	P value
6 weeks	6-8	7.4±0.88	-	-	-
3months	6-12	9.1±1.33	-1.700	-8.233	<0.001**
6months	7-13	10.85±1.75	-3.450	-11.716	<0.001**
9months	8-15	12.25±1.99	-4.850	-13.857	<0.001**
12months	11-16	14.15±1.56	-6.750	-23.352	<0.001**

In our study there was statistically significant difference in RUST scores between 6 weeks to 3 months and Rust scores improved with each subsequent follow up.

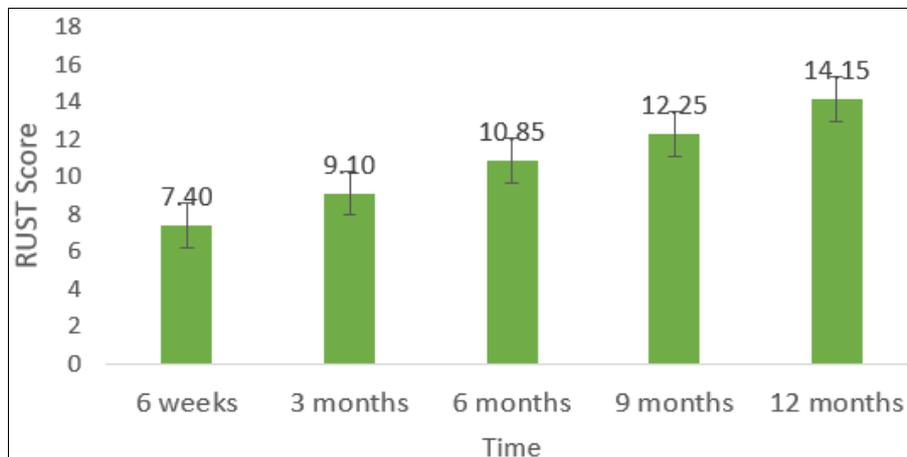


Chart 4: Mean RUST score at different follow up intervals

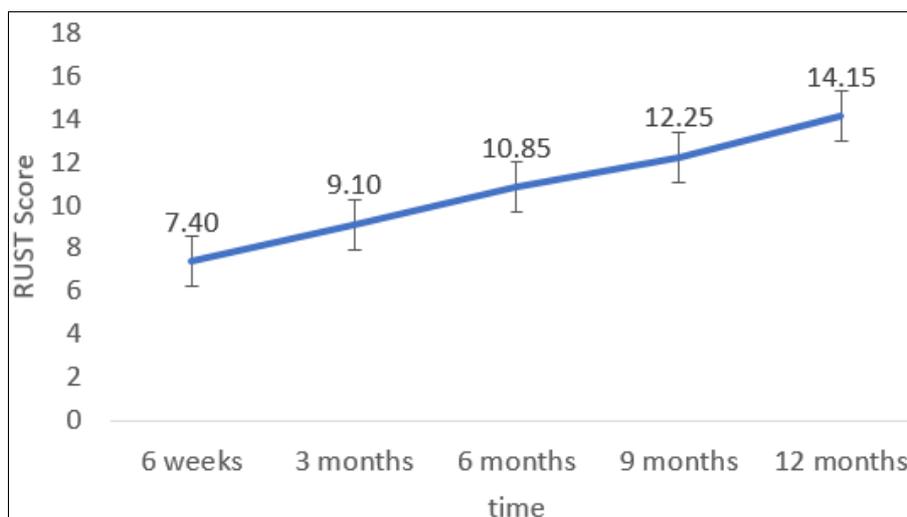


Chart 5: RUST score trend with relation to patient age

Discussion

Tibial fractures are frequently encountered in orthopaedic practice and interlocking nailing is one of the primary treatment modalities for tibial shaft fractures. The treatment strategies and methods are constantly evolving and suprapatellar approach for tibial nailing in semi extended knee position is a recent advance that is being embraced increasingly amongst orthopaedic surgeons.

In our study we had 20 patients with tibial mid shaft fractures who were treated with suprapatellar interlocking nailing. Patients were followed up to assess radiological fracture union and functional outcome using RUST and LEFS.

Functional outcome

The functional outcome in the study was measured by Lower extremity functional score which uses a set of daily activities to gauge the level of function after surgery.

- In this study the LEFS showed a consistent improvement from
- 14 to 31 with mean of 23.35 in the 6 weeks.
- 22 to 38 with mean of 31.50 in the 3rd month.
- 35 to 69 with mean of 54.10 in 6th month.
- 45 to 74 with mean of 63.40 in 9th month.
- 52 to 79 with mean of 69.25 at the end of the study.
- At the end of the study 55% shows excellent outcome, 35% show good outcome and 10% show fair outcome.

In this study the RUST score showed a consistent improvement from

- 6 to 8 with mean of 7.4 in the first month;
- 6 to 12 with mean of 9.1 in the 3rd month.
- 7 to 13 with mean of 10.85 in 6th month.
- 8 to 15 with mean of 12.55 in 9th month.
- 11 to 16 with mean of 14.55 at the end of the study.
- By the end of the study 100% patients showed consistent improvement in RUST score.

In a study done by Jasrotia *et al.* [6], which was conducted from august 2015 to May 2017 in Department of Orthopaedics, Sri Guru Ram Das Institute of Medical Science and Research, Amritsar included a follow up of 30 patients over a 6 month period who had undergone suprapatellar nailing for tibial fractures and concluded that suprapatellar approach for nailing of tibial shaft fractures had good functional and radiological outcomes.

In a study done by Singh *et al.* [7], included patients treated with intra-medullary nailing, for diaphyseal tibia fractures, between March 2013 to August 2015 at North West London Major Trauma Centre and, Chelsea and Westminster Hospital, London. This study showed that suprapatellar approaches were more advantageous in achieving better fracture reduction and had better functional outcome scores at 15 months as compared to the patients treated with infrapatellar approaches.

Conclusion

- Suprapatellar approach for nailing of tibial shaft fractures has well to excellent functional and radiological

outcomes and is associated with lesser operative time and radiation exposure.

- The suprapatellar approach for nailing of tibial shaft fractures has shown lesser incidence of postoperative knee pain and stiffness and has exhibited good union rates.
- However further studies are needed encompassing larger sample sizes and longer follow up intervals to explore the efficacy of suprapatellar nailing.

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Author's Contribution

Not available

Conflict of Interest

Not available

Financial Support

Not available

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