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Original research article

Efficacy of suprapatellar nailing in tibia fractures with knee in semiextended position

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Abstract

Fractures of tibia are primarily caused by high-energy trauma [1], and are one of the most common diaphyseal fractures in adults, accounting for about 13.7% of all fractures [2]. most serious long bone fractures, it has the potential to go into non-union, malunion and long-term dysfunction leading to socio economic unrest and poor mental and physical health.

At present, there are several treatment methods for tibial shaft fractures, such as open reduction and internal fixation with plates, external fixation, and intramedullary nailing [3]. Intramedullary nailing is the gold standard treatment option for midshaft tibial fractures open or closed irrespectively [3, 4]. 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

An infrapatellar and patellar tendon splitting entry to the tibia with the knee joint flexed 90 degrees seems to be the preferred entry for tibial nailing. If the indications for nailing of proximal and distal tibial fractures are extended, this is a challenge for surgical techniques. With proximal fractures, there is a tendency for anterior malalignment of the proximal fragment from pull of the patellar tendon, and this pull is increased further when the knee is flexed during nailing.[5]With nailing in a conventional manner, there is a risk of poor repositioning, suboptimal reaming, and a poor placement of the nail with added risk posterior perforation of nail [5, 6]. Also, the extended position of the lower leg allows for easier fluoroscopic imaging [6].

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 [5, 6].

The purpose of this article is to 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) over a period of 12 months.

Study design: Prospective study

Methodology: 40 patients with closed or open (type 1 and 2) 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 40 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 and. In our study analysis out of 40 patients, 22 patients had excellent LEFS score, 14 patients had good LEFS score and 4 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.

Introduction

Tibial fractures are quite common injuries caused by trauma and are highly referred to hospitals. Tibial

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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.

The insertion of an intramedullary nail (IMN) with interlocking screws is considered the standard of care for operatively managed tibial shaft fractures [3, 4]. However, IMN insertion through the infrapatellar (IP) approach remains technically challenging due to proximal fracture fragment displacement with knee flexion induced by quadriceps and extensor complex as well as the multiple adjustments made during imaging [7]. Further, postoperative anterior knee pain is a common if not the most frequent complication after IMN insertion, with a reported incidence varying from 10% to 86% [7, 8, 9].

Tibial shaft fracture management has consistently been evolving with newer treatment methods being discovered [5]. Tibial nailing with the semi extended knee was begun to counteract post-operative pro curvatum 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 patella femoral joint [10].

Suprapatellar nailing has shown a significantly shorter and easier fluoroscopy time,[6] less VAS pain score, better sagittal plane alignment and lower incidence of angular misalignment.[5,6] 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 [6, 7, 10, 11]. More RCTs are required for further research.

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 [6, 7, 10, 11].

Methodology

40 patients with tibial 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.

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

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.

Follow up

All the patients were followed up at immediate post-op, 6 weeks, 3 months, 6 months 9 months and 1 year post-operatively.

Assessment of Results

Assessment of the patient was done using by Lower extremity functional score (LEFS) and to assess Radiological outcomes of suprapatellar approach in mid shaft tibial fractures by the Radiological Union in Tibia Score (RUST).

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.

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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 can be m al rotated 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

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 the 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 3: Entry gained through suprapatellar portal

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Fig 4: Reaming the medullary canal of tibia through trocar and protection sleeve

Once the reaming process is complete the ball tip guide wire is exchanged for a plain guide wire. The nail is the 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.

Observation and Results

Our study included 40 patients with closed and open (type 1, 2, and 3A) tibial fracture and all patients were treated with Closed reduction and internal fixation with suprapatellar nailing technique. In our study, there were 12 (30%) females and 28 males (70%) in the group showing predominance of fractures in males. The Mean age of patients were 33 years (SD12.50), Mean age among males was 34.85 years (SD 10.86) Mean age among female was 28.67 years (SD 15.97), In our study, 30 (75%) patients had road traffic accidents, 6(15%) patients had fall from height and 4 (10%) patients sustained blunt trauma with distribution of both right and left extremities equally of which 30 were of closed and 10 were open in nature.

In our study, there was a statistical improvement in LEFS at the end of year follow with an increase from a mean LEFS of 23.90 at 6 weeks to a mean LEFS of 70.88 at the end of 1 year follow up. Highest improvement was noted between 3 months to 6 months (31.82 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 70.88) as 100% of patients had attained fracture union.

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	23.90±4.10	-	-	-
3 months	22-38	31.82±4.49	-7.925	-11.131	<0.001
6 months	35-69	54.10±9.24	-30.200	-20.706	<0.001
9 months	45-77	65.63±7.95	-41.725	-39.328	<0.001
12 months	52-79	70.88±6.93	-46.975	-47.858	<0.001

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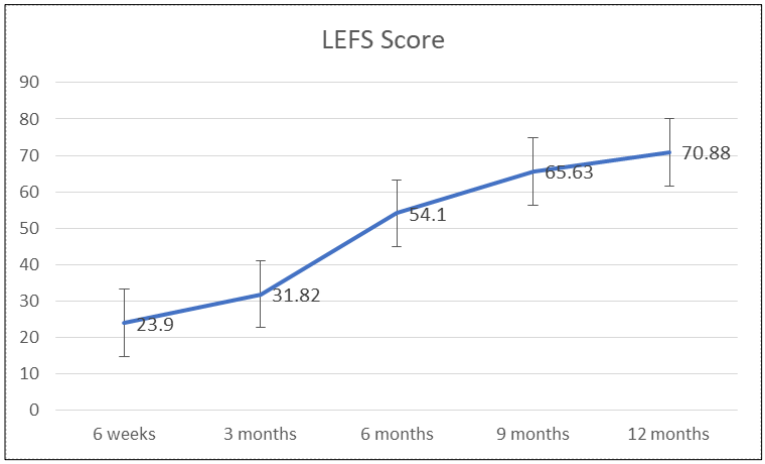

Chart 1: LEFS progression

In our study 24(60%) patients had excellent LEFS at end of 12 months, 13(32.5%) had good outcome, 3(7.5%) had fair outcome and none had poor outcome.

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

LEFS Score Category	6 weeks	3 months	6 months	9 months	12 months
<40 (Poor)	40 (100%)	40 (100%)	2 (5.0%)	0	0
40-60 (Fair)	0	0	26 (65.0%)	13 (32.5%)	3 (7.5%)
60-70 (Good)	0	0	12 (30.0%)	12 (30.0%)	13 (32.5%)
>70 (Excellent)	0	0	0	15 (37.5%)	24 (60.0)
Total	40 (100%)	40 (100%)	40 (100%)	40 (100%)	40 (100%)

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

Table 3: RUST scores at different follow up intervals

RUST Score	Min-Max	Mean ± SD	Difference	t value	p value
6 weeks	6-8	7.40±0.87	-	-	-
3 months	6-12	9.15±1.27	-1.750	-11.287	<0.001
6 months	7-13	10.85±1.73	-3.450	-16.786	<0.001
9 months	8-15	12.25±1.97	-4.850	-19.853	<0.001
12 months	11-16	14.15±1.54	-6.750	-33.456	<0.001

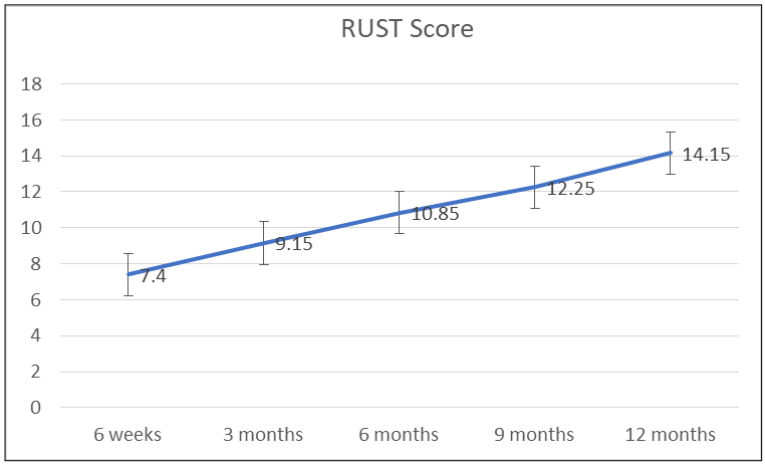

Chart 2: Mean RUST score at different follow up intervals

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 40 patients with tibial midshaft fractures who were treated with suprapatellar interlocking nailing. Patients were followed up to assess radiological fracture union and functional

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outcome using RUST and LEFS.
Results were analysed and observations were made. Our study was comparable to other studies done by other authors.
In a study done by Singh *et al*, [14] 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.
A study done by Sanders *et al* comprised 36 patients who had undergone suprapatellar nailing for tibial shaft fractures in semiextended knee position and assessing for functional and radiological outcomes at the end of 12 months showed that suprapatellar approach has excellent tibial alignment and union, and knee range of motion. Patients postoperatively had no issues of anterior knee pain commonly seen in patients with standard infrapatellar nailing.
In our study of 40 patients operated with suprapatellar nailing in semi extended knee position for tibial shaft fractures 60% patients had excellent LEFS outcome, 32.5% patients had good LEFS outcome and 3 patient had a fair LEFS outcome.

- Suprapatellar approach for intramedullary nailing of fractures of shaft of tibia has good to excellent functional and radiological results and is associated with lesser operative time and radiological hazards.
- The study has been carried out to assess the functional and radiological outcome of suprapatellar nailing for tibial fractures.
- In our study the LEFS improved from a mean of 23.90 at 6 weeks to a mean of 70.88 at 12 months whereas the RUST score improved from a mean of 7.4 at 6 weeks to a mean of 14.15 at 12 months.
- Suprapatellar nailing is an efficient surgical technique in treatment of tibial shaft fractures and offers advantages of lesser operative and fluoroscopy time and facilitation of reduction with good to excellent radiological and functional outcomes

Conclusion

Suprapatellar approach for nailing of tibial shaft fractures has good to excellent functional and radiological outcomes and is associated with lesser operative time and radiation exposure.at the same time 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.

Case 1: A 52 year old man sustained left tibial fracture due to road traffic accident. Pre op X ray shows middle one third tibial shaft fracture fixed with Intramedullary nail by Suprapatellar approach

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Follow up X ray at 12 months shows united midshaft tibial fracture with Suprapatellar nail in situ

Clinical photos at 12 months follow up

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