Section: Orthopaedics

Original Research Article

A COMPARATIVE STUDY OF FUNCTIONAL AND RADIOLOGICAL OUTCOME OF TIBIAL FRACTURES TREATED WITH INTRAMEDULLARY AND INTERLOCKING NAILING THROUGH SUPRAPATELLAR AND INFRAPATELLAR APPROACH

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ABSTRACT

Background: Tibial shaft fractures are among the most common long bone injuries in adults. Intramedullary interlocking nailing (IMIL) is the preferred treatment, with two main surgical approaches: suprapatellar (SP) and infrapatellar (IP). This study compares functional and radiological outcomes between these techniques. **Materials and Methods:** A prospective randomized study was conducted on 50 skeletally mature patients with tibial shaft fractures between January 2021 and September 2022. Patients were divided equally into SP and IP groups. Outcomes were assessed using Lysholm Knee Score, Visual Analog Scale (VAS) for anterior knee pain, and Radiographic Union Scale for Tibial Fractures (RUST SCORE). Follow-up was at immediate post op, 1, 3, 6, and 9 months postoperatively. **Result:** The mean operative time was significantly lower in SP group (73 min) compared to IP group (98.8 min, $p < 0.001$). Mean RUST scores at 9 months were higher in SP group (11.84) versus IP group (10.64, $p = 0.003$). At 9 months, 88% of SP patients achieved "excellent" Lysholm scores compared to 56% in IP group ($p = 0.012$). Anterior knee pain was reported in 16% of IP patients and none in SP group. Infection occurred in 24% of IP group and 0% in SP group. **Conclusion:** The suprapatellar approach provides superior functional and radiological outcomes compared to the infrapatellar approach, with shorter operative times, faster fracture union, and reduced anterior knee pain. SP nailing may be considered the preferred technique for tibial shaft fractures.

INTRODUCTION

The larger and more powerful of the two bones in the lower leg just below the knee is the Tibia (shinbone). High-energy trauma frequently results in Tibial Shaft Fractures and significant concurrent soft-tissue damage.[1] With 2% of all Fractures in adult patients, the Tibial Shaft Fracture are the most frequent long bone Fracture, and commonly resulted from High Energy Trauma.[2–4] The goals of the surgical intervention are to achieve a solid bone union without hypertrophy, rapid mobilisation, and complete Range of Motion, without further soft-tissue damage.[1] Different terminology, such as "spiral," "transverse," "oblique," and "comminuted," are used to categorise the varied patterns of Fracture in the Tibial Shaft.[5] In order to treat Tibial Fractures, surgeons employ a variety of techniques, including non-operative, surgical, and adjuvant techniques, meant to hasten healing and to lower the likelihood of Non-union.[6] When a patient has adequate compliance, non-displaced Tibial Shaft Fractures can be managed conservatively. The main concerns of conservative treatment include Deep Vein Thrombosis, Compartment Syndrome, Soft Tissue Injury, and Persistent Regional Pain Syndrome. The Implant of choice appears to be intra-medullary nailing, which has a significantly better biomechanical stability. There are very few indications for plate osteosynthesis. External fixation is also preferred implant for the initial management of numerous traumas in accordance with damage control principles, its use has been declining steadily in the last decade. A successful outcome requires the

reconstruction of the axis, length, and rotation. Technique selection is influenced by the location, Fracture geometry, history, and soft tissue injury, of the patient and existing Co-morbid conditions with the Fracture.[1]

Intra-medullary Nail (IMN) has higher benefit ratio and lower risk of complications and reoperations.[8-10] The Tibia Shaft Fractures were typically treated using the conventional Infrapatellar technique, through a medial or lateral para-tendinous incision or a midline Trans-tendinous incision.[11] However, due to the quadriceps and extensors complex, which causes proximal Fracture fragments to move with the knee in flexion, and several adjustments during imaging, IMN insertion through the Infrapatellar approach remained technically challenging.[12] Additionally, chronic anterior knee discomfort was one of the most frequent complications following IMN insertion, with an incidence that ranged from 10 to 80percent.[13,14]

The Suprapatellar (SP) technique may be preferable to the Infrapatellar (IP) approach, allowing for an easier reduction, shorter fluoroscopy time, and a relatively lower incidence of malunion and anterior knee discomfort,[11] The potential drawback of this method may be inadvertent intra-articular damage.[15] Damage to the patello-femoral joint is only concern with the SP method.[16,17]

Aim

To compare the Functional and Radiological outcome of Tibial Fractures treated with Intra-medullary and Inter-locking Nailing (IMIL) through Suprapatellar and Infrapatellar approach.

Objectives

- To Compare the functional outcome of Tibial Fractures treated with Intra-medullary and Inter-locking Nailing (IMILN) through the Suprapatellar and Infrapatellar approach.
- To Compare the Radiological outcome of Tibial Fractures treated with Intra-medullary and Inter-locking Nailing (IMILN) through the Suprapatellar and Infrapatellar approach.
- To Determine the factors influencing the Functional and Radiological outcome, of Tibial Fractures, treated with Intra-medullary and Inter-locking Nailing (IMILN) through the Suprapatellar and Infrapatellar approach.

MATERIALS AND METHODS

Study Design: The prospective study was conducted among patients with Fracture Shaft Tibia.

Study area: The Study was conducted among patients who presented, to an Emergency Department, and Department of Orthopaedics and Traumatology, Trichy SRM Medical College Hospital and Research Centre, Irungalur, Tamil Nadu.

Study Period: Period between January 2021 and September 2022

Study Population: All patients diagnosed with Tibial Shaft Fractures presented to an Emergency Department, and Department of Orthopaedics and Traumatology during the period between January 2021 and December 2021 with a minimum follow-up period shall be 9 months till September 2022, so that the entire study shall encompass a period of 1-year, 9months.

Inclusion Criteria

- Age above skeletal maturity
- All closed Fractures
- Open Fractures (Gustilo Anderson grade 1 and grade 2 Fractures of Tibia within 6 hours)

Exclusion Criteria

- Intra articular Tibial plateau Fractures
- Compound grade IIIB and IIIC Fractures
- Fractures with compartment syndrome
- Pathological Fractures of Tibia

Sampling Method: By using Universal Sampling, All Patients with Tibial Shaft Fractures presented to an Emergency Department, and Department of Orthopaedics and Traumatology during the period between January 2021 and December 2021, 50 Skeletally Mature Adults with Tibia Shaft Fractures were recruited who satisfied our Inclusion Criteria, were randomly split into the Suprapatellar Approach Group (SPAG n= 25) and the Infrapatellar Approach Group (IPAG n= 25) by using random number generator.

Data Collection Procedure: Data on every Patient were gathered at the time of admission, Patients demographics, Gender, Age, Smoking status, Presence of Diabetes, Fracture Type and Associated Fractures, Neurovascular status examined at the time of admission were recorded. Radiographs – Full length X-rays of the Tibia and Fibula were collected in the Antero-Posterior and Lateral views taken on the day of admission along with One Joint above and One Joint below. According to our randomised surgical allocation, all patients were divided into 2 groups (SPAG and IPAG) and their clinical results and prognosis were evaluated.

Surgical Intervention: All patients were Positioned in the Supine position while undergoing surgery after receiving Anaesthetic induction and Parenteral Antibacterial Prophylaxis.

Suprapatellar Approach (SPA): The Knee joint was slightly flexed to a 15–20o angle. Quadriceps tendon was split after a 2.5 x 3 cm longitudinal incision that started 2.0 cm from the superior pole of the patella. The Articular cavity at the back of the patella was then made into a functional duct. (In a single instance of patello-femoral joint hypertextension, which typically made it difficult to insert "trocar" inside the tunnel, relieving the pressure by lateral patellar retinaculum lysis could lessen the damage to the articular cartilage.) Fluoroscopic Assistance was used to confirm the drilling site, which was then plugged in to ensure accuracy on the point and direction of reaming. The drilling point was proven to be 5mm behind the midpoint of the anterior rim of the Tibial plateau. Second shift tibial fractures

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were treated using the "Finger" approach throughout the reduction-assistance process. After several rounds of reaming, a suitable nail was picked out, implanted, and then locked both distally and proximally. Finally, after numerous cavity suctions and drainages, the "trocar" was plugged out and subcutaneous tissue and skin were closed.

Infrapatellar Approach (IPA): The surgical technique was carried down to directly split/retract the patella ligament after starting from the patella tip to the Tibial tuberosity for about 5 cm. Extreme knee flexion of 120° to 130° was used before separating the sub-patellar fat tissue to clearly reveal the upper portion of the Tibial tuberosity. The drilling point was at the same location as that in the SPAG, but to ensure the accuracy of the reduction, the "S"-shaped opening device's major axis had to be lined up with the axis of the Tibia prior to drilling. The guiding wire was then connected. However, situations that showed up with displacement or more during the reduction operation were referred to as "Second shift." For this kind of displacement, bare-hand method was given top emphasis, which included pressing the displaced piece back while distally retracting and maintaining its position. The subsequent implant nailing surgical procedures were reported in exact detail as those in the SPN group. The skin and subcutaneous tissue were then closed.

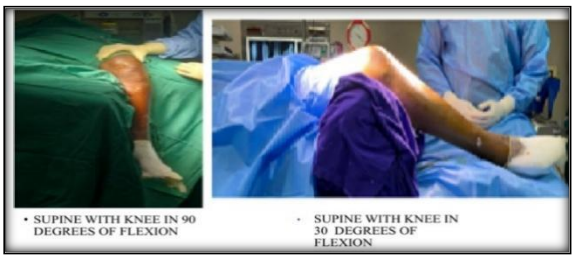

Figure 1: Positioning of the patient in Infrapatellar(left) & Suprapatellar(right)

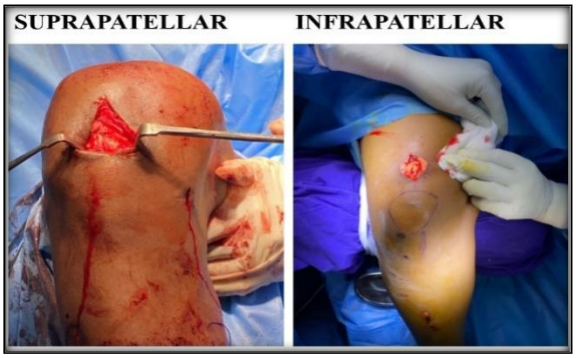

Figure 2: Incision of Suprapatellar (Left) & Infrapatellar (Right)

Figure 3: Entry point with Awl in Infrapatellar(left) and Trochar sleeve in Suprapatellar(right)

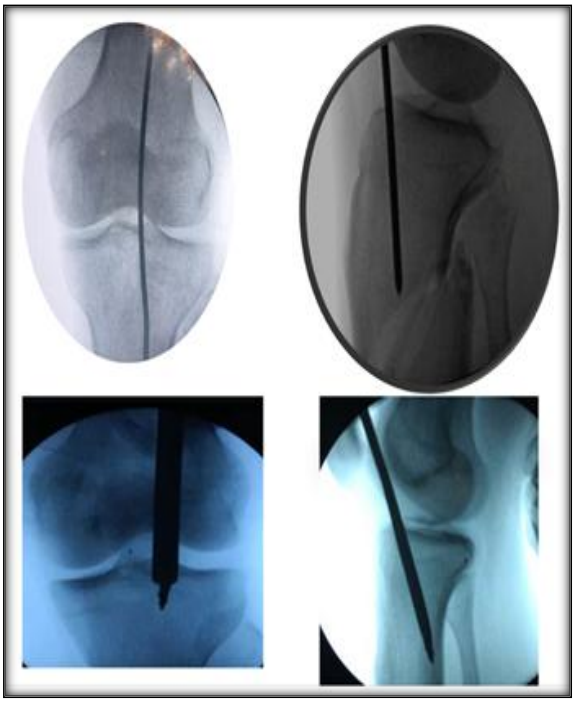

Figure 4: Guide wire passing AP & lateral view of Upper two image show Infrapatellar & AP & lateral view of Lower two images show Suprapatellar

Post Op Protocol and Evaluation: Immediate Post-op, Pain management and Antibiotic Prophylaxis were carried out. Active Quadriceps Exercises and Ankle ROM were initiated on POD-1, 1st look Dressing on POD-2. Weight bearing is determined by the axial stability of Fracture pattern. If there is good axial stability as seen in Non-Comminuted Diaphyseal Fracture pattern, then Immediate weight bearing as tolerated. Non weight bearing walking with walker frame support for at least 6 weeks after discharge in case of Comminuted Fracture pattern. Partial Weight Bearing were initiated after Radiological callus formation. Suture removal on POD- 12. Anterior Knee Pain were evaluated using VAS Pain Scale, Functional outcome were evaluated using Lysholm Knee Score and RUST Score for Radiology (Full-length X-rays of the Tibia and Fibula were collected in the Antero-Posterior and Lateral view, at 1st, 3rd, 6th and 9th months to evaluate the Bony Union), all were recorded for each group at 1st, 3rd, 6th, and 9th month post operatively.

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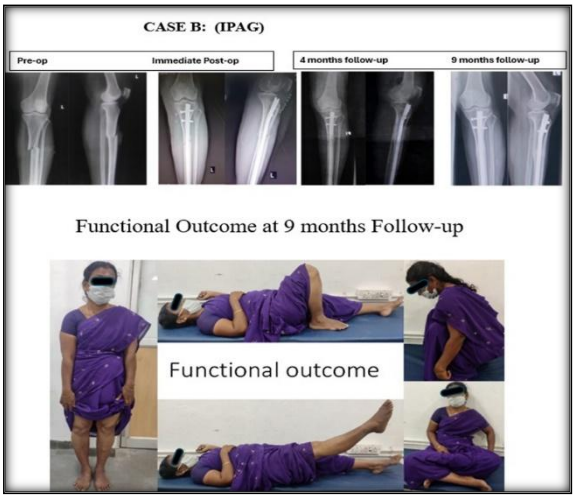
Data Analysis

- The collected data were entered in MS Excel and analysed using IBM.SPSS statistics software 23.0 Version (SPSS Inc., Chicago IL).
- By using the Shapiro-Wilk test, All Measurement data was shown to have a normal distribution. To calculate ranges, means, and standard deviations, descriptive statistics were utilised. To compare two groups, one-way analysis of variance and Student T tests were employed. To confirm the count data of two groups, the Chi Square test was used.
- In all the above statistical tools, the probability value 0.05 was considered as significant level.

CASE A: SPAG

Functional Outcome at 9 months Follow-up



RESULTS

The mean operative time was significantly lower in SP group (73 min) compared to IP group (98.8 min, $p < 0.001$). Mean RUST scores at 9 months were higher in SP group (11.84) versus IP group (10.64, $p = 0.003$). At 9 months, 88% of SP patients achieved "excellent" Lysholm scores compared to 56% in IP group ($p = 0.012$). Anterior knee pain was reported in 16% of IP patients and none in SP group. Infection occurred in 24% of IP group and 0% in SP group.

Table 1: Distribution of the study participants according to their age,gender,smoking & diabetic status

Parameter	Infrapatellar Group (n=25)	Suprapatellar Group (n=25)
Mean Age (years)	38.92 ± 13.56	38.96 ± 13.65
Gender (M/F)	14/11	12/13
Smokers (%)	16%	12%
Diabetes (%)	28%	24%

Table 2: Comparison of the study participants according to mean operative time(min),Mean RUST Score at 9month, Mean time for union (weeks)

Outcome	Infrapatellar Group (n=25)	Suprapatellar Group (n=25)
Mean operative time (min)	98.8 ± 11.7	73.0 ± 11.2
Mean RUST score at 9 months	10.64 ± 1.8	11.84 ± 0.55
Mean time for union (weeks)	24.4 ± 6.5	19.0 ± 3.7

Table 3: Comparison of the study participants with Lysholm Knee Score

Lysholm Score Category	Infrapatellar Group (n=25) (%)	Suprapatellar Group (n=25) (%)
Excellent	56%	88%
Good	44%	12%
Fair/Poor	0%	0%

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Table 4: Comparison of the study participants according to study complications

Complication	Infrapatellar Group (n=25) (%)	Suprapatellar Group (n=25) (%)
Infection	24%	0%
Anterior knee pain	16%	0%
Non-union	16%	0%
Malunion	0%	4%
Delayed union	16%	12%

DISCUSSION

Tibial shaft fractures represent one of the most common long bone fractures, with intramedullary interlocking nailing being the current gold standard of treatment. Traditionally, the infrapatellar (IP) approach has been widely used, but recent years have seen increasing adoption of the suprapatellar (SP) approach. This study compared the functional and radiological outcomes of the two approaches in a prospective randomized cohort of 50 patients.[18-22]

Our results demonstrated that the suprapatellar approach had several advantages. The operative time was significantly shorter in the SP group compared to the IP group (73 min vs. 98.8 min, $p < 0.001$). This finding aligns with earlier reports by Al-Azzawi et al and Williamson et al, who showed that the SP technique required less intraoperative fluoroscopy time and had a shorter learning curve. The semi-extended knee position in SP approach facilitates easier fracture reduction and nail insertion, thereby contributing to reduced surgical time.[23-39]

Radiological outcomes also favored the SP approach. The mean RUST score at 9 months was significantly higher in the SP group (11.84 vs. 10.64, $p = 0.003$), indicating faster and more consistent fracture union. This is consistent with Avilucea et al,[32] who observed lower malalignment rates with the SP approach compared to the IP approach. In our study, the mean time to union was also shorter in SP patients (19.0 weeks vs. 24.4 weeks). This suggests that better intraoperative alignment and stability achieved in the semi-extended position may enhance the biological environment for fracture healing.

Functional outcomes were significantly better in the SP group. At 9 months, 88% of patients in the SP group achieved "excellent" Lysholm Knee Scores compared to 56% in the IP group ($p = 0.012$). The most striking difference was the absence of anterior knee pain in SP patients, whereas 16% of IP patients reported this complication. Anterior knee pain is a well-documented drawback of the infrapatellar approach, reported in 10–80% of cases in prior studies. By avoiding repeated manipulation of the patellar tendon, the SP approach minimizes soft tissue irritation and thereby reduces postoperative pain during kneeling and squatting. Similar findings have been described in prospective trials by MacDonald et al and Fontalis et al who reported significantly less anterior knee pain in SP patients.[38,39]

Complication rates were lower in the SP group. No infections occurred in the SP group, whereas 24% of IP patients developed superficial or deep infections. While this difference may also reflect patient- or wound-related factors, the SP technique avoids an incision close to the anterior tibial soft tissues, which are often vulnerable to infection. Additionally, no cases of non-union were seen in the SP group compared to 16% in the IP group, again highlighting the stability advantage of the SP technique. However, one case of malunion was reported in the SP group, emphasizing that careful intraoperative alignment remains crucial.[40-45]

Our study's findings strengthen the growing body of evidence supporting the SP approach as a safe and effective alternative to the conventional IP approach. The SP technique not only improves intraoperative efficiency but also enhances long-term functional recovery, reduces anterior knee pain, and promotes earlier fracture union.[46,47]

Nevertheless, certain concerns remain. The SP technique involves passage through the patellofemoral joint, raising theoretical risks of cartilage damage and post-traumatic osteoarthritis. Cadaveric studies and arthroscopic evaluations (Chan et al,[33]) have shown cartilage changes in some SP cases, although the clinical significance of these findings remains uncertain. In our cohort, no long-term patellofemoral complications were observed during the 9-month follow-up. Longer follow-up studies are required to assess whether intra-articular entry predisposes patients to degenerative changes.

Limitations:

- We admit that there are increased margins of error when evaluating clinical outcomes because this trial had a relatively small sample size.
- Our results are based on clinical examination and patient satisfaction ratings; however, a more objective way to evaluate healing and damaged articular surface, such as post-operative knee arthroscopy or MRI scan, might add validity to our study.
- No arthroscopic examination was performed to detect cartilage alterations before surgery and at the end of the patient's follow-up.
- To compare the various fixation techniques and the results to the practical application in clinical practice, additional work-up in terms of biomechanical stability and finite element analysis is required.
- The long-term consequences of the therapies will be better understood with follow-ups lasting beyond 2 years.

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CONCLUSION

Our study demonstrates that, when compared to the traditional Infrapatellar Approach, the Suprapatellar Approach, has a much smaller learning curve and offers the potential for shorter operating times, faster mean times for union, and better patient reported outcomes. The SPAG experiences a faster increase in the mean RUST score values than the IPAG, making the Suprapatellar approach superior to the Infrapatellar technique. Approximately 88 percent of trial participants fell into the excellent category on the Lysholm Knee Score 9 months following the operation, compared to 56 percent of patients in the IPAG. In the SPAG, where no Infection-related complications, on the contrary, the IPAG had a higher rate of infection among 24 percent of the study participants. The SPAG had No Anterior Knee Pain, whereas in IPAG, 16 percent of the study participants in regular follow up period.

When compared to the IPN technique, clinical follow-up of patients showed greater patient satisfaction scores after SPN technique, with no change in the complication rate at 9 months follow-up. Overall, our study supports SPA to being a relatively superior surgical techniques, provided that the inclusion criteria if strictly adhered to.

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