

Clinical and Radiological Outcomes of Proximal Third Tibia Fractures Treated with Supra patellar Intramedullary Nailing: Technical Insights and Study Results

ABSTRACT

Aims: Here we tend evaluate efficacy of supra patellar nailing in proximal tibia fracture by analysing clinical, functional and radiological outcomes. Further we have described about technical aspect for young surgeon as to how to avoid the intra-op and post-op complications.

Study design: Retrospective study design.

Place and Duration of Study: In the Department of orthopedics ,at G.K.General hospital bhuj , between march 2022 and march 2024.

Methodology: This is a retrospective For the result of supra-patellar tibia nail in proximal tibia fracture, total 50 patients were evaluated, in the time frame of 2 year starting from march 2022 till march 2024 at Gujarat adani institute of medical science, bhuj in the Dept. of orthopaedics

Results: We interviewed 50 pateints for the above study and noted the clinical, functional and radiological outcome using appropriate score . we found that mean VAS score at the end of 1 yr to be 0.45,mean lysholm score at the end of 1 year to be 97.12, mean radiological union time to be 5 weeks.

Conclusion: We recommend suprapatellar nailing in proximal third tibial fractures when meticulously performed using the current surgical principles and techniques with proper implant selection. It results in good clinical and radiological outcomes with minimal complications when compared to other modalities of management. Suprapatellar nailing is a viable option for proximal third tibia fractures due to its inherent advantages of positioning, perfect nail entry and placement.

Keywords: Proximal tibia, functional, technical aspects.

1. INTRODUCTION

Tibial fractures represent the most prevalent among long bone fractures, with extra-articular proximal tibial fractures comprising 6-12% of tibial shaft fractures. These injuries typically arise from high-energy trauma and frequently involve concomitant soft tissue damage [1]. The preferred therapeutic strategy for extra-

articular tibial fractures, irrespective of their location (epiphysis, metaphysis, or diaphysis), involves stabilization and osteosynthesis utilizing intramedullary nails [2]. These nails are introduced through an infrapatellar portal with the knee in full flexion [3]. However, this method presents dual challenges. Firstly, maximal knee flexion impacts the fixation of proximal fractures due to the patellar tendon's antecurvatum deformity. Secondly, the integrity of the nail entry site is often compromised by soft tissue injuries resultant from these fractures. | In 1996, Tornetta and Collins [4] introduced their study on the semi extended technique involving a medial Para patellar arthrotomy to enhance outcomes in proximal metaphyseal tibial fractures. They observed approximately 15 degrees of displacement in proximal third tibial shaft fractures when the knee was flexed between 80 to 90 degrees, attributing this to the displacing force exerted by the quadriceps on the proximal segment. Consequently, proximal third tibial fractures are particularly susceptible to positional influences and derive significant benefit from a semi extended approach. By maintaining the leg at approximately 15-20 degrees of flexion, surgeons could mitigate the quadriceps' force and concentrate on establishing a precise and secure entry point. According to Tornetta's description, the optimal starting point lies on the medial aspect of the lateral tibial spine in the coronal plane and at the articular margin on the sagittal image [5]. It was not until 2010 that Eastman et al. demonstrated in a cadaveric study the feasibility of passing a tibial nail in a retro patellar manner with a considerably smaller incision than the medial Para patellar approach proposed by Tornetta [6]. Subsequently, manufacturers began developing tibial nails designed for insertion proximal to the patella through a small division in the quadriceps tendon, using protective sleeves to navigate beneath the patella, known as the suprapatellar tibial nail (SPTN). These sleeves, typically composed of metal or plastic, serve to safeguard the patellofemoral cartilage and vary depending on the manufacturer utilized. This study is designed to review our experience with the supra-patellar approach for semi extended nail insertion. Our goal is to compare the technique to published reports of traditional intra-medullary nail of the tibia with regards to postoperative alignment, healing, functions, range of motion(ROM) and pain.

2. MATERIAL AND METHODS

This is a retrospective For the result of supra-patellar tibia nail in proximal tibia fracture, total 50 patients were evaluated, in the time frame of 2 year starting from march 2022 till march 2024 at Gujarat adani institute of medical science, bhuj in the Dept. of orthopaedics. All the patients were classified as per the AO classification terminology. all the patients will be post operatively followed up at regular intervals of 4-6 weeks till 2 year. Clinical outcome of patients were measured using **VAS** score[IMAGE-1], functional score were noted in form of **Lysholm** score[TABLE-2], radiological union were assessed in terms of **RUST**

score[TABLE -1]. Pre operatively it is necessary for a surgeon to assess the patellar mobility of the affected limb and thorough assessment of pre operative radiographic films for signs of any patella femoral arthritis. The affected limb is completely shaved and prepped. During the procedure, the patient assumes a supine position on a radiolucent table, with the injured leg carefully supported by a knee roll/bolster, maintaining a flexion angle of approximately 15–20 degrees. The affected limb is draped, and the C-arm is strategically positioned to ensure optimal imaging in both lateral views. Patient is properly painted and draped in a standard sterile method. Skin incision of size 2cm (centimetre) is made approximately 1-2 cm proximal to superior pole of patella. Soft tissue dissection is done. Quadriceps tendon is identified and split in the middle of tendon in its full quantity. Bluntly assessment of retro patellar space is done for proper passage of trocar. trocar is introduced into the well dissected space below the patella until the tibia is encountered. Once we are safe into the the retro patellar space, trocar is removed from the cannula and is replaced with a guide-wire sleeve. A 3.2 mm Guide-pin is inserted through it. fluoroscopic ap and lateral image of guide-pin is obtained. If the pin is angled in Varus/valgus in ap view, it should be re-directed and if the pin is incorrectly placed in lateral view the manipulation of position of bolster is done either proximally or distally to correct the trajectory of the pin. The multi-hole sleeve is removed and then entry reamer is introduced through guide pin. It should be kept n mind that reduction is to be done and hold first with the help of reduction bone camps of external reduction manoeuvres and then the reaming process should be held forward. Successive rimming is done, 1.5-2 mm above the selected nail diameter. Appropriate size of nail is measured under fluoroscope and inserted through the guide- pin. The nail should be fixed with help of screw with a conventional method. If compression at the fracture is site is required, then after distal screw insertion – back slapping technique can be adopted for it. Fracture reduction and implant position should be checked under fluoroscopic imaging. Thorough wash along with suction and drainage of soft tissue debris should be done to avoid any damage to knee joint in future. A full range of motion should be checked for verification of patellar tracking. Closure should be done using convention surgical technique using appropriate available suture materials. [IMAGE-2,3,4,5]

❖ INCLUSION CRITERIA:

- Extra-articular fracture of the proximal tibia (AO type 41A2)
- Skeletal mature adult patient above 18 year of age
- Closed fracture and type 1 Gustilo Anderson open fracture
- Simple and comminuted fracture at metaphyseal-diaphysis junction

❖ EXCLUSION CRITERIA:

- Tibia diaphyseal fractures
- Patients with distal neurovascular deficit
- Pathological fractures
- Grade 2 and 3 Gustilo an Anderson open injury
- Polytrauma patients
- Segmental tibia fracture

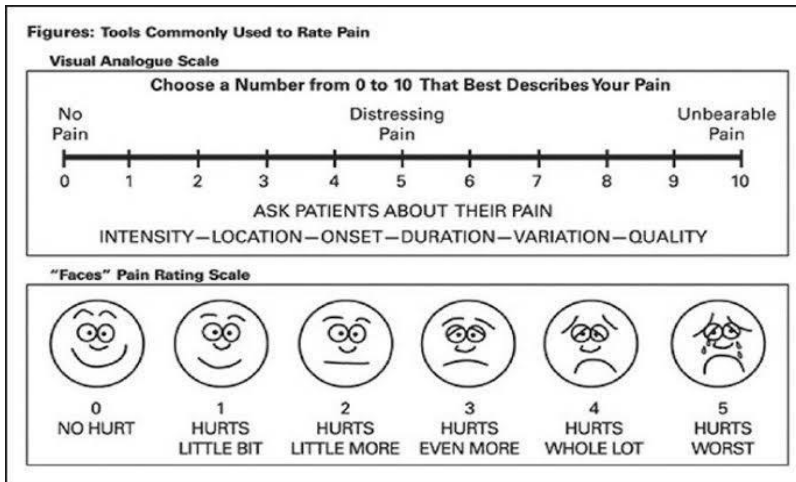


IMAGE 1-VAS SCORE

Radiographic Criteria		
Score per Cortex	Callus	Fracture Line
1	Absent	Visible
2	Present	Visible
3	Bridging	Visible
4	Remodeled	Invisible

TABLE-1 RUST SCORE[7][8]

1. Limp (5 points)	None	5
	Slight or Periodic	3
	Severe/Constant	0
2. Support (5 points)	None	5
	Cane/Crutch Needed	3
	Unable to bear weight	0
3. Locking (15 points)	None	15
	Catching	10
	Occasional	6
	Frequently	2
	Currently Locked	0
4. Instability (25 points)	Never gives way	25
	Rarely with sports	20
	Often with sports	15
	Sometimes with ADL's	10
	Often during ADL's	5
	Every Step	0
5. Pain (25 points)	None	25
	Slight or periodic	20
	Severe/Constant	15
	Marked walking > 2km	10
	Marked walking < 2 km	5
	Constant	0
6. Swelling (10 points)	None	10
	After sports	3
	After daily activities	2
	Constant	0
7. Stairs (10 points)	No problem	10
	Slight Problem	6
	One step at a time	2
	Impossible	0
8. Squatting (5 points)	No problem	5
	Slight Problem	4
	Not beyond 90°	2
	Impossible	0

TABLE -2 Lysholm score[9]

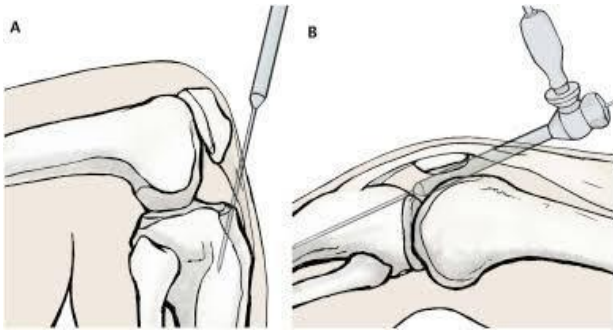


IMAGE-2 Technique of nailing, A-infrapatelar nailing, B-supra patelar nailing



IMAGE-3 intra-op. IITV images



IMAGE-4 Position of zig-ap view



IMAGE-5 Position of zig

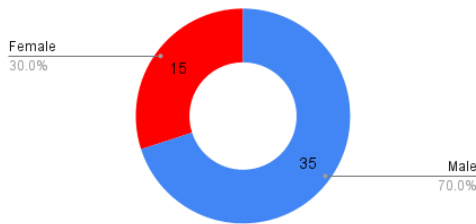
RESULTS AND DISCUSSION

1. PATIENT RELATED

This is a Retrospective type of study. In which All patients were selected according to inclusion criteria. The Follow-up time period was of 2 year. Total patients selected were 50 Of which there were (70%)35 male and (30%) 15 females. Out of 50 patients (55%) 28 patients were having fracture over RIGHT side and (45%) 12 having fracture over LEFT side. Average age of patients was 44.3 years. Open fractures were (35%) 18 and Closed fractures were (65%)32. Maximum patients (75%) 38 had a history of major RTA and other (25%) 12 had as history of Trivial fall/ domestic fall . All fractures were of AO type 41A2. [GRAPH-1,2,3,4]

Sex distribution

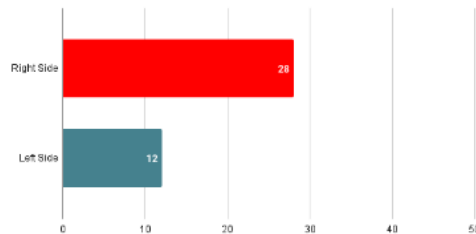
Out of 50 patients



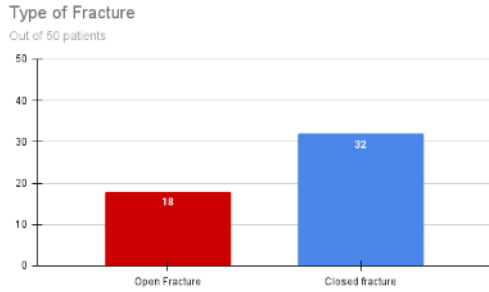
GRAPH 1-SEX DISTRIBUTION

Affected side of fracture

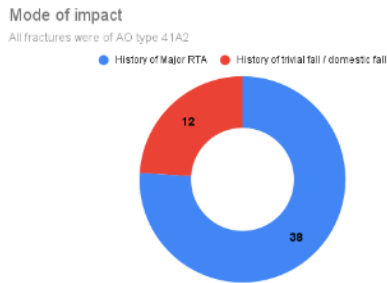
Out of 50 patients



GRAPH 2-AFFECTED SIDE



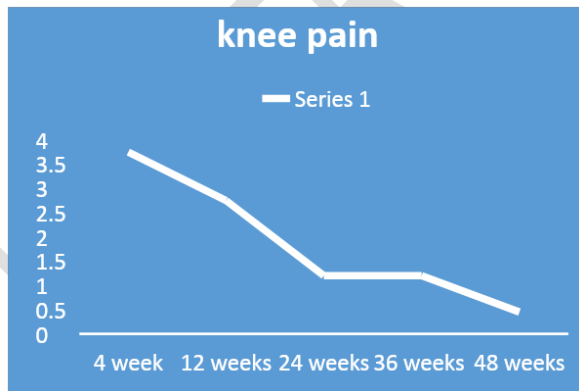
GRAPH 3-TYPE OF FRACTURE



GRAPH 4-MODE OF IMPACT

2. KNEE PAIN (VAS score)

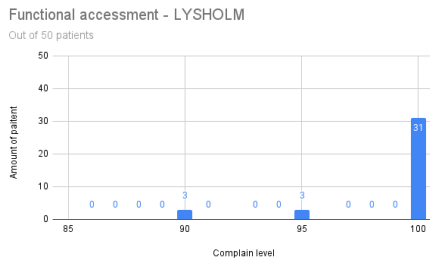
For the post operative assessment of knee pain **VISUAL ANALOGUE SCORE(VAS)** was used, on scale of 0-10 with 10 being the severe and worst feeling of pain and 0 being no pain at all. At 2 years follow up of 50 patients, 38 patient had no complain of any nee pain in any of the quadrant of knee, while 3 patient had a knee pain (VAS = 2) over the superior quadrant at the site of incision and 3 patient had knee pain (VAS = 1) over the lower quadrant of patella below the tibial tuberosity at the fracture site. Rest 6 patients were of old age had started pain with osteoarthritic changes in knee and had knee pain (VAS= 2). Given below is the graphical representation of mean VAS score we have noted throughout our study period in an interval of 1,3,6,9,12 and 24 months.[GRAPH-5]



GRAPH 5-KNEE PAIN

3. FUNCTIONAL OUTCOME (Lysholm score)

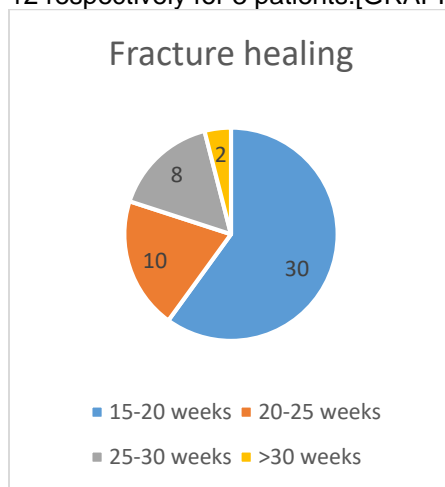
For the functional assessment of knee function the **Lysholm** score is used having general components of limp, need of support, locking of knee, instability in knee, pain over the knee, swelling, ability to climb the stairs, squatting. Assessing 50 patients at 2 year follow-up the mean LYSHOLM score was found to be 97.12 ,if we take specific difficulties out of 50 patients, **13** patients were still having complain of pain(95,95,90,90,85) , **3** patients were having difficulty in climbing stairs(96) and **3** patient was having difficulty in squatting(92).[GRAPH-6]



GRAPH 6-FUNCTIONAL ASSESMENT SCORE

4. HEALING OF FRACTURE (RUST SCORE)

Radiological union of the proximal tibia fracture was assessed after 2 year of postoperative management using **Radiographic union scale in tibia (RUST)**.4 cortex assessment was done i.e. AP & LATERAL view x-rays of all the patients for the proper confirmation of radiological fracture union. The mean radiological union time noted to be as 20.4 (ranging from 16-38 weeks). Out of the 20 patients all but 3 patients fracture had healed (85%). Of this 3 patients due to side addiction history of 3 patients of long term ingestion of smoking and alcohol the RUST score obtained at end of 2 year was 8,10 and 12 respectively for 3 patients.[GRAPH-7]

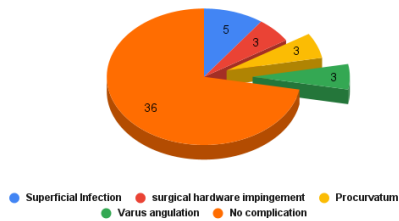


GRAPH 7-FRACTURE HEALING

5. COMPLICATION:

Every procedure, technique and surgery carries potential risk of complication with itself. In our study of supra-patellar nailing in proximal tibia fracture we encountered some of the short term complication, as our study is of only 1year follow-up of patients selected in retrospect manner. Out of the 50 patients we studied in the 2 year of our data base **5** patient had developed superficial infection over incision site, **3** patient had a surgical hardware (implant) impingement, **3** patient had procurvatum, **3** patient had fracture fixation in varus angulation. [GRAPH-8]

Complication
Out of 50 patients



GRAPH 8-COMPLICATIONS

DISCUSSION

Our study evaluated the functional, radiological outcomes and technical aspects of proximal third extra-articular tibial fractures, classified as AO/OTA, treated with the supra-patellar nailing technique. At the most recent follow-up, almost all fractures had united with satisfactory functional outcomes. Proximal third tibial fractures, accounting for 6-12% of all tibial fractures, are typically high-energy injuries associated with significant soft tissue and systemic trauma. Given the peri-articular location of these fractures, achieving precise anatomical alignment is crucial for functional restoration. While open reduction and plate osteosynthesis can restore anatomical alignment, they often fail to achieve satisfactory functional outcomes due to associated complications. In contrast, intramedullary nailing, which offers advantages such as minimal soft tissue disruption, load-sharing, minimally invasive procedure, reduced blood loss, and partial weight-bearing, has shown promising results. However, traditional infrapatellar nailing has been associated with high rates of malunion, nonunion, and other complications, largely due to the limitations of older nail designs and the difficulties of the infrapatellar approach, which includes medial and posterior entry issues leading to malalignment and increased anterior knee pain. Modern nails with improved design features, including reduced Herzog's bend and multiple proximal locking options, have mitigated these issues. The supra-patellar approach, recommended by studies including those by Tornetta and Eastman, avoids the complications of hyper flexion and improper entry seen in infrapatellar nailing, providing better alignment and fewer issues related to anterior knee pain and intra-articular damage. Our study, using a homogeneous group of fractures, including extra-articular (41 A2), managed with suprapatellar nailing, demonstrated functional outcomes comparable to or better than those in the literature, with fewer complications. Despite some patients requesting implant removal, no anterior knee pain was reported post-removal. Limitations of our study include its retrospective nature, the absence of a control group, and relatively short-term follow-up, which may not capture long-term outcomes such as arthritic changes. Nonetheless, our study benefits from a single-centre design, standard protocols, a trauma-trained surgeon, and adequate follow-up, with malalignment assessed using measurements of the normal contralateral tibia rather than fixed values.[TABLE -3]

	<u>VAS –SCORE</u>	<u>UNION TIME</u>	<u>LYSHOLM - SCORE</u>	<u>LEFS</u>
<u>OUR STUDY</u>	<u>0.45</u>	<u>5 MONTHS</u>	<u>97.12</u>	=
<u>STUDY 1</u> (11 PATIENTS)	<u>0.18</u>	=	<u>89.9</u>	-
<u>STUDY 2</u>	<u>0.05</u>	<u>8 MONTHS</u>	<u>82.14</u>	=
<u>STUDY 3</u> (60 PATIENTS)	<u>0.00</u>	<u>7.3 MONTHS</u>	=	<u>89.4</u>
<u>STUDY 4</u> (32 PATIENTS)	<u>0.20</u>	<u>12.45 MONTHS</u>	<u>95</u>	=
<u>STUDY 5</u> (62 PATIENTS)	<u>0.20</u>	<u>5 MONTHS</u>	<u>88.2</u>	

TABLE: 3 Vas Score showing Normal contralateral tibia

CONCLUSION

It is very wise and thoughtful to use suprapatellar nailing in proximal 1/3rd tibial fracture as it gives us excellent results in terms of clinical, functional, and radiological outcomes. We recommend the supra patellar nailing with current and advanced surgical principles and proper instruments systems. The technique has the added advantage for proximal 1/3rd tibia fracture in terms of positioning, placement of nail entry. And other disadvantages of conventional infrapatellar nailing are omitted using this technique. Suprapatellar nailing for proximal third tibial fractures offers superior clinical, functional, and radiological outcomes, adhering to advanced surgical principles and utilizing contemporary instrumentation. This technique enhances nail entry and positioning while mitigating the drawbacks associated with conventional infrapatellar nailing. However, our study highlights that the learning curve for suprapatellar nailing is notably steep and progresses slowly. It is imperative for novice surgeons to thoroughly understand the fundamental principles, knee joint anatomy, and to employ a well-supported zig system for optimal results in suprapatellar tibial nailing.

REFERENCES

1. Franke J, Hohendorff B, Alt V, Thormann U, Schnettler R. Suprapatellar nailing of tibial fractures—Indications and technique. *Injury*. 2016 Feb 1;47(2):495-501.
2. Githens M, Bishop J. Complex tibial fractures: tips and tricks for intramedullary nail fixation. *Clinical Medicine Insights: Trauma and Intensive Medicine*. 2014 Jan;5:CMTIM-S12264.
3. Sanders RW, DiPasquale TG, Jordan CJ, Arrington JA, Sagi HC. Semiextended intramedullary nailing of the tibia using a suprapatellar approach: radiographic results and clinical outcomes at a minimum of 12 months follow-up. *Journal of orthopaedic trauma*. 2014 May 1;28(5):245-55.
4. Tornetta P, Collins E. Semiextended position for intramedullary nailing of the proximal tibia. *Clinical Orthopaedics and Related Research*®. 1996 Jul 1;328:185-9.
5. Tornetta III P, Riina J, Geller J, Purban W. Intraarticular anatomic risks of tibial nailing. *Journal of orthopaedic trauma*. 1999 May 1;13(4):247-51.
6. Eastman J, Tseng S, Lo E, Li CS, Yoo B, Lee M. Retropatellar technique for intramedullary nailing of proximal tibia fractures: a cadaveric assessment. *Journal of orthopaedic trauma*. 2010 Nov 1;24(11):672-6.
7. Byrne JP, Nathens AB, Gomez D, Pincus D, Jenkinson RJ. Timing of femoral shaft fracture fixation following major trauma: a retrospective cohort study of United States trauma centers. *PLoS medicine*. 2017 Jul 5;14(7):e1002336.
8. Sekimpi P, Okike K, Zirkle L, Jawa A. Femoral fracture fixation in developing countries: an evaluation of the Surgical Implant Generation Network (SIGN) intramedullary nail. *JBJS*. 2011 Oct 5;93(19):1811-8.
9. Tegner YE, Lysholm JA. Rating systems in the evaluation of knee ligament injuries. *Clinical Orthopaedics and Related Research (1976-2007)*. 1985 Sep 1;198:42-9.
10. Delgado DA, Lambert BS, Boutris N, McCulloch PC, Robbins AB, Moreno MR, Harris JD. Validation of digital visual analog scale pain scoring with a traditional paper-based visual analog scale in adults. *JAAOS Global Research & Reviews*. 2018 Mar 1;2(3):e088.