Original Research Article

"Evaluation of Anterior Knee Pain in Diaphyseal Tibial Fracture Treated with Intramedullary Nailing"- A Retrospective Study

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Abstract

Intramedullary Nailing is considered as gold standard treatment option for diaphyseal tibial fractures in adults. Anterior knee pain is the commonest post-operative complication encountered in diaphyseal tibial fracture treated with intramedullary nailing. Incidence of anterior knee pain ranges from 10% to 86% respectively. Moreover, aetiology of anterior knee pain is multifactorial following intramedullary nailing. This study was undertaken to analyse the association between knee apex distance, anterior cortical nail distance and anterior knee pain. **Methods and Material:** 36 consecutive patients with diaphyseal tibial fracture treated with intramedullary interlocking nailing using either trans-tendious approach / paratendinous approach from March 2017 to March 2019 were studied. Anterior knee pain was measured and assessed at regular successive interval using Visual analogue scale scoring system and its association with 2 parameters i.e., knee apex distance, anterior cortical nail distance. **Result:** Out of 36 patients evaluated, 14 patients i.e., 38.88% had knee apex distance >2.5 and 22 patients i.e., 61.11% had knee apex distance < 2.5 where as 12 patients i.e., 33.33% had ACND > 1.0 cm, 8 patients i.e., 22.22% had ACND between 0.5-1.0 cm, 16 patients i.e., 44.44% ACND below 0.5cm in which 10 patients i.e., 27.77% (ACND was negative) nail was buried. **Conclusion:** Anterior cortical nail distance had a strong association with postoperative anterior knee pain. This study finds statistically significant association of anterior cortical nail distance with anterior knee pain ($p = 0.023$) while knee apex distance doesn't show a statistical association with anterior knee pain ($p = 0.781$). The surgical approaches show no significant association with anterior knee pain.

Keywords: knee apex distance, anterior cortex nail distance, diaphyseal tibia fracture, transtendinous approach, paratendinous approach

Introduction

Intramedullary Nailing is considered as gold standard treatment option for diaphyseal tibial fractures in adults. Complication reported in the literature with intramedullary nailing includes infection, compartment syndrome, deep vein thrombosis, and thermal necrosis of bone, implant failure, non-union, malunion, joint stiffness. [1] Anterior knee pain is the commonest post-operative complication encountered in diaphyseal tibial fracture treated with intramedullary nailing. Incidence of anterior knee pain ranges from 10% to 86% respectively. [2] Moreover, aetiology of anterior knee pain is multifactorial following intramedullary nailing. In literature, nail or screw prominence, traumatization of the fat pad or patellar tendon, iatrogenic intra-articular damage and neuroma of the infra-patellar branch of the saphenous nerve have been reported to be the cause of anterior knee pain. [3] The purpose of this study was to analyse whether knee-apex distance, anterior cortex nail distance attributes to anterior knee pain post tibial nailing.Prevalence of anterior knee pain for nail insertion is higher in Transtendinous approach compared to Paratendinous approach.[4,5] Moreover, post-operative muscle weakness and younger age like another factor is the culprit for post-operative anterior knee pain.[6]

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Materials & Methods

This was a retrospective, observational, and hospital-based study conducted in the department of the R. L. Jalappa Hospital and Research Centre attached to Sri Devaraj Urs Medical College, Sri Devaraj Urs Academy of Higher Education and Research, Kolar. Patient meeting the inclusion criteria and who are willing to participate will be recruited after obtaining written informed consent. Patient data will be collected as per the predesigned proforma. At baseline, demographic details and relevant history will be collected from the patient. The study was approved by the institutional human ethics committee, and informed written consent was obtained from all study participants, with confidentiality maintained. Patients with Patients aged more than 18 years underwent Diaphyseal tibial fracture treated by intramedullary nailing were included in the study.

Patients with Previous history of injury around knee like patella fracture, associated neurovascular injury, compartment syndrome, Weakness of quadriceps and hamstring muscles were excluded from the study.36 cases were followed up for a period of 12 month and Informed consent was obtained from all patients when called for follow-up and the purpose of the study was explained for them.The patients were allocated into two group: **group A** included patients with anterior knee pain and **group B** included patients without anterior knee pain respectively.Demographic data including age, sex and also information about the fracture, surgery, recovery and post recovery periods were obtained from the medical documents of the patients. The information regarding presence of anterior knee pain was obtained from case records.Radiologically, Knee-apex distance, Anterior cortex nail distance are the two parameter needs to be evaluated in radiographs.

Knee apex distance: Knee apex distance = anterior prominence plus superior prominence. [7]

- >2.5 cm less incidence of pain
- < 2.5cm high incidence of pain.

Bhattacharyya et al. measured the nail-apex distance as the sum of the superior prominence and the anterior prominence and found that knee pain was minimized if the nail-apex distance was less than 2.5 mm. [8]

Anterior cortex nail distance: The distance between the lines drawn on the anterior cortex of the tibia and the anterior tip of the nail. Quantify its effect on knee pain (VAS score).Based on the measurements, the patients were divided into three groups. The first group with ACN more than 5mm, second group with ACN between 0mm to 5mm and the third group where ACN had a negative value, which meant that the nail tip was buried within the anterior cortex in the lateral radiograph.Keating et al. calculated the ACD (Anterior cortex nail distance) in symptomatic cases to quantify its effect on knee pain score Group I had ACD 0–0.5 cm, Group II had ACD 0.5–1.0 cm, and Group III had ACD >1.0 cm. Average VAS for pain in Group I was 1.9, 3.5 in Group II, and 5.4 in Group III. [9]

Follow Up: Clinical, Radiological outcomes performed at subsequent months post-surgery on the basis of below stated parameters assessed retrospectively.

Statistical Analysis: The clinical data collected and evaluated on follow-up radiographs. Data were entered into Microsoft excel sheet and were analysed using statistical program for social sciences software. Statistical analysis was done using SPSS software (IBM, SPSS). Qualitative data will be presented in the form of Proportions and pie diagrams, bar charts will be used to represent graphically. Quantitative data were presented as mean, standard deviation. Independent student t test was used to compare the significance of difference in mean in VAS scores, knee apex distance etc. Chi square test for comparing difference in proportion of cases having nail protrusion value. P value < 0.05 will be considered statistically significant.

Criteria to assess results: Assessment based on:

1. Knee-Apex Distance
2. Anterior Cortical Nail Distance
3. Visual Analogue Scale (VAS)

Result

All the patients were available for follow-up and followed up till 1 year. The results were evaluated based on anterior cortical nail distance, knee apex distance and surgical approach i.e., transt-endinous vs. paratendinous approach. Out of 36 patients 32 (88.88%) were male and 4 (11.11%) were female. There was male preponderance. Majority of the cases i.e., 32 cases (88.88%) occurred as a result of road traffic accidents, 3 (8.33%) cases as a result of fall from height and 1 (2.77%) case as a result of assault. In this study, there were a total of 21 cases (58.33%) had right sided fracture, 15 (38.88%) cases had left sided fracture.In this study 28 (77.77%) out of 36 cases had associated fibula fracture i.e., 10 (27.77%) patients had associated middle third and distal third fibula fracture respectively, 2 (5.55%) patients had associated proximal fibula fracture, 3 (8.33%) patients had associated middle-distal third fibula fracture, 4 (11.11%) patients had associated segmental fibula fracture and 7 (19.44%) patients had isolated tibia diaphyseal fracture. All the patient underwent intramedullary interlocking nailing (IMIL) for diaphyseal tibial fracture either by tendon splitting approach/trans-tendinous or tendon sparring approach/ para-tendinous approach. The results were evaluated based on anterior cortical nail distance, knee apex distance and surgical approach i.e., transtendinous vs. paratendinous approach.

Approach:20 out of 36 cases i.e. (55.55%) underwent tendon splitting approach/trans-tendinous out of which were 11 out of 20 were symptomatic and 9 out of 20 were asymptomatic. 16 out of 36 cases i.e. (44.44%) underwent tendon sparring approach/ para-tendinous approach out of which 8 were symptomatic and 8 were asymptomatic.

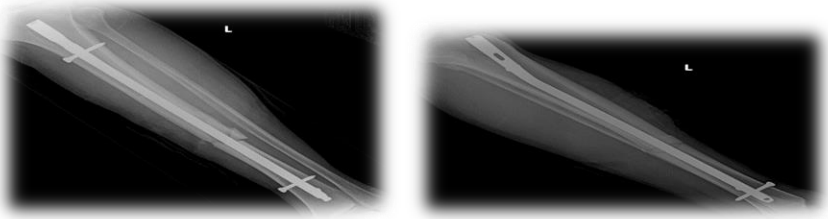

Fig 1:**Postoperative radiograph of left tibial diaphyseal fracture showing buried Nail.**

Fig 2:Postoperative radiograph of right tibial diaphyseal fracture showing nail protrusion

Knee Apex Distance

Out of 36 patients evaluated, 14 patients i.e., 38.88% had knee apex distance >2.5 and 22 patients i.e., 61.11% had knee apex distance < 2.5.In group A, 15 out 22 patients had KAD < 2.5cm, 4 out of 14 patients had KAD > 2.5 cm. In group B, 7 out 22 patients had KAD < 2.5cm, 10 out of 14 patients had KAD > 2.5 cm.

Table 1: Shows the association of knee apex distance and VAS score with consideration of mean standard deviation and standard error. P-value is calculated by independent T-test

	KAD	N	Mean	Std. Deviation	Std. Error Mean	P value
KNEE APEX DISTANCE	1.00	22	1.66909	.605970	.129193	0.781
	2.00	14	3.23143	.499690	.133548	
VAS	1.00	22	3.23	2.544	.542	
	2.00	14	4.07	2.433	.650	

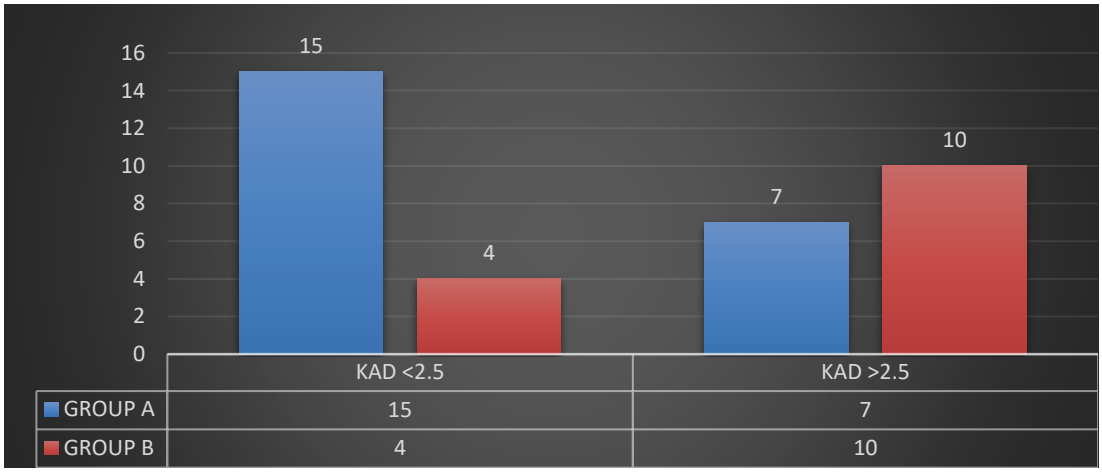

Fig 3: Shows the allocation of patients in Group A (patients with anterior knee pain) and Group B (patients without anterior knee pain) with respect to Knee apex distance.

Anterior Cortical Nail Disatnce: Out of 36 patients evaluated, 12 patients i.e., 33.33% had ACND > 1.0 cm, 8 patients i.e., 22.22% had ACND between 0.5-1.0 cm, 16 patients i.e., 44.44% ACND below 0.5cm in which 10 patients i.e., 27.77% (ACND was negative) nail was buried.

In group A, 4 (25%) out of 16 patients in group A had ACND < 0mm, 6 (75%) out of 8 patients had ACND 0mm – 5mm and 9 (75%) out of 12 patients had ACND > 10 mm. In group B, 12 (75 %) out of 16 patients in group A had ACND < 0mm, 2 (25%) out of 8 patients had ACND 0mm – 5mm and 3 (25%) out of 12 patients had ACND > 10 mm.

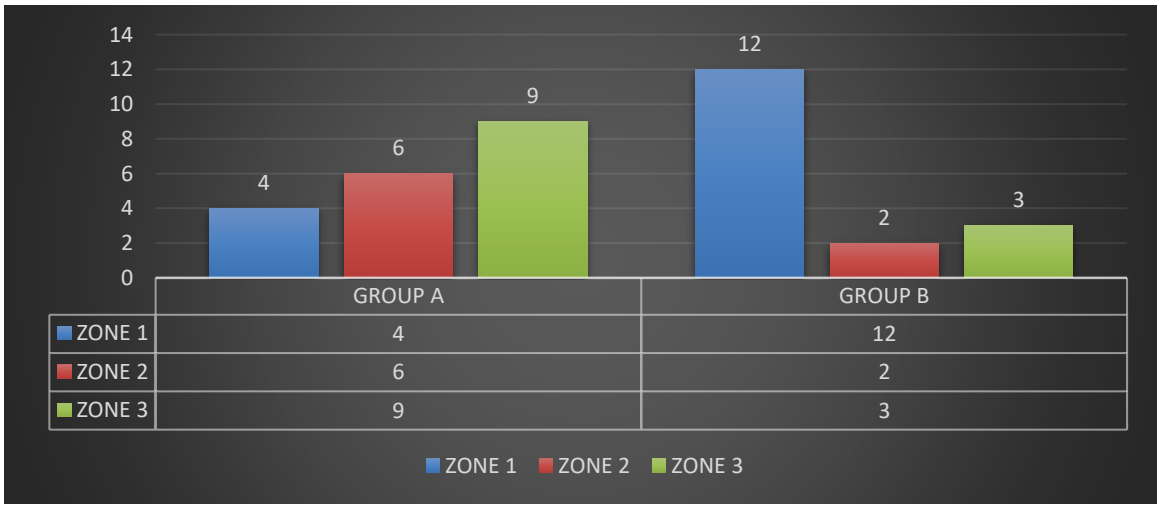

Fig 4: Shows the allocation of patients in Group A (patients with anterior knee pain) and Group B (patients without anterior knee pain) with respect to Anterior cortical nail distance. Zone I - ACD 0–0.5 cm, Zone II - ACD 0.5–1.0 cm and Zone III - ACD >1.0 cm.

Table 2: Shows the association of anterior cortical nail distance and VAS score with consideration of mean standard deviation and standard error and confidence interval. P value is Calculated by ANOVA

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		P value
					Lower Bound	Upper Bound	
0	16	2.31	2.387	.597	1.04	3.58	
1	10	4.40	2.366	.748	2.71	6.09	0.023
2	10	4.70	2.058	.651	3.23	6.17	
Total	36	3.56	2.501	.417	2.71	4.40	

Discussion

Tibia is exposed to frequent injury there by being the most commonly fractured long bone. Because one third of tibial surface is subcutaneous throughout the most of its length and it also has a precarious blood supply than other bones, which are enclosed by bulky muscles. The presence of the hinge joints at the knee and ankle allow to no adjustment of the rotatory deformity after fracture requiring during correction of reduction. [2, 10].Ahmad, S et al 2016 in their randomised controlled trail, [11] aimed to compare the post-operative anterior knee pain after intramedullary nailing technique by trans-patellar approach compared to medial Para patellar approach. They were divided into two groups with 30 patients in each group, Group A containing patients operated through Trans patellar tendon approach while group B containing patients operated through medial parapatellar tendon approach. In Group A, 27 patients were male and 3 patients were female with a mean age of 28.667±9.63 while in Group B, 28 were male and 2 were female with a mean age of 34.63±15.82. In Group A mean anterior knee pain was 4.4 while in Group B, it was 2.5 with a p-value of.0001. This study shows that medial parapatellar tendon approach causes less pain as compared to trans-patellar approach.A similar study by Sadeghpour A et al 2011, [12]aimed to evaluate the post-operative complications of intramedullary nailing technique by Trans-patellar approach compared to medial parapatellar approach. Fifty patients with tibial fractures treated by intramedullary nailing through two Trans patellar (T-group) and medial parapatellar (p-group) approaches were studied. Knee pain was assessed with visual analogue scale (VAS) for 2 weeks, 1, 3 and 6 months and range of motion (ROM) in 2 weeks and 3 months after surgery. There were 23 males and 2 females with a mean age of 28.68 +/- 5.78 years in T-group and 21 males and 4 females with a mean age of 28.80 +/- 5.82 in p-group. There was significant difference in knee pain score after 3 months ($p = 0.013$) and 6 months ($p = 0.009$) between the two study groups (p-group had less pain than T-group). This study recommends medial parapatellar tendon approach, although both approaches are safe. Orfaly et al. also found a clear association between a transtendinous surgical approach and chronic anterior knee pain, and they recommended the routine use of a medial paratendinous approach. [13] Our study showed no significant association between medial parapatellar approaches is superior to trans-patellar approach. The result of our study is in agreement with Bishop AJ, Tahririan MA, Ziaei E, Osanloo R. [14, 15, 16]

Uzumcugil et al. investigated 30 patients after intramedullary nailing of the diaphyseal tibia fracture. Their result showed no significant association between nail protrusion and nail distance from the cortex and postoperative knee pain.[17] In our study, we found a significant correlation between AKP with nail position in relation to the anterior tibial cortex or tibia plateau ($p= 0.023$).

Ozbek EA et al. 2019 Conducted a retrospective study on 40 patients who underwent tibial IMN by the transtendinous approach to determine the association of the postoperative AKP with two factors, which are the thigh muscle weakness and alterations in the Staheli lower extremity rotational profiles in which progression angle (FPA), thigh-foot angle (TFA), and transmalleolar angle (TMA)) were compared. There was a significant difference ($p<0.05$) between injured limb with contralateral extremity hamstring mean muscle strength. Although there was a significant difference between the two extremities rotational profile angles, there was no significant correlation between the rotational profile angles and knee pain. Hence, AKP appears to be significantly related to the loss of hamstring muscle strength. These finding didn't carry much importance and was not considered in our study. [18]Yu et al. in which they compared anterior knee pain with surgical approaches and nail parameter like nail protrusion on radiographs. They concluded nail protrusion is a risk factor of knee pain after intramedullary nailing. [19]

Andreas ladurner et al. [20] 2018 conducted a study to compare the difference in three surgical approaches i.e., medial para-patellar, Trans patellar and lateral patellar approach with semi flexed position for diaphyseal tibial shaft fracture treated with IMN in regard with surgical duration. Twenty-six patients were treated by use of a lateral parapatellar approach, a Trans-patellar or a medial parapatellar approach was chosen in 29 and 18 cases, respectively. When compared to the trans patellar (126 ± 30 min) or the medial parapatellar approach (105 ± 29 min), surgical time was significantly shorter in the lateral parapatellar approach group (96 ± 29 min). The extra-articular semi-extended tibial nailing technique using a lateral parapatellar approach was associated with a significant decrease in time of surgery. The operative time was not taken into consideration in our study.Vaisto et al. formed ultrasonography study of patellar tendon after intramedullary nailing to compare the changes between patients with and without anterior knee pain. They also reported no clear correlation between two surgical incision technique and knee pain. [21] In our study, we found no significant correlation between anterior knee pain and surgical approaches.Theoretically, repeated injury to patellar tendon substance and retro-tendinous pad fat is specifically attributed to reamers and retractors in tendon splitting approach/trans-tendinous approach. On the other hand, patellar sparring approach/paratendinous approach damage to patellar tendon, sheath, and the fat pad attributed to vigorous use of retractors while

Devitt et al. on their cadaveric study noted significant increase in contact pressure at patellofemoral joint post-nailing. Paratendinous approach attributes to increase in contact pressure in lateral facet while transtendinous approach attributes to increase in contact pressure on both the facets, hence transtendinous approach is more susceptible to chondral injury. [22]

Cartwright-Terry et al. study revealed patient's age doesn't attributes to the anterior knee pain. [23] Court-Brown et al. However, in their retrospective study of 169 patients concluded knee pain is significant in younger age group. [24] This studied showed no significant association between anterior knee pain and age group.

Hernigou et al. based on their study on cadaveric knee reported intraarticular structure particularly at risk are the anterior horns of the medial and lateral menisci, the anterior part of the medial and lateral plateaux and the ligamentous transversum while making entry point in intramedullary nailing. However, they recommend entry point anterior to the transverse ligament and anterior horn of each meniscus. [25] However, the study conducted by McConnell et al. [26]in contemporary have recommended entry point medial to the lateral tibial spine and anterior to articular margin to avoid articular cartilage damage and is in agreement with the findings of Althausen

PL, Neiman R, Finkemeier CG. [27, 28] these finding didn't carry much importance and was not considered in our study.

This study had certain limitations i.e., Retrospective study design and relatively small sample size. Various potential factor that attributes to chronic anterior knee pain includes sedentary lifestyle, occupation, smoking, alcohol consumption was not investigated.

Conclusion

Anterior cortical nail distance had a strong association with postoperative anterior knee pain. This study finds statistically significant association of anterior cortical nail distance with anterior knee pain (p = 0.023) while knee apex distance doesn't show a statistical association with anterior knee pain (p =0.781).The surgical approach i.e., tendon splitting, Trans tendinous vs. tendon sparring/paratendinous approach no significant association with anterior knee pain. We acknowledge that our current manuscript has some limitations i.e. Retrospective study design and relatively small sample size. Various potential factor that attributes to chronic anterior knee pain includes sedentary lifestyle, occupation, smoking, alcohol consumption was not investigated. Since anterior knee pain has multifactorial etiology i.e., reflex sympathetic dystrophy, retro patellar fat necrosis, tendinitis, meniscus damage, cartilage damage, quadriceps atrophy,ligament injury and change in gait, hence additional studies to assess their role in anterior knee pain is warranted.

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