COMPARISON OF EFFECTS OF DIFFERENT NAIL TIP POSITIONS ON ANTERIOR KNEE PAIN AFTER INTRAMEDULLARY INTERLOCKING NAILING FOR TIBIAL SHAFT FRACTURES

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ABSTRACT

Objective: To determine the frequency of anterior knee pain after intramedullary interlocking nailing in tibial shaft fractures and to compare the intensity of anterior knee pain between positive and negative anterior cortex nail groups.
Study Design: Quasi-experimental study.
Place and Duration of Study: Department of Orthopaedic Surgery, Combined Military Hospital Rawalpindi, from Oct 2018 to Apr 2019.
Methodology: 100 cases of tibial shaft fracture were divided into two groups according to anterior cortex nail distance. Patients 18-40 years of age of both genders, closed fractures, Gustilo Andersen I open tibial diaphyseal fractures and nail tip more than 5mm from tibial tuberosity were included. Patients with osteoarthritis, pathological fractures, renal disease, open fracture GA-II & GA-III and knee instability were excluded from the study. Both groups with positive and negative anterior cortex nail distance were compared for pain using the chi-square test.
Results: Frequency of anterior knee pain after intramedullary interlocking nailing in tibial shaft fractures was found in 24% of patients. 8 (16%) out of 50 patients in the group with nail tip deep to anterior cortex had anterior knee pain while 16 (32%) out of 50 patients in the group with nail tip protruding from anterior cortex suffered anterior knee pain (p-value = 0.061).
Conclusion: Intramedullary interlocking nailing in tibial shaft fractures with nail tip deep to anterior cortex showed less pain as compared to nail tip protruding from anterior cortex although it was not statistically significant.

Keywords: Anterior knee pain, Intramedullary interlocking nailing, Tibial shaft fractures.

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INTRODUCTION

Tibial shaft fractures are very commonly encountered by orthopaedic surgeons. One of the recent studies showed that the prevalence of tibial shaft fracture is around 17/100000/year.[1] There have been several methods of managing tibial shaft fractures including non-operative with casting and various operative techniques like Intramedullary Interlocking nails (IM/IL) and various plating techniques. All of these have been compared with each other in different studies and literature has shown that intramedullary nailing can be considered as a better mode of treatment as it shows the lesser risk of complications and better reunion of fracture.[2-4] IM/IL nail delivers satisfactory mechanical stability with commendable fracture alignment and a competent biological environment while preserving soft tissue and blood supply to the bone. It is considered the most common mode of managing tibial shaft fractures by surgeons.[3]

Although IM/IL nail for tibial shaft fracture is a common and popular mode of treatment it also has some disadvantages such as resulting in a common complication of anterior knee pain. In one of the studies, 11% of the patients treated with intramedullary interlocking nails had clinically significant anterior knee pain after 1 year of follow-up.[5] Causes of anterior knee pain following intramedullary interlocking nail include skin incision, injury to the intra-articular structures, size of tibial plateau and damage to the infrapatellar branch of the saphenous nerve.[6] Several studies in the literature have shown that the position of the proximal nail tip may be one of the causative factors of anterior knee pain after tibia nailing. One of the studies showed that anterior knee pain results due to anterior nail prominence of more than 5mm and superior prominence of nail closer to the tibial articular surface.[7] In another study, the tip of the nail position more than 5.5mm and 2.5mm from tibia plateau and tibial tuberosity respectively were considered factors for anterior

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knee pain.[8] Another recent study also showed that place of the proximal tip of the tibial nail is a significant factor associated with anterior knee pain, in which 18% of patients in the group with nail tip deep to the anterior cortex and 37.8% in the group with nail tip protruding from anterior cortex suffered anterior knee pain.[9]

Although the position of the nail tip has been mentioned in various studies, an important factor as a predictor and etiological factor of anterior knee pain after tibial intramedullary interlocking nailing, very few articles are available regarding nail tip position relative to the anterior cortex of the tibia. This study aimed to compare the frequency of anterior knee pain in intramedullary interlocking nailing after grouping patients according to anterior cortex nail distance (ACN), as it will help the surgeons to determine the better position of nail tip relative to the anterior cortex of the tibia for intramedullary interlocking nailing in the tibia.

METHODOLOGY

A quasi-experimental study was conducted in the Department of Orthopedic Surgery, Combined Military Hospital Rawalpindi, from October 2018 to April 2019 after the approval from the Institutional Review Board (Ltr no. CPSP/REU/OSG-2016-120-1667). A total sample of 100 was calculated by using the WHO sample size calculator, with population size being 2,281,000 and population proportion/prevalence of tibial shaft fractures in Pakistan being 4.16% as found in a study done in Lahore by Malik *et al*.[10] Non-probability, consecutive sampling technique was used.

Inclusion Criteria: Patients 18-40 years of age of both genders, closed fractures, Gustilo Andersen I (GA I) open tibial diaphyseal fractures and nail tip more than 5mm from tibial tuberosity were included in the study.

Exclusion Criteria: Patients who already have other causes of knee pain for example osteoarthritis of knee joint, patients having pathological fractures, patients having renal disease, revision cases, open fracture GA-II & GA-III and patients with knee instability were excluded from the study.

Once the patients were recruited according to the inclusion criteria, the study procedures were explained to the patient and informed consent was attained. We made two groups of the sample size according to anterior cortex nail distance, with the "positive ACN" group indicating patients in which nail tip protrudes from anterior cortex while the "negative ACN" group indicates patients in which nail tip is deep to anterior cortex. There was no extra financial burden to the patient except for the cost of the implant which had to be paid by the patient as per hospital policy. The first follow up was 2 weeks after surgery and then every 4 weeks until the union of fracture 16 weeks after surgery. The outcome was measured by pain on the visual analogue scale (VAS) at 16 weeks after surgery.

The data was entered and analyzed using Statistical Package for the social sciences (SPSS) version 22. Quantitative variables like age and BMI were calculated as mean and standard deviation. Qualitative variables like gender and pain were calculated as frequency and percentages. Both groups with positive and negative anterior cortex nail distance (ACN) were compared for pain as per VAS and association of anterior knee pain to age, gender and BMI assessed by applying chi-square test. The *p*-value of ≤0.05 was considered as significant.

RESULTS

The mean age of the hundred participants was 29.15 ± 5.29 years with 18 being the minimum value and 40 being the maximum value. The majority of the patients 51 were between 18-30 years of age. Out of 100 patients, 69 were male and 31 were females. The mean BMI of the study subjects was 28.99 ± 3.02 kg/m^2. 30 patients had BMI ≤27 kg/m2 and 70 patients had BMI value >27 kg/m2.

In this study, frequency of anterior knee pain after intramedullary interlocking nailing in tibial shaft fractures was found in 24 patients. Eight (16%) out of 50 patients in the group with nail tip deep to anterior cortex had anterior knee pain while 16 (32%) out of 50 patients in the group with nail tip protruding from anterior cortex suffered anterior knee pain. The *p*-value =0.061 showed that there was no statistically significant difference between the frequency of anterior knee pain in the two groups as shown in Table-I.

The Association of anterior knee pain in both the ACN distance groups was also evaluated concerning age groups, gender and BMI as shown in Table II. There was not any statistically significant difference found with age groups and BMI of patients. However, while finding an association of anterior knee pain with gender, a statistically significant difference was observed with males having *p*-value=0.050. No statistically significant difference was seen with females having *p*-value=0.552. Thus, anterior knee pain was not correlated with the age and BMI of the patients but has a relation with the male gender among the patients.

Table-I: Comparison of the frequency of anterior knee pain after intramedullary interlocking nailing of tibia in the respective two groups.

Anterior Cortex Nail Distance	Anterior Knee Pain		*p*-value
	Yes	No	
Positive	16 (32%)	34 (68%)	0.061
Negative	8 (16%)	42 (84%)	

Table-II: Association of anterior knee pain with age, gender and body mass index of the patients in both groups.

Factors	Positive CAN (n=50)		Negative ACN (n=50)		*p*-value
	Anterior Knee Pain				
	Yes (%)	No (%)	Yes (%)	No(%)	
Age (Years)					
18-30	8 (16)	17 (34)	4 (8)	22 (44)	0.212
31-40	8 (16)	17 (34)	4 (8)	20 (40)	0.162
Gender					
Male	9 (18)	25 (50)	3 (6)	32 (64)	0.050
Female	7 (14)	9 (18)	5 (10)	10 (20)	0.552
BMI (kg/m²)					
≤27	7 (14)	22 (44)	5 (10)	26 (52)	0.438
>27	9 (18)	12 (24)	3 (6)	16 (32)	0.062

DISCUSSION

In the management of tibial shaft fractures, intramedullary nailing is the treatment of choice.[11] Low percentage of complications like non-union, infection, mal-union, deep venous thrombosis, thermal necrosis and compartment syndrome has been reported following tibial nailing in literature.[12] The most frequent adverse consequence of tibial nailing is chronic anterior knee pain. A study done by Toivanen has revealed a 69% incidence of knee pain after tibia nailing after 8 years of follow-up.[13] Anterior knee pain is multifactorial. Skin incision, injury to intra-articular structures, gender, size of tibial plateau and presence of implant in the medullary cavity are other factors causing anterior knee pain.[11] Combination of these factors may result in such pain. Therefore, the prediction of developing anterior knee pain after tibial nailing may be difficult based on any single factor. The prominence of nails has been proposed as a major factor causing anterior knee pain by various studies discussed as under.[14-16]

The present study showed 24% frequency of anterior knee pain with 8 (16%) out of 50 patients in the group with nail tip deep to anterior cortex had anterior knee pain while 16 (32%) out of 50 patients in the group with nail tip protruding from anterior cortex suffered anterior knee pain. In accordance with our results, a study done by Tahririan in 2014 in Iran, also showed that the position of the proximal tip of the tibial nail is a significant factor associated with anterior knee pain, in which 9 (18%) out of 50 patients in the group with nail tip deep to anterior cortex had anterior knee pain while 17 (37.8%) out of 45 patients in the group with nail tip protruding from anterior cortex suffered anterior knee pain.[9]

Keating *et al*. revealed an observation that anterior knee pain was more associated with anterior cortex nail distance of more than 5mm instead of the height of the nail. Two groups were formulated: one in which insertion of an intramedullary nail was done para-tendinously and another tendon splitting incision group. The results demonstrated the incidence of knee pain to be about 50% in the first group whereas it was around 80% in the second group and this was statistically proven with a significant *p*-value of 0.01. The study recommended a parapatellar tendon incision for insertion of the nail.[14] However, Bhattacharyya *et al*. stated that both anterior and superior nail prominence can cause knee pain. This particular study demonstrated that pain at rest is more related to anterior nail prominence whereas pain while kneeling is associated with superior nail prominence. It was also concluded that adequate depth of tip of the nail below the bony cortex will allow for easy removal of nail in the future when required.[15]

A local study done by Ahmed in Lahore concluded in his study that anterior knee pain is linked with injury of the infrapatellar branch of the saphenous nerve.[16] Obremskey *et al*, found out that in their study smoking, comminuted fractures, and surgeons with less than 5 years of experience were some predictors of knee pain.[17,18]

Darabos *et al* studied patients, who had undergone intramedullary nails and evaluated the distance from the tip of the nail to the tibial plateau and tibia tuberosity on lateral knee radiographs. It was concluded that the position of the tip of the nail and its adverse impact on the innervation pattern of the area dorsal to the patellar tendon could lead to anterior knee pain.[19] In contrast to our study; Cartwright-Terry *et al*, had shown that 83% of patients developed anterior knee pain after tibial nailing. Their study revealed that those who were manual workers developed more knee pain after tibial nailing.[20] Hence, it is in order to speculate that information about the occupation and lifestyle of the participants is important. The results of another study were somewhat close to our results as they showed that about 10% of the patients under-

going intramedullary interlocking nails had clinically significant anterior knee pain.[5]

In contrast to Cartwright-Terry *et al*, study and the present study that found no relationship between age and knee pain, Court-Brown *et al*, have reported that patients with knee pain after tibial nailing were significantly younger.[21] Our study found an association between male gender and anterior knee pain. However, Kim *et al*, have reported that knee pain after tibial nailing was more common among women. In accordance with our results, Kim *et al*. also found no relationship between age and type of fracture and knee pain.[22] Bakhsh *et al*, compared the semi-extended lateral parapatellar, medial parapatellar, and tendon splitting groups regarding knee pain severity, location and functional outcome. The study revealed that there is no significant difference among these three approaches of intramedullary nailing resulting in knee pain.[23] Another ultrasonographic study evaluated 32 patients who underwent intramedullary nailing revealed that the patellar tendon in the painless group was wider and thicker while that of 10 patients with knee pain there was not any different. Therefore, the thicker and wider tendon is less related to knee pain.[24]

Very scarce literature has been observed regarding the nail tip positioning during IM/IL, which can result in lesser anterior knee pain. This study bridges this gap in literature contributing to the knowledge about the nail tip positioning for tibial shaft fractures resulting in less pain and morbidity. Thus, our study recommends that the nail tip deep to anterior cortex technique should be used as a first-line technique in intramedullary interlocking nailing in tibial shaft fractures to reduce the morbidity of these patients.

LIMITATION OF STUDY

As it was a single-centre study with a small sample size in a limited time period, further longitudinal studies are recommended in the Pakistani population.

CONCLUSION

Intramedullary interlocking nailing in tibial shaft fractures with nail tip deep to anterior cortex showed less pain as compared to nail tip protruding from anterior cortex although it was not statistically significant.

Conflict of Interest: None.

Authors' Contribution

MH: Contributed to the concept, design and data collection, HUDH: Contributed to the data analysis and write up, AA: Contributed to the write-up and proof reading of the manuscript, MRS: Contributed to the design and critical review of the manuscript, UA: Contributed to the design and literature review.

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