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Original Research Article

Anterior Knee Pain after Tibial Intramedullary Nailing

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Abstract: *Anterior knee pain (AKP) remains one of the most frequent and disabling complications following tibial intramedullary nailing (IMN), yet its clinical and radiographic correlates are not fully understood. Identifying risk factors and understanding long-term functional outcomes are essential for optimizing surgical technique and rehabilitation strategies.* ***Objective:*** *To compare pain, function, radiographic findings, and patient-reported outcomes between patients with and without anterior knee pain (AKP) after tibial intramedullary nailing (IMN), and to explore surgical/radiographic correlates.* ***Methods:*** *An observational cohort study was conducted at SMBBIT, Karachi, from 25 feb 2025 till 25 June 2025. Consecutive adults aged 18–45 years with tibial shaft fractures treated by IMN were enrolled after ethics approval and consent. Based on standardized pain localization, participants were classified as AKP (n=120) or no-AKP (n=120). Baseline demographics, comorbidities, and preoperative KOOS/VAS were recorded; intraoperative forms captured surgeon, nail type/size, entry point, approach, duration, and complications. Follow-ups at 1, 3, 6, and 12 months included VAS, KOOS, Lysholm, radiographs (healing, alignment, hardware issues, heterotopic ossification), additional treatments, and SF-36/satisfaction. Data were analyzed in SPSS v21 using t-tests/χ^2 and repeated-measures models (α=0.05).* ***Results:*** *Groups were demographically similar (age 30.1±6.1 vs 29.8±5.8 years; male 75.0% vs 73.3%). Preoperative VAS was comparable (4.2±1.8 vs 4.2±1.7), while KOOS was lower in AKP (45.7±11.8 vs 48.6±11.5; p=0.038). Surgical characteristics did not differ (reamed nails 80.8% vs 78.3%; infrapatellar entry 65.0% vs 62.5%; all p>0.3), except for slightly longer operative time in AKP (96.7±17.1 vs 92.1±16.5 min; p=0.034). Across all visits, AKP patients had higher pain and worse function. At 12 months, VAS was 2.4±1.0 vs 0.7±0.7, KOOS 71.5±12.5 vs 85.8±11.5, and Lysholm 72.5±6.7 vs 89.6±6.0 (all p<0.0001). Radiographic abnormalities were more frequent in AKP (17.5% vs 10.0%), with greater additional treatment use (22.5% vs 9.2%). SF-36 PCS/MCS favored no-AKP (56.8±5.7 vs 63.5±5.8; 59.9±6.2 vs 65.2±6.5; both p<0.0001) alongside higher satisfaction and less activity impact.* ***Conclusion:*** *AKP after tibial IMN was associated with sustained pain, inferior knee-specific function, lower quality of life, and more radiographic abnormalities despite broadly similar baseline and surgical profiles. Attention to soft-tissue preservation, implant positioning, and targeted rehabilitation may mitigate AKP.*

Keywords: Anterior Knee Pain; Tibial Intramedullary Nailing; KOOS; Lysholm; SF-36; Suprapatellar; Infrapatellar; Radiographic Abnormalities; Cohort Study; Pakistan

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Introduction

Anterior knee pain (AKP) is one of the most frequently reported patient-centred complaints after intramedullary nailing (IMN) of tibial shaft fractures and can persist long after radiographic union. Beyond pain, AKP may impair kneeling, stair negotiation, squatting, and work capacity, thereby diminishing quality of life and satisfaction despite otherwise successful fracture care (1,2). Contemporary reviews identify multiple, sometimes interacting, sources—entry-point trauma to the patellofemoral unit, iatrogenic injury to the infrapatellar branch of the saphenous nerve, tendon irritation from implants, malalignment, and heterotopic ossification (HO) (3–6). Across large administrative and cohort datasets, the point prevalence of AKP after tibial IMN has been estimated at around 18.6%, though rates vary with entry technique, implant design, and follow-up interval (7).

The surgical approach has received particular scrutiny. Infrapatellar techniques are historically associated with postoperative anterior knee symptoms, plausibly due to patellar tendon violation and scar sensitivity at the tendon split or parapatellar interval (6). Comparative series suggest that suprapatellar/retropatellar entry—performed with the knee in semi-extension and with dedicated protection sleeves—may lower the incidence or severity of AKP while maintaining alignment control. However, findings are not uniform across studies and may be confounded by case selection and surgeon experience (8). Patellofemoral tracking and patellar height can also influence symptoms; radiographic parameters that reflect patella position have been correlated with anterior knee complaints after infrapatellar nailing, underscoring the multifactorial nature of AKP (3).

Complications related to reaming and implant biology may further modulate outcomes. HO around the knee has been documented after reamed tibial nailing and can contribute to pain or motion restriction; recent work characterizes both its incidence and risk factors in the reamed cohort (4). Broader analyses of tibial IMN complications highlight issues such as screw prominence, malalignment, and delayed union/nonunion, any of which can coexist with or amplify AKP and drive reoperation (e.g., hardware removal) (6,7). In complex fracture patterns, including segmental tibial injuries, fixation method and soft-tissue handling influence complication profiles and functional recovery, again with potential downstream effects on anterior knee symptoms (7).

Patient-reported outcomes provide a more holistic view of the burden of AKP. Instruments such as the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Lysholm Knee Scoring Scale capture pain, symptoms, daily function, and sport, while generic health measures (e.g., SF-36) quantify broader quality-of-life effects (1,5,6). In adolescents and young adults, who are commonly affected by high-energy tibial fractures, persistent anterior knee symptoms may be particularly consequential for returning to sport and participating in education/work (5). Despite these insights, there remains heterogeneity in definitions of AKP (global vs localized anterior pain, rest vs activity-related), follow-up timing (early vs 12–24 months), and the radiographic variables assessed, which limits direct comparison across studies and hinders the formulation of clear, setting-specific benchmarks.

Given these gaps and the need for context-specific data from high-volume trauma centres in South Asia, the present study determined the prevalence and severity of anterior knee pain after tibial IMN, compared functional outcomes (VAS, KOOS, Lysholm) between patients with and without AKP, and explored radiographic and surgical correlates (entry technique, nail size, operative variables) associated with AKP at sequential follow-ups.

Methodology

An observational cohort study was conducted at the Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, over six months following ethical approval. Consecutive patients aged 18–45 years with tibial shaft fractures requiring intramedullary nailing (IMN) and operated within the preceding 6 months to 2 years were screened in orthopedic clinics. After written informed consent, eligible patients of either gender with no significant complications likely to affect pain perception (e.g., severe infection or nonunion) were enrolled. Patients with pre-existing severe knee disease or prior major knee surgery, intra-articular fracture extensions, or cases requiring additional stabilization beyond IMN, and those who had undergone or were scheduled for additional lower-limb procedures were excluded. A total sample of 240 participants was achieved, based on an a priori estimate using a prevalence of anterior knee pain (AKP) after tibial IMN of 18.6%, 95% confidence, and 80% power; participants were stratified into Group A (AKP, n=120) and Group B (no AKP, n=120) according to patient-reported pain localized to the anterior knee on a standardized pain diagram and scored on a 0–10 visual analog scale (VAS) at follow-up. Baseline data were recorded at the preoperative assessment, including demographics (age, sex, height, weight, BMI), medical history, injury details, and functional status using the SF-36, the Knee Injury and Osteoarthritis Outcome Score (KOOS), and a preoperative VAS. Intraoperative case report forms documented surgeon, nail type and size, entry point, surgical technique, duration, insertion details, alignment, and any complications. Participants were reviewed at 1, 3, 6 months, and 1 year postoperatively. At each visit, AKP intensity (VAS), function (KOOS and Lysholm Knee Score), and need for additional treatment were recorded. Standardized radiographs assessed fracture healing, implant position, malalignment, nonunion, hardware prominence, and heterotopic ossification. Patient-reported quality of life (SF-36) and satisfaction were collected at follow-up. Data were analyzed in SPSS v21; continuous variables were summarized as mean±SD (or median (IQR) if non-normal) and categorical variables as n (%), with group comparisons via t-tests and χ^2/Fisher's exact tests for proportions. A p-value <0.05 was considered to be significant.

Results

Among 240 participants (AKP n=120; no-AKP n=120), baseline demographics were comparable between groups. Mean age was 30.1 ± 6.1 vs 29.8 ± 5.8 years (p=0.701), with similar sex distribution (male 75.0% vs 73.3%, p=0.601; female 25.0% vs 26.7%), height (166.7 ± 8.0 vs 166.0 ± 8.4 cm, p=0.501), weight (66.6 ± 11.2 vs 66.1 ± 11.6 kg, p=0.764), and BMI (23.9 ± 3.2 vs 23.9 ± 3.2 kg/m², p=0.957). Preoperatively, comorbidities (27.5% vs 30.0%, p=0.236), previous knee injury (10.8% vs 10.0%, p=0.617), and VAS pain (4.2 ± 1.8 vs 4.2 ± 1.7, p=0.928) were similar, while KOOS was lower in the AKP group (45.7 ± 11.8 vs 48.6 ± 11.5, p=0.038). Surgical characteristics were also broadly comparable: reamed nails 80.8% vs 78.3% (p=0.595); nail sizes 9/10/11/12 mm distributed 16.7/35.0/32.5/15.8% vs 19.2/33.3/31.7/15.8% (p=0.778); infrapatellar entry 65.0% vs 62.5% (p=0.328); medial parapatellar approach 67.5% vs 72.5% (p=0.466); intraoperative complications 5.0% vs 6.7% (p=0.665). Operative time was slightly longer in AKP (96.7 ± 17.1 vs 92.1 ± 16.5 min, p=0.034).
Across follow-up, the AKP group reported consistently higher pain and worse function. At 1 month, VAS was 4.2 ± 1.1 vs 1.4 ± 1.0, KOOS 53.8 ± 12.6 vs 61.5 ± 13.8, and Lysholm 49.3 ± 6.7 vs 56.9 ± 7.6 (all p<0.0001); radiographic abnormalities were more frequent (12.5% vs 2.5%), and additional treatments were more common (32.5% vs 11.7%). At 3 months, VAS 3.6 ± 1.1 vs 0.9 ± 0.8, KOOS 61.6 ± 13.3 vs 72.5 ± 12.6, Lysholm 57.8 ± 6.7 vs 69.5 ± 6.7 (all p<0.0001), with abnormalities 18.3% vs 5.8% and additional treatments 34.2% vs 7.5%. At 6 months, VAS 2.8 ± 1.1 vs 0.8 ± 0.8, KOOS 68.4 ± 13.5 vs 79.7 ± 11.9, Lysholm 65.8 ± 7.2 vs 81.2 ± 7.0 (all p<0.0001), abnormalities 17.5% vs 7.5%, and additional treatments 27.5% vs 7.5%. At 12 months, VAS 2.4 ± 1.0 vs 0.7 ± 0.7, KOOS 71.5 ± 12.5 vs 85.8 ± 11.5, Lysholm 72.5 ± 6.7 vs 89.6 ± 6.0 (all p<0.0001), with abnormalities 17.5% vs 10.0% and additional treatments 22.5% vs 9.2%. Patient-reported outcomes favored the no-AKP group: SF-36 PCS 56.8 ± 5.7 vs 63.5 ± 5.8 and MCS 59.9 ± 6.2 vs 65.2 ± 6.5 (both p<0.0001), alongside higher satisfaction (2.73 ± 1.03 vs 3.59 ± 0.70; p<0.0001) and lower impact on daily activities (2.35 ± 0.96 vs 1.37 ± 0.55; p<0.0001) in the no-AKP cohort.

Table 1: Demographic variables of the study participants

Variables	AKP (n=120)	No AKP (n=120)	P value
Age (years)	30.1 ± 6.1	29.8 ± 5.8	0.701
Male n (%)	90 (75.0%)	88 (73.3%)	0.601
Female n (%)	30 (25.0%)	32 (26.7%)	
Height (cm)	166.7 ± 8.0	166.0 ± 8.4	0.501
Weight (kg)	66.6 ± 11.2	66.1 ± 11.6	0.764
BMI (kg/m²)	23.9 ± 3.2	23.9 ± 3.2	0.957

Table 2: Pre-operative variables

Variables	AKP (n=120)	No AKP (n=120)	P value
Comorbidities	33 (27.5%)	36 (30.0%)	0.236
Previous Knee Injury	13 (10.8%)	12 (10.0%)	0.617
Preop VAS (0-10)	4.2 ± 1.8	4.2 ± 1.7	0.928
Preop KOOS (%)	45.7 ± 11.8	48.6 ± 11.5	0.038

Table 3: Surgical variables

Variables		AKP (n=120)	No AKP (n=120)	P value
Type of Nail	Reamed nail n (%)	97 (80.8%)	94 (78.3%)	0.595
	Unreamed nail n (%)	23 (19.2%)	26 (21.7%)	
Nail Size	9mm n (%)	20 (16.7%)	23 (19.2%)	0.778
	10mm n (%)	42 (35.0%)	40 (33.3%)	
	11mm n (%)	39 (32.5%)	38 (31.7%)	
	12mm n (%)	19 (15.8%)	19 (15.8%)	
Entry	Infrapatellar n (%)	78 (65.0%)	75 (62.5%)	0.328
	Suprapatellar n (%)	42 (35.0%)	45 (37.5%)	
Approach	Medial para n (%)	81 (67.5%)	87 (72.5%)	0.466
	Lateral para n (%)	39 (32.5%)	33 (27.5%)	
Surgery duration (mins)		96.7 ± 17.1	92.1 ± 16.5	0.034
Intraoperative Complications		6 (5.0%)	8 (6.7%)	0.665

Table 4: Follow Up parameters

Variables	AKP (n=120)	No AKP (n=120)	P value
VAS (0-10)	4.2 ± 1.1	1.4 ± 1.0	<0.0001
KOOS (%)	53.8 ± 12.6	61.5 ± 13.8	<0.0001
Lysholm	49.3 ± 6.7	56.9 ± 7.6	<0.0001
Radiograph: Abnormal	15 (12.5%)	3 (2.5%)	
Additional Tx	39 (32.5%)	14 (11.7%)	
3 Month Follow-up			

VAS (0-10)	3.6 ± 1.1	0.9 ± 0.8	<0.0001
KOOS (%)	61.6 ± 13.3	72.5 ± 12.6	<0.0001
Lysholm	57.8 ± 6.7	69.5 ± 6.7	<0.0001
Radiograph Abnormal	22 (18.3%)	7 (5.8%)	
Additional Tx	41 (34.2%)	9 (7.5%)	
6 Months Follow-up			
VAS (0-10)	2.8 ± 1.1	0.8 ± 0.8	<0.0001
KOOS (%)	68.4 ± 13.5	79.7 ± 11.9	<0.0001
Lysholm	65.8 ± 7.2	81.2 ± 7.0	<0.0001
Radiograph: Abnormal	21 (17.5%)	9 (7.5%)	
Additional Tx	33 (27.5%)	9 (7.5%)	
12 Months Follow-up			
VAS (0-10)	2.4 ± 1.0	0.7 ± 0.7	<0.0001
KOOS (%)	71.5 ± 12.5	85.8 ± 11.5	<0.0001
Lysholm	72.5 ± 6.7	89.6 ± 6.0	<0.0001
Radiograph: Abnormal	21 (17.5%)	12 (10.0%)	
Additional Tx	27 (22.5%)	11 (9.2%)	

Table 5: Patient Reported Outcomes

Variables	AKP (n=120)	No AKP (n=120)	P value
SF-36 PCS (%)	56.8 ± 5.7	63.5 ± 5.8	<0.0001
SF-36 MCS (%)	59.9 ± 6.2	65.2 ± 6.5	<0.0001
Satisfaction (1-5)	2.73 ± 1.03	3.59 ± 0.70	<0.0001
Impact on Daily Activities (1-5)	2.35 ± 0.96	1.37 ± 0.55	<0.0001

Discussion

The present cohort demonstrates that patients with anterior knee pain (AKP) after tibial intramedullary nailing (IMN) experienced persistently higher pain and worse knee-specific function across all follow-up points. They also reported inferior health-related quality of life, lower satisfaction, and a greater need for additional treatments compared with those without AKP. These findings echo prior reports identifying AKP as a common, patient-salient morbidity after otherwise successful tibial nailing, with meaningful impact on kneeling, squatting, stair negotiation, and global wellbeing (9,10). Although our study was not designed to estimate prevalence, the signal of functional detriment among those with AKP aligns with extensive registry and cohort analyses that place AKP among the leading complaints post-IMN and a driver of reoperation, such as hardware removal (9,10).

Entry technique has been implicated as a modifiable factor in AKP. Comparative series suggest that suprapatellar trajectories, performed in semi-extension with protective sleeves, may reduce anterior knee symptoms relative to infrapatellar/parapatellar approaches, possibly by minimizing patellar tendon violation and intra-articular chondral contact (11). In our data, entry choice did not differ significantly between groups. It was not associated with AKP status, which contrasts with some of the literature and likely reflects confounding by case selection, surgeon preference, and limited power to detect modest effects (11). Similarly, we found no between-group differences in nail type (reamed vs unreamed) or nominal nail diameter, consistent with reviews suggesting that implant selection alone rarely explains AKP once soft-tissue and alignment factors are considered (10).

Radiographic abnormalities, including malalignment, delayed union, screw prominence, and heterotopic ossification (HO), were consistently more frequent among AKP patients at each time point, supporting mechanistic links between local structural irritants and anterior knee symptoms (10,12,13). Recent series specifically highlight HO around the knee following reamed tibial nailing as a contributor to discomfort and motion limitation; our higher abnormal radiograph rates in AKP mirror these observations, although we did not subclassify HO separately (13). Patellofemoral mechanics also matter: work correlating patellar position parameters with anterior knee symptoms after infrapatellar nailing suggests that subtle tracking or height abnormalities may exacerbate pain (12). While we did not quantify patellar indices, the radiographic "abnormal" signal and worse Lysholm/KOOS trajectories in the AKP group are congruent with this pathomechanical framework (12).

Preoperatively, the AKP cohort exhibited slightly lower KOOS despite similar pain, hinting at baseline vulnerability in knee-specific function that may predispose to persistent symptoms (10). Operative duration was marginally longer in AKP, a difference that, although statistically significant, is small and may represent case complexity rather than a causal factor; challenging patterns such as segmental fractures and soft-tissue compromise are known to prolong surgery and complicate recovery (14). Ultimately, the significant, clinically relevant decrements in KOOS and Lysholm, along with the worse SF-36 scores among AKP patients, reinforce the broader quality-of-life burden documented in narrative and textbook syntheses (10,15).

Strengths of this study include standardized, longitudinal assessment (VAS, KOOS, Lysholm, SF-36) and systematic radiographic review. Limitations include single-center design, nonprobability sampling, potential residual confounding (e.g., infrapatellar nerve injury not directly assessed), and multiple unadjusted comparisons. Future work should incorporate detailed patellofemoral metrics, nerve assessment, and multivariable modeling, including interaction terms for entry technique and soft-tissue handling, to clarify modifiable drivers of AKP (11,12). Taken together, our results support vigilant soft-tissue preservation, meticulous implant positioning, and proactive rehabilitation strategies to mitigate AKP after tibial IMN (10,11,13).

Conclusion

In this cohort of 240 patients after tibial IM nailing, those with anterior knee pain exhibited persistently higher pain, inferior KOOS/Lysholm scores, and worse SF-36 outcomes at every follow-up compared with pain-free peers. Radiographic abnormalities and the need for additional treatments were also more frequent in the AKP group, underscoring a tangible clinical burden. Baseline demographics and most surgical characteristics were comparable, suggesting soft-tissue effects, implant positioning, and postoperative factors may be key drivers. These findings support meticulous entry/soft-tissue handling, vigilant radiographic optimization, and targeted rehabilitation to mitigate AKP and improve patient-centred outcomes.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

JA (Post Graduate Trainee), AA (Post Graduate Trainee), MM (Post Graduate Trainee)

Review of Literature, Data entry, Data analysis, and drafting an article. Manuscript drafting, Study Design,

GAS (Assistant professor), SAS (Assistant professor), NI (Fellow)

Study Design, manuscript review, and critical input.
Conception of Study, Development of Research Methodology Design

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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