



Surgical approaches to intramedullary nailing of the tibia: Comparative analysis of knee pain and functional outcomes



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ABSTRACT

Introduction: Post-operative knee pain is common following intramedullary nailing of the tibia, regardless of surgical approach, though the exact source is controversial. Historically, the most common surgical approaches position the knee in hyperflexion, including patellar tendon splitting (PTS) and medial parapatellar (MPP). A novel technique, the semi-extended lateral parapatellar approach simplifies patient positioning, fracture reduction, fluoroscopic assessment, and implant insertion. It also avoids violation of the knee joint capsule. However, this approach has not yet been directly compared against the historical standards. We hypothesised that in a comparison of patient outcomes, the semi-extended approach would be associated with decreased knee pain and better function relative to knee hyperflexion approaches.

Methods: A trauma patient database from a Level I centre was queried for patients who underwent intramedullary nailing of the tibia between 2009 and 2013. Patients were surveyed for knee pain severity (NRS scale 1 to 10) and location, and completion of the Lysholm Knee Scale (LKS). Data was compared between the semi-extended lateral parapatellar, medial parapatellar, and tendon splitting groups regarding knee pain severity, location, total LKS, and individual knee function scores from the Lysholm questionnaire. Pre-hoc power analysis determined the necessary sample size ($n = 34$). Post-hoc analysis utilised two-way ANOVA analysis with a significance threshold of $p < 0.05$.

Results: Comparison of knee pain severity between the groups found no significant difference ($p = 0.69$), with average ratings of: semi-extended (3.26), PTS (3.59), and MPP (3.63). Analysis found no significant differences in total LKS score ($p = 0.33$), with average sums of: semi-extended (75.97), MPP (77.53), and PTS (81.68). Individual knee function scores from the LKS were similar between the groups, except for limping, with MPP being significantly worse ($p = 0.04$). There was no significant difference in knee pain location ($p = 0.45$).

Conclusion: In this adequately-powered study, at minimum 1 year follow-up there were no significant differences between the 3 approaches in knee pain severity, location, or overall function. The three were significantly different in post-operative limping, with medial parapatellar having the lowest score. The semi-extended lateral parapatellar approach vastly simplifies many technical aspects of nailing compared to knee hyperflexion approaches, and does not violate the knee joint.

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Introduction

Tibial shaft fractures are extremely common injuries [1]. The preferred management for most tibial shaft fractures is intramedullary nailing, which generally yields a high rate of union, low complication rates, and good functional outcomes [2]. However,

knee pain after tibial nailing has historically been problematic. One classic study on knee pain following tibial nailing using traditional approaches reported an incidence of 56% [3]. While the exact aetiology of this knee pain is unknown, suggested factors include surgical approach relative to the patellar tendon, nerve transection, violation of the fat pad or joint capsule, nail diameter, and implant prominence [4].

Traditional surgical approaches involve hyperflexion of the knee to access the nail starting portal. However, knee hyperflexion leads to difficulty with fluoroscopic imaging, fracture reduction,

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and deforming forces. The positioning of the leg in a semi-extended position greatly simplifies patient positioning, fracture reduction, fluoroscopic assessment, and implant insertion [5]. The use of an extra-articular incision with the leg in a semi-extended position was evaluated in a case series by Weil et al. in 2008, and was more recently described by Kubiak et al. [6]. However, the effects of this approach on knee pain after tibial nailing compared to standard “hyperflexed” approaches, including medial parapatellar and patellar tendon splitting, are unknown [7].

The purpose of this study was to compare long-term patient outcomes between the novel semi-extended lateral parapatellar approach and the traditional hyperflexed medial parapatellar and patellar tendon splitting approaches. The null hypothesis of this study is that use of the semi-extended lateral parapatellar approach does not result in significantly different post-operative knee pain or function compared to traditional hyperflexion approaches.

Patients and methods

After Institutional Review Board approval, a Level I trauma patient database was queried for all patients at least 1 year post intramedullary nailing of the tibia for acute fracture between 2008 and 2013. All patients had undergone one of the three approaches under investigation: a semi-extended lateral parapatellar approach, a hyperflexion medial parapatellar, or a hyperflexion patellar tendon splitting approach based on attending surgeon. Exclusion criteria were diabetic neuropathy or loss of lower extremity sensation, prior intramedullary nailing of the ipsilateral tibia or other lower extremity instrumentation, inability to ambulate, or major post-operative complications (such as gross implant prominence). For patients that underwent bilateral intramedullary nailing of the tibia, data on the patient’s most painful and dysfunctional side were used. For patients who were significantly further post-operatively (e.g. >3 years), outcomes were determined based on patient recall of knee pain and function at 1 year post-operation.

Surgical technique

Patients who underwent the semi-extended lateral parapatellar approach for tibial nailing were positioned supine on a radiolucent table with the leg and ipsilateral hip bumped. The surgical approach was slightly modified based on previously described techniques [7]. A slightly curvilinear incision was made just lateral to the patella and the patellar tendon, and was approximately 5 cm in length. The retinaculum lateral to the patellar tendon was incised, and the interval between the tendon and the fat pad was developed. The fat pad was retracted proximally and its insertion into the proximal tibia was incised, allowing for its protection. The retinaculum was then incised just lateral to the patella along its entire length, allowing a cuff for repair. An awl was then used to medialise the patella and patellar tendon, and to obtain a fluoroscopically-directed starting portal. After the starting portal was created a ball-tipped guide wire was passed to the fracture site, and reduction and nailing proceeded in the standard fashion.

Patient charts were reviewed for demographic data, including date of birth, height, weight, date of surgery, and history of smoking, diabetes mellitus, or steroids. Other chart data gathered included duration of follow-up, surgical approach, mechanism of injury, open versus closed injury, complications, and nail diameter. Eligible patients were then contacted via telephone and asked specifically about knee pain severity (NRS scale of 1 to 10) and location (anterior, posterior, medial,

or lateral). The Lysholm Knee Scale (LKS) questionnaire was also administered.

A pre-hoc power analysis was conducted to determine the minimum number of patients necessary to detect a difference in Lysholm Knee Score. Review of the literature and expected outcomes found the minimum number of patients per group to be $n = 34$ in order to detect a clinically significant difference in post-operative knee pain and function. In each surgical approach group, patients were sequentially contacted until complete responses were obtained from the required 34 patients per group, for a total of 102 patients. 140 total patients were successfully contacted, 38 of which were excluded for confounding comorbidities, revision procedures, or conditions that would obscure post-operative knee pain and function score reporting. All attempts at contact were documented.

Data were compared between the three surgical approaches regarding knee pain severity, knee pain location, total LKS, and individual knee function scores from the Lysholm questionnaire. The aim of the study was to detect any significant differences between the groups, using ANOVA analysis. All statistical analyses were run using StatPlus software (AnalystSoft, Vancouver, Canada). Significance was determined using a p -value threshold of <0.05 and a two-tailed distribution.

The average age across the three surgical approach groups (semi-extended 44, medial parapatellar 42, tendon splitting 49) varied but the difference was insignificant ($p = 0.08$). The most common mechanism of injury in all 3 groups was a fall, ranging from 29 to 44% of responses. Other mechanisms of injury included motorcycle collision (9–12%), motor vehicle collision (12–26%), pedestrian struck (12–18%), gunshot wound (6–12%), and crush/strike (8–12%). Open fractures accounted for 35–38% of injuries across all 3 groups, and the mean nail diameter was 9.9–10.3 mm (Table 1).

Results

On the NRS pain scale, knee pain severity was not significantly different between the semi-extended lateral parapatellar group (mean 3.3, stdev 2.1), the medial parapatellar (mean 3.6, stdev 2.3), and the tendon splitting (mean 3.6, stdev 2.3) groups ($p = 0.69$; Table 2). The location of knee pain was also compared. Across all three groups, the anterior knee was the most common site of pain. There was no significant difference between the groups in location ($p = 0.45$).

Analysis of the differences between the surgical approaches regarding knee function demonstrated no significant difference between the three approaches in total LKS score ($p = 0.33$), with the tendon splitting group having the highest average score (81.7) in comparison to the semi-extended (76.0) and medial parapatellar (77.5) groups (Table 3). Analysis of patient responses to each individual question on the LKS found no significant difference between the groups except for limping. Patient survey responses to post-operative limping were found to be the highest (best associated outcomes- “no limp” for 5) for the patellar tendon splitting group (4.4), versus the semi-extended (4.1) and medial parapatellar (3.7) groups. This difference was found to be statistically significant ($p = 0.04$). While there was a substantial range between the surgical approaches in patient response to the knee giving way (semi-extended 20.1, medial parapatellar 22.7, tendon splitting 22.1), this difference was found to be insignificant ($p = 0.06$).

Comparison of the demographic and patient characteristic data between the groups revealed only one statistically significant difference (Table 1). The three groups differed in average length of time (months) since surgery (semi-extended 31, medial parapatellar 65, tendon splitting 61; $p < 0.001$).

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