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Functional Knee Outcomes in Suprapatellar and Infrapatellar Tibial Nailing: Does Approach Matter?

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Introduction

With an incidence of 75,000 per year in the United States alone, fractures of the tibial shaft are among the most common long bone fractures.[1] Techniques using a semi-extended suprapatellar approach can facilitate intraoperative imaging, allow easier access to starting site position and counter deforming forces. While outcomes following traditional infrapatellar nailing have been well documented, there is a paucity of literature regarding outcomes following the use of a suprapatellar approach. By splitting the quadriceps tendon, scar tissue will form superior to the patella as opposed to the anterior knee, which may reduce flexion-related pain or pain while kneeling.[2] The infrapatellar nerve is also well protected during this approach. The purpose of this study was to determine differences in functional knee pain in patients who underwent suprapatellar nailing versus traditional infrapatellar nailing.

Methods

This study received no outside funding and was approved and conducted according to the guidelines set forth by our Institutional Review Board (IRB). We searched our department trauma database for all patients who underwent Current Procedural Terminology (CPT) code 27759 for treatment of tibial shaft fracture with intramedullary implant at a single Level 1 trauma center from January 2009 to February 2013. Radiographs, operative reports, and inpatient records were reviewed. Patients over age 18 at the time of injury and those with an isolated tibial shaft fracture (OTA type 42 A-C) fixed surgically with an intramedullary nail via a suprapatellar approach or a traditional infrapatellar approach were included in the study. Exclusion criteria were a treatment regimen that included fasciotomy, Gustilo type 3B or 3C open fractures, a history of additional orthopaedic injuries or prior knee surgeries, and pre-existing radiographic evidence of degenerative joint disease.

Each patient was contacted via telephone by an investigator who administered the 12 question Oxford Knee Score questionnaire (Figure 1). Investigators were blinded to surgical exposure. Operative time, quality of reduction on postoperative radiographs, and intraoperative fluoroscopy time were compared between the two approaches. We determined quality of reduction by measuring the angle between the line perpendicular to the tibial plateau and plafond on both the anteroposterior and lateral

1. How would you describe the pain you usually have in your knee?
2. Have you had any trouble washing and drying yourself (all over) because of your knee?
3. Have you had any trouble getting in and out of the car or using public transport because of your knee? (with or without a stick)
4. For how long are you able to walk before the pain in your knee becomes severe? (with or without a stick)
5. After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your knee?
6. Have you been limping when walking, because of your knee?
7. Could you kneel down and get up again afterwards?
8. Are you troubled by pain in your knee at night in bed?
9. How much has pain from your knee interfered with your usual work? (including housework)
10. Have you felt that your knee might suddenly give way or let you down?
11. Could you do household shopping on your own?
12. Could you walk down a flight of stairs?

Figure 1. Oxford Knee Score questionnaire administered to each patient via telephone. Each question had specific answers corresponding to a score from 0 (worst function) to 4 (best function).

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postoperative radiographs. Rotation was determined by measuring the displacement of the fracture by cortical widths.

We conducted an a priori power analysis to determine the appropriate sample size. In order to detect the reported Minimally Clinically Important Difference (MCID) in the Oxford Knee Score of 5.2,[3] estimating an approximate 20% larger patient population in the infrapatellar group, we calculated a need to enroll 24 infrapatellar patients and 20 suprapatellar patients. Our calculations predict this study design would achieve a power of 0.80 with a type I error rate of 0.05.[4] This power analysis was based on an estimated Oxford Knee Score standard deviation of 6, as previously reported in several studies.[5,6]

Results

We identified 176 patients who underwent intramedullary fixation of tibial shaft fractures from January 2009 to February 2013. After analyzing radiographs and medical records, 82 patients met inclusion criteria. Thirty-six of the original 82 patients (45%) were lost to follow-up after attempts to contact them by telephone. Twenty-four patients underwent traditional infrapatellar nailing and 21 patients had a suprapatellar nail placed with approach-specific instrumentation. No significant difference was found between the groups in terms of gender, age, BMI, mechanism of injury or operative time (Table 1). The mean ages for the infrapatellar and suprapatellar group were 37.6 (range 20-65 years) and 38.5 years (range 18-68 years) respectively ($p=0.839$). The average follow-up for the suprapatellar approach (8.0, range 3-33 months) was significantly shorter than the infrapatellar approach (12.8, range 4-43 months, $p<0.001$).

The mean Oxford Knee Score (maximum of 48 points) was 40.1 and 36.2 ($p=0.221$) for the infrapatellar (range 11-48) and suprapatellar groups (range 2-48), respectively. Suprapatellar nailing had improved radiographic reduction (2.90 degrees) in the sagittal plane when compared to infrapatellar nailing (4.58 degrees, $p=0.044$). There was no difference in rotational malreduction (0.32 vs. 0.25 cortical widths, $p=0.599$) or reduction in the coronal plane (2.52 vs. 3.17 degrees, $p=0.280$). The suprapatellar approach did require less operative fluoroscopy time (80.8 seconds, range 46-180) than the standard infrapatellar approach (122.1 seconds, range 71-240, $p=0.003$). Our results data are summarized in Table 2.

Discussion

We present one of the first retrospective cohorts comparing functional knee scores between suprapatellar nailing and the traditional infrapatellar approach. While much has been written about the incidence of anterior knee pain through a patellar splitting or parapatellar approach, the clinical effects of knee pain after suprapatellar nails have yet to be addressed in the literature. Our data show no difference in the Oxford Knee Score between the two groups. Although the suprapatellar approach is intra-articular, approach-specific instrumentation may protect the trochlea and patellar cartilage.

Even though our data did not show a difference in operative time between the two groups, suprapatellar nails required significantly less fluoroscopy time than infrapatellar nails (80.8 seconds versus 122.1 seconds, $p = 0.003$). Positioning the knee in the semi-extended position allows easier access for fluoroscopy and less radiation exposure for the patient.

Table 1. Demographic data on patients who underwent tibial intramedullary fixation via a suprapatellar and traditional infrapatellar approach.

Patient Data	Infrapatellar (n=24)	Suprapatellar (n=21)	P value
Gender (%)			
Male	11 (46)	15 (71)	0.082
Female	13 (54)	6 (29)	
Age (Years)	37.6	38.5	0.839
Follow up (Months)	25.2	8.0	<0.001
BMI	26.4	26.5	0.975
Mechanism of Injury (%)			
Fall	14 (58)	6 (29)	0.150
MVC	5 (21)	9 (43)	
Sports	4 (17)	3 (14)	
GSW	1 (4)	3 (14)	

Table 2. Oxford knee score, reduction, operative time, and intraoperative fluoroscopy of patients.

Results (Standard Deviation)	Infrapatellar (n=24)	Suprapatellar (n=21)	P value
Oxford Knee Score	40.1 (8.8)	36.2 (11.9)	0.221
Operative Time (minutes)	145 (43)	147 (41)	0.884
Fluoroscopy time (seconds)	122.1 (41.6)	80.8 (36.7)	0.003
Coronal plane reduction (degrees)	3.17 (1.99)	2.52 (1.94)	0.280
Sagittal plane reduction (degrees)	4.58 (2.86)	2.90 (2.57)	0.044
Rotation (cortical widths)	0.25 (0.32)	0.31 (0.42)	0.599

While acknowledging the retrospective nature of this study, it does have several strengths. Our sample size met the pre-study power analysis to determine a clinically important difference in the Oxford Knee Score. The investigator administering the telephone survey was blinded to the approach. It is also the first clinical study comparing outcomes of suprapatellar and infrapatellar nails. Rate of follow-up, however, was a weakness of this study. We lost 37 patients (45%) to follow-up, presumably as a result of the telephone numbers noted in the hospital records having changed since surgery.

Our retrospective cohort identified no difference in knee pain between a suprapatellar approach and traditional infrapatellar nailing for diaphyseal tibia fractures. Suprapatellar nails require less fluoroscopy time and may show improved radiographic reduction in the sagittal plane. While further study is needed, the suprapatellar entry portal appears to be a safe alternative for tibial nailing when using the appropriate instrumentation.

References

1. Praemer A, Furner S, Rice DP. Musculoskeletal conditions in the United States. Park Ridge, IL. American Academy of Orthopaedic Surgeons; 1992.

2. Morandi M, Banka T, Gairarsa GP, et al. Intramedullary nailing of tibial fractures: Review of surgical techniques and description of a percutaneous lateral suprapatellar approach. *Orthopaedics* 2010 Mar;33(3):172-9

3. Bohm ER, Loucks L, Tan QE, et al. Determining Minimum Clinically Important Difference and Targeted Clinical Improvement Values for the Oxford 12. Presented at the American Academy of Orthopaedic Surgeons annual meeting. San Francisco, CA. 2012.

4. Dupont WD, Plummer WD. Power and Sample Size Calculations: A Review and Computer Program. Controlled Clinical Trials 1990;11:116-28.

5. Streit MR, Walker T, Bruckner T, et al. Mobile-bearing lateral unicompartmental knee replacement with the Oxford domed tibial component: an independent series. *J Bone Joint Surg Br* 2012 Oct;94(10):1356-61

6. Jenny JY, Diesinger Y. The Oxford Knee Score: compared performance before and after knee replacement. *Orthop Traumatol Surg Res* 2012 Jun;98(4):409-12.