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

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Abstract

We conducted a study to determine differences in knee pain in patients who underwent either traditional infrapatellar nailing or suprapatellar nailing. From a single institution, we identified patients who had an isolated tibial shaft fracture (Orthopaedic Trauma Association type 42 A-C) surgically fixed with an intramedullary nail between 2009 and 2012. Each patient was contacted by telephone by an investigator blinded to surgical exposure, and the Oxford Knee Score (OKS) questionnaire was administered. Operative time and quality of reduction on postoperative radiographs were compared between the 2 approaches.

Twenty-four patients underwent infrapatellar nailing, and 21 patients had a suprapatellar nail placed with approach-specific instrumentation. Mean OKS (maximum, 48 points) was 40.1 for the infrapatellar group and 36.7 for the suprapatellar group ($P = .293$). Compared with the infrapatellar approach, suprapatellar nailing improved radiographic reduction in the sagittal plane (2.90° vs 4.58°; $P = .044$) and required less operative fluoroscopy time (81 vs 122 s; $P = .003$).

We found no difference in OKS between the infrapatellar and suprapatellar approaches. Although further study is needed, the suprapatellar entry portal appears to be a safe alternative for tibial nailing with use of appropriate instrumentation.

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] Diaphyseal tibial fractures present a unique treatment challenge because of complications, including nonunion, malunion, and the potential for an open injury. Intramedullary fixation of these fractures has long been the standard of care, allowing for early mobilization, shorter time to weight-bearing, and high union rates.[2-4]

The classic infrapatellar approach to intramedullary nailing involves placing the knee in hyperflexion over a bump or radiolucent triangle and inserting the nail through a longitudinal incision in line with the fibers of the patellar tendon. Deforming muscle forces often cause proximal-third tibial fractures and segmental fractures to fall into valgus and procurvatum. To counter these deforming forces, orthopedic surgeons have used some novel surgical approaches, including use of blocking screws[5] and a parapatellar approach that could be used with the knee in semi-extended position.[6] Anterior knee pain has been reported as a common complication of tibial nailing (reported incidence, 56%).[7] In a prospective randomized controlled study, Toivanen and colleagues[8] found no difference in incidence of knee pain between patellar tendon splitting and parapatellar approaches.

Techniques have been developed to insert the nail through a semi-extended suprapatellar approach to facilitate intraoperative imaging, allow easier access to starting-site position, and counter deforming forces. Although outcomes of traditional infrapatellar nailing have been well documented, there is a paucity of literature on outcomes of using a suprapatellar approach. Splitting the quadriceps tendon causes scar tissue to form superior to the patella versus the anterior knee, which may reduce flexion-related pain or kneeling pain.[9] The infrapatellar nerve is also well protected with this approach.

We conducted a study to determine differences in functional knee pain in patients who underwent either traditional infrapatellar nailing or suprapatellar nailing. We hypothesized that there would be no difference in functional knee scores between these approaches and that, when compared with the infrapatellar approach, the suprapatellar approach would result in improved postoperative reduction and reduced intraoperative fluoroscopy time.

Materials and Methods

This study was approved by our institutional review board. We searched our level I trauma center's database for *Current Procedural Terminology* (CPT) code 27759 to identify all patients who had

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a tibial shaft fracture fixed with an intramedullary implant between January 2009 and February 2013. Radiographs, operative reports, and inpatient records were reviewed. Patients older than 18 years at time of injury and patients with an isolated tibial shaft fracture (Orthopaedic Trauma Association type 42 A-C) surgically fixed with an intramedullary nail through either a traditional infrapatellar approach or a suprapatellar approach were included in the study. Exclusion criteria were required fasciotomy, Gustilo type 3B or 3C open fracture, prior knee surgery, additional orthopedic injury, and preexisting radiographic evidence of degenerative joint disease.

In addition to surgical approach, demographic data, including body mass index (BMI), age, sex, and mechanism of injury, were documented from the medical record. Each patient was contacted by telephone by an investigator blinded to surgical exposure, and the 12-item Oxford Knee Score (OKS) questionnaire was administered (**Figure**). Operative time, quality of reduction on postoperative radiographs, and intraoperative fluoroscopy time were compared between the 2 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 postoperative radiographs. Rotation was determined by measuring displacement of the fracture by cortical widths. The infrapatellar and suprapatellar groups were statistically analyzed with an unpaired, 2-tailed Student t test. Categorical variables between groups were analyzed with the χ^2 test or, when expected values in a cell were less than 5, the Fisher exact test.

We then conducted an a priori power analysis to determine the appropriate sample size. To detect the reported minimally clinically important difference in the OKS of 5.2,[10] estimating an approximate 20% larger patient population in the infrapatellar group, we would need to enroll 24 infrapatellar patients and 20 suprapatellar patients to achieve a power of 0.80 with a type I error rate of 0.05.[11] This analysis is also based on an estimated OKS standard deviation of 6, which has been reported in several studies.[12,13]

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

Results

We identified 176 patients who had the CPT code for intramedullary fixation of a tibial shaft fracture between January 2009 and February 2013. After analysis of radiographs and medical records, 82 patients met the inclusion criteria. Thirty-six (45%) of the original 82 patients were lost to follow-up after attempts to contact them by telephone. One patient refused to participate in the study. Twenty-four patients underwent traditional infrapatellar nailing, and 21 patients had a suprapatellar nail placed with approach-specific instrumentation. Nine patients had an open fracture. There was no significant difference between the groups in terms of sex, age, BMI, mechanism of injury, or operative time (**Table 1**). There was also no difference ($P = .210$) in fracture location between groups (0 proximal-third, 14 midshaft, 10 distal-third vs 3 proximal-third, 10 midshaft, 8 distal-third). Mean age was 37.6 years (range, 20-65 years) for the infrapatellar

Table 1. Demographic Data of Patients Who Underwent Tibial Intramedullary Fixation Through Infrapatellar or Suprapatellar Approach, Mean (SD)

	Approach		
Demographic Data	Infrapatellar (n = 24)	Suprapatellar (n = 21)	*P*
Sex, %			.082
Male	11 (46)	15 (71)	
Female	13 (54)	6 (29)	
Age, y	37.6	38.5	.839
Follow-up, mo	25.2	11.8	<.001
Body mass index	26.4	26.5	.975
Mechanism of injury, %			.150
Fall	14 (58)	6 (29)	
Motor vehicle collision	5 (21)	9 (43)	
Sports	4 (17)	3 (14)	
Gunshot wound	1 (4)	3 (14)	
Fracture location, %			.210
Proximal third	0 (0)	3 (14)	
Midshaft	14 (58)	10 (48)	
Distal third	10 (42)	8 (38)	

group and 38.5 years (range, 18-68 years) for the suprapatellar group (P = .839). Mean follow-up was significantly (P < .001) shorter for the suprapatellar group (12 mo; range, 3-33 mo) than for the infrapatellar group (25 mo; range, 4-43 mo).

Mean OKS (maximum, 48 points) was 40.1 (range, 11-48) for the infrapatellar group and 36.7 (range, 2-48) for the suprapatellar group (P = .293). **Table 2** summarizes the data. Radiographic reduction in the sagittal plane was improved (P = .044) in the suprapatellar group (2.90°) compared with the infrapatellar group (4.58°). There was no difference in rotational malreduction (0.31 vs 0.25 cortical width; P = .599) or in reduction in the coronal plane (2.52° vs 3.17°; P = .280). All patients in both groups maintained radiographic reduction within 5° in any plane throughout follow-up. There was no difference (P = .654) in radiographic follow-up between the infrapatellar group (11 mo) and the suprapatellar group (12 mo). The 1 nonunion in the suprapatellar group required return to the operating room for exchange intramedullary nailing. The suprapatellar approach required less (P = .003) operative fluoroscopy time (80.8 s; range, 46-180 s) than the standard infrapatellar approach (122.1 s; range, 71-240 s). Two patients in the suprapatellar group and 8 in the infrapatellar group did not have their fluoroscopy time recorded in the operative report.

Discussion

We have described the first retrospective cohort-comparison study of functional knee scores associated with traditional infrapatellar nailing and suprapatellar nailing. Although much has been written about the incidence of anterior knee pain with use of a patellar splitting or parapatellar approach, the clinical effects of knee pain after use of suprapatellar nails are yet to be addressed. In a cadaveric study, Gelbke and colleagues[14] found higher mean patellofemoral pressures and higher peak contact pressures with a suprapatellar approach. These numbers, however, were still far below the threshold for chondrocyte damage, and that study is yet to be clinically validated. Our data showed no difference in OKS between the 2 groups. Despite being intra-articular, approach-specific instrumentation may protect the trochlea and patellar cartilage. Although the OKS questionnaire was originally developed and widely validated to describe clinical outcomes of total knee arthroplasty,[15,16] it has also been evaluated for other interventions, including viscosupplementation injections[17] and high tibial osteotomy.[18] We used the OKS questionnaire in our study because it is simple to administer by telephone and is not as cumbersome as the Knee Society Score or the Western Ontario and McMaster Universities Osteoarthritis Index. It is also more specific to the knee than generalized outcome measures used in trauma, such as the Short Form 36 (SF-36). Sanders and colleagues[19] reported excellent tibial alignment, radiographic union, and knee range of motion using semi-extended tibial nailing with a suprapatellar approach. For outcome measures, they used the Lysholm Knee Score and the SF-36. Our clinical and radiographic results confirmed their finding—that the semi-extended suprapatellar approach is an option for tibial nailing.

OKS results by question (**Table 3**) showed that the infrapatellar group had less pain walking down stairs. This result approached statistical significance (P = .063). As surgeons at our institution began using the suprapatellar approach only during the final 2 years of the study period, mean follow-up was significantly (P < .001) less than for the infrapatellar group (12 vs 25 mo). Although there was no statistically significant difference in reduction quality on anteroposterior radiographs, the suprapatellar approach had improved (P = .044) reduction on lateral radiographs (2.90° vs 4.58°).

Although operative time did not differ between our 2 groups, significantly (P = .003) less fluoroscopy time was required for suprapatellar nails (80.8 s) than for infrapatellar nails (122.1 s). Positioning the knee in the semi-extended position offers easier access for fluoroscopy and less radiation exposure for the patient. Placing the nail in extension also

Table 2. Patients' Mean (SD) Oxford Knee Scores, Operative and Fluoroscopy Times, Reductions, Radiographic Follow-Up, and Rotation

	Approach		
Result	Infrapatellar (n = 24)	Suprapatellar (n = 21)	*P*
Oxford Knee Score	40.1 (8.8)	36.7 (12.3)	.293
Operative time, min	145 (43)	147 (41)	.884
Fluoroscopy time, s	122.1 (41.6)	80.8 (36.7)	.003
Coronal plane reduction, °	3.17 (1.99)	2.52 (1.94)	.280
Sagittal plane reduction, °	4.58 (2.86)	2.90 (2.57)	.044
Radiographic follow-up, mo	11.1 (6.3)	12.4 (8.3)	.654
Rotation, cortical widths	0.25 (0.32)	0.31 (0.42)	.599

Table 3. Results of Oxford Knee Score by Question

	Approach		
Question	Infrapatellar	Suprapatellar	*P*
1	2.75	2.62	.749
2	3.83	3.57	.252
3	3.54	3.14	.176
4	3.17	2.91	.417
5	3.38	3.00	.220
6	3.17	3.19	.947
7	3.25	2.71	.133
8	3.29	3.33	.908
9	3.21	3.00	.571
10	3.42	3.29	.681
11	3.54	3.05	.158
12	3.54	2.91	.063

helps eliminate the deforming forces that cause malreduction of proximal tibial shaft or segmental fractures. However, our study was limited in that only 2 surgeons at our institution used the suprapatellar approach, and both were fellowship-trained in orthopedic traumatology. This situation could have introduced bias into the interpretation of fluoroscopy data, as these surgeons may have been more comfortable with the procedure and less likely to use fluoroscopy. Both surgeons also performed infrapatellar nailing during the study period, and there was no statistical difference in fracture patterns between the groups, thus minimizing bias.

This study was retrospective but had several strengths. Sample size met the prestudy power analysis to determine a minimally clinically important difference in OKS results. The investigator who administered the telephone survey was blinded to surgical approach. This study was also the first clinical study to compare outcomes of infrapatellar and suprapatellar nailing. However, the study's follow-up rate was a weakness. The patient population at our academic, urban, level I trauma center is transient. We lost 36 patients (45%) to follow-up; their telephone numbers in the hospital records likely changed since surgery, and we could not contact these patients.

Conclusion

Our retrospective cohort study found no difference in OKS between traditional infrapatellar nailing and suprapatellar nailing for diaphyseal tibia fractures. Suprapatellar nails require less fluoroscopy time and may show improved radiographic reduction in the sagittal plane. Although further study is needed, the suprapatellar entry portal appears to be a safe alternative for tibial nailing with use of appropriate instrumentation.

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This paper will be judged for the Resident Writer's Award.