

# A retrospective review of the rate of septic knee arthritis after retrograde femoral nailing for traumatic femoral fractures at a single academic institution

Ryan S. Bailey, MD, Benjamin A. Nwadike, MD\*, Thomas Revak, DO

**Background:** Retrograde intramedullary nailing of the femur is a popular treatment option for femoral shaft fractures. However, this requires accessing the intramedullary canal through the knee, posing a risk of intra-articular infection. The purpose of this study was to examine the rate of intra-articular infection of the knee after retrograde nailing of femoral shaft fractures.

**Methods:** All patients who underwent retrograde intramedullary nailing for femoral shaft fractures between June 2004 and December 2017 at a level 1 trauma center were reviewed. Six months of follow-up or documented fracture union was required. Records were reviewed for documentation of septic arthritis of the ipsilateral knee during the follow-up period.

**Results:** A total of 294 fractures, including 217 closed and 77 open injuries, were included. Eighteen had an associated ipsilateral traumatic arthrotomy; 188 cases had an associated ipsilateral lower extremity fracture. No cases of septic arthritis were identified.

**Conclusion:** There were no cases of septic arthritis in 294 fractures treated with retrograde intramedullary nailing. Retrograde nailing appears safe for risk of postoperative septic arthritis of the knee even in the face of open fractures and traumatic wounds.

**Key Words:** trauma, femur, infection, complications, retrograde, intramedullary nail, septic knee, arthritis, level 1 trauma center

## 1. Introduction

Femoral shaft fractures are a common orthopaedic injury with most occurring because of high-energy mechanisms but can also occur from low-energy falls namely in elderly populations. These fractures may be associated with additional injuries or multisystem trauma, posing many challenges to the treating orthopaedic surgeon. Numerous treatment options exist to stabilize femoral shaft fractures. The most common method is intramedullary nailing by an antegrade approach at the hip or by a retrograde approach at the knee.

Retrograde femoral nailing has gained popularity since its original description by Swionowski et al in 1984, in which an extra-articular approach to the distal femur was described.<sup>1</sup> This was later modified into an intra-articular, intracondylar approach as described by Patterson et al<sup>2</sup> in 1995. However, a common concern with retrograde femoral nailing is the

theoretical risk of knee sepsis. The risk stems from accessing the knee joint for nail placement which creates a potential conduit for infection between the knee joint, the environment, and the intramedullary implant. Furthermore, open fracture, contaminated wounds, and ipsilateral knee traumatic arthrotomy may pose additional risk of knee sepsis when associated with the retrograde technique. These additional vectors are sometimes viewed as relative contraindication to retrograde nail insertion.<sup>3–6</sup>

Previous studies on the subject are limited to small case series and retrospectively designed studies, with some reviews finding only 1–2 documented cases of knee sepsis for an overall rate of approximately 1%.<sup>3</sup> Halvorson et al<sup>7</sup> did not find any documented cases of septic arthritis, but estimated that overall incidence could be as high as 2% for closed fractures or up to 9% for open fractures treated with retrograde nailing. However, underpowered data and confounding patient or injury factors have made establishing a true incidence difficult.

The goal of the study was to determine the incidence of septic knee after retrograde femoral nailing of femoral fractures at a single level 1 trauma center and determine whether there is an increased risk of septic knee associated with open fractures, contaminated wounds, and ipsilateral traumatic arthrotomy of the knee. We hypothesized that the rate of knee sepsis would be low, less than 1 %, for both open and closed femur fractures.

## 2. Methods

After obtaining institutional review board approval, a retrospective review was performed to identify all femur fractures treated with intramedullary nailing, using CPT code 27506, from June 2004 to December 2017. Inclusion criteria were patients aged 18–90 years based on institutional guidelines. Additional inclusion criteria were patients with femur fractures treated with retrograde femoral nailing alone and at least 6 months of follow-up or documented

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*Department of Orthopaedic Surgery, Saint Louis University, School of Medicine, St. Louis, MO.*

*\* Corresponding author. Address: Department of Orthopaedic Surgery, Saint Louis University, School of Medicine, 1008 S. Sprind Ave, St. Louis, MO 63110. E-mail: Benjamin.nwadike@health.slu.edu*

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fracture union. Bilateral femur fractures were considered individually. Exclusion criteria included pathologic fractures, antegrade nailing or hybrid fixation, insufficient follow-up, or incomplete clinical documentation.

For patients meeting inclusion criteria, data were recorded for age at the time of injury and mechanism of injury. Fracture characteristics including laterality, closed or open fracture, presence of traumatic knee arthroscopy, and presence/type of ipsilateral lower extremity fractures were also recorded. Open fracture type was recorded according to the Gustilo and Anderson classification.<sup>8</sup> Additional soft-tissue injuries of the ipsilateral lower extremity were noted.

Follow-up notes and laboratory results were reviewed for documented signs of soft-tissue infection, including the presence of intra-articular infection of the knee. Knee aspirates were reviewed for cell count and culture; these were considered positive for intra-articular infection if a cell count of >50,000 or organisms were identified on Gram stain or culture results. Minor wound complications, defined as postsurgical wound problems treated with nonsurgical interventions such as local wound care and oral antibiotics, were recorded. Major wound complications, defined as postsurgical wound problems requiring operative intervention, were also recorded. Qualitative statistics were calculated and reported as incidences and percentages.

### 3. Results

Initial search yielded 935 fractures that had undergone intramedullary nailing of the femur during the study period. 138 fractures were treated with antegrade nailing and were excluded from review, yielding 797 fractures that had undergone retrograde intramedullary nailing. An additional 249 fractures were excluded for pathological fractures, for not being within the age range, and for incomplete documentation, yielding 548 fractures for review. Two hundred fifty-four fractures were excluded because they did not meet follow-up criteria. This yielded 294 fractures treated with retrograde intramedullary nailing, including 217 closed and 77 open fractures (Fig. 1).

The average patient age at the time of surgery was 44 years (range 21–90). There were more men than women included in the study overall, 191 and 103, respectively. The most common mechanism of injury was motor vehicle collision, totaling 165 (56.0%). Reported falls were the second most common mechanism of injury, with 42 in total (14.3%), followed by 32 motorcycle collisions (10.9%), 29 gunshot wounds (9.9%), 19 cases of pedestrian versus vehicle (6.5), 4 crush injuries (1.4%), and 3 industrial accidents (1.0). Seventy-seven fractures were open injuries (26.2%), with the most common open fracture type being Gustilo Type I (Table 1); fracture classification was based on documentation in the operative report. One hundred eighty-eight fractures (63.9%) had an associated ipsilateral lower extremity fracture; the most common associated ipsilateral injury was associated ipsilateral proximal femur fractures, followed by pelvic ring injuries and tibial shaft fracture. One hundred fifty-seven associated ipsilateral fractures were closed and 31 were open. The most common associated ipsilateral open fracture was tibial shaft fracture (Table 2). Eighteen fractures had associated ipsilateral traumatic arthroscopy of the knee with nail placement after operative irrigation and debridement. The average follow-up time was 15.4 months.

Eight knees (2.7%) were aspirated during the follow-up period due to suspicion for intra-articular infection. The aspirations were performed between 8 and 17 weeks postoperatively. All aspirations were performed for swelling, effusion, persistent

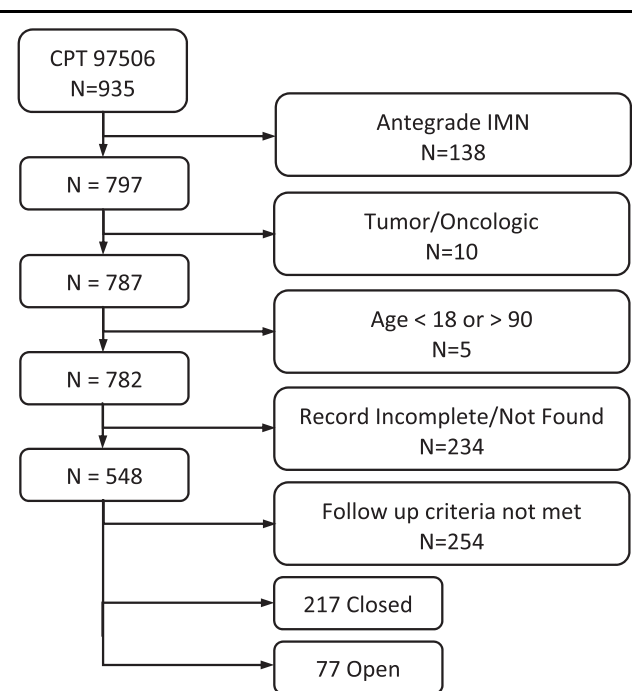


Figure 1. CPT code review and application of inclusion/exclusion criteria.

pain, erythema, or a combination of these factors. All joint aspirations performed were negative for septic arthritis, with cell counts less than 50,000 and negative cultures. No procedures were performed for a septic knee joint.

Fifteen minor wound complications (5.1%) were documented. Minor complications included a stitch abscess treated with local wound care, a superficial draining wound of the knee that was treated with local wound care after knee aspiration was negative, a slow-healing surgical knee wound also treated with local wound care, and a draining thigh wound noted 8 months postoperatively that was treated with wound care and antibiotics. Another patient continued to complain of thigh pain at late follow-up, and MRI of the extremity revealed a chronic Morel-Lavallée lesion. This was treated with observation. An additional patient developed a pin site infection around a previous external fixator pin site and was treated with wound care and oral antibiotics. No further intervention was required in all cases.

There were 3 (1.0%) major wound complications. One included a thigh degloving injury that later required flap coverage by plastic surgery. Another developed a thigh abscess, which was above the fascia and did not involve bone, 6 months postoperatively that was treated with irrigation and debridement and resolved with no further intervention. Another patient presented 2 months postoperatively with a superficial surgical knee wound dehiscence that was treated with irrigation and debridement with

TABLE 1  
Gustilo-Anderson Classification of Open Fractures

Type	Cases
1	41
2	26
3A	7
3B	2
3C	1
Total	77

**TABLE 2**  
**Associated Ipsilateral Lower Extremity Injuries**

	Closed	Open
Pelvic ring	26	0
Acetabulum	12	0
Proximal femur	28	0
Distal femur	6	0
Patella	9	7
Tibia plateau	10	2
Tibia shaft	13	10
Fibula	8	0
Tibia plafond	5	2
Ankle	15	3
Talus	5	3
Calcaneus	3	3
Foot	17	1
Total	157	31

knee aspiration; the results of the aspiration were negative. None of these cases developed septic arthritis of the knee.

#### 4. Discussion

Retrograde intramedullary nailing of the femur is widely regarded as an acceptable method of intramedullary fixation of the femur. Studies have demonstrated its clinical efficacy, including union rates and functional outcomes similar to antegrade nailing.<sup>9–12</sup>

Retrograde nailing confers multiple potential benefits in the treatment of femoral shaft fractures, one being the patient's supine position, which allows for expedient stabilization of a polytraumatized patient.<sup>13,14</sup> Retrograde nailing is also useful in obese patients where difficulty with proximal access to the hip can lead to increased complications.<sup>15</sup> Distal femoral shaft fractures can also be difficult to address with antegrade nailing, with one study demonstrating improved alignment for distal femoral shaft fractures that underwent retrograde nailing.<sup>12</sup>

O'Toole et al<sup>3</sup> retrospectively reviewed open femoral fractures treated with retrograde intramedullary nailing. Ballistic fractures were excluded. Ninety patients with 93 open fractures were reviewed. One case of septic arthritis was identified, corresponding to an infection rate of 1.1%. However, it was noted that the infection was identified at the time of repeat irrigation and debridement for a massive degloving wound with no skin coverage over the knee. They concluded that retrograde nailing of open fractures was relatively safe for risk of knee sepsis.

Halvorson et al<sup>7</sup> examined 185 femur fractures treated with retrograde nailing including 143 closed fractures and 38 open fractures. Four closed fractures had an ipsilateral knee traumatic arthroscopy. No evidence of septic arthritis was identified. They estimated, based on a Wilson confidence interval statistic, that the rate of septic knee after retrograde nailing was between 0% and 2% overall, 0% and 2.6% for closed fractures, and 0% and 9% for open fractures with 95% confidence. The authors noted that while these data trended toward a low incidence of knee sepsis in retrograde nailing, they could not state with certainty the true incidence of septic arthritis after retrograde nail placement.

Cannada et al<sup>16</sup> reviewed 73 patients with 74 femur fractures from gunshot wounds treated with retrograde intramedullary nailing. Thirty-five of the 73 patients were available for follow-up an average of 7 months after surgery. No cases of postoperative knee sepsis were identified in these 35 patients. Similarly, Poyanli et al<sup>4</sup> reviewed 15 patients with supracondylar femur fractures

due to gunshot wounds treated with retrograde nailing. None developed postoperative knee sepsis or osteomyelitis.

Another study by Dougherty et al<sup>17</sup> retrospectively reviewed 81 diaphyseal femur fractures treated with intramedullary nailing. Fifty-three fractures were treated with retrograde nailing and 28 with antegrade nailing. They found no statistically significant difference in the rate of complications. No cases of septic arthritis, defined as culture-positive aspirate of the knee or return to the operating room for debridement of the knee, were identified.

Other studies have examined the risk of intra-articular knee infection in patients treated with tibial intramedullary nailing by a suprapatellar approach. In principle, similar risk should exist with this technique of tibial intramedullary nailing because of its intra-articular approach. Maracek et al<sup>18</sup> compared knee sepsis risk between 142 infrapatellar and 147 suprapatellar approaches for intramedullary tibial nail placement. They identified 2 (1.36%) cases of septic arthritis after a suprapatellar approach compared with 0 cases with an infrapatellar approach, but the difference was not statistically significant. One case occurred after exchange nailing for deep infection after IIIB open fracture with the subsequent development of septic arthritis 1 month later. The other developed knee pain 1 week after a knee aspiration revealed septic arthritis. This same patient developed knee pain a month later significant for septic arthritis requiring arthroscopy and debridement. Mitchell et al<sup>19</sup> reviewed 139 open tibial fractures treated with a suprapatellar approach. No cases of knee sepsis were identified.

Bible et al<sup>20</sup> compared 34 retrograde and 24 antegrade femoral nails in patients with ipsilateral traumatic knee arthroscopy. There were no cases of knee septic arthritis in the retrograde group and one case in the antegrade group. They concluded that retrograde nailing could be performed safely even in the presence of an ipsilateral traumatic knee arthroscopy.

Our study identified no cases of postsurgical septic arthritis of the knee in 294 fractures treated with retrograde intramedullary nailing. Seventy-seven fractures were open, and 18 of these had concomitant ipsilateral traumatic knee arthroscopy, raising concern for potentially increased risk of infection with retrograde nailing. However, our study was unable to demonstrate any clinically proven infection in any of these cases. To the best of our knowledge, this is the largest single reported cohort examining intra-articular infection after retrograde femoral nailing. Prior literature suggests that the rate of septic knee after retrograde intramedullary nailing is low, and this study suggests that the true incidence may be even lower.

Limitations of this study include its retrospective design. The patient charts reviewed span a period of more than 10 years, and changes or inconsistencies in documentation (including migration to an electronic medical record system) may have confounded analysis. Functional outcome data were sparse and inconsistently documented and therefore not included for analysis. A certain amount of selection bias is also likely in patients who had sufficient follow-up. Patients with polytraumatic injuries including related orthopaedic injuries may be followed for a longer time by multiple services, giving disproportionate opportunity to capture clinical data on these patients compared with isolated femur fractures. The rate of adequate follow-up was also limited (53.6%), but this is similar to previous trauma literature. Potential bias also exists because knee aspirations were performed at clinician discretion without specific or documented criteria. This study, combined with prior related literature, demonstrates that larger and prospectively collected studies are needed to establish the true incidence of septic knee after this surgical procedure.

## 5. Conclusion

This review of retrograde femoral nailing at a single institution did not demonstrate any documented cases of subsequent septic arthritis of the knee after retrograde femoral nailing. To the best of our knowledge, this is the largest reported series examining this potential complication. However, our data suggest that the incidence is very low and retrograde nailing is reasonably safe for intra-articular infection, even in the presence of open fracture, contaminated wounds, or ipsilateral traumatic knee arthrotomy. This study, along with the established body of evidence, may eliminate septic arthritis as a relative contraindication for retrograde femoral nailing.

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