Chapter 4

The incidence of septic arthritis is low after retrograde nailing of femoral shaft fractures

Abstract

Introduction: Several concerns have been raised about retrograde intramedullary nailing of femoral shaft fractures, including septic arthritis. The purpose of this study was to evaluate the infectious complications in retrograde nailing of femoral shaft fractures, particularly the incidence of septic arthritis of the knee.

Patients and methods: All patients who have been treated with a retrograde nail for traumatic femoral shaft fractures between January 1998 and December 2012 were retrospectively reviewed. In this study, 120 patients with 134 femoral shaft fractures were included, including 25 open fractures. All nails were inserted without reaming. The minimal follow-up was one year in all cases.

Results: Septic arthritis was seen in one patient (0.75%; 95% CI: 0.04 – 4.7%) after a closed type B3 femoral shaft fracture. There was one case of osteomyelitis (0.75%; 95% CI: 0.04 – 4.7%) at the fracture site after a grade III open, type B3 femoral shaft fracture along with critical injury to the superficial femoral artery. This eventually resulted in an above knee amputation. There were no other cases of osteomyelitis, particularly not in the group of open fractures. Non-union was seen in 8 patients (6.0%; 95% CI: 2.8-11.9%).

Conclusion: The incidence of septic arthritis following treatment of femoral shaft fractures with retrograde nailing is low. This study shows that retrograde nailing is an acceptable treatment of femoral shaft fractures.
**Introduction**

Intramedullary nailing is the treatment of choice for stabilisation of femoral shaft fractures. Interlocking nails can be inserted via the antegrade or retrograde approach. Antegrade femoral nailing is a wide-spread technique and has demonstrated high rates of healing and low rates of infection and malunion\(^1\)\(^-\)\(^6\). Disadvantages of antegrade nailing of the femur include the risk of injury to the hip abductors or its nerve supply\(^7\), limited application of this approach to the combined ipsilateral femoral neck and shaft fractures, difficulty in finding the entry point, especially in obese patients\(^8\)\(^,\)\(^9\), the risk of heterotopic ossification around the hip\(^10\)\(^,\)\(^11\), and implant related pain\(^12\).

Retrograde nailing involves insertion of the nail through the intercondylar notch of the femur and may result in knee related complications, including infection, damage to the articular cartilage and persistent knee pain\(^11\)\(^,\)\(^12\). The advantages of retrograde femoral nailing include no need for a fracture table, ease of entry point, and accessibility for performing additional surgical procedures with the patient in a supine position\(^13\). It is also thought that retrograde nailing is faster than antegrade nailing\(^14\), although prospective randomised studies did not confirm this\(^12\)\(^,\)\(^15\). Retrograde nailing has been recommended in cases of polytrauma; ipsilateral pelvic, acetabular, tibial and femoral neck fractures; bilateral femur fractures; obese and pregnant patients\(^11\)\(^,\)\(^12\)\(^,\)\(^14\)\(^-\)\(^18\).

Several concerns have been raised about retrograde nailing, including the incidence of non-union, knee complications, malalignment, and shortening. We conducted this retrospective study primarily to evaluate the incidence of septic arthritis of the knee after retrograde intramedullary nailing of traumatic femoral fractures. Secondary endpoints were deep infection, osteomyelitis, nonunion and knee range of motion.

**Patients and Methods**

In a period of 14 years (1998 – 2012), 148 patients with 162 femoral fractures were treated with retrograde intramedullary nailing. Indications for retrograde nailing included polytrauma (thoracic injury, abdominal injury, and spinal injury); ipsilateral acetabulum, pelvis, tibia or femoral neck fractures; bilateral femoral fractures, and extreme adipositas.

Patients were excluded if they had a pathologic fracture (n=5) or insufficient follow-up data (n=23), including 10 patients who were transferred to other hospitals, 5 died in the early postoperative period (< 2 week), and 2 were excluded secondary to refusing follow-up visits.
All patients were skeletally mature. The remaining 120 patients had 134 traumatic femoral shaft fractures. Half of these patients had ipsilateral lower limb injuries (95.5% of them had ipsilateral fractures). A Distal Femoral Nail (DFN, Synthes®) was used to stabilise 53 femoral shaft fractures, an RAFN (Synthes®) in 42 femoral fractures, and an ACE nail (Depuy®) was used in the remaining cases. All nails were inserted without reaming. Primary dynamic locking was performed in 38 fractures. In these patients full weight bearing was permitted after wound healing. The nails were statically locked in 96 fractures. These patients were allowed progressively full weight bearing after 6 weeks.

Medical records and radiographs were reviewed by two authors (MM, DEJF). Variables that were retrieved included age, sex, mechanism of injury, associated injuries, injury severity score (AIS-ISS), AO/ATO type of fracture, degree of soft tissue injury, and type of used nail. For each patient, we specifically recorded septic arthritis, superficial (involving skin and subcutaneous tissues) and deep (involving deep tissues, e.g. fascia, muscle) infections, osteomyelitis, and non-union. Septic arthritis was defined as arthritis caused by any infectious organism. Osteomyelitis was defined as an inflammatory process, localized to the bone, accompanied by bone destruction and caused by an infecting microorganism. Non-union was regarded as failure of clinical and radiological union at 1 year. Minimal follow-up was 1 year in all cases. The knee range of motion (ROM) was obtained at the latest follow-up visit. The patients were followed at regular intervals with clinical and radiographs at 6 weeks, 3, 6, 9, 12 and 18 months postoperatively. Formal ethical approval and written informed consent were not required for this retrospective case series.

Descriptive statistics and 95% confidence intervals (95% CI), using the Wilson score interval, were calculated with the use of PASW Statistics for Windows, version 20.0 software (SPSS Inc., Chicago, IL).

Results

Demographics of the study population are presented in Table I. There were 85 male and 35 female patients with an average age of 39 years (range 16-88 years). Fractures were caused by traffic accidents in 95, by fall in 13, and by other causes in 12 patients. The mean injury severity score (AIS-ISS) was 18 (range 9-66). Fifty-six patients (47%) had an AIS-ISS≥16. According to the AO/OTA fracture classification system, we identified 47 type A, 59 type B,
Table I. Characteristics of the study group.

<table>
<thead>
<tr>
<th>Variable</th>
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<tbody>
<tr>
<td>Age (in years)</td>
<td>39 (range 16 – 88)</td>
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<tr>
<td>Injury Severity Score</td>
<td>18 (range 9 – 66)</td>
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<tr>
<td>Sex (M/F)</td>
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<tr>
<td>Mechanism of injury</td>
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<tr>
<td>- traffic accident</td>
<td>95</td>
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<tr>
<td>- fall from height</td>
<td>13</td>
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<tr>
<td>- other</td>
<td>12</td>
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<tr>
<td>Side of fracture (R/L)</td>
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<tr>
<td>Type of fracture</td>
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<td>- Closed</td>
<td>109</td>
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<tr>
<td>- Open</td>
<td>25</td>
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<td>- Gustilo grade I</td>
<td>10</td>
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<td>- Gustilo grade II</td>
<td>8</td>
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<tr>
<td>- Gustilo grade III</td>
<td>7</td>
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<td>AO/OTA classification</td>
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<tr>
<td>- A 1-3</td>
<td>47</td>
</tr>
<tr>
<td>- B 1-3</td>
<td>59</td>
</tr>
<tr>
<td>- C 1-3</td>
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</tbody>
</table>

and 28 type C fractures. Open fractures were seen in 25 patients. According to Gustilo open fracture classification, there were 10 grade I, 8 grade II, and 7 grade III soft-tissue injuries. Septic arthritis of the knee, which became first manifest after 2 years, was seen in one patient (0.75%; 95% CI: 0.04 – 4.7%). By that time, the fracture (a closed type B3 fracture) was healed. Intraoperative cultures were positive for Staphylococcus Areus. The same species was found in blood cultures in the early postoperative period due to peripheral vein suppurative thrombophlebitis. The DFN was removed, the intramedullary canal was reamed and surgical drainage of the knee was performed. Additional antibiotic treatment was given for 6 weeks. There was no persistent knee pain and the knee function restored completely, i.e. no extension deficit and flexion of 120°.
There was one patient (0.75%; 95% CI: 0.04 – 4.7%) with multiple injuries (AIS-ISS=25) who developed osteomyelitis at the traumatic site after a grade III open, type B3 femoral shaft fracture along with critical injury to the superficial femoral artery. This eventually resulted in an above knee amputation. A multidrug resistant Acinetobacter Baumannii was isolated from blood cultures. This specimen was also isolated from the open fracture site and the knee. In all other patients (n=118) there were no cases of osteomyelitis, particularly not in the group of open fractures (n=25).

Evaluating the fracture union process we observed the following. To promote union secondary dynamization was performed in 19 of the 96 initially statically locked fractures. In two fractures cancellous bone graft procedures had to be performed; one procedure after four months was needed to come to union in one fracture; in the second fracture with a critical bone defect of 8.2 cm several grafting procedures were needed to come to union (a period of longer than one year).

After one year eight non-unions (6.0; 95%; CI: 2.8 – 11.9%) were observed. There were three open fractures and five closed fractures, none was infected. Four of those eight non healed fractures were successfully treated with removal of the nail, bone grafting and plate fixation. In two non-unions the bone went on healing after reaming the intramedullary canal and inserting a thicker nail.

One patient needed several bone graft procedures to bridge a critical bone defect of 8.2 cm, as mentioned before, and one patient developed a non-infected non union of the right femur after a high energy trauma with multiple fractures of both lower limbs. This non-union has not been treated during the study period, because of the current treatment of an infected non-union of the other femur, a distal type 33-C2 femur fracture that was fixed primarily with an angular stable plate.

Knee range of motion was assessed in all patients, except the one who developed a deep infection which resulted in an above knee amputation. Of note, 60 patients (50%) had ipsilateral pelvis, acetabulum and/or lower leg injuries. Knee flexion ≥ 120° was seen in 115 knees (86%) and flexion < 120° in 18 (including 8 with knee flexion less than 100°). Eight of these 18 patients had an ipsilateral fracture of the limb, or an ipsilateral neurovascular injury. An extension deficit was seen in 9 knees (5 degrees in 6 knees, and 10 degrees in 3 knees).
Discussion

Retrograde nailing is an attractive alternative to antegrade intramedullary nailing of femoral shaft fractures. It has been recommended in cases of polytrauma; ipsilateral pelvic, acetabular, tibial and femoral neck fractures; bilateral femur fractures; obese and pregnant patients\textsuperscript{11, 12, 14, 16-18}. However, retrograde nailing may result in knee related complications. Septic arthritis of the knee is a major concern in closed as well as open fracture. Especially in open femoral fractures, an infection at the fracture site theoretically can lead to a septic arthritis of the knee. In our study, only one patient (0.75%) developed a septic arthritis after stabilization of a closed fracture which became first manifest after 2 years. We did not observe any septic arthritis of the knee after open fractures (n=25), including 7 cases with grade III soft-tissue injuries. These findings are comparable with those published by Halvorson et al\textsuperscript{28}. They retrospectively reviewed 185 patients with 143 closed and 42 open fractures, including 7 with gunshot wounds. All patients were treated with retrograde nailing. No cases of septic knee were found in the medical records.

The risk of a septic knee ranges from 0 to 2% in the literature\textsuperscript{12-14, 17, 20-27}. A systematic review literature showed that the overall incidence of infection in retrograde nailing is 1.1% and for septic arthritis of the knee 0.18%\textsuperscript{26}. This infection rate at the fracture site is comparable with antegrade nailing\textsuperscript{1-6}. Though views differ on the indication to retrograde nail an open femoral fracture, Ostrum et al recommended that grade III open fractures should not be treated with a retrograde nail to prevent septic arthritis of the knee\textsuperscript{20}. However, Leggon and Feldmann have treated 5 grade III-C open femoral fractures with a retrograde nail without this complication\textsuperscript{21}. They argued that the grade III-C open femur fractures are relative indications for the use of retrograde nailing, with minimal additional soft-tissue trauma. In another study, O’Toole et al identified only one acute septic knee after retrograde nailing in a series of 93 open femoral fractures, including 75 fractures classified as grade III open fractures\textsuperscript{29}. Four of these fractures were grade IIIC open fractures. Recently published studies, including just patients with gunshot femoral fractures, reported none of the patients developed a septic arthritis of the knee or osteomyelitis\textsuperscript{30-32}. These data suggest that a septic knee after retrograde femoral nailing is a rare event, even after an open fracture. To illustrate, the rate of knee infection after retrograde nailing of femoral fractures is comparable to that observed after arthroscopic anterior cruciate ligament reconstruction (0.3%-1.7\%)\textsuperscript{33}, and total knee arthroplasty (1%-2\%)\textsuperscript{34,35}.
The non-union rate in retrospective studies varies from 0 to 6% with retrograde nailing of femoral shaft fractures\textsuperscript{13, 20, 21, 23, 27}. The incidence of non-union in our study (6.0%) is comparable with the literature. Given the sample size of our study, the 95% confidence interval is wide. In addition, it seems that open fractures are associated with a higher incidence of non-union. We found a non-union incidence of 13.0% in open fractures, whereas in closed fractures the incidence was 4.6%.

Comparative studies failed to demonstrate any difference between antegrade and retrograde femoral nailing with respect to rates of union\textsuperscript{11, 12, 15, 24, 25}. However, several authors have reported that antegrade nailed femurs healed faster\textsuperscript{12, 24, 25}. Others did not find a difference in the time taken to achieve union\textsuperscript{15}. A recent review of the literature showed a 96% union rate after retrograde femoral nailing compared to 98% after antegrade nailing\textsuperscript{26}.

Reaming has been considered to stimulate fracture healing\textsuperscript{29}. However, to our best knowledge there are no comparative studies (reamed versus unreamed) with respect to retrograde nailing in femoral shaft fractures.

The majority of our patients (86%) had a range of knee flexion of at least 120 degrees. This is comparable to what has been reported previously\textsuperscript{13, 17, 23, 26}. Comparative studies reported no difference in the range of knee motion between antegrade and retrograde nailing of femoral shaft fractures\textsuperscript{12, 15, 24, 25}. Furthermore, Herscovici\textsuperscript{24} and Tornetta & Tiburzi\textsuperscript{15} did not find a difference in range of motion (ROM) of the hip either. Papadokostakis et al showed in a review that the mean ROM of the knee in patients with femoral shaft fractures was 127.6 degrees after retrograde nailing\textsuperscript{26}. There was also a small but significant greater ROM in patients with type A compared to type C fractures. In this study, we found no difference in ROM between these patients (data not shown).

Our study has limitations since it is a retrospective analysis. Included were mainly young multiply injured patients treated in one Level I trauma centre. Furthermore, the small number of patients precludes a definitive conclusion about the risk of septic arthritis following retrograde nailing of femoral shaft fractures. However, our findings indicate that there is a very low incidence of septic arthritis following treatment of traumatic femoral shaft fractures with retrograde nailing. Furthermore, only one case of osteomyelitis was seen, which occurred after a grade III open fracture with significant vascular injury. A high union rate was achieved. Combined with results described in the literature, we believe that retrograde nailing is an effective method in treating femoral shaft fractures, particularly
when supine position is preferred for treatment of other injuries as in polytraumatized patients. Even in open fractures or fractures caused by gunshots, retrograde nailing of these fractures seems a safe option.
References


