Knee Arthrodesis With an Intramedullary Antegrade Rod as a Salvage Procedure for the Chronically Infected Total Knee Arthroplasty

Abstract

Introduction: Infection is a challenging complication after total knee arthroplasty (TKA) that is often treatable. However, recurrent infection may require resection, amputation, or arthrodesis. The purpose of this study was to evaluate the results of antegrade nailing with an intramedullary rod for the treatment of a chronically infected TKA.

Methods: This study was a retrospective review of a consecutive series of 18 patients with chronically infected TKA treated with arthrodesis using a long antegrade intramedullary nail. There were 11 women and 7 men with an average age of 65 years and average body mass index of 33.8 kg/m². Patients had an average of 7.4 procedures before fusion, and mean follow-up was 50 months. One patient died in the early postoperative period, leaving 17 patients for evaluation. Fusion was defined radiographically as bony bridging of the joint surfaces visible on both anterior-posterior and lateral radiographs. Ambulatory ability, need for chronic antibiotic suppression, complications, and nail removal were recorded.

Results: Sixteen of 17 patients (94%) underwent successful fusion. Ten of 17 patients (59%) continued to ambulate with 9 of these patients requiring an assist device and 7 of 17 patients (41%) predominantly used a wheelchair. Chronic antibiotic suppression was used in 13 of 17 patients (76%). Two patients required nail removal (one for pseudarthrosis and one for possible total hip arthroplasty) and overall 8 of 17 patients (47%) had a complication. Six of 18 patients (33%) died within 2 years of their fusion procedure.

Discussion: Knee arthrodesis with an antegrade intramedullary nail is a viable treatment option for the chronically infected TKA. There was a high rate of successful fusion, along with a high rate of complications, mortality, and need for chronic antibiotic suppression.

Conclusion: Knee arthrodesis with a long IMN is a suitable treatment method as salvage for a chronically infected TKA, but

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Treatment of a chronically infected total knee arthroplasty (TKA) is a difficult clinical problem. Infection occurs in approximately 1% to 2% of primary and 8% to 10% of revision TKA patients. Treatment options for periprosthetic infection include antibiotic suppression, irrigation and débridement with component retention, one-stage exchange, two-stage exchange, resection arthroplasty, amputation, and knee arthrodesis. Arthrodesis is most commonly required for cases of chronic infection, particularly when the patient is immunocompromised, the infection is polymicrobial, or the organism is particularly virulent or resistant to antibiotics. Arthrodesis is also indicated in cases of significant bone loss, severe ligamentous instability, poor soft-tissue envelope, or deficient extensor mechanism.

Arthrodesis can be achieved by external fixation, compression plating, and modular or monoblock intramedullary nailing. All of these techniques have advantages and disadvantages, clinical scenarios were each may be preferred, but no one technique is clearly superior. However, intramedullary nailing is a commonly used method because it allows for rigid fixation and early weight-bearing. The downsides of long monoblock nails include the requirement for a second hip incision, potential infectious seeding of the hip, and common mismatch between canal diameters. Modular nailing lacks these drawbacks, but removal is difficult and can be associated with large amounts of bone loss. The senior author’s preference is long intramedullary nailing. In this study, a consecutive series of patients who underwent knee fusion as a salvage procedure for chronic infection were reviewed. All patients underwent fusion with the use of a long intramedullary titanium fusion nail. The purpose of this study was to evaluate the results and complications of this fusion technique.

Methods

After approval from our institutional review board, we retrospectively reviewed a consecutive series of 18 patients with a chronically infected TKA treated by a knee arthrodesis using an antegrade intramedullary nail (IMN) (Figures 1 and 2). These patients were identified by searching the institutional database and the individual surgeons’ records. Patients were included in the study if they underwent fusion with a long IMN for the treatment of a chronic periprosthetic joint infection. Patients were excluded if the fusion was performed for other diagnoses or a different technique was used. The chart review was performed by an orthopaedic resident at the senior author’s institution.

All patients underwent surgery with the T2 Stryker fusion nail (Kalamazoo, MI). This is a hollow titanium alloy nail that was placed antegrade through the femur with a piriformis starting point. These procedures were performed on a radiolucent table with the patient in slight or “sloppy lateral” position. The intramedullary canals were reamed with flexible reamers after passing a guidewire in either a retrograde or antegrade direction depending on the circumstances of the case. The bone ends were typically already cut relatively congruent for coaptation between them, given the previous knee replacements, and although efforts were made to maintain bone stock, freshening cuts were used as needed to create parallel surfaces. Compression was achieved through manual pressure and the compression feature of the nail was used if more compression was believed necessary. Autograft obtained from patella or femoral condyles was used to help fill any residual space in most cases. No additional antibiotics were added to the

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construct although antibiotic cement was occasionally used to fill additional space beyond the limits of available autograft. Patients were fused in slight flexion, valgus, and external rotation by using the parallel articular surface cuts. Rivaroxaban (3 patients) or coumadin (14 patients) was used for deep vein thrombosis prophylaxis.

Fusion was defined radiographically as bony bridging of the joint surfaces visible on both anterior-posterior and lateral radiographs. Clinical outcomes were determined by manual chart review of hospital and clinic notes and included ambulatory capacity, need for chronic antibiotic suppression, complications, and nail removal.

**Results**

Three surgeons at two institutions done the procedures between December 2004 and June 2013. There were 11 women and 7 men with an average age of 63 years (range 32 to 83 years old) at time of the fusion procedure. These patients had a mean body mass index of 33.8 (range 16.1 to 55.6), mean charlson comorbidity index of 4.3 (range 1 to 9), and had an average of 7.4 (range 5 to 13) previous surgeries on the knee before fusion. All patients had undergone 6 to 8 weeks of treatment with a static antibiotic spacer before fusion. The spacer in all cases consisted of antibiotic cement coated Steinman pins with antibiotic cement filling the remaining joint space. One patient died in the immediate postoperative period of hypotension and anoxic brain injury after a hypotensive episode during cement pressurization. The remaining 17 patients had a mean follow-up of 50 months (range 2 to 150 months). Five of these patients had less than 2-year follow-up because of death within this period.

Sixteen of 17 patients (94%) had a successful radiographic fusion. The patient without a successful fusion required nail removal for chronic infection and pseudarthrosis at 5 months postoperatively. This same patient was subsequently treated with a knee immobilizer and chronic antibiotic suppression. Overall, 13 of 17 patients (76%) were treated with chronic antibiotic suppression. The decision for chronic suppression was based on recommendations by the infectious disease service on a case-by-case basis and was dependent on the infecting organism’s susceptibility to oral antibiotics. The most common suppressive oral antibiotics were doxycycline, clindamycin, and cephalosporins. Infecting organisms included polymicrobial (8), methicillin-resistant staph aureus (5), methicillin-sensitive staph aureus (2), coagulase-negative staphylococci (1), and...
streptococcus (1). Methicillin resis-
tant staph aureus (MRSA) was pre-
sent in five of eight polymicrobial in-
fec tions. Ten of 17 patients (59%) con-
tinued to ambulate (all but one re-
quired an assist device) and 7 of 17 
patients (41%) predominantly used a 
wheelchair. Overall, 8 of 17 patients (47%) 
experienced a postoperative compli-
cation, with one patient of the origi-
nal 18 who died in the immediate 
post-op period. One complication 
was the previously mentioned patient 
who had pseudarthrosis secondary to 
persistent infection that required nail 
removal. Two of 17 patients (12%) 
required removal of a symptomatic 
distal locking screw. Another patient 
developed postoperative gastrointestinal 
Clostridium difficile infection and 
was readmitted for sepsis. One patient 
had their nail removed because they 
developed ipsilateral hip arthritis and 
had subsequent plans for total hip 
arthroplasty. However, cultures were 
positive at the time of removal with the 
same infecting organism as the knee 
(methicillin sensitive staph aureus 
[MSSA]), and therefore, it was pre-
sumed the hip was either seeded at the 
time of fusion or the nail acted as a 
conduit from the knee to the hip. The 
patient had an antibiotic spacer placed 
because of concern for infection at 
the time of surgery and eventually 
underwent permanent hip resec-
tion arthroplasty. Another patient 
required irrigation and débride-
ment at 2 weeks postoperatively 
for persistent drainage. Additional 
complications included a patient 
with a MRSA positive sacral ulcer 
and another patient who 
developed a contralateral knee 
periprosthetic infection with the 
same infecting organism as their 
fused knee (MRSA). In addition, 6 
patients of the original cohort of 18 
died within 2 years of their fusion 
surgery.

Discussion

This study retrospectively reviewed 18 
patients who had knee fusion done with 
an antegrade long femoral nail. There 
was a high rate of fusion (94%), but 
nearly half of the patients suffered 
a complication (47%), many lost 
their ambulatory ability (41%), and 
the majority continued treatment with 
chronic oral antibiotics (76%). Fur-
thermore, one-third of patients died 
within 2 years of their fusion surgery. 
These results suggest that this is a 
satisfactory technique for limb salvage of a 
recurrently infected TKA but associated 
with high morbidity and mortality.

There are a variety of ways to achieve 
knee fusion. One method is external 
fusion, which can be monoplanar, 
biplanar, or circular. Advantages to 
this technique include lack of intra-
medullary infection dissemination, 
ability to modify alignment, and poss-
sibility of simultaneous lengthening. 
However, disadvantages include pin 
loosening, pin site infection, difficulty 
with placement, and delayed weight-
bearing.10-14 Knee fusion can also be 
achieved with compression plating. 
This technique allows for a single 
icision and immediate compression 
inaudamentarily but often requires 
extensive soft-tissue stripping, pro-
longed limited weight-bearing, and 
limb stabilization.15 IMN fixation al-
loes for rigid fixation, early weight-
bearing, and seems to have quicker 
fusion and lower complication rates 
than the other techniques. Intra-
medullary fusion is achieved typically 
with either long monoblock or mod-
ular nails.7-9,14,16-19

The fusion rate in this study was 
comparable with other published 
reports of fusion with an IMN. Overall 
fusion rates for knee arthrodesis 
including all techniques range from 
around 50% to 100%.13,17-23 Leroux et 
al21 demonstrated the exact same fusion 
rate found in our study showing 16 
of 17 patients with chronic infection 
underwent successful knee fusion 
with the Stryker T2 nail. Bargiotas et 
al22 demonstrated successful 
fusion in 10 of 12 patients who 
underwent treatment with a long 
IMN because of chronic infection. 
Puranen et al24 showed an 87% 
fusion rate with the use of a long 
IMN, although only 15 of 33 pa-

tients had the procedure done for a 
failed arthroplasty (8 infection and 
7 aseptic loosenings).

Both this report and other similar 

studies suggest that fusion rates with 
IMN fixation are higher than with 
alternate techniques. Hak et al25 
reported a fusion rate 58% in pa-
tients treated with a monoplanar 
external fixator and 65% in patients 
treated with biplanar fixators. How-
ever, this lower fusion rate may be 

somewhat because of selection bias 
because more difficult patients can 
necessitate fusion with external fixa-
tion. Circular fixators have shown 
higher fusion rates with Manzotti et 
al26 reporting a fusion rate of 100%, 
and Oostenbroek and Van Roer-
mund13 reported a fusion rate of 93% 
in 15 patients. However, the compli-
cation rate in this study was 80%, and 
patients required treatment for an 
average of 51 weeks. Schwarzkopf 
et al16 directly compared fusion rates 
with multiple techniques (IMN, com-
pression plating, and external fixation) 
in a series of 41 patients, and although 
the numbers did not reach statistical 
significance, the patients treated with 
intradueullary nailing had the highest 
fusion rates. Mabry et al had similar 
findings in their study comparing 

knee fusion with intramedullary nai-
ling to external fixation. This study 
was underpowered to reach statistical 
significance, but intramedullary nail-
ling trended toward a higher rate of 
fusion.14

This study found these patients to 
have a 47% rate of complications, 
with 76% on chronic antibiotic sup-
pression and 33% dying with 2 years
of the procedure. Persistent infection was the etiology of the one pseudarthrosis and the difficulty in definitively clearing the infections was evident, given the high rate of chronic suppression. This is not surprising, given the multiple comorbidities, obesity, advanced age, multiple procedures, and virulent organism profile of the patients in this study. Persistent infection has been reported to occur in 10% to 21% of cases when an IMN is used for fusion.22,27-29 The rate was evidently, given the high rate of chronic suppression was much higher in our study likely because all of these patients were fused because of chronic infection. Furthermore, many patients had infections elsewhere in their body, particularly in those infected with staph aureus.

One limitation to this study was its retrospective nature, although this is a fortunately rare procedure, so prospective data collection is difficult. These results were with one technique for the treatment of chronic infection, and although this presents a clear view of the outcomes with this technique and implant, it may limit its applicability to other techniques. In addition, 6 of our 18 patients died within 2 years, which limited the long-term follow-up.

This study found a high rate of fusion in this difficult population of patients with chronic infection after TKA. However, the complication rate was high, as expected in this difficult and unhealthy population of patients. Persistent infection and need for chronic antibiotic suppression were commonly encountered. Polymicrobial and MRSA infection was prevalent. In addition, in one patient utilization of the nail effectively seeded the hip joint precluding subsequent arthroplasty. Overall, we feel that knee arthrodesis with a long IMN is a suitable treatment method as salvage for a chronically infected TKA, but patients should be counseled on the high rate of postoperative complications, poor ambulatory rate, likely need for suppressive antibiotics, and high mortality rate.

**Conclusion**

Knee arthrodesis with a long IMN is a suitable treatment method as salvage for a chronically infected TKA, but patients should be counseled on the high rate of postoperative complications, poor ambulatory rate, likely need for suppressive antibiotics, and high mortality rate.

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