

Unsatisfactory Outcome of Arthrodesis Performed After Septic Failure of Revision Total Knee Arthroplasty

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Background: Periprosthetic infection is one of the most dreaded orthopaedic complications. Current treatment procedures include one-stage or two-stage revision total knee arthroplasty. If the periprosthetic infection is no longer controllable after several revision total knee arthroplasties, many surgeons regard knee arthrodesis as a promising option. The aim of our study was to ascertain whether intramedullary nailing results in the suppression or eradication of an infection and to identify risk factors for persistent infection.

Methods: All patients who had undergone intramedullary nailing following septic failure of revision total knee arthroplasty between 1997 and 2013 were included in the study. Pathogens, risk factors predisposing to persistent infection, and the rate of persistent infections were recorded. In addition, a visual analog scale (VAS) and Knee injury Osteoarthritis Outcome Score (KOOS), Knee Society Score (KSS), Lysholm, Short Form-36 (SF-36), and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaires were completed to assess clinical outcomes and quality of life.

Results: Twenty-six patients were included in the study. Thirteen (50%) had a persistent infection requiring additional revision surgery. Nineteen patients (73%) reported persistent pain (VAS score of >3). All scores showed marked impairment of quality of life.

Conclusions: Intramedullary nailing following septic failure of revision total knee arthroplasty must be regarded with skepticism, and we cannot recommend it. Repeat revision total knee arthroplasty or amputation should be considered as an alternative in such difficult cases.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

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Periprosthetic infection is a serious complication of knee replacement. Infection eradication represents a challenge to both patients and surgeons¹⁻⁶. The problem is of economic importance for the health-care system, since the treatment of a periprosthetic infection is associated with substantial costs. Standard procedures include one-stage or two-stage revision arthroplasty⁷⁻¹⁰. Most authors prefer a two-stage revision arthroplasty with the placement of a static or mobile cement spacer⁸⁻¹³. Despite surgical debridement and systemic

antibiotic therapy, the recent literature has shown reinfection rates of 15% to 24% following revision surgery for periprosthetic infection, which is possibly due to the shift in the pathogen spectrum to multiresistant bacteria such as methicillin-resistant *Staphylococcus aureus* or *epidermidis* or vancomycin-resistant enterococci¹¹⁻¹⁷.

If the infection is not eradicated after a one-stage or two-stage revision total knee arthroplasty, permanent suppression therapy with antibiotics, amputation, or arthrodesis are treatment

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options. Because of the usually substantial bone defects and the critical situation concerning the blood supply to the bone adjacent to the joint following multiple debridement procedures, the ability to achieve primary bone fusion of the defect area is compromised¹⁸⁻²⁰. Therefore, cement-coated intramedullary nails are preferred, as they allow immediate and full weight-bearing by patients, who are often elderly with morbidities, and do not require osseous consolidation of the defect area. Moreover, the addition of antibiotics adapted to the resistance situation allows topical treatment of the infection^{21,22}.

A 2014 review by Wu et al. revealed a good success rate following intramedullary nailing done after failed total knee revision²⁰. The argument for intramedullary nailing was better infection control and early load-bearing of the extremity. One reason for the superior infection eradication might be the immobilization of the soft tissues by the arthrodesis, which enhances tissue integration. The counterargument is that bacteria on implant surfaces form a biofilm that protects them against antibiotic treatment. Implant movement therefore does not appear to play a role for the pathogens. If the focus of infection is not eradicated, the infection will persist irrespective of the type of implant.

The aim of this study was to ascertain whether intramedullary nailing results in the suppression or eradication of an infection and to identify risk factors for persistent infection.

Materials and Methods

The study had the approval of the local ethics committee (3846-08/13). Written informed consent was obtained from each patient.

Patient Selection

All patients who had received a cemented intramedullary nail after septic failure of several revision total knee arthroplasties in the period between 1997 and 2013 were included in this retrospective study. Age at the time of the operation, body mass index (BMI), health state, comorbidities, perioperative and postoperative complications, and type of pathogen were documented in the patients' record. The mean age (and standard deviation) was 68 ± 20 years, and the mean BMI was 31 ± 5 kg/m² (see Appendix). All patients were managed with the same arthrodesis technique. All patients completed questionnaires and/or were interviewed by telephone to determine their pain history and current clinical scores (Lysholm, visual analog scale [VAS], Knee injury Osteoarthritis Outcome Score [KOOS], Knee Society Score [KSS], Western Ontario and McMaster Universities Osteoarthritis Index [WOMAC], and Short Form-36 [SF-36]). All patients were evaluated with use of radiographs. Loosening was defined as the presence of a radiolucent line larger than 2 mm or as migration of the implants.

Operative Technique

All procedures were done in two stages. In the first operation, the implant and all cement remnants were removed. This was followed by a standardized radical debridement with removal of all macroscopically suspicious soft tissue and bone. In all cases, an antibiotic (gentamicin)-loaded spacer was implanted. In the second operation, the spacer was removed, repeat debridement of the soft tissues and bone was performed, and an arthrodesis nail was implanted with cement. The spacer was not premanufactured but formed by the surgeon during the operation and included 1 g of gentamicin and 1 g of clindamycin per 40 g of cement. Bone defects were managed with antibiotic-loaded bone cement and not reconstructed with allogenic or vascularized bone grafts.

Clinical Assessment

Reinfection or persistent infection was diagnosed on the basis of American Academy of Orthopaedic Surgeons (AAOS) recommendations^{23,24}. These included positive identification of pathogens in the joint-puncture fluid and an abnormal C-reactive protein (CRP) level and/or elevated erythrocyte sedimentation rate (ESR)^{23,24}. In addition, a persistent infection was deemed to be confirmed by the presence of a fistula and/or the positive identification of a pathogen²². Comorbidities, pathogen spectrum, previous surgical procedures, and surgery following intramedullary nailing were documented for all patients on the basis of their charts.

Source of Funding

No external funding was used for this study.

Results

Twenty-six patients were treated with intramedullary nailing after septic failure of several revision total knee arthroplasties in the period between 1997 and 2013. The most common pathogens resulting in reinfection were *S. aureus*, *Enterococcus faecalis*, or mixed infections with at least two different bacteria (see Appendix). The patients had undergone an average (and standard deviation) of 6 ± 3 procedures before definitive arthrodesis. In thirteen (50%) of the patients, one or more surgical revisions were necessary after intramedullary nailing because of reinfection or persistent infection. An above-the-knee amputation was done in three of these patients, the intramedullary nail was changed in nine, and a stable fistula was created in two. There were no cases of aseptic loosening of the intramedullary implant.

Nineteen of the twenty-six patients reported permanent pain (defined as a VAS score of >3) after definitive arthrodesis (see Appendix); thirteen of the nineteen patients had a score of >6, and six of the thirteen had a score of >8.

On average, the Lysholm score was 17 ± 12 points, the KSS score was 40 ± 25 points, and the WOMAC score was 39 ± 16 points (all out of a possible 100 points). The KOOS averaged 71 ± 17 out of a maximum possible 168 points. All scores were therefore less than 50% of the maximum number of points (see Appendix). The SF-36 score showed decreased values in all dimensions after the knee arthrodesis. With 100% being the maximum achievable score, physical functioning averaged 8% ± 13%; role-physical, 15% ± 34%; bodily pain, 26% ± 18%; general health, 34% ± 15%; vitality, 36% ± 18%; social functioning, 43% ± 26%; mental health, 50% ± 26%; and role-emotional, 17% ± 36% (see Appendix).

Obesity, hypertension, and diabetes mellitus were shown to be definite predictors of reinfection (see Appendix).

Discussion

Management of periprosthetic infection of the knee joint continues to pose a challenge to patients and surgeons. Many authors have proposed that, if the infection is not suppressed or eradicated after several revision total knee arthroplasties, arthrodesis is a promising procedure^{18,20,25,26}. This recommendation is not supported by the present study. The functional outcome scores revealed marked impairment of mobility and quality of life. Diabetes mellitus, obesity, and

hypertension were identified as significant risk factors for persistent infection.

Iacono et al. compared the results of intramedullary nailing with those of arthrodesis by means of an external fixator²⁷. Of twenty-two patients in the intramedullary nail group, 14% exhibited persistent infection. The VAS pain score averaged 1.2. The mean reduction in lower-limb length was 0.8 cm (range, 0 to 22 cm). In comparison, our study showed a more than threefold higher reinfection rate (50%) as well as an average VAS pain score of 6. The higher rate of persistent infections in our study may be the result of the nonstandard definition of infection prior to the AAOS consensus in 2010. Conversely, high infection-eradication rates in older publications should be analyzed critically with regard to the definition of a persistent infection.

The success rate of repeated two-stage revision total knee arthroplasties for the treatment of infection is lower than that after the initial revision attempt to eradicate the infection. Nevertheless, Azzam et al. showed that repeated two-stage revisions had a success rate of 78% in eighteen patients. When these data are compared with the results of the present study, in which the success rate of arthrodesis was only 50%, the outcome of repeated total knee arthroplasty exchange appears to be equivalent to, or better than, arthrodesis for treatment of persistent infections²⁸.

In a systematic review article, Wu et al. analyzed twenty-six papers in full after examining the literature on the treatment of periprosthetic infections of the knee joint and excluding inadequate reports²⁰. The included studies showed a mean success rate of 79% after two-stage revision total knee arthroplasty for the treatment of periprosthetic infection. In contrast, the success rate after knee arthrodesis, particularly with respect to achievable quality of life, was so high that revision arthroplasty would only have been superior to arthrodesis if its success rate had been $\geq 90\%$. Precisely because of the large disparity between the success rates of two-stage revision replacement among the studies, ranging from 33% to 100%, knee arthrodesis was considered to be the superior procedure in this meta-analysis²⁰.


It has been shown that, if an intramedullary nail is coated with antibiotic-impregnated cement, bacteria can form a biofilm on the cement^{29,30}. As a result of modern coupled prosthetic components, including distal femoral and proximal tibial replacements, no compromises in terms of debridement are

required today, even with a revision total knee replacement performed because of periprosthetic infection. So, once again, the intramedullary nail does not offer any biological advantage over revision replacement. In contrast, not only does the regular and desired reduction in limb length accompanied by joint stiffness impair the affected limb, but adjacent joints (hip, sacroiliac joint, and lumbar spine) undergo increased stress as well^{31,32}.

The main limitations of this study, like all other studies of knee arthrodesis for periprosthetic infection available in the literature, are the retrospective design and the limited number of cases.

In conclusion, on the basis of the results described, intramedullary nailing following septic failure of revision arthroplasty must be regarded with skepticism. Apart from a substantial rate of persistent infections, patients had substantial impairment of their quality of life associated with pain even when the arthrodesis had been successful in eradicating the infection. We therefore cannot recommend knee arthrodesis after septic failure of revision total knee arthroplasty. Repeat revision total knee arthroplasty or amputation should be considered as an alternative therapy in such difficult cases.

Appendix

 Tables showing patient demographics, functional outcomes, and predictors of reinfection are available with the online version of this article as a data supplement at jbj.org. ■

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