The Infected Total Knee Arthroplasty Part 2: Management Options

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This is the second in a 2-part series on infected total knee arthroplasty. Part 1 in the series, published in the January 2006 issue of *Hospital Physician*, reviewed evaluation, diagnosis, and classification of infection from a primary care physician's perspective. This article discusses management of total knee arthroplasty infection from a surgical perspective.

Once the diagnosis of deep infection has been established, a number of factors must be considered to determine the appropriate treatment: the duration of time between the index arthroplasty and the diagnosis of infection; the pathogen(s) responsible for infection and subsequent antibiotic sensitivities; host factors that may adversely affect successful treatment; status of the soft tissue envelope and the extensor mechanism; whether the arthroplasty is fixed or loose; and assessment of the patient's expectations and functional demands. Treatment goals for an infected total knee arthroplasty are eradication of infection, pain relief, and maintenance of a functional lower extremity. Secondary attempts to eradicate infection after a treatment failure are often hindered and adversely affected by progressive arthrofibrosis, devitalization of the soft tissue envelope, additional bone loss, and the possible development of antibiotic-resistant organisms. Therefore, it is important to achieve the best possible outcome with the first treatment attempt.

The 6 basic treatment options for an infected total knee arthroplasty include: (1) antibiotic suppression, (2) open débridement, (3) resection arthroplasty, (4) arthrodesis, (5) amputation, and (6) single-staged or 2-staged resection and reimplantation of another prosthesis.

TAKE HOME POINTS

- Factors that determine proper treatment for an infected total knee arthroplasty include time between index arthroplasty and diagnosis of infection, pathogen(s) responsible for infection, host factors, status of the soft tissue envelope and extensor mechanism, status of the arthroplasty, and patient expectations and functional demands.
- The gold standard for treating an infected total knee arthroplasty is delayed reimplantation (ie, 2-stage exchange).
- In select cases, single-stage exchange may provide excellent results.
- Treatment failure for an infected total knee arthroplasty (ie, a second infected total knee arthroplasty) greatly reduces the chance of obtaining a functioning total knee arthroplasty.
- Antibiotic suppression, resection arthroplasty, arthrodesis, and amputation have important but limited roles in the treatment of an infected total knee arthroplasty.

ANTIBIOTIC SUPPRESSION WITHOUT DEBRIDEMENT

In limited situations, suppressive antibiotic treatment alone may be reasonable and indicated when all the following criteria are met: (1) prosthesis removal is not feasible, most commonly because medical comorbidities preclude an operative procedure; (2) virulence of the microorganism is low and the microorganism is susceptible to an oral antibiotic agent; (3) antibiotics appropriate for suppression will not cause serious toxicity; and (4) the prosthesis is not loose.[1] Relative contraindications to chronic antibiotic suppression include the presence of other joint arthroplasties or other indwelling synthetic devices (eg, artificial heart valves or vascular grafts). In a multicenter study that evaluated treatment

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of 357 infected knee arthroplasties, infection was eradicated in 44 of 225 knees (19%) treated with systemic antibiotics alone.[2] The combined results of several series show that antibiotic suppression was successful in 24% of patients (62 of 261 knees).[1–5] The use of a combined oral regimen of rifampin and a quinolone has been reported to be more successful than treatment with a single antibiotic agent for deep periprosthetic infection from *Staphylococcus* species.[6]

It cannot be overemphasized that unless the long-term goal is antibiotic suppression without eradication of infection in a patient with a known organism, the practice of prescribing antibiotics empirically for patients with a potentially infected arthroplasty is strongly discouraged and typically only complicates future definitive treatment.

OPEN DEBRIDEMENT

Open débridement (ie, débridement with prosthesis retention) may be indicated for acute infection in the early postoperative period or for acute hematogenous infection of a well-fixed and well-functioning prosthetic component that is diagnosed within 2 to 4 weeks from the onset of symptoms. Suggested criteria for this treatment include a short duration of symptoms (preferably < 2 weeks), susceptible organisms, the absence of prolonged postoperative drainage or a draining sinus tract, and a well-fixed, well-functioning implant.[7] As previously mentioned, a contraindication for component retention may be the presence of other joint replacements or indwelling prosthetic or synthetic devices. When performing open débridement, it is imperative that all modular components be replaced (ie, polyethylene insert). This allows better access to perform a complete débridement and allows access to modular interfaces that may harbor microorganisms.

Overall, results of open débridement are not encouraging, with control of infection achieved in only 18% to 24% of patients.[1,2,8] The single most important variable for infection resolution is the duration of infection prior to surgical débridement.[7,9] In a subgroup of 34 patients who initially underwent débridement and prosthetic retention, infection was successfully controlled in 13 patients (mean time to débridement, < 5 days from the onset of symptoms) compared with 21 patients who required additional surgical intervention (mean time to débridement, 54 days).[9] A study by Mont et al[10] demonstrated better results; 10 of 10 knees treated for immediate postoperative infections and 10 of 14 hematogenously infected knees were infection-free at 48 months. The literature does not support the use of débridement with prosthetic component retention in cases of late chronic infection on a routine basis. Furthermore, multiple attempts at débridement and component retention to salvage the joint are typically counterproductive and lead to extensive periarticular scarring, making subsequent revision surgery more difficult and subjecting the patient to an undue number of procedures.

RESECTION ARTHROPLASTY

In cases of infected total knee arthroplasty, definitive resection arthroplasty is defined as implant removal with no intention of subsequent knee reconstruction. The ideal candidate for this procedure is a patient with polyarticular rheumatoid arthritis with limited functional demands who is likely to have difficulty eradicating infection and/or tolerating more than 1 surgical procedure. Resection arthroplasty allows the patient to sit more readily than does a knee arthrodesis. The primary disadvantage of resection arthroplasty is the frequent occurrence of knee instability and pain if the lower extremity is used for transfers or ambulation. This technique requires adequate initial débridement; removal of all infected and necrotic tissue and foreign debris; temporary fixation with pins, which helps to maintain alignment and apposition of the tibia and femur and assists with stability thus allowing fibrosis to occur; and immobilization with a cast for a minimum of 6 months to allow fibrous stability to develop. Although eradication of infection has been well documented with this technique, suboptimal functional results limit its use except in very select patients with limited ambulatory demands.

ARTHRODESIS

Arthrodesis has excellent potential for resolving infection, alleviating pain, and providing a stable joint; however, it precludes knee motion, making sitting and other associated activities more difficult. Contraindications to arthrodesis include significant ipsilateral hip or ankle arthritis, contralateral knee arthritis, contralateral upper extremity amputation, and severe segmental bone loss. Arthrodesis can be performed in patients with a high functional demand, single joint disease, young physiologic age, extensor mechanism disruption, a poor soft tissue envelope requiring extensive soft tissue reconstruction, systemic immunocompromise making successful aseptic reimplantation less likely, or infection with microorganisms that require highly toxic antibiotic therapy or are resistant to conventional antibiotics, and in patients who refuse amputation and are willing to accept a stiff, shortened lower extremity. Various of techniques have been used in knee arthrodesis, including the use of external

fixators, plate fixation, and intramedullary nail fixation.

The optimum position for knee arthrodesis is 10 degrees to 20 degrees of flexion to assist with foot clearance and prevent the need for hip circumduction during the swing phase of gait. However, the amount of knee flexion should be decreased proportionally to the amount of shortening of the leg. In the presence of substantial bone loss, knee position near full extension helps to maintain maximal extremity length and still allows foot clearance. When considering optimal positioning, most authors recommend 5 to 8 degrees of valgus and 10 degrees of external rotation. The use of soft tissue flaps in cases of a poor soft tissue envelope should be liberally considered to help minimize wound healing complications as well as the rate of reinfection, and to provide healthy, well-vascularized tissue to the arthrodesis area. Even with a successful arthrodesis, additional energy expenditure will be near 20%, and this may preclude some debilitated patients from realizing the full benefit of the arthrodesis.

SINGLE-STAGE EXCHANGE

Removal of an infected total knee arthroplasty followed by débridement and immediate reimplantation of a new prosthesis (ie, single-stage exchange) has limited popularity in North America. Success rates are lower for eradication of infection as compared with 2-stage exchange. In studies from the Endo-Klinic in Germany, 76 of 104 and 22 of 31 infected total knees were infection-free after a minimum of 2 years follow-up after single-stage exchange. Cure rates in these studies were only 73% and 71%, respectively.[11,12] The obvious advantage of this technique is the need for a single surgical procedure and the subsequent decreased costs and rehabilitation time associated with 1 operation.

More recently, however, more promising results have been seen. Buechel et al[13] showed a 90.9% success rate at an average of 10 years. These patients were treated with single-stage exchange, using adjunctive antibiotic impregnated polymethylmethacrylate (PMMA), 4 to 6 weeks of intravenous antibiotics, and 6 to 12 months of oral antibiotics. This technique may prove beneficial, but the bulk of the data still favors delayed reimplantation. Patients best suited for single-stage exchange include those who have a symptomatically loose prosthesis, patients who would not tolerate staged surgical procedures, or patients in whom long-term antibiotic suppression is possible in the event they fail single-stage exchange. This cohort of patients is typically the elderly patient with limited life-expectancy and a bacterial infection that is sensitive to a nontoxic oral agent.

2-STAGE EXCHANGE

Two-stage reimplantation (ie, prosthesis removal and delayed reimplantation) is the gold standard for treatment of late, chronic, periprosthetic knee infection. This technique provides the most predictable result for eradication of infection and has the advantage of improved functional outcome compared with arthrodesis, definitive resection arthroplasty, or amputation.[14–17] Contraindications for a 2-stage reimplantation include persistent infection following the initial débridement procedure, medical contraindications precluding an additional surgical procedure, and a poor soft tissue envelope not amenable to reconstruction around the knee. Although the absence of a functional extensor mechanism is also considered a contraindication to 2-stage exchange, for some patients total knee arthroplasty with a drop lock knee brace may be preferable to an arthrodesis or an amputation. Additionally, some surgeons will attempt extensor mechanism reconstruction at the time of reimplantation, but this remains controversial and is not well supported in the literature.

The most important treatment variables are the thoroughness of débridement with removal of all foreign material, including all cement, and a patient who is not immunocompromised. Other important treatment factors include a sufficient delay from the time of resection arthroplasty to the time of reimplantation; the appropriate type, duration, and route of antimicrobial therapy; use of local antibiotic-impregnated PMMA spacers; and use of antibiotic containing PMMA at the time of reimplantation. The use of an articulating antibiotic spacer may improve function between stages and possibly improve long-term functional outcomes. The ideal duration of time between the resection arthroplasty and reimplantation remains poorly defined; however, in a retrospective study by Rand et al,[14] 2-stage exchange was successful in only 8 of 14 patients (57%) in whom reimplantation was performed within several weeks of removal of the index implant. In a more recent study of 89 infected total knee replacements, the use of antibiotic-impregnated PMMA at the time of reimplantation was the only variable that correlated with cure of deep infection.[15]

The 2-stage exchange described by Goldman and colleagues[16] and Insall and colleagues[17] has been effective in the treatment of deep periprosthetic knee infections. During the procedure, the prosthesis and all nonviable tissue and cement are removed, soft tissues and bone are débrided, and an antibiotic-impregnated spacer is implanted. The patient is given 6 weeks of parenteral antibiotics, maintaining a minimum serum

bactericidal titre of 1:8, and a new prosthesis is then reimplantated. After the patient has been withdrawn from intravenous antibiotics for 7 to 10 days (before reimplantation), a normal erythrocyte sedimentation rate and C-reactive protein level are helpful to support eradication of deep infection. Using a similar protocol, results of 64 infected total knee arthroplasties demonstrated that 6 knees had become reinfected (only 2 with the same organism) at a minimum 2-year follow-up.[16] Including all reinfections, these results indicate an infection cure rate of 91%.[16]

Using an antibiotic cement spacer after thorough débridement helps preserve length of the leg by maintaining the prosthetic space and helps reduce soft tissue contractures. Additionally, if an "anterior flange" is placed near the anterior distal femur, excessive scarring of the extensor mechanism may be mitigated. Most importantly, the antibiotic spacer delivers high-dose local antibiotic therapy.[18,19]

The use of a block spacer, even if macrointerdigitated (ie, a match between bone surface and cement spacer) to prevent migration and erosion of the bone, still can allow excessive scarring to occur. To help minimize stiffness and scar formation, some authors advocate using articulating spacers. The PROSThesis of Antibiotic Loading Acrylic Cement (PROSTALAC) concept was first described by Masri et al,[20] but similar concepts were simultaneously developed by other authors.[21,22] Of 45 patients treated with 2-stage exchange using the PROSTALAC spacer, 41 (91%) were infection-free after a minimum follow-up of 20 months and a mean follow-up of 48 months.[21] Only 1 patient remained infected with the original organism, resulting in a cure rate for the original organism in 98% of patients. Additionally, Haddad et al[21] felt that the knee motion maintained between stages helped to facilitate the reimplantation procedure.

AMPUTATION

Amputation may be occasionally required for the management of an infected total knee replacement, but it is used as a last resort. It is typically indicated for life-threatening systemic sepsis, failed attempts at arthrodesis, cases in which the soft tissue envelope cannot be predictably restored, or in cases where the patient elects for amputation over arthrodesis or multiple surgical procedures. Amputation should be performed at a level that maximizes function, yet predictably eradicates infection. Following amputation, however, elderly patients may remain minimal ambulators or nonambulators due to the increased energy expenditure required for ambulation after amputation. Of 23 patients treated with above-knee amputation for failed total knee arthroplasty, only 7 patients reported being able to ambulate regularly; 20 used a wheelchair part of the day and 12 patients (55%) were confined to a wheelchair the entire day.[23] However, many of these patients may have been minimal ambulators even with reconstructive procedures.

CONCLUSION

Although infection of a total knee arthroplasty is a devastating complication, it can be treated. Goals and options for treatment should be carefully determined by the treating physician for the best possible outcome. Newer data provide some support for single-stage exchange, but 2-stage exchange is considered the gold standard of initial treatment of an infected total knee arthroplasty. Any failure of initial treatment almost assuredly excludes the patient from having a painless, functioning total knee arthroplasty. **HP**

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