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Treatment of infected total knee arthroplasty in patients with rheumatoid arthritis

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Abstract The primary aim of treating infected knee joints after total knee arthroplasty is to eradicate the infection, but this is difficult to achieve. We reviewed the treatment of infections that occurred after total knee arthroplasty in patients with rheumatoid arthritis. The subjects were 14 patients with rheumatoid arthritis (3 men, 11 women; ages 38–81 years) who had 14 infected knee joints. The outcome was preservation of the implant in two cases, revision arthroplasty in six cases, arthrodesis in three cases, resection arthroplasty in one case, amputation in one case, and death in one case. If there is no loosening, preservation of the implant should be attempted. If preservation is impossible, revision arthroplasty is the next best option considering the effect on daily activities in patients with the disease affecting multiple joints.

Key words Infection · Rheumatoid arthritis (RA) · Total knee arthroplasty (TKA)

Introduction

The results of total knee arthroplasty (TKA) in patients who have osteoarthritis (OA) or rheumatoid arthritis (RA) have improved with recent advances in implant materials, implant design, and operative techniques. The biggest problem that remains to be overcome is knee joint infection, both early and late. Because an infected joint may result in septicemia and even death, the first priority of treatment must be to eliminate the infection completely. However, eradicating infection from the knee joint after TKA is difficult. Treatment can be provided while preserving the implant or after removing it. If the implant is removed, the

options include revision arthroplasty, knee arthrodesis, resection arthroplasty, and amputation.

We review here cases of knee joint sepsis that occurred at our department in patients with RA who underwent TKA. Based on the relevant literature, we also discuss improvements in the treatment of infected TKA.

Materials and methods

Subjects

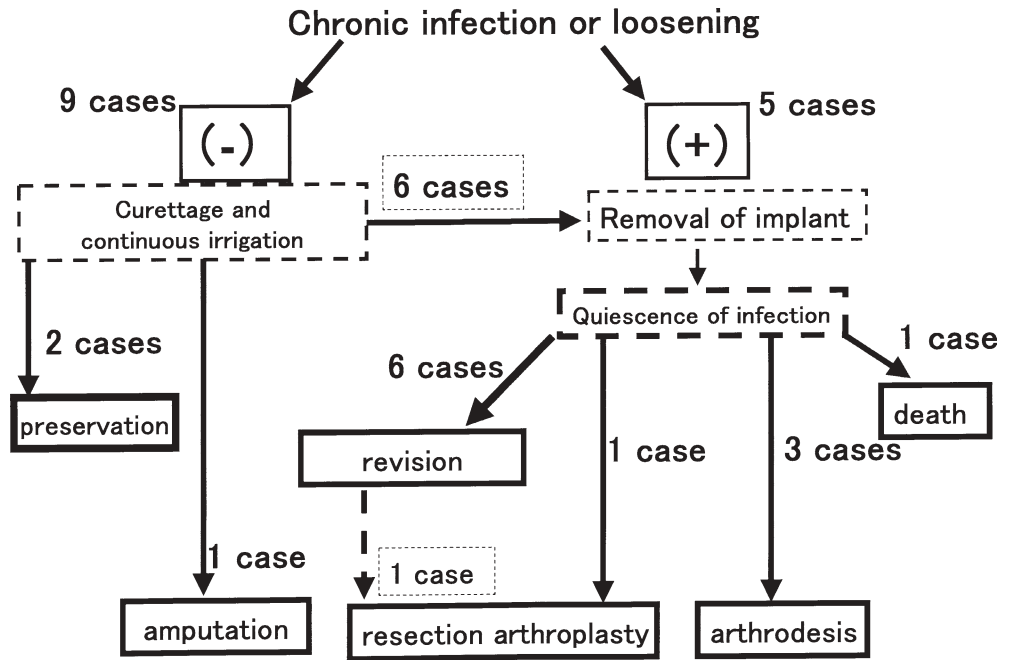
Among 869 TKA procedures performed in patients with RA and OA at this department between 1975 and December 2002 (491 RA joints, 378 OA joints), infection developed in 19 joints of 19 patients (12 with RA, 7 with OA). The overall infection rate in our series was therefore 2.2%, being 2.4% in RA patients and 1.9% in OA patients (1.7 times higher in the former than in the latter). One of the RA patients with infection after TKA was managed at another institution. We also treated four patients with infected knee joints who had undergone TKA at other institutions (three with RA and one with OA), so a total of 22 infected knee joints in 22 patients (14 with RA, 8 with OA) were managed at our department. The present study focused on the 14 patients with RA. Their ages at the onset of infection ranged from 38 to 81 years (mean 60.1 years), and there were 3 men and 11 women.

Methods

Our treatment policy for infected TKA is to attempt to preserve the implant if the infection is not chronic and there is no loosening. To preserve an implant, early detection is necessary, as is thorough early curettage of the infected areas and continuous irrigation. When the infection persists, we remove the implant and perform further curettage and irrigation or insert antibiotic-impregnated hydroxyapatite. Once bacterial eradication has been achieved, we perform revision arthroplasty whenever possible. When a

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Fig. 1. Our treatment algorithm for infected total knee arthroplasty (TKA) and the results obtained



revision procedure cannot be done, the choice is either arthrodesis, resection arthroplasty, or amputation (Fig. 1).

The treatment of choice is arthrodesis, which provides maximum support with minimum pain. The following parameters were investigated: use of disease-modifying anti-rheumatic drugs (DMARDs) and corticosteroids, the type of prosthesis used for initial TKA, the use of bone cement, the time from TKA to the onset of infection (onset within 3 months after surgery was defined as early infection), the causative organism(s), the interval from onset of symptoms to admission and surgery, the outcome of the treatment, the number of procedures and pathogens stratified by the therapeutic technique, the time until resolution of infection, and the final outcome.

Results

Four patients were taking DMARDs, and nine were on corticosteroids. The implant used for initial TKA was a Kinematic in five cases, a Kinemax in three, a Total Condylar in two, and a NexGen, MG-II, or Keiou in one case each (it was unknown in one patient). Bone cement was used in almost all patients, and there was only one hybrid TKA with a cementless femoral component.

The interval between the procedure and the onset of infection ranged from 5 weeks to 23 years (average 5 years 4 months). There were 2 cases of early infection and 12 cases of delayed infection. The causative organism was *Staphylococcus aureus* in five cases, methicillin-resistant *S. aureus* (MRSA) in five, *Streptococcus pyogenes* in one, *Staphylococcus coagulase* in one, and *Escherichia coli* in one; cultures were negative in one case.

The time from the onset of symptoms to admission and initial treatment at our department ranged from less than

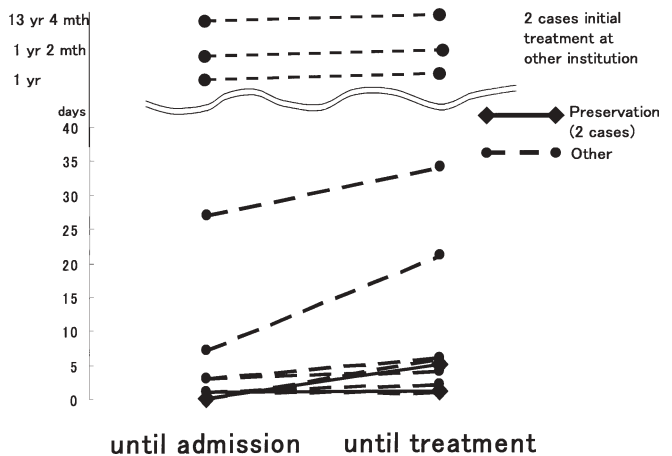


Fig. 2. Time from the onset of symptoms to admission and from the initial surgery (day 1) to 13 years 4 months of age. In 58.3% of our patients, admission and initial surgery occurred within 6 days. Implant salvage was difficult to achieve if the initial surgery was delayed

1 day to 13 years 4 months, with 58.3% of patients being admitted within 6 days. Preservation of the implant was difficult when initial treatment was delayed (Fig. 2).

Implant preservation was possible through curettage and continuous irrigation in two cases. Revision arthroplasty was performed in six cases, arthrodesis in three cases, and resection arthroplasty in one case. Amputation was necessary in one case, and death occurred during treatment in one case. Curettage and continuous irrigation was performed for a period of 2 weeks using the Hamano continuous-perfusion tube. The implant preservation rate was 14.3%. The causative organisms in the two patients whose implants could be saved were *S. pyogenes* and *S. aureus*, respectively, with one case each of early and delayed infection. Both patients presented to the hospital

soon after the onset of symptoms, and continuous irrigation was started within 5 days of the onset. All revision procedures were performed within 4 months of achieving bacterial clearance. The times between the onset of infection and implant removal or revision for the six patients who underwent revision arthroplasty are shown in Fig. 2. There was recurrence of infection in three cases (Fig. 3). The implant used for the revision procedure was the Kinematic rotating hinge in two cases. The Deltafit modular, Omnifit long, Scorpio total stabilizer, and Kyocera were used in one case each.

The causative organisms in the joints that required arthrodesis were MRSA in two patients and *S. aureus* in one patient, with one case of early and two cases of delayed infection. More than 2 years elapsed from the onset of symptoms until arthrodesis was performed. External fixation was employed to achieve arthrodesis in two patients. In the third case, medullary allogenic bone grafting was done, and the joint was immobilized in a plaster cast. The patient who underwent resection arthroplasty presented for the

first time 13 years 4 months after the onset of infection. Despite the presence of a fistula, there was little discharge and cultures were negative. Revision was ruled out because of the long duration of the infection, so resection arthroplasty was performed at the patient's request. Amputation was required in a 74-year-old bedridden woman with mutilans RA who developed infection 23 years after TKA. After a supracondylar fracture of the femur, bone union had been achieved, but decubitus ulceration caused by the fixateur led to infection with MRSA. Continuous irrigation was performed from 6 days after the onset of infection, but the affected region continued to expand, and amputation was performed to prevent septicemia.

We examined the relation between the method of treatment, the number of procedures, and the causative organisms. When the implant was preserved, only one operation was performed and there were no MRSA infections, whereas the number of procedures was higher when revision arthroplasty or arthrodesis was performed. There was an average of 4.4 procedures in patients with MRSA and 3.2 procedures in patients with other strains of *S. aureus* (Fig. 4).

The time required for resolution of the infection was longest for *S. aureus*, being an average of 2 years (3 months to 4 years 10 months). In patients with MRSA it was an average of 2 years 7 months (1 month to 6 years 6 months), whereas it was 3 months for *S. pyogenes*, and 8 months for *S. coagulase*. The interval was 13 years 9 months for the culture-negative case. The patient with *E. coli* infection died from heart failure during treatment.

Recurrence of infection was seen in three patients after revision arthroplasty. In two of them, reconstruction of the patellar tendon was done with a synthetic ligament graft at the time of revision. In both patients there was some delay after the onset of infection until removal of the original implant, and revision was performed only 1 month after bacterial clearance in one of them. The recurrent infection was caused by *S. aureus* in two cases and MRSA in one case.

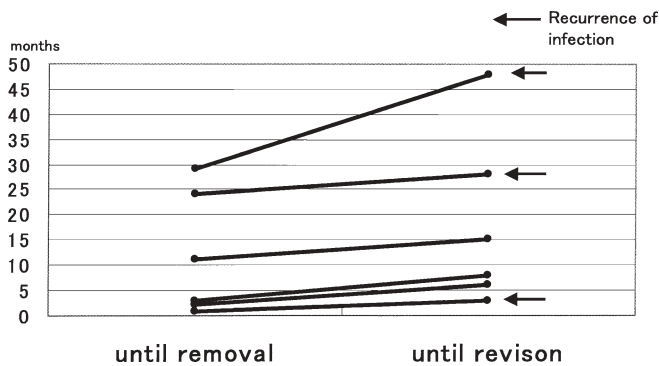
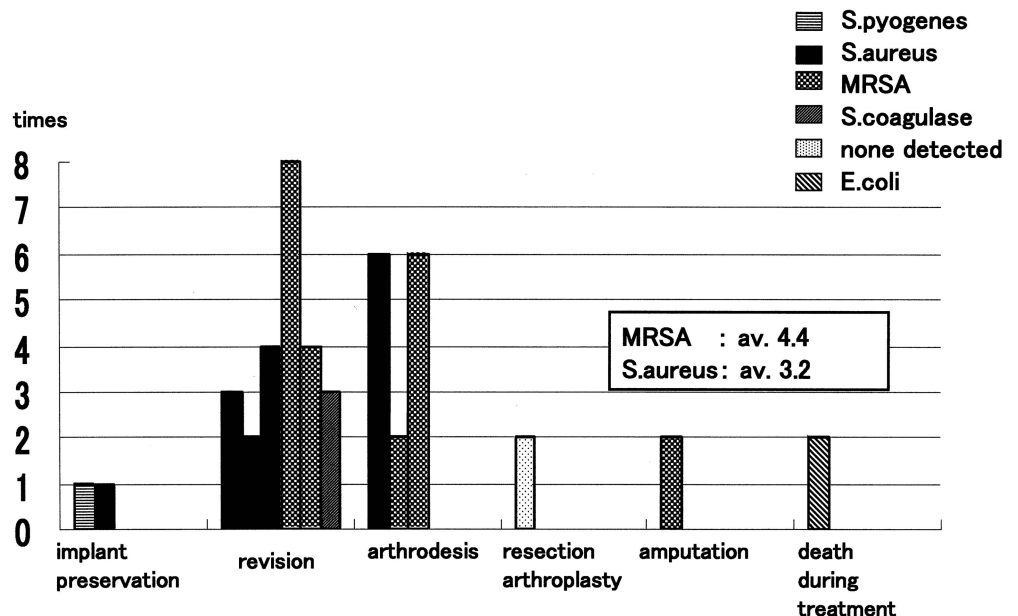


Fig. 3. Time from detection of infection to implant removal and revision arthroplasty. There was a recurrence in six joints (42.9%). Implant removal was delayed in two joints with recurrence of infection. In one case of recurrence, revision was performed only 1 month after implant removal and clearance of infection

Fig. 4. Number of operations and causative organisms in relation to the treatment modality. There were more operations in patients undergoing revision arthroplasty or arthrodesis, and in those with a methicillin-resistant *Staphylococcus aureus* (MRSA) infection. The salvaged joints did not have an MRSA infection. *S. pyogenes*, *S. aureus*, and *S. coagulase* were all staphylococcal infections. *E. coli*, *Escherichia coli*



In a patient with recurrent infection 5 years 10 months after revision, the synthetic patellar tendon graft was removed, but a fistula persisted. In a patient with recurrent infection at 6 months after revision, resection arthroplasty was performed to remove the second implant, and the infection became quiescent after 8 months. In another patient, dehiscence of the sutures occurred after the revision procedure. Although the defect was repaired using a musculocutaneous flap, purulent discharge developed 6 weeks after revision, and there was a persistent fistula.

During follow-up, 6 patients died at a mean age of 64.3 years (range 57–77 years). The cause of death was heart failure in five cases and pneumonia in one case, with no deaths due to septicemia. The follow-up period since the last procedure ranged from 4 months to 18 years 9 months in the eight surviving patients. Using the Fujibayashi classification of walking impairment,¹ one patient is at level 3c, two are 3d, two are 4b, one is 4c, and two are 4d. The walking impairment is secondary to cerebral infarction in one of the two patients at level 4d, and the other patient was bedridden before the onset of knee joint infection.

Case study

The patient was a 59-year-old woman with an MRSA infection. She underwent right TKA using the MG-II prosthesis with cemented femoral and patellar components. The onset of infection was detected 6 years 5 months after TKA. Curettage and continuous irrigation was commenced 4 days after the onset of symptoms. A radiolucent area was detected on plain radiographs obtained at admission, but no loosening was seen, so the implant was preserved. Infection recurred 3 months after the initial treatment, however, and further curettage and continuous irrigation failed to achieve a response. Accordingly, the implant was removed 11 months after the onset of infection, and antibiotic-impregnated hydroxyapatite (HA) was inserted into the joint. Cultures subsequently became negative. Four months after the insertion of HA, a two-stage revision was done using a Kinematic rotating hinge. At 3 years postoperatively, this patient is able to walk with the aid of a single stick, the range of motion of the right knee is 0°–110°, and she is at Fujibayashi level 3d (Fig. 5).

Discussion

The incidence of infected TKA is estimated to range from 1% to 2%.^{2,3} It is 1.5–2.0 times more common in patients with RA than with OA,³ as was also the case in our series. A satisfactory outcome was achieved in most of our 14 patients with infected TKA. Each of the therapeutic methods is reviewed next.

Implant preservation

The success rate of implant preservation is estimated to range from 27% to 40%.^{3–6} (The preservation rate in our

series was low, only 14.3%. Burger et al. set the conditions for successful implant preservation as thorough débridement and antibiotic administration plus the following four criteria⁷: (1) a short duration of symptoms (<2 weeks)⁸; (2) nonresistant Gram-positive bacteria as the causative organisms; (3) no prolonged postoperative wound discharge or joint swelling; and (4) no loosening of the implant and no evidence of infection on plain radiographs.^{4,9} Burger et al. believed that preservation is possible after prompt treatment of infections due to Gram-positive bacteria. Others recommend implant preservation only if the time between the onset of symptoms and surgical treatment is extremely short (2–5 days).¹⁰ Optimum management requires educating patients to visit the hospital as soon as they experience symptoms of infection and a system that allows the commencement of treatment immediately after the onset. Success rates have been reported to be higher with streptococcal infection than with *S. aureus* infections³ and are higher with acute infection.⁴

Bacteria can form a biofilm on biological prostheses, leading to an extremely high rate of resistance, which is some 500–5000 times that of free bacteria.¹¹ When infection is not controlled by administration of antimicrobial agents and continuous irrigation, preservation of the implant is difficult because of the presence of such a bacterial biofilm, and removal becomes necessary.¹²

In our two cases of successful implant preservation, treatment was commenced within 5 days after the onset of infection. The time of onset after surgery had no influence, with one early and one delayed infection. In our series, a waiting period was adopted for some patients, but this was in retrospect, and treatment should have commenced immediately after infection was suspected. When bony radiolucency is seen on plain radiographs or when the infection fails to settle after continuous irrigation, it is better to aim for a revision procedure than persist uselessly with attempts to preserve the implant. Early removal is preferable to shorten the overall treatment period. If the causative organism is MRSA, implant preservation is more difficult and early removal is generally required. In the case presented above, prompt treatment led to favorable progress at first. In patients with MRSA infection and bony translucency on plain radiographs, however, it is difficult to avoid removal even if there is no loosening at the beginning.

Revision

The best treatment for chronic infection is often reported to be a two-stage revision procedure.^{13–16} In patients with MRSA infection and those in whom infection cannot be controlled while preserving the implant, it should be removed promptly with a view to a subsequent revision procedure. Opinions vary as to the waiting time between removing the initial implant and the revision procedure, and a consensus has yet to be established. The results of revision after too short a waiting period are reported to be poor.¹⁷ The incidence of recurrent infection varies inversely with the waiting period, and some recommend that revision

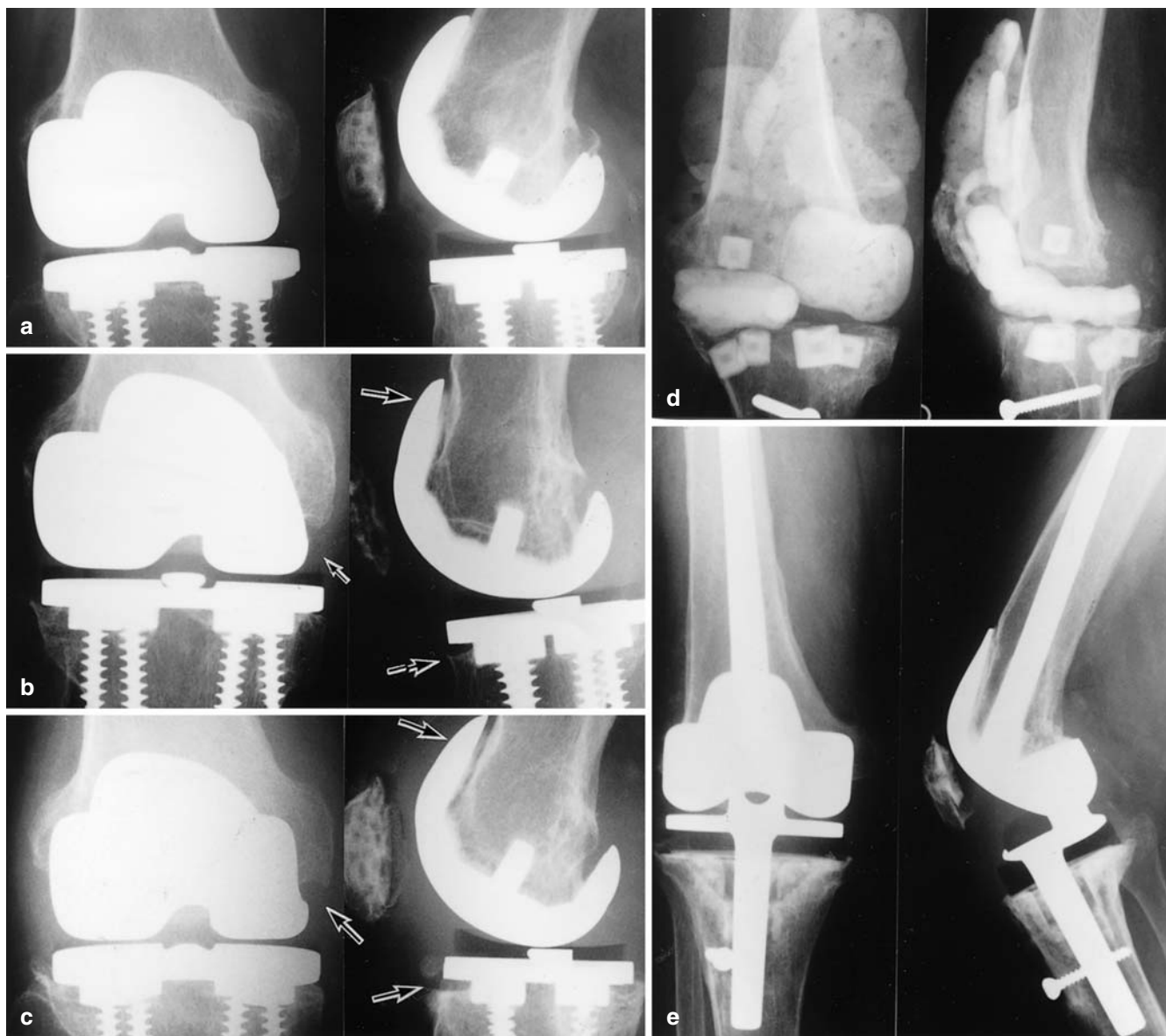


Fig. 5. Plain radiograph of a 59-year-old woman with MRSA infection (arrows) showing bony radiolucency. **a** Immediately after TKA. **b** At the onset of infection, bony radiolucency can be seen. **c** At the time of

implant removal, the area of radiolucency is enlarged. **d** After implant removal and insertion of antimicrobial-impregnated hydroxyapatite and a cement spacer. **e** After revision arthroplasty

be performed about 1 year after removing the initial implant.⁹ A long waiting period decreases the recurrence of infection but increases the overall treatment period as well as the patient's discomfort and expenses. Furthermore, the bones become brittle and the muscles contract in the affected leg, so a longer period of rehabilitation is required after the revision procedure. Satisfactory results have been reported with a waiting period of around 6 weeks.¹³ At present, we employ a 2-month waiting period after bacterial clearance.¹⁸

Another problem with two-stage revision procedures is the widespread development of adhesions and fibrosis during the waiting period. To counteract this problem, a cement spacer impregnated with antimicrobial agents is inserted to maintain the soft tissue balance and bathe the

area in the antibiotics, thereby extending the appropriate time until the next procedure. The diffusion rates of antimicrobial agents vary with the type of cement used, and although the fatigue strength is reduced there are thought to be no other adverse effects.¹⁹ The only drawback is that some cement remains at the site of insertion and may act as a foreign body. Newer spacer blocks have been reported recently.²⁰ At present, we insert several antimicrobial-impregnated HA blocks into the medullary cavity and insert antimicrobial-impregnated bone cement (cut to size) into the joint space to prevent adhesions. The reported success rates for two-stage revision procedures are satisfactory, ranging from 57% to 100%.^{5,13-15,21} Wang et al. reported an infection recurrence rate of 9.4%.²²

Hasegawa et al. reported that the time between the onset

of infection and curettage of the lesion was extremely long in cases of recurrence and emphasized the importance of carrying out surgical treatment as soon as possible.²³ In our series, implant removal was delayed in the two patients with infection recurrence, with the result that widespread joint débridement was also delayed.

Compared with the initial TKA, there are a number of technical difficulties associated with reimplantation procedures, such as the choice of prosthesis, the method of approaching the joint, and the handling of bone defects.²⁴ Postinfection revision procedures that follow bony curettage are performed with little bone stock and therefore require extensive bone grafting (autografts or allografts). The choice of prosthesis (e.g., wedge or hinged) is also important.²⁵ We generally use a stem extension or wedge prosthesis for a posterior-stabilized knee prosthesis but also have hinged prostheses on hand. The final choice is made intraoperatively.

The recurrence rate of infected TKA is 4.7% after treatment using cement impregnated with antimicrobial agents versus 28% without such cement, indicating the effectiveness of this treatment.²⁶ We use cement containing amikacin sulfate (400 mg/40 g) in our revision procedures.

Knee arthrodesis

Arthrodesis has several advantages over other treatment methods in that only one procedure is needed, the knee joint supports weight well, and a stable lower limb is achieved with relatively little pain. The disadvantages of arthrodesis are that (1) the limb is shortened (causing a discrepancy in leg length); (2) there is loss of function because the knee remains permanently extended; (3) there is a risk of incomplete bony union; and (4) the effort of walking is increased. The procedure is also made more difficult by the lack of bone stock following implant removal, and prolonged rehabilitation is required. Low levels of patient satisfaction are reported, even after successful knee arthrodesis.²¹ Morry et al. reported a 6% recurrence rate for infection following arthrodesis,² whereas we had no recurrences in our series. If the infection is quiescent at the time of the procedure, intramedullary rods can be used, but external fixation is considered safer in the presence of active infection.⁴ In our series, bony union was achieved in two patients using bone autografts and external fixation. The other patient was treated with bone allografts to the knee joint and immobilization in a plaster cast, but it was difficult to achieve complete immobilization.

Resection arthroplasty

The advantages of resection arthroplasty are its relatively low invasiveness and simplicity, as well as the short treatment duration and the likelihood that infection will resolve. Some authors add that slight movement is maintained at the knee and that it is possible to perform arthrodesis subsequently.²²

The disadvantages are that fixation is required because

of the pain and instability associated with the creation of a pseudoarthrosis. Hence, this treatment generally fails to provide satisfactory results.^{9,27} When revision is a possibility, resection arthroplasty seems to be unacceptable as the final treatment.⁹ Rand reported that patient satisfaction ranged from 20 to 83% after this procedure, and Kaufer et al. reported that only 14 of 28 patients were able to walk.²⁸

We believe that this procedure¹⁶ should be reserved for elderly patients, RA patients with destruction of multiple joints in whom knee joint function is not particularly important, and patients with recurrent infection following a revision procedure.⁴ In our patient who underwent resection arthroplasty, the functional outcome was Fujibayashi level 3c, and the patient was satisfied with the result.

Amputation

Amputation is appropriate only in patients at risk of death, those with intractable pain, or those with massive bone defects. Even with early fitting of a leg prosthesis, only one in three patients is able to walk after amputation.²⁹ Patients with above-knee amputation are said to expend at least 140% more energy than normal when walking. The reported amputation rate in patients with an infected TKA is 6%.³⁰ In our series, the rate was slightly higher (7.1%), but it represented only one patient. The patient was bedridden before infection occurred, and amputation was successful in preventing septicemia. Although amputation provides rapid control of infection, this method should be the last resort for patients with extensive, life-threatening infection.

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