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Synovectomy, debridement, and continuous irrigation for infected total knee arthroplasty

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Abstract Since 1990, a total of ten joints in nine patients with infected total knee arthroplasty have been treated in our department within 21 days of the onset of infection. Their radiographs showed no evidence of implant loosening or “moth-eaten” appearance. They underwent synovectomy, debridement, and continuous irrigation without implant removal. Continuous irrigation was maintained for 7–29 days. It was possible to retain implants in eight joints of seven patients. Two joints of two patients were removed. Pain disappeared in all eight joints in which the implants were retained. Four patients could walk with one cane; one patient could walk with one crutch. Range of motion in five joints remained over 100°. We recommend synovectomy, debridement, and continuous irrigation to cure an early stage infection of total knee arthroplasty.

Résumé Depuis 1990, dix articulations chez neuf malades avec une arthroplastie totale infectée du genou ont été traitées dans notre département dans les 21 jours après le début de l’infection. Les radiographies n’ont pas montré de descellement d’implants ou d’anomalie de la texture osseuse. Ils ont subi synovectomie, débridement et irrigation continue sans ablation de l’implant. L’irrigation continue a été maintenue pour sept à 29 jours. Il a été possible de conserver les implants de huit articulations chez sept malades. Deux articulations de deux malades ont subi l’ablation de l’implant. La douleur a disparu de toutes les articulations ou les implants avaient été conservés. Quatre malades devaient marcher avec une canne et un avec une béquille. L’amplitude de mobilité est restée au-dessus de 100° pour cinq articulations. Nous recomman-

dons la synovectomie, le débridement et l’irrigation continue pour traiter une infection précoce d’arthroplastie totale du genou.

Introduction

Total knee arthroplasty (TKA) is a successful procedure to relieve pain and restore knee function. However, Blom et al. reported an infection rate of 0.5–12% [1] in their review of TKA. Infection seriously affects knee function and in the worst case may lead to amputation. It is thus meaningful to establish a strategy for the treatment of an infected TKA.

There are various treatment options: long-term antibiotics, arthroscopic irrigation [17], open synovectomy and debridement [14], and irrigation [11]; antibiotic-loaded cement beads [2]; one-stage reimplantation [15]; two-stage reimplantation [5, 6, 12]; arthrodesis [10, 18]; resection arthroplasty [4]; and amputation [7], which are all reported in the literature. Implant removal might be a big advantage to control infection; however, it is a major operative intervention. It is desirable to preserve the implants if they are not loose. Burger et al. [3] reported that in 39 cases, all but five attempts to retain implants with debridement and antibiotic irrigation failed. They concluded that the retention of implants was to be strictly limited to cases that met their four criteria: short duration of symptoms, infection caused by susceptible gram-positive organisms, absence of prolonged postoperative wound secretion, and no prosthetic loosening. Mont et al. [11] reported that multiple debridement and irrigation had a high success rate for treatment of infection without implant removal. Their cases satisfied specific indications, namely, onset of infection or symptoms within 30 days of presentation with no radiographic evidence of osteitis or component loosening. However, multiple operations have the disadvantages of damaging the skin and creating anxieties in patients.

In order to preserve the unloosened implants, we treated infected TKA with debridement and continuous irrigation

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Table 1 Clinical characteristics. *OA* osteoarthritis, *RA* rheumatoid arthritis, *MRSA* methicillin-resistant *Staphylococcus aureus*

Case no.	Age	Gender	Disease	Timing of infection (months)	Duration of symptom (days)	Culture
1	67	F	OA	11.6	18	–
2	75	F	OA	112	7	–
3	79	M	OA	1.9	1	<i>Staphylococcus aureus</i>
4	89	F	OA	94	4	<i>Staphylococcus lugdunensis</i>
5	69	F	RA	0.6	1	<i>Staphylococcus aureus</i>
6	50	F	RA	2.5	3	Beta-streptococcus
7 right	53	F	RA	39.4	0	<i>Streptococcus pneumoniae</i>
7 left	53	F	RA	39.4	0	<i>Streptococcus pneumoniae</i>
8	54	M	OA	0.2	0	MRSA
9	61	F	RA	1.9	2	MRSA

with antibiotic solution using a Salem double-lumen tube. The results of our experience are reported here.

Patients and methods

Since 1990, a total of ten joints in nine patients with infected TKA have been treated in our department within 21 days of the infection. Radiographs showed no evidence of implant loosening or “moth-eaten” appearance. The patients underwent synovectomy, debridement, and continuous irrigation without implant removal. These patents were reviewed retrospectively. In five joints of five patients, there were signs of infection within 3 months after the primary TKA. In the other five joints of four patients, the infection was of haematogenous origin. These nine patients included two men

and seven women ranging in age from 53 to 89 (mean 65) years. Preoperative diagnosis was based on the findings on physical examination, increased erythrocyte sedimentation rate (ESR), increased C-reactive protein (CRP) levels, and examination of the synovial fluid. Synovectomy, debridement, and continuous irrigation using a Salem double-lumen tube was performed without implant removal. Diagnosis was finally confirmed based on the results of bacterial cultures or histopathological examination of the synovial membrane. A causative microorganism was detected in eight joints (Table 1). In the other two joints, the diagnosis was based on the histopathological examination of synovial membrane that showed more than ten granulocytes in a high-power field [8].

Surgical procedure

Before inflating a pneumatic tourniquet, the affected leg was raised for 3–5 min instead of using a rubber Esmarch bandage. The same skin incision as the previous operation was used. Synovectomy and thorough debridement was done. Debridement of the posterior region should be performed after removal of the polyethylene insert, if possible. A pulsatile washer was used in the operation. Two Salem double-lumen tubes (size over 16 Fr), separated to prevent short circuit of fluid, were used for irrigation. The size of the skin incision for the tube should be minimal and the tube fixed using a peritoneal button to prevent leakage of irrigation solution, as recommended by Kawashima et al. [9]. Monofilament nylon sutures were used for suturing and fixing the button. Suction pressure was set at 20 cm H₂O. Continuous irrigation was generally maintained for 10–14 days, and the tube was removed after confirming the absence of infectious agents in three consecutive cultures.

Results

Continuous irrigation was maintained for 7–29 days (Table 2). Infection could be controlled without the re-

Table 2 Clinical results of the ten infected total knee arthroplasties (TKAs). *CLDM* clindamycin, *AMK* amikacin, *CTM* cefotiam, *IPM* imipenem, *ABK* arbekacin, *PIPC* piperacillin, *CEZ* cefazolin, *ABPC* ampicillin, *VCM* vancomycin

Case no.	Retention of implants	Follow-up period (years)	Number of operations	Period of irrigation (days)	Antibiotics
1	Success	1.1	1	18	CLDM
2	Success	1.1	1	7	AMK
3	Success	2	1	16	CTM, CLDM
4	Success	1.2	1	29	IPM, CLDM
5	Success	2	1	29	ABK, CLDM, IPM
6	Success	11.3	2	14+17	PIPC
7 right	Success	7.8	1	18	CEZ, ABPC
7 left	Success	7.3	2	18+12	CEZ, ABPC
8	Failure	Cement spacer	2	22+27	VCM
9	Failure	Arthrodesis	1	14	CMZ, IPM, VCM

Table 3 Knee function of the ten infected total knee arthroplasties (TKAs)

Case no.	Extension at follow-up	Flexion at follow-up	Pain	Walking ability
1	0	110	None	With cane
2	-15	15	None	With cane
3	-10	110	None	With cane
4	0	40	None	Wheel chair (due to hemiplegia)
5	-10	120	None	With cane
6	-15	75	None	With crutch
7 right	0	120	None	Wheel chair (due to foot deformity)
7 left	0	120	None	
8	0	80	Sometimes	With walker
9	-10	10	None	With two crutches

removal of implants in eight joints of seven patients. Two joints of two patients underwent implant removal. One patient underwent an arthrodesis of the knee, and the other patient was treated with reimplantation after a period with an antibiotic-impregnated cement spacer. The causative microorganism was methicillin-resistant *Staphylococcus aureus* (MRSA) in both cases. In two of the eight successfully treated joints, debridement and continuous irrigation were performed twice (Table 2).

Clinical evaluations are shown on Table 3. Pain disappeared in all eight implant-retained joints. Four patients could walk with one cane, one patient could walk with one crutch, and two patients used a wheel chair due to hemiplegia and foot deformity, respectively. Range of motion in five joints remained over 100°. However, a fibrous ankylosis was recognized in one joint.

Recurrence of infection did not occur during the follow-up period of 4.2 (range 1.1–11.3) years.

Discussion

There are many reports describing strategies for the treatment of infected TKA. However, most of them focus on the removal of implants and reimplantation. Two-stage reimplantation with or without antibiotic-impregnated cement was considered to be the gold standard. Rasul et al. [13] discussed several controversial issues in treating infected TKA; for example, appropriate surgical treatment for chronic infected TKA without implant loosening. In their paper, they also urged new approaches to improve the unacceptable failure rate of current efforts to retain implants.

Trousdale and Hanssen [16] reported an algorithm of treatment strategy for infected TKA. It was practical and educational. We have created our own algorithm (Fig. 1) reflecting the demands of Japanese patients.

The advantages of continuous irrigation indicated by this study were the possibility of administration of high-dose antibiotics, drainage of debris and blood clots, monitoring the joint contents via the waste solution, and the ability to switch antibiotics depending on the sensitivity of the microorganisms. The concentration of antibiotics was high. For example, second-generation cephalosporin solution for irrigation was 1 g per 1,000 ml. This concentration was at least 100 times the MIC₅₀ of common gram-positive bacteria. However, Kawashima et al. [9] reported that the absorption of antibiotics from the site of continuous irrigation was very small. It was obvious that the drainage was useful for the treatment of infection. The monitoring of joint contents was not described in the previous reports. The examination of waste solution (color, amount of debris, white blood cell count) reveals whether the infection continues or not. Culture of the waste solution was helpful in choosing anti-

Fig. 1 Treatment algorithm for an infected total knee arthroplasty (TKA). These procedures could be repeated two or three times if unsuccessful at first.

biotics and determining when to stop irrigation. The disadvantages of continuous irrigation were the large amount of bleeding in the perioperative period, the possibility of contamination at the time of changing solutions, the possibility of contamination from the portal of the Salem double-lumen tube, and the necessity of staying in bed during the treatment. It is important to educate all medical staff in aseptic techniques involved in exchange of solutions for irrigation.

Waldman et al. [17] reported the result of arthroscopic irrigation and debridement in 2000. Although the patients underwent this procedure within 7 days from onset of symptoms, the success rate for retaining implants was 38% (6/16 cases). They concluded that they would use this method only in patients who were medically unstable or on anticoagulants. Mont et al. [11] reported the results of multiple irrigation and debridement of 24 cases while retaining implants in 1997. The success rate was 83% (20/24 cases). However, the rate of first surgical treatment cure was 42% (10/24 cases). In our study, the success rate was 80% (8/10 cases), and the rate of first surgical treatment cure was 60% (6/10). Our method decreased the number of surgical treatments compared to the method of Mont et al.

We conclude that synovectomy, debridement, and continuous irrigation are an effective method to cure early-stage infection of TKA. The method could be especially useful in decreasing the number of surgical interventions required to control infection. This method should be considered as a method of treatment in early cases of infected TKA.

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