Journal of Orthopaedics, Trauma and Rehabilitation 18 (2014) 79–82

Contents lists available at ScienceDirect

Journal of Orthopaedics, Trauma and Rehabilitation

Journal homepages: www.e-jotr.com & www.ejotr.org

Original Article

The Clinical Outcome of Management of Periprosthetic Infection in Total Knee Replacement
治療全膝關節置換術假體周圍感染的臨床結果

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ARTICLE INFO

Article history:
Received 28 May 2013
Received in revised form
15 August 2013
Accepted 21 September 2013

Keywords:
infection
outcome
total knee replacement

ABSTRACT

Background/Purpose: Infection is a severe complication after total knee replacement (TKR) and creates great disability. We reviewed our 11-year experience in the management of TKR infection and its outcome.
Methods: Patients who had TKR infection from 2001 to 2011 in our hospital were reviewed retrospectively.
Results: A total of 727 TKRs were performed from 2001 to 2011 and 12 cases of post-TKR infection were identified (1.65%). In the acute group, two patients had debridement with exchange of liner and four patients had a two-stage operation. No re-infection was noted. For the chronic presentation group, four out of six patients had a two-stage operation and none of them suffered from re-infection. The remaining two patients had debridement and exchange of liner and both had re-infection with a two-stage operation performed afterwards. One patient had no re-infection thereafter. Another patient was on long-term suppressive antibiotics because of the failure to eradicate the infection.
Conclusion: The incidence of TKR infection in our hospital is comparable to the reported incidence in the literature. This study also showed that a two-stage operation has a higher success rate in the management of chronic TKR infection.

中 文 摘 要

引言：全膝關節置換術後感染是一種嚴重的併發症，並能引致巨大的殘障。我們回顧過去11年治療此併發症的經驗及其臨床結果。
材料與方法：我們回顧分析了由2001年至2011年，在本院患有全膝關節置換術後感染的病人。
結果：本院在2001年至2011年期間施行了727宗全膝關節置換術，當中12病例有術後感染（1.65%）。在急性術後感染組別的病人中，2名病人接受了清創及塑膠假體更換手術，4名病人接受了兩階段全膝關節重換手術，他們在術後均沒有再受感染。在6名慢性術後感染組別的病人中，4名病人接受了兩階段全膝關節重換手術而在術後並沒有再受感染，其餘2名病人接受了清創及塑膠假體更換手術，但因感染情況未能控制而需要接受兩階段全膝關節重換手術。其後1人的感染痊癒但另1人因感染未能根除而需長期服用抑制抗生素。
結論：本院全膝關節置換術後感染的發病率與其他同類研究相近。本研究亦顯示在慢性全膝關節置換術後感染患者施行兩階段全膝關節重換手術會有較高的成功率。

Introduction

Periprosthetic infection is one of the most devastating and dreaded complications of total knee replacement (TKR). The quoted incidences in the literature are 1–3%[1] and 2.5%[2] with contemporary infection preventive measures. Treatments of these infections are often costly and involve prolonged hospital stays, therefore effective management is important. In this study, we aim at reviewing the incidence of periprosthetic infection in total knee arthroplasty, their outcomes, and the success rate of revision surgeries in our hospital.

Methods

We retrieved all patients who underwent TKRs in our hospital from 2001 to 2011. The files for patients who were diagnosed with

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http://dx.doi.org/10.1016/j.jotr.2013.09.002

periprosthetic infection were retrieved. Their management plans and treatment outcomes were analysed. We diagnosed periprosthetic infection based on the criteria suggested by Parvizi et al,[1] which involved satisfying one of the following criteria: (1) presence of an abscess or sinus tract communicating with the joint space; (2) positive preoperative culture of aspirate on solid culture medium; or (3) two or more positive intraoperative cultures of the same organism, or one positive culture in conjunction with the presence of gross intracapsular purulence or abnormal histological findings.

Debridement with liner exchange and two-stage revision surgery were the two forms of management that we employed to treat our patients with periprosthetic infection. For the debridement and liner exchange, we performed thorough debridement and replaced the polyethylene insert in a one-stage procedure. Antibiotics were continued for at least 6 weeks afterwards. For the two-stage revision, the first stage involved removal of the implant with its cement and thorough debridement was performed. A self-moulded antibiotics-loaded cement spacer was then inserted. The antibiotics we used were tobramycin 1 g per 40 g cement with the addition of 1 g vancomycin per 40 g cement if the culture revealed methicillin-resistant *Staphylococcus aureus* (MRSA), methicillin-resistant coagulase-negative *Staphylococcus*, or if a Gram stain showed Gram-positive cocci in clusters. Systemic antibiotics according to the culture sensitivity were then continued for a minimum of 6 weeks (range 6–14 weeks, mean duration 9 weeks). The second stage of the procedure involved implantation of a new prosthesis—this was performed a minimum of 8 weeks after the first stage of the procedure when the inflammatory markers were normalised. The infection was considered eradicated when a patient underwent no subsequent operations for the infectious organism after reimplantation. Patients who maintained on long-term suppressive antibiotics due to positive intraoperative wound culture in second stage operation were also considered as failure to eradicate infection.

Results

A total of 727 TKRs were performed between 2001 and 2011, and 12 cases of periprosthetic infections were identified. All the patients had elevated white cells and neutrophils in their knee aspirations, high erythrocyte sedimentation rate, and high C-reactive protein, as well as positive culture from the knee aspirations (Table 1). The incidence of infection of TKRs in our hospital was 1.65%.

We identified a few risk factors in our patients. Two patients had rheumatoid arthritis, one had diabetes mellitus, one had a history of recurrent lower limb cellulitis, and one had a history of septic knee arthritis. In all cases, the causative organism could be identified. Three patients had MRSA, two had methicillin-resistant coagulase-negative *Staphylococcus*, one had methicillin-sensitive coagulase-negative *Staphylococcus*, three had *Streptococcus agalactiae*, and three had *Streptococcus* Group G.

The patients were classified into early postoperative, acute haematogenous, and late chronic infections based on the Tsukayama classification.[3] Early postoperative infection is defined as infection occurring < 4 weeks after the operation. Acute haematogenous infection is signified by acute onset of symptoms in a previously well-functioning joint. Late chronic infection is present when infection occurs ≥ 4 weeks after the index operation. In our study, one patient had early postoperative infection, five had acute haematogenous infection, and six had late chronic infections.

For patients who had early postoperative infection and acute haematogenous infections, two of them had debridement and liner exchange and four of them had a two-stage revision done. None of the patients had re-infection with a mean follow-up time of 12.7 months (range 8–20 months).

Table 1
Details of patients with infected total knee replacements (TKRs)

Case number	Sex/age (years)	Risk factors	Culture	Classification	Type of surgery	Postoperative antibiotics	Antibiotics (wk)	Outcome
1	M/70		*Streptococcus* Group G	Acute haematogenous	Two-stage revision	IV Penicillin G, then oral levofloxacin	14	Success
2	F/64	Diabetes mellitus	*Streptococcus agalactiae*	Acute haematogenous	Two-stage revision	IV Penicillin G, then oral penicillin V	7	Success
3	F/48	Rheumatoid arthritis	*Streptococcus* Group G	Acute haematogenous	Debridement and liner exchange	IV Penicillin G, then IV levofloxacin	8	Success
4	M/76	History of recurrent lower limb cellulitis	*Streptococcus* Group G	Acute haematogenous	Two-stage revision	IV Penicillin G, then oral penicillin V	9	Success
5	F/77	History of knee septic arthritis	MRSA	Early postoperative	Debridement and liner exchange	IV Vancomycin, then oral septrin	9	Success
6	F/54		*Streptococcus agalactiae*	Acute haematogenous	Two-stage revision	IV Penicillin G, then oral levofloxacin	7	Success
7	F/71		MRSA	Chronic	Debridement and liner exchange	IV Vancomycin + oral fusidic acid	6	Failed
					Two-stage revision	IV Vancomycin + oral fusidic acid	6	Success
8	F/70	Rheumatoid arthritis	MRSA	Chronic	Debridement and liner exchange	IV Vancomycin + oral fusidic acid, then oral septrin + oral fusidic acid	12	Failed
					Two-stage revision	IV Vancomycin	6	Long-term antibiotics (oral fusidic acid)
9	F/69		Coagulase −ve *Staphylococcus*, methicillin-resistant	Chronic	Two-stage revision	IV Vancomycin	8	Success
10	F/69		Coagulase −ve *Staphylococcus*, methicillin-resistant	Chronic	Two-stage revision	IV Vancomycin	7	Success
11	M/60		*Streptococcus agalactiae*	Chronic	Two-stage revision	IV Penicillin G, then oral penicillin V	11	Success
12	F/73		Coagulase −ve *Staphylococcus*, methicillin-sensitive	Chronic	Two-stage revision	IV Penicillin G + IV cloxacillin, then oral penicillin V + oral cloxacillin	14	Success

F = female; IV = intravenous; M = male; MRSA = methicillin-resistant *Staphylococcus aureus*; −ve = negative.

Table 2
Results of management of late chronic infections

	Infection eradicated/number of patients (%)
Two-stage revision	4/4 (100)
Debridement and liner exchange	0/2 (0)
Two-stage revision after failed debridement and liner exchange	1/2 (50)

Six patients presented with late chronic infections. Four of them had a two-stage revision and no re-infection was noted on follow up. The other two patients with late chronic infections (both had symptoms of knee pain and swelling for a duration of 7 weeks and 8 weeks, respectively) had debridement and liner exchange and both failed to control the infection. A two-stage revision was performed in these two patients afterwards and one of them had no subsequent re-infection. However, another patient was found to have two positive intraoperative cultures of MRSA (the same organism of the infected TKR) taken during the second stage reimplantation procedure. This patient required long-term suppressive antibiotic treatment and was considered as failure to eradicate the infection. The mean follow-up duration in patients with late chronic infection was 39 months (range 15–89 months). There was a 100% success rate for primary two-stage procedures, 0% for simple debridement and liner exchange, and 50% for the salvage two-stage procedure (Table 2). The success rate of the primary two-stage operation in chronic TKR infection was higher than debridement and exchange of liner with prosthesis retention ($p = 0.067$) with statistical significance. The success rates of eradicating infections with respect to various organisms are listed in Table 3.

In the two-stage revision procedure, we employed a self-moulded dynamic spacer at the first stage of the operation (Figure 1). The mean range of movement after insertion of the articulating spacer was 7.5–59° and the mean range of movement after the second stage reimplantation was 0–92.5°.

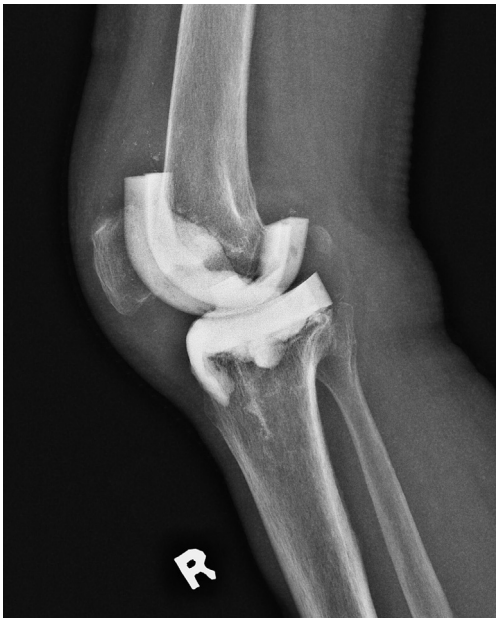

Figure 1. A dynamic cement spacer was inserted at the first stage operation.

Discussion

The management of an infected TKR is one of the greatest challenges for arthroplasty surgeons. Fortunately, the incidence of infection of TKRs in our hospital was 1.65%, which is comparable to figures quoted in other literatures.[1,2]

Treatment options included debridement with retention of the prosthesis, reimplantation arthroplasty (one- and two-stage procedures), permanent prosthesis removal (resection arthroplasty, arthrodesis), long-term suppressive antibiotic therapy, and amputation. The success rates for the different procedures varied tremendously depending on patient selection, microbiology, duration of symptoms, infection types, and length of follow-up. However, the gold standard is still the delayed two-stage reimplantation protocol. Insall et al[4] and Windsor et al[5] reported their experience of two-stage reimplantation with long-term follow-up. The infection eradication rate was 97.4%.

Poor prognostic factors are long duration of infection and symptoms, multidrug resistant (MDR) organisms, Gram-negative organisms, staphylococcal infection, and negative culture. The prevalence of MDR organisms has increased greatly. Infected TKRs with resistant organisms are difficult to treat and a high failure rate was reported.[6] However, a recent study of the two-stage reimplantation protocol showed similar successful eradication rates—91.3% for sensitive organisms and 91.2% for resistant organisms.[7]

Open debridement with prosthesis retention is the least invasive method that may eradicate infection of prosthetic joints. It enables patients to regain function rapidly and is therefore an appealing surgical strategy. Mont et al[8] reported a high success rate for acute haematogenous and 100% for early postoperative TKR infections without removal of the prosthesis. Segawa et al[3] reported a very poor result with this surgical treatment for late chronic TKR infection. A few studies concluded that a shorter duration of symptoms was associated with a more favourable treatment outcome in patients who underwent debridement with prosthesis retention.[8–10] Although this procedure was not as successful as a delayed exchange procedure in other studies,[11,12] careful patient selection is likely to yield favourable results comparable

Table 3
Success rate of infection eradication in different organisms

	Number of patients	Debridement and liner exchange	Two-stage procedure	Combined
		Infection eradicated/number of patients (%)	Infection eradicated/number of patients (%)	
MRSA	3	1/3 (33.3)	1/2 (50)	2/3 (66.7)
Coagulase −ve *Staphylococcus*, methicillin-resistant	2	0	2/2 (100)	2/2 (100)
Coagulase −ve *Staphylococcus*, methicillin-sensitive	1	0	1/1 (100)	1/1 (100)
Streptococcus agalactiae	3	1/1 (100)	2/2 (100)	3/3 (100)
Streptococcus Group G	3	3/3 (100)	0	3/3 (100)

MRSA = methicillin-resistant *Staphylococcus aureus*; −ve = negative.

with more invasive strategies, as suggested by Laffer et al,[13] Zimmerli and Ochsner,[14] and Zimmerli et al.[15] The treatment algorithm developed by Zimmerli et al[15] for treatment with retention of the prosthesis helps selection of patients who fulfilled all selection criteria (early postoperative or acute haematogenous infection, duration of clinical symptoms < 3 weeks, stable implant with intact soft tissue, and microorganism susceptible to antibiotics with activity against surface-adhering bacteria) for successful debridement with prosthesis retention. However, staphylococcal infection is found to be an independent predictor of failure of treatment involving irrigation and debridement with implant retention.[11,16–22] It is also found that MRSA is poorly eradicated with this treatment.[20,22] This was also shown in our study—we had a lower success rate of infection eradication with MRSA, especially when debridement and liner exchange was performed (33.3% after debridement and liner exchange, 66.7% overall success rate after debridement and liner exchange and the two-stage procedure). Streptococcal infections, which have historically been well treated with irrigation and debridement with implant retention, had an eradication rate (65%) that was comparable with that of all other organisms (71%).[18]

In our study, we have noted that debridement with liner exchange has a much higher success rate in patients with early postoperative or acute haematogenous infections, when compared with patients with late chronic infections. This finding is comparable to studies done by Segawa et al[3] and Chiu and Chen.[23] With the two-stage procedure, we had a 100% success rate when it was done in a primary setting and 83.3% success rate when both primary and secondary procedures were included. This is in accordance with studies done by Westrich et al[7] and Gooding et al[24] that had success rates of 91.3% and 87.8%, respectively.

The drawback of the debridement and exchange of liner is the lower eradication rate following two-stage reimplantation in patients who have undergone previous irrigation and debridement compared with patients treated directly with two-stage reimplantation.[19] This was exemplified by our review where a lower success rate (50%) of eradicating infection was noted when two-stage procedures were performed on patients who had failed first debridement and liner exchange.

Prostalac is an antibiotics-loaded cement with a small metal-on-polythene articular surface; it is used to maintain alignment, stability, and range of movement in knees after the first stage of a procedure.[25] In our hospital, we have been using a self-moulded articulating spacer made from antibiotics-loaded cement. Tobramycin was commonly chosen because it had a broad spectrum of susceptible organisms and an effective bactericidal level intra-articularly with negligible serum levels after 24 hours.[26] Static cement spacers were not used because they did not allow patients to move their knees and required cast immobilisation before the second stage of the operation. They also carried a risk of dislodgement and bone erosion.[27] We found that our self-moulded articulating spacer made from antibiotics-loaded cement was a lower-cost alternative to Prostalac. It also gave a reasonable range of knee movement and facilitated the rehabilitation after the second stage of the procedure for our patients.

The limitations of our study were that is was retrospective and only a small number of patients could be studied because of the low incidence of infected TKR in our centre. There was no standardised treatment protocol for infected TKR. The follow-up duration was relatively short when compared with other similar studies.

We recommend a two-stage revision operation for patients with late chronic infection because it was shown to have a higher success rate in eradicating infection.

Conflicts of interest

The authors declare that they have no financial or non-financial conflicts of interest related to the subject matter or materials discussed in the manuscript.

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