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Conservative medical therapy of prosthetic joint infections: retrospective analysis of an 8-year experience

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ABSTRACT

Successful treatment of prosthetic joint infections often requires multiple surgical interventions and prolonged antimicrobial therapy. However, in certain situations, a surgical approach may not be in the best interest of the patient. A conservative approach was used to treat 34 patients with prosthetic joint infection between 1995 and 2003. Diagnosis of infection was based on clinical–microbiological evidence, confirmed by ^{99}Tc-labelled leukocyte scintigraphy, and involved 12 *Staphylococcus aureus* infections, nine *Staphylococcus epidermidis* infections, two *Enterococcus faecalis* infections, two mixed infections (*S. aureus* plus *Pseudomonas aeruginosa*; *S. epidermidis* plus *E. faecalis*), with the infecting pathogen being unidentified for nine patients. Most infections were treated initially with intravenous or intramuscular teicoplanin ± ciprofloxacin or rifampicin, followed by oral ciprofloxacin or minocycline plus rifampicin. The mean duration of antimicrobial therapy was 41.2 weeks. Overall, only three patients did not respond to therapy, and infection was controlled in the remaining 31 patients. Among these, no relapse was observed in 17 patients during follow-up for 9–57 months; improvement with early (within 6 months of antibiotic discontinuation) or late relapse was observed in seven and three patients, respectively; two patients improved clinically, but continued to receive antibiotic therapy; and two patients whose condition improved initially were lost after a 6-month follow-up following discontinuation of antibiotics. No patient complained of side effects requiring discontinuation of antibiotic therapy. The study confirmed that suppression of infection, with salvage of the infected device in an acceptably functional state, can be achieved in selected cases.

Keywords Antibiotic therapy, infected prosthetic joints, prosthetic joint infections, therapy

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INTRODUCTION

Infection rates following prosthetic joint implantations occur at a frequency of 0.5–2% [1]. *Staphylococcus aureus* and coagulase-negative staphylococci account for 45–55% of such infections, regardless of the type of implant [1]. Successful treatment of these infections is difficult, and usually requires multiple surgical interventions (removal of the device, one- or two-stage reimplantation of a new device) and prolonged antimicrobial therapy to achieve microbial sterilisation and a satisfactory functional result [1]. However, the patient may not always consent to further surgery, or contraindications may exist, including the patient's clinical status, non-acceptable functional results after removal of the prosthesis, or a well-fixed prosthesis that is difficult to remove [2,3]. It has been suggested that a conservative approach to certain prosthetic joint infections could be an appropriate option if adequate surgical debridement is combined with prolonged pathogen-targeted therapy [2–8]. To determine the efficacy of such a therapeutic strategy, the present study reviewed retrospectively the

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clinical–microbiological features and response to therapy of 34 patients with prosthesis infection who were treated in our institution over an 8-year period.

PATIENTS AND METHODS

Thirty-four consecutive patients with prosthetic joint infections (24 total hip prosthesis replacements; ten total knee prosthesis replacements) who had received antimicrobial therapy in the outpatient clinic between 1995 and 2003 were reviewed retrospectively. Each patient was followed from the first visit through all treatment and follow-up by one investigator (MV). All patients included in the study had clinical, laboratory and radiological evidence of orthopaedic implant infection. In particular, the diagnosis of joint prosthesis infection was based on the presence of at least one of the following: (1) hip or knee prosthesis fistula; (2) inflammation in the area around the joint and biological inflammatory syndrome; (3) hip or knee prosthesis pain and biological inflammatory syndrome; or (4) joint swelling and inflammatory syndrome. Biological inflammatory syndrome included an erythrocyte sedimentation rate (ESR) of > 50 mm/h and elevated levels of C-reactive protein (CRP). For the purpose of this study, loosening of the joint, identified radiographically, was not a diagnostic criterion, since only patients with stable prostheses could be enrolled for conservative medical treatment. Initial patient evaluation always included ^{99}Tc-labelled leukocyte scintigraphy to corroborate the diagnosis of prosthesis infection and to evaluate the extent of the infectious process.

Infectious episodes were defined as early, delayed or late infections according to the appearance of signs and symptoms of infection during the first 3 months, between 3 months and 2 years, or > 2 years following prosthesis implant, respectively [7]. Early infections occurring within 4 weeks of surgery were also recorded [7,8]. Microbiological studies were performed on bone samples and sinus drainage, including direct microscopic examination of leukocytes and bacteria, as well as aerobic and anaerobic cultures. Bacteria were considered to be pathogens if isolated at least twice from sinus drainage, or at least once from fluid collected during deep needle aspiration or from an intra-operative deep tissue specimen. Patients were checked initially for blood cell count, liver and kidney function, and ESR and CRP levels. Where indicated, extensive surgical debridement was also combined with medical therapy. Planned courses of antibiotic therapy, based on in-vitro susceptibility data, were at least 6 months for hip prosthesis infections and 9 months for knee prosthesis infections [2,4–6]. In circumstances where microbiological studies could not be performed, or gave equivocal results (e.g., coagulase-negative staphylococci from a single fistula discharge), empirical anti-staphylococcal therapy was attempted. As a general approach, after initiation of therapy, all patients were seen every 2–3 weeks for the first 3 months, then every 4–12 weeks for 6–24 months after antibiotic discontinuation, and finally every 6–12 months for a further 2 years.

Since, theoretically, microbial eradication of orthopaedic device infections was not considered to be achievable [9,10], improvement was assessed initially on the basis of disappearance of clinical, biological and radiological evidence of infection at the end of medical treatment, with no relapse within the 6-month period following discontinuation of antibiotics [2,5]. Whenever possible, to corroborate evidence of improvement, ^{99}Tc-labelled leukocyte scintigraphy was performed at the end of treatment and follow-up. Response to therapy was eventually defined as follows: (1) improvement with no apparent relapse after a 6-month follow-up; (2) improvement with early relapse if the relapse occurred within 6 months of discontinuation of antibiotics; (3) improvement with late relapse when the relapse occurred > 6 months following discontinuation of antibiotics; (4) improvement with no early relapse when improved patients were lost to follow-up > 6 months following discontinuation of antibiotics; (5) improvement with continued suppressive therapy when oral antibiotics were continued for > 6 months (hip prosthesis) or > 9 months (knee prosthesis) on the basis of minimal signs of persisting infection on leukocyte scintigraphy despite a clear clinical recovery, and/or the patient's refusal to discontinue medical treatment; or (6) failure—no response to antibiotic therapy.

Statistical analysis of the data was carried out with a two-tailed chi-square or Fisher's exact test, as appropriate.

RESULTS

Thirty-four cases of prosthetic joint infection were included in the retrospective analysis. The demographic characteristics of the patients and details of their response to therapy are shown in Table 1. The infections involved 24 hip prostheses and ten knee prostheses, with 12 early, 16 delayed and six late infections. Potential host factors predisposing to prosthesis infection [1] included nine (26.5%) patients with a history of previous joint arthroplasty on the same joint, three (8.8%) patients with diabetes, two (5.9%) patients receiving steroid therapy, two (5.9%) patients with peri-operative wound complications, one (2.9%) obese patient, and 20 (58.8%) patients aged > 70 years. The clinical presentation was variable, ranging from acute septic arthritis, with the sudden onset of joint pain, erythema, swelling and drainage at the wound site, to a more frequent syndrome of chronic and progressive pain, particularly with motion or when bearing weight, functional restriction and fistula with purulent secretion. All the patients yielded initial positive results in ^{99}Tc-labelled leukocyte scintigraphy.

Pathogens identified were methicillin-susceptible *Staphylococcus aureus* (four infections), methicillin-resistant *S. aureus* (MRSA) (eight infections), methicillin-susceptible *Staphylococcus epidermidis* (four infections), methicillin-resistant *S. epidermidis* (five infections), *Enterococcus faecalis* (two infections), methicillin-resistant *S. epidermidis* plus *E. faecalis* (one mixed infection), and MRSA

Table 1. Characteristics of 34 cases of prosthetic joint infection

Case	Age, sex	Risk factors	Type of prosthesis	Onset of infection	Bacteria/ diagnostic procedure	Debridement	Initial treatment (weeks)	Subsequent oral treatment (weeks)	Total treatment duration (weeks)	Follow-up (months)	Outcome
1	79, F	AA	Hip	Delayed	MRSA, drainage of sinuses	No	cip (20)	mh + rd (20)	40	19	INR → Surgery for LAL after 9 months
2	50, F	PWC	Hip	Early, (within 1 month)	MRSE + *Enterococcus faecalis*, deep aspiration	Yes	tec + cip + rd (16)	amc + rd (10)	26	9	IER (relapsed after 1 month) → Surgery
3	73, F	AA, PJS	Hip	Early	MSSA, deep aspiration	No	tec + rd + levo (12)	levo + rd (12)	24	27	INR
4	48, F	PJS	Hip	Early	MSSE, drainage of sinuses	Yes	tec + amc + rd (18)	mh + rd (14)	32	40	INR → Surgery for LAL after 18 months
5	60, F	No	Hip	Delayed	MSSA, drainage of sinuses	Yes	cip + rd (24)	No	24	–	INER
6	55, M	DM, PJS	Hip	Early	MRSE, intra-operative culture	Yes	tec + fos (20)	cip + rd (4)	24	36	INR
7	75, F	AA, PJS	Hip	Delayed	Unknown	No	mh + rd (48)	–	48	–	Failure
8	65, F	No	Hip	Delayed	Unknown	Yes	amc + rd (14)	mh + rd (14)	28	12	INR
9	79, F	AA	Hip	Delayed	MRSA + *Pseudomonas aeruginosa*, drainage of sinuses	No	tec + cip (16), tec + levo (12)	–	28	27	INR
10	78, F	AA, PJS	Hip	Late	MRSE, drainage of sinuses	No	tec + rd (12)	mh + rd (30)	42	27	ILR (relapsed after 14 months) → ICST (mh)
11	86, F	AA	Hip	Early (within 1 month)	*Enterococcus faecalis*, drainage of sinuses	No	amc (4)	amc + levo (20), amc (4)	28	–	INER
12	78, F	AA, PJS	Hip	Delayed	MRSA, drainage of sinuses	No	tec + cip + rd (8)	mh + rd (24)	32	17	IER (relapsed after 2 months) → ICST (mh rd)
13	81, F	AA	Hip	Delayed	MRSA, intra-operative culture	Yes	va, cld (4)	mh (64)	68	10	ILR (relapsed after 8 months) → ICST (mh)
14	64, F	DM	Hip	Late	MSSE, intra-operative culture	Yes	va, cld + levo (6)	mh + rd (24), mh (27)	57[a]	–	ICST (mh)
15	56, F	O	Hip	Early	MRSA, drainage of sinuses	Yes	tec + cld (12), tec + fos (12)	sxt + rd (16)	40	34	INR
16	67, F	No	Hip	Delayed	Unknown	No	cip + rd (38)	–	38	57	INR
17	70, F	AA, PJS, PWC	Hip	Late	Unknown	No	tec (4)	mh + rd (38)	42	15	IER (relapsed after 2 months) → Surgery
18	59, F	PJS	Hip	Early (within 1 month)	MRSA, drainage of sinuses	Yes	va + rd + cip (12), tec + levo (8)	mh + rd (4)	24	26	INR
19	67, F	No	Hip	Delayed	MRSA, intra-operative culture	Yes	tec (24)	mh + rd (20)	44	40	ILR (relapsed after 12 months) → ICST (mh)
20	77, F	AA	Hip	Delayed	MRSA, drainage of sinuses	No	tec + rid (8)	mh + rd (76)	84[a]	–	ICST (mh + rd)
21	74, F	AA	Hip	Late	Unknown	No	tec + cip (8)	mh + rd (28)	36	9	INR
22	70, M	AA, ST	Hip	Delayed	MSSE, intra-operative culture	Yes	tec + cip + rd (20) cip + rd (4)	mh + rd (4)	28	11	IER(relapsed after 5 months) → ICST (mh)
23	72, M	AA, PJS	Hip	Late	MRSA, deep aspiration	Yes	tec + moxi (12)	mh + moxi (4), cld (12)	28	17	IER (relapsed after 4 months) → ICST (mh)

Table 1. Continued.

Case	Age, sex	Risk factors	Type of prosthesis	Onset of infection	Bacteria/ diagnostic procedure	Debridement	Initial treatment (weeks)	Subsequent oral treatment (weeks)	Total treatment duration (weeks)	Follow-up (months)	Outcome
24	63, F	No	Hip	Delayed	MRSE, drainage of sinuses	No	cip (24)	cld + levo (8)	30	12	INR
25	71, M	AA	Knee	Early (within 1 month)	MSSA, intra-operative culture	Yes	tec + cip + rd (12), tec + moxi + rd (12)	mh (12)	36	–	Failure → Surgery
26	81, F	AA	Knee	Late	Unknown	No	amc + rd (12)	cld (4), mh + rd (24)	40	9	INR
27	73, M	AA	Knee	Early	Unknown	Yes	amc + cn (36)	amc (12)	48	43	INR → Surgery for LAL after 13 months
28	65, F	DM	Knee	Delayed	MSSA, drainage of sinuses	No	tec + cip + rd (8)	cip + rd (20), levo (16)	44	10	INR
29	73, M	AA	Knee	Delayed	MSSE, drainage of sinuses	No	cip + a-cxm + rd (28), tec + cip (8)	cip + rd (56)	92	31	IER (relapsed after 5 months) → Surgery
30	72, F	AA	Knee	Early	MRSE, drainage	No	tec + cip (4), tec + levo (16)	mh + levo (20)	40	9	INR
31	75, M	AA	Knee	Early (within 1 month)	*Enterococcus, faecalis*, deep aspiration	No	amc + genta (4)	amc + rd (48)	52	9	INR
32	60, F	No	Knee	Early	Unknown	No	tec (12)	mh + rd (36)	36	20	INR
33	43, F	ST	Knee	Delayed	MRSE, drainage of sinuses	No	tec + cip (24), tec + rd (12)	mh + rd (24), levo (24), amc + rd (12)	96	–	Failure → Surgery Surgery
34	71, F	AA	Knee	Delayed	Unknown	No	mh + rd (8) tec + cip (6)	mh + cip(16)	30	19	IER (relapsed after 4 months) → Surgery

levo, levofloxacin; cxm, cefuroxime; a-cxm, axetil-cefuroxime; rd, rifampicin; tec, teicoplanin; sxt, co-trimoxazole; fos, fosfomycin; mh, minocycline; cip, ciprofloxacin; va, vancomycin; ma, cefamandole; ak, amikacin; cn, gentamicin; cld, clindamycin; amc, amoxycillin–clavulinic acid; moxi, moxifloxacin; INR, improvement with no relapse after 6 months following antibiotic discontinuation; IER, improvement with early relapse (within 6 months of antibiotic discontinuation); ILR, improvement with late relapse (> 6 months following antibiotic discontinuation); INER, improvement with no early relapse (patients lost to follow-up after 6 months following antibiotic discontinuation); ICST, improvement with continued suppressive therapy; LAL, late aseptic prosthesis loosening; ST, steroid therapy; AA, advanced age (> 70 years); DM, diabetes mellitus; O, obesity; PWC, peri-operative wound complications; PJS, previous joint surgery; MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *S. aureus*; MRSE, methicillin-resistant *Staphylococcus epidermidis*; MSSE, methicillin-sensitive *S. epidermidis*.
[a]Still receiving oral treatment.

plus *Pseudomonas aeruginosa* (one mixed infection). Clinical specimens from which pathogens were isolated are shown in Table 1. Blood cultures were obtained from most cases of acute onset infection, but no pathogens were isolated from blood. The aetiology remained unknown in the nine remaining cases, either because of negative cultures or patient refusal of invasive procedures (arthrocentesis, biopsy, etc.).

All patients received antibiotic therapy on an outpatient basis, with three exceptions where therapy was administered initially in hospital (cases 13, 14 and 18). All patients began antimicrobial therapy within 3 months of the clinical onset of infection. As shown in Table 1, most patients underwent initial treatment with a glycopeptide, usually intramuscular teicoplanin 6 mg/kg/day every 12 h for the first three to five doses, then 6 mg/kg/day every 24 h, either alone or in combination with oral ciprofloxacin and/or oral rifampicin (17 cases), or oral fosfomycin 3 g/day (two cases). For patients with MRSA and methicillin-resistant *S. epidermidis* infections, oral minocycline 200 mg/day, either alone or in combination with rifampicin 600 mg/day, was the usual subsequent therapy. For methicillin-susceptible *S. aureus* infections, a quinolone (usually oral ciprofloxacin 1.5 g/day), either alone or in combination with rifampicin or a β-lactam (usually axetil cefuroxime 3 g/day), was the usual therapy. The mean total duration of antibiotic therapy was 41.2 weeks (range 24–96 weeks). The average duration of follow-up for the 29 cases where antibiotics were, eventually, discontinued was 22 months (range 9–57 months). Two patients (cases 13 and 14) developed mild and transient renal failure during initial therapy with vancomycin; no other patient complained of significant side effects requiring discontinuation of antibiotic therapy.

Fig. 1 summarises the clinical outcomes in this series of patients. Only three patients did not

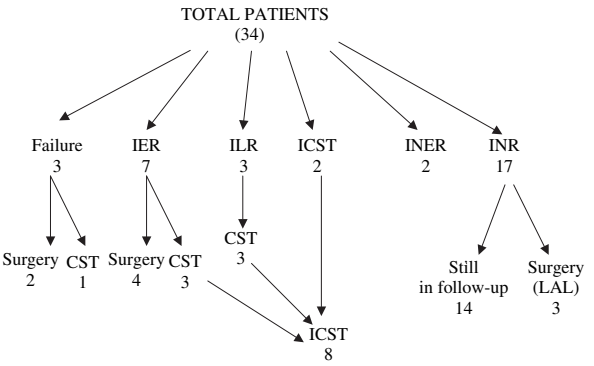

Fig. 1. Clinical outcome of conservative medical therapy in 34 prosthetic joint infections. IER, improvement with early relapse; ILR, improvement with late relapse; INR, improvement with no relapse; INER, improvement with no early relapse; ICST, improvement with continued suppressive therapy (CST); LAL, late aseptic loosening.

respond to therapy, despite some initial signs of clinical improvement. Eventually, two of these patients underwent two-stage prosthesis replacement (cases 25 and 33). The third patient (case 7) had significant improvement, with pain reduction and amelioration of the functional status of the infected joint, but elevated ESR and CRP values and positive ^{99}Tc-labelled leukocyte scintigraphy persisted. This patient refused surgery and is still receiving chronic suppressive antibiotic therapy with oral minocycline and rifampicin.

Two patients who improved (cases 5 and 11) were lost to follow-up 6 months after discontinuation of antibiotics; they were categorised as improved with no early relapse, but could not be evaluated for late relapse.

Improvement with no relapse was observed in 17 patients. Of these, three eventually underwent surgery for late aseptic loosening, while the remaining 14 patients are still undergoing clinical observation (9–57 months).

Improvement with early relapse was observed in seven patients. Of these, four (cases 2, 17, 29 and 34) underwent two-stage prosthesis replacement and, eventually, were cured. The remaining three patients improved further following continued suppressive therapy with oral minocycline, either alone (cases 22 and 23) or in combination with rifampicin (case 12), and are still undergoing clinical observation (11–17 months).

Improvement with late relapse was observed in three patients. Clinical symptoms (local pain, fistula and positive ^{99}Tc-labelled leukocyte scintigraphy) and microbiological relapse (new isolation of MRSA from fistula) was observed in one patient with a hip prosthesis infection following discontinuation of antibiotics (case 19). The remaining two patients (cases 10 and 13) had clinical symptoms only (local pain with altered ESR and CRP values and positive ^{99}Tc-labelled leukocyte scintigraphy). All three of these patients eventually improved again with continued suppressive therapy with oral minocycline.

Two patients improved, but continued to receive suppressive antibiotic therapy. One of these patients (case 20) refused to discontinue antibiotics at the end of the planned period; the other (case 14) was a high-risk diabetic patient (female) with serious peripheral vascular disease and polyneuropathy, for whom oral therapy with minocycline was prescribed to avoid an infectious relapse. As shown in Fig. 1, with the inclusion of these two cases, eight patients were categorised as improved with continued suppressive therapy.

Table 2 shows the relationship between early, delayed and late appearance of prosthesis joint infection and outcome. Overall, improvement with no relapse was achieved in nine (75%) of 12 early infections vs. eight (36.3%) of 22 delayed or late infections (p 0.03).

DISCUSSION

The conventional treatment for infected prostheses is still excision arthroplasty with a staged revision, one- or two-stage reimplantation of a new device, in conjunction with prolonged, pathogen-targeted antibiotic treatment [1]. However, this therapeutic strategy may sometimes require prolonged hospitalisation, while infected patients are often elderly, with multiple comorbidities, who may suffer additional discomfort or serious peri-operative complications. For these patients, and patients who cannot or will not undergo further surgical interventions, prolonged antibiotic therapy in conjunction with

Table 2. Relationship between early, delayed and late appearance of prosthetic joint infection and improvement with no relapse (INR)

Onset of infection	Number (%) of cases with INR
a. Early (n = 12)	9 (75%)
b. Delayed (n = 16)	6 (37.5%)
c. Late (n = 6)	2 (33.3%)

a vs. b, p 0.04; a vs. b +c, p 0.03.

surgical debridement, when necessary, seems a reasonable alternative, despite only a few studies regarding the efficacy of this therapeutic approach [2,3,8,11].

In France, excellent cure rates were obtained for staphylococcal orthopaedic infections with three oral antibiotic regimens and a therapeutic strategy similar to that adopted in the present study [2,4–6]. Ofloxacin plus rifampicin cured 17 (81%) of 22 hip prosthesis infections and nine (69%) of 15 knee prosthesis infections; in the cured cases, seven hip prostheses and two knee prostheses were not removed [5]. Fusidic acid plus rifampicin cured 11 (52.3%) of 21 hip prosthesis infections and eight (72.7%) of 11 knee prosthesis infections; in only five of 19 cured cases was device removal necessary [4]. Finally, cure was achieved with high-dose oral co-trimoxazole for eight (53.3%) of 15 prosthetic joint infections (six hip prostheses and nine knee prostheses); four (57%) of the seven failures were a result of intolerance to the study drug or lack of compliance with the therapeutic regimen [6]. Zimmerli *et al*. [8] studied eight patients with a staphylococcal prosthesis infection (five hip prostheses, three knee prostheses) who presented within 28 days of implant, and obtained a 100% cure rate without prosthesis removal with oral ciprofloxacin plus rifampicin. However, these findings cannot be compared to those of the present study, in which only a minority (14.7%) of patients presented with an infection within 1 month of the prosthesis implant.

In previous studies [2,4–6,8], treatment efficacy was evaluated after a post-treatment follow-up period of 9–84 months. However, since a failure rate of 69–77% with retention of the device has been observed, relapse of an orthopaedic implant infection treated by such conservative medical therapy always remains possible [11–13]. Moreover, although there is a higher chance of relapse within 6 months of the discontinuation of antibiotics, some studies [8,11] have observed relapse after 1 year, as was seen for one patient in the present series.

The present study adopted antibiotic regimens that have either been used successfully for 'long-term outpatient antibiotic therapy' of orthopaedic implant infections or appeared promising in in-vitro/in-vivo experimental models of foreign body infection [1,8,14,15]. Rifampicin has been used frequently, since this antibiotic retains bactericidal activity against sessile staphylococci adherent to implants and reaches high tissue and intracellular concentrations [1,2,8]. When it is used in combination with other active, lipid-soluble agents, such as a quinolone or minocycline, or with glycopeptides, emergence of resistance to rifampicin can be prevented [1,8,16–18]. Combinations of ofloxacin, ciprofloxacin or pefloxacin plus rifampicin have been used successfully for staphylococcal orthopaedic infections, caused usually by methicillin-susceptible strains [1,4,8,17]. However, the combination of a glycopeptide and a quinolone may prove synergic *in vitro* against methicillin-resistant staphylococci, and is more efficacious than glycopeptide monotherapy in in-vivo experimental models of staphylococcal foreign body infection [17,19].

In the present series, infection was suppressed in 31 (91.2%) of 34 patients, with no relapse being observed in 17 (50%) patients after follow-up for 9–57 months following discontinuation of antibiotics. As observed previously [2,3,11], there was a significantly better outcome for early compared to delayed and delayed plus late infections (p 0.04 and p 0.03, respectively). Prolonged suppressive antibiotic therapy was eventually adopted for eight patients in order to treat or prevent early and late relapses. As these infections are rarely life-threatening, the pain-free, long-term function of the device and the optimal tolerance of oral antibiotics (usually minocycline ± rifampicin) were the major criteria for prescribing continued suppressive therapy [1,3,20].

The present study had some major limitations relating to the retrospective nature of the analysis, the fact that the patient population was not homogeneous, and the wide ranges in duration of therapy and follow-up. The apparently favourable results should therefore be considered with caution as further, but not definitive, evidence that medical therapy with prosthesis retention is feasible in orthopaedic implant infections. As outlined previously [2], in the absence of large, randomised, prospective trials evaluating different therapeutic strategies for the management of orthopaedic device infection, solutions to the controversial issues surrounding prosthetic joint infection will be reached only by exploiting large databases that lend themselves to rigorous statistical analysis [2,7]. To this end, patients receiving medical therapy while retaining the prosthesis, and/or receiving long-term ambulatory antibiotic

regimens, should be included in research protocols defining: (1) strict criteria for diagnosis, prognosis and cure of the prosthesis infection [2]; (2) a scoring system for the clinical status [7]; and (3) specific antimicrobial treatment courses according to the pathogen and prosthesis (e.g., knee vs. hip) involved [1,2,5,21,22].

Overall, the present data seem to confirm that suppression of infection with salvage of the infected device in an acceptably functional state can be achieved in selected cases. In particular, long-term outpatient antibiotic therapy may be a feasible alternative option for patients with early infection in which surgery may be contraindicated (e.g., older patients with multiple co-morbidities), patients for whom the post-surgical functional result may be non-acceptable (e.g., patients with previous multiple joint surgery), and patients who refuse surgery. Continued suppressive antibiotic therapy may be required for some patients who appear to be at higher risk of relapse despite significant clinical improvement. However, a conservative medical approach requires strict clinical monitoring of its performance, of possible side effects, and of the patient's compliance with the therapeutic regimen. Finally, prolonged follow-up after discontinuation of antibiotics is necessary to assess whether a definitive cure has been achieved.

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