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ORIGINAL PAPER

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The outcome of perioperative wound infection after total hip and knee arthroplasty

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Abstract Forty-one consecutive patients with primary knee arthroplasty and 37 with primary hip arthroplasty, all with perioperative wound infections, were followed for 50 (12–130) months. Staphylococci (coagulase negative and positive) accounted for 74% of wound infections. Mixed organisms accounted for 10%. Prosthetic infections developed in eight patients and aseptic loosening in three patients. All the prosthetic infections developed within 6 months of the primary surgery. Organisms responsible for superficial infections were responsible for prosthetic infection in five patients; no organisms were isolated in the remaining three patients. The presence or absence of wound dehiscence, wound haematoma, and postoperative pyrexia did not predict the development of deep sepsis; however, the presence of wound discharge was a significant risk factor.

Résumé Une série de patients consécutifs présentant une infection péri-opératopire ont été suivis pendant 50 (12 à 130) mois ; 41 après une arthroplastie primaire du genou et 37 après une arthroplastie primaire de la hanche. Le staphylocoque (coagulase positif et negatif) était en cause dans 74% des cas. Dans 10% des cas plusieurs germes étaient en cause. Les infections sur prothèse se sont développées chez huit patients et il y eu un descellement aseptique chez trois patients. Toutes les infections sur prothèse se sont développées dans les six mois suivant la chirurgie primaire. Les germes responsables des infections superficielles étaient responsables de l'infection sur prothèse chez cinq patients. Aucun germe n'a été isolé chez les trois autre patients. La présence d'une déhiscence de la plaie, l'existence d'un hématome ou la pyrexie postopératoires n'avaient pas de valeur prédictive pour le développement d'un sepsis profond mais la présence d'un écoulement de la plaie opératoire était un facteur de risque considérable.

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Introduction

Nowadays, infections of hip and knee prostheses occur in 1–2% of patients who have primary hip and knee arthroplasties [2, 5, 8, 12, 13]. Infection of prostheses is generally more common after primary knee arthroplasty than after hip arthroplasty – probably due to the more superficial location of the former [6].

Perioperative superficial wound infections are more common than deep prosthetic infection. The presence of a wound infection has been identified as a significant risk factor for development of prosthetic infection, but the exact extent of the risk is unknown [10, 20, 24]. This is, in part, due to the relative infrequency of wound infections after total hip and knee arthroplasty, resulting in difficulties in accrual of sufficient numbers of patients in any series. Also, the definition of wound infection remains a problem because of difficulties in distinguishing wound inflammation from wound infection. It is therefore not surprising that there is a wide variation in the published rates of wound infection in the perioperative period [10, 11, 23].

The Surgical Infection Study Group defines wound infection purely on clinical grounds and does not require microbiological confirmation [19]. Although this definition is easy to apply, many studies have shown that it results in a high audited rate of wound infection and that it is a poor predictor of ongoing wound problems and outcome of wound infections [4, 15]. The other commonly used definition is the Center for Disease Control and Prevention (CDCP) definition of infection at a surgical site [14]. The CDCP definition relies on clinical signs of infection with a positive microbiological culture from the site of surgery and without clinical evidence of deep involvement. This definition has been shown to be more reliable in predicting the outcome of wound infection in surgical patients [7].

The purpose of this study was to quantify the risk of deep prosthetic infections in patients who develop perioperative wound infections and identify factors that predispose patients to prosthetic infection after wound in-

fections. We also studied the microbiology and antibiotic sensitivity of wound and prosthetic infections to determine any relationship between the two.

Materials and methods

The present study is a retrospective review of the data collated by the Infection Control Committee over a 10-year period (1989–1999) during which a total of 6,782 patients underwent primary total arthroplasty of the hip or knee joints in our hospital. All patients had prophylactic antibiotics – most commonly cefuroxime at induction of anaesthesia and three doses after surgery. Of these patients, 81 (1.3%) developed perioperative wound infections defined as the presence of varying degrees of wound erythema or heat or discharge associated with a positive microbiological culture within 4 weeks of surgery, as recommended by CDCP criteria for infection at a surgical site [14]. None of the patients had clinical signs of deep infection during the perioperative period. The clinical and radiological records of the patients with wound infections were studied. The microbiology and antibiotic sensitivities of the infecting organisms were obtained from laboratory records. Deep sepsis was defined as the presence of early loosening of implant with the presence of pus with or without positive cultures in joint aspirates or tissue biopsy samples obtained at the time of surgery, as used in the Swedish Hip Register study [1].

Follow-up regime for the patients was a clinical review at between 4 and 6 weeks post surgery, or earlier if indicated for clinical assessment of the wound. Further routine follow-up was at 3, 6, and 12 months after surgery for all patients, and then yearly in most patients. Patients that had not been followed up recently were contacted by telephone for information about their joint replacements since surgery. For patients that had died from unrelated causes, information on the clinical state of the patients' joint replacements prior to death was obtained from either the patients' next of kin or the general practitioner. Three patients were excluded because of inadequate clinical data or loss to follow-up. Seventy-eight patients were included in the study. Statistical analysis was performed with chi-square test for nominal data, with P values ≤ 0.05 considered significant.

Results

We studied 78 patients with wound infections, including 41 with total hip replacement and 37 with total knee replacements. All the patients had a cemented arthroplasty, except one patient who had an uncemented total hip replacement. There were 50 women and 28 men. The mean age at the time of surgery was 71 years (23–89) and mean follow-up from the time of surgery was 50 months (12–130). The indication for surgery was osteoarthritis in 69 patients (88%), rheumatoid arthritis in six (8%), ankylosing spondylitis in one, haemophilic arthropathy in one, and non-union of a femoral neck fracture in one. At the time of review 67 patients were alive and 11 had died.

A wound discharge was present in 68 patients: 61 had associated wound hematoma, 17 had postoperative wound dehiscence, and 13 had postoperative pyrexia more than 37.5°C for more than 24 h postsurgery. The results of patients with total hip and knee arthroplasties were similar and are therefore presented together.

Table 1 Organisms responsible for perioperative wound infections in all the patients

Organism(s)	Number of patients
Staphylococcus aureus	28 (36%)
Staphylococcus epidermidis	29 (38%)
Staphylococcus epidermidis and diphtheroids	3 (4%)
Staphylococcus epidermidis and group D streptococci	1 (1%)
Staphylococcus aureus and *Peptococcus*	1 (1%)
Staphylococcus aureus and group D streptococci	1 (1%)
Staphylococcus aureus and *Streptococcus faecalis*	1 (1%)
Diphtheroids	4 (5%)
E. coli	2 (3%)
Enterococcus	1 (1%)
f3-Haemolytic streptococci group G	2 (3%)
Pseudomonas aeruginosa	1 (1%)
Serratia	2 (3%)
Pseudomonas aeruginosa and *Serratia* and *Bacillus*	1 (1%)

Microbiology and antibiotic sensitivity of infecting organisms

A variety of organisms were responsible for the wound infections (Table 1). Staphylococci were the predominant infecting organism. Microbiological cultures revealed pure *Staphylococcus epidermidis* in 29 patients (38%), *Staphylococcus aureus* in 27 patients (36%), and *S. aureus* or *S. epidermidis* in mixed culture with other organisms in seven patients (9%). Overall, staphylococci were involved in 81% of the patients.

Sensitivity of the infecting organism to antibiotics was not performed in 29 patients (37%). All the infecting organisms in the 49 patients who had antibiotic sensitivity performed were sensitive to common antibiotics. The most common antibiotics to which the infecting organisms were sensitive were erythromycin and flucloxacillin. Twenty-seven patients (55%) had organisms sensitive to erythromycin, 23 (47%) had organisms sensitive to flucloxacillin, 11 (22%) had organisms sensitive to gentamicin, and seven (14%) and five (10%) respectively to fusidic acid and amoxicillin. Only two patients (4%) had organisms sensitive to cefuroxime, the antibiotic that was most commonly used for perioperative prophylaxis.

The risk of prosthetic infection

Deep infection involving the prostheses developed in eight patients (10.2%). All prosthetic infections reported here developed within 6 months of surgery. The treatment of prosthetic infection was two-stage revision surgery in three patients, débridement in four patients, and long-term antibiotics in one patient. Positive microbiological cultures were obtained in five of the eight patients (63%). The infecting organisms for prosthetic infections were similar to those responsible for wound infections, although the organisms were not subtyped (Table 2). There was no difference in the risk of pros-

Table 2 Relationship between infecting organisms for perioperative wound infection and prosthetic infection. *TKR* total knee replacement, *THR* total hip replacement

Age (years)/sex	Operation	Wound infection	Prosthetic infection
84/female	TKR	*Staphylococcus epidermidis*	*Staphylococcus epidermidis*
41/male	TKR	*Staphylococcus aureus*	*Staphylococcus aureus*
68/male	TKR	*Staphylococcus epidermidis*	*Staphylococcus epidermidis*
68/female	TKR	Diphtheroids	Diphtheroid and *Staphylococcus aureus*
81/female	THR	*Staphylococcus aureus*	*Staphylococcus aureus* and *epidermidis*
79/male	THR	β-Haemolytic streptococci group G	No growth
66/female	THR	*Staphylococcus aureus*	No growth
74/female	THR	*Staphylococcus epidermidis*	No growth

thetic infections between patients who had total knee or total hip replacements. Four out of 41 patients (9.7%) with total knee replacements and four of 37 (10.8%) with total hip replacements developed prosthetic infections. Three other patients (one knee and two hips) had developed aseptic loosening at a mean of 8 years from surgery (range 6–11years). Two of these had revision surgery, and intraoperative cultures did not reveal any microbiological growth.

There was no significant statistical relationship between development of prosthetic infections and the presence of wound hematoma, wound dehiscence, or postoperative pyrexia. All the patients who developed prosthetic infection had wound discharge accompanying the wound infection. Eight out of 68 (12%) patients with wound discharge developed prosthetic infections, while none of the ten patients without wound discharge developed prosthetic infection. However, the difference was not statistically significant.

Discussion

The definition of wound infection remains controversial. Definitions that rely only on clinical diagnosis of wound infection in the absence of positive microbiological cultures lack specificity and are poor predictors of outcome [4, 15]. For this reason a definition that relies on clinical signs and positive microbiological wound culture for diagnosis of wound infection is preferable. Using this definition we identified 81 patients (1.3%) with wound infection occurring within 4 weeks of surgery out of 6,782 consecutive patients who underwent primary arthroplasty of the hip and knee joints at our center over a ten-year period. Our rate of wound infection (1.3%) is similar to the 1.2% rate reported by Fernandez et al. [9] who used a similar definition. However, it was lower than other series in which positive microbiological cultures were not required for diagnosis of wound infection [8, 10]. We believe our method provides a more accurate diagnosis of infection.

As previously reported in other series the most common organisms responsible for wound infection are *Staphylococcus aureus* and *Staphylococcus epidermidis* [2, 20, 22]. In this series 81% of all wound infection was due to staphylococci, either in pure forms or in mixed culture with other organisms. Most of the organisms were sensitive to erythromycin and flucloxacillin. Only 4% of the organisms were sensitive to cefuroxime, probably because virtually all our patients had cefuroxime as prophylactic antibiotics in the perioperative period. This indicates that the initial antibiotic treatment of a patient with perioperative wound infection after total hip and knee replacements should be flucloxacillin or erythromycin until the definitive organism and its antibiotic sensitivity is identified.

The risk of prosthetic infection in a patient with perioperative wound infection with a positive microbiological culture is 10.2%. The exact pathogenesis of prosthetic infections remains an issue. Prosthetic infections that develop within 6 months of surgery are generally attributed to organisms acquired perioperatively [18]. It is therefore not surprising that all the prosthetic infections in this series occurred within 6 months of surgery. The organisms responsible for perioperative wound infections are often responsible for prosthetic infections. In five out of eight patients with positive microbiological cultures obtained at the time of revision surgery of the infected prostheses, the organisms isolated were similar to those responsible for perioperative infection; however, no subtyping was performed to determine conclusively that the same organisms were responsible. The recovery of the same organisms from wound infection and infected joint replacements has been reported by other authors [16, 22]. We found no association between the presence of postoperative pyrexia and development of prosthetic infection. This finding is similar to those of Shaw and Chung [21], and suggests that postoperative pyrexia is a normal inflammatory response in the majority of patients.

There is controversy in the literature about the association between perioperative wound discharge and development of prosthetic infection [3, 10, 17, 22]. Surin et al. [22] showed that a wound discharge was associated with a significant risk of prosthetic infection, particularly in the presence of a positive culture. Our results are entirely consistent with this. Eight out of 68 (12%) patients with a discharging wound infection developed prosthetic infection while none of the ten patients with a dry wound infection developed prosthetic infection. However, the difference did not reach statistical significance due to the small number of patients in the series. Notwithstanding, we believe early aggressive surgical management of wounds with an infected discharge is justified, particu-

larly when the discharge does not settle after a short course of antibiotics.

This study has some limitations. First, it is a retrospective review, but the data we analysed have been prospectively collected and monitored by a dedicated team and therefore provide a good resource for the analysis of patients with documented wound infections. Second, the study extended over a long time period during which changes occurred in the practice of orthopaedic surgery and microbiology – particularly knowledge of the clinical importance of certain organisms that were previously regarded as non-pathogenic, such as *Staphylococcus epidermidis*. This is why one-third of patients with documented wound infection with known organisms in this series did not have antibiotic sensitivities for the organisms performed. Despite these limitations we believe that the issues examined here are of great clinical importance to orthopaedic surgeons, and that this study is the first of its kind to quantify the risk of prosthetic infections in patients who developed wound infections after primary total knee and hip arthroplasty. The results of the study will therefore serve as useful baseline information for future studies.

In conclusion, perioperative wound infections present a significant risk of early prosthetic infection. Patients with wound discharge are at a high risk of prosthetic infection, and early surgical treatment of the wound infection is recommended. Most organisms responsible for wound infections are sensitive to flucloxacillin and erythromycin, and these antibiotics are recommended for initial treatment until results of microbiological cultures and antibiotic sensitivities are known. The infecting organisms are usually resistant to cefuroxime if this has been used for prophylaxis at the initial surgery. The organisms responsible for perioperative wound infection and prosthetic infection are similar. When organisms are not cultured at the time of revision surgery, the organisms responsible for wound infection can be assumed to be responsible for prosthetic infection. However, it is important to be aware that a mixed culture, including wound-infecting organisms, may be responsible for the prosthetic infection.

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