The use of two-stage exchange arthroplasty with depot antibiotics in the absence of long-term antibiotic therapy in infected total hip replacement

We present a series of 114 patients with microbiologically-proven chronically-infected total hip replacement, treated between 1991 and 2004 by a two-stage exchange procedure with antibiotic-loaded cement, but without the use of a prolonged course of antibiotic therapy. The mean follow-up for all patients was 74 months (2 to 175) with all surviving patients having a minimum follow-up of two years. Infection was successfully eradicated in 100 patients (87.7%), a rate which is similar to that reported by others, but where prolonged adjuvant antibiotic therapy has been used. Using the technique described, a prolonged course of systemic antibiotics does not appear to be essential and the high cost of the administration of antibiotics can be avoided.

The treatment of the chronically-infected total hip replacement (THR) remains controversial. Numerous protocols using one- or two-stage procedures have been described.1-5 A two-stage exchange is recommended by some authors.1,2 Others recommend a one-stage procedure, generally with adjuvant long-term antibiotic treatment either orally or intravenously.3-7 This often necessitates a long in-patient stay and the placement of a central venous catheter. The costs both to the patient and health service are high.8,9

Since 1991, the senior author (IS) has used a two-stage approach with the use of depot antibiotic therapy only. Prolonged courses of antibiotics have not been routinely used. The rationale for this approach is that the mainstay of treatment is surgical and that the local elution of depot antibiotic suffices after thorough debridement. We have analysed all patients treated in this way.

Patients and Methods

Between 1991 and 2004, 114 consecutive patients with microbiologically-proven deep chronic infection of the hip were managed by a two-stage exchange procedure. We defined infection as being present when a positive pre-operative aspiration and/or multiple positive cultures had been obtained at the first-stage debridement. There were 51 women and 63 men with a mean age of 64 years (28 to 83) at the time of the first stage procedure. The reasons for the primary THR are outlined in Table I. In all, 91 (79.8%) of the patients referred for revision were tertiary referrals.

The mean number of surgical procedures performed before presentation to our unit was 2.5 (2 to 10). A total of 46 patients (40.4%) presented with open wounds, discharging sinuses or frank abscess formation.

Aspiration was performed on all patients before the first-stage debridement since we regarded this as an essential part of their management. Previous work from our unit has shown high rates of sensitivity and specificity for the diagnosis of prosthetic joint infection in appropriately selected patients.10,11 The results were interpreted in conjunction with a microbiologist (PN) who has a particular interest in prosthetic infection. Suppressive antibiotics if previously prescribed were stopped at least two weeks before aspiration.

At the first-stage procedure, further antibiotics were withheld until multiple-tissue specimens had been taken. These samples were also taken before there was any disturbance of cement in case elution of antibiotics occurred.12 Both components including any accessory implants such as cement restrictors or wires, and all cement if present were removed. Most importantly, a radical debridement of the bone and soft tissues was then performed.

Local elution of antibiotics was achieved by fashioning antibiotic-loaded methylmethacrylate cement beads. This method has been shown to give higher concentrations of antibiotic locally than that achieved by intravenous administration of antibiotics.13-15 Additional antibiotics were added to the cement as indi-
cated by the culture results from the pre-operative aspiration. If the aspiration was negative, but other indices of infection were positive, we routinely added gentamicin and vancomycin since this would cover the sensitivity profile of most bacteria encountered in prosthetic joint infection.

With vancomycin, we added 2 g of powder to each 40 g mix of Palacos R cement (Schering Plough Ltd, Welwyn Garden City, United Kingdom). When additional gentamicin was used, 1 g per mix was added. Mixing was performed with a spatula without the application of a vacuum and the cement formed into the shape of small (< 1 cm) biconcave discs and held on 18-gauge braided wire to form chains. A single batch of cement was adequate to provide sufficient beads for both the acetabulum and the femoral canal.

After taking specimens for culture, a broad-spectrum antibiotic, typically a cephalosporin, was given intravenously as surgical prophylaxis, with two further doses given post-operatively. No additional oral or intravenous antibiotics were given. The patients were mobilised bearing weight as tolerated and were discharged home when their wound was dry and they were mobile.

Outpatient monitoring included clinical examination and assessment of inflammatory markers such as erythrocyte sedimentation rate (ESR) and the level of C-reactive protein (CRP). When the soft tissues were quiescent and the serological markers were satisfactory (ESR < 20 mm/hr, CRP < 10 mg/l), the patients were considered for a second-stage reconstruction. If there was evidence of persistent infection the first-stage procedure was repeated without delay.

At the time of re-implantation, multiple-tissue specimens were taken again before the administration of prophylactic antibiotics. The sensitivity pattern of the organisms cultured from the first stage determined which additional antibiotics were to be added to the cement used for reconstruction. A variety of different reconstruction techniques was used depending upon available bone stock (Table II).

All the patients were followed up prospectively, both clinically and radiologically since our policy is the long-term annual review of such patients.

### Results

In the 114 patients, the mean interval between stages was 6.4 months (2 to 22). A repeat of the first-stage debridement was required for five patients. The mean follow-up after the second stage was 74 months (2 to 175) with all surviving patients having a minimum follow-up of two years.

A positive culture was obtained from aspiration of the hip in 91 (79.8%) patients with all the remaining patients having positive cultures from tissue samples taken at the first stage.

The infecting organisms identified at pre-operative aspiration and at the first stage are given in Table III. The most commonly-encountered organism was coagulase-negative *Staphylococcus aureus*. Polymicrobial infections were identified in 14 patients.

No organisms were cultured from second-stage samples in 96 (84.2%) patients. In those with a positive second-stage culture, the same organism was identified as had been found at the first stage.

Infection appeared to have been eradicated in 100 (87.7%) patients. The remaining 14 patients (12.3%) were considered to be failures since subsequent investigations
revealed positive bacteriology. In nine of these, recurrence of the infection occurred within one year of the second stage.

The 14 persistently infected patients were all offered further surgery. Seven elected not to undergo a further two-stage revision, of whom six have been managed by lifelong suppressive antibiotic therapy with retention of the components. One patient with a total femoral replacement underwent disarticulation of the hip.

The remaining seven patients had a further two-stage exchange procedure with antibiotic-loaded cement as previously described. In two of these, an additional debridement was required after the first stage since infection persisted as revealed by the formation of an abscess. In five of these seven patients, infection was eradicated. Of the remaining two, one has undergone excision arthroplasty and the other has been managed by suppressive antibiotic therapy. The mean follow-up of this group of patients with repeat revisions was 90 months (25 to 150).

The success of our two-stage exchange technique, as defined by the eradication of infection, was 88% after the first attempt which increased to 92% after a subsequent exchange procedure.

There was no association between success or failure with respect to the infecting organism, positive second-stage cultures, comorbidity, diagnosis at the initial procedure or the number of previous operations.

Discussion
This is a consecutive series of microbiologically-confirmed cases of infected THR managed by a single surgeon. As in other series, multiple operations and medical comorbidities were common. Other similar series have reported comparable results in terms of the eradication of infection, but all have used long-term antibiotic therapy, either oral or intravenous, ranging in duration between three weeks and 16 months. In our series, long-term antibiotic therapy was not routinely used.

A radical debridement is paramount to the success of eradicating infection since all foreign material and abnormal tissue must be removed. A complete capsulectomy is necessary and osseous debridement must also be radical. No compromise should be made to simplify a subsequent reconstruction. If necessary, a repeat debridement may be required as was performed in five patients.

The elution of antibiotic into the site of an excision arthroplasty must be high and sustained. Antibiotic-loaded polymethylmethacrylate beads continue to elute antibiotic at concentrations in excess of that required to control the pathogen long after most intravenous protocols have ceased.16 The ratio of shape and volume in generating the greatest surface area for antibiotic elution is well established with small (< 1 mm) ovoid or biconcave discs having the greatest surface area available.17,18 There is a direct relationship between the elution of the antibiotics and porosity of the cement and, therefore, vacuum mixing of cement should be discouraged.

Polymethylmethacrylate beads achieve concentrations of local antibiotic up to 17 times higher than that found after intravenous administration without the toxic side-effects of the commonly-used intravenous antibiotics.19 Cement spacers have been recommended in order to try and preserve soft-tissue tension and thereby improve interim function and decrease the cost and length of hospital stay. Advocates of this technique feel that those patients without a spacer are prone to soft-tissue contraction, poorer mobility, and a more difficult second-stage reconstruction.20-22 This has not been our experience and to date, there has been no prospective randomised, controlled trial which has examined patient satisfaction and function after the use of articulating spacers.

We conclude that prolonged courses of antibiotics are unnecessary provided that the protocol described is carried out rigorously. After debridement, microbiological advice must be followed regarding the addition of appropriate antibiotics to the cement at both the first stage and subsequent re-implantation of the definitive prosthesis. Our protocol has provided comparable results to those of other series, all of which used prolonged courses of antibiotics in addition to surgical debridement. We have noted, as with other authors, that any recurrence of infection is usually seen within 12 months of revision surgery.23 We also found similar results with this technique in the management of the infected total knee replacement.24

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


