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ORIGINAL ARTICLE

The management of infected elbow arthroplasty by two-stage revision

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Background: Deep prosthetic infection is a potentially devastating complication after total elbow arthroplasty, with an incidence of up to 12%. This study examined the demographics, microbiologic profile, and outcomes of infected total elbow arthroplasty treated with 2-stage revision in a tertiary referral unit.

Methods: We identified 19 consecutive patients (mean age, 65 years) undergoing revision arthroplasty for deep prosthetic infection. All patients underwent a first-stage procedure with removal of implants, débridement, and insertion of an antibiotic-loaded cement spacer, followed by at least 6 weeks of intravenous antibiotics. Fourteen patients required a second-stage revision.

Results: Five patients did not undergo a second-stage procedure because of patient choice (n = 2), medical or surgical risk factors (n = 2), and death from an unrelated cause (n = 1). Of the 19 patients undergoing a first-stage procedure, 16 (84%) remained infection free, and 11 of the 14 patients (79%) undergoing reimplantation of an elbow prosthesis remained infection free. Six patients required further surgery (3 for recurrent infection, 3 for noninfective indications). The commonest infecting organism was *Staphylococcus aureus* (47%). A degree of postoperative ulnar nerve dysfunction occurred in 37% of patients, but all resolved fully without further treatment.

Conclusions: Management of prosthetic joint infection using 2-stage revision can result in high rates of eradication, although rates of reoperation and transient ulnar nerve dysfunction are high.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Elbow; arthroplasty; infection; revision; periprosthetic; replacement

Total elbow arthroplasty (TEA) is an effective treatment for a range of pathologies, including rheumatoid arthritis (RA), primary osteoarthritis, acute fracture, and post-traumatic arthritis. Deep prosthetic infection is a potentially devastating complication, with infection rates of between 1.5% and 12% having been reported in the literature.[1,7,8,10,12,13,19] The treatment options include suppressive antibiotics,[9] débridement and retention of implants,[20,21] excision arthroplasty,[14,20] arthrodesis,[16,20] and revision arthroplasty—either as a 1-stage[8] or 2-stage procedure.[5,18]

Retaining the implants after débridement or simply providing ongoing suppressive antibiotics results in a high rate of recurrent infection.[21] Excision arthroplasty often results in a poor functional outcome,[14] and arthrodesis has an unacceptably high failure rate, with 1 series reporting a 100% failure to achieve union.[16] Revision arthroplasty may restore

Ethical approval for this study was not required or obtained because it was a retrospective outcome review of a series of patients.

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function[5,18] but can be technically challenging due to bone loss and soft tissue scarring. Recurrent infection rates of 11.5% to 28% have been reported,[5,8,18] with 2-stage revision appearing to give a lower rate of recurrent infection.[8,18] We reviewed our experience with 2-stage revision arthroplasty for the treatment of infected TEA with respect to the presenting features of the infected joint, microbiologic profile, eradication of infection, and reoperation rates.

Materials and methods

Patients

We reviewed the medical records and imaging of all patients undergoing revision arthroplasty for infected TEA at our institution between 2009 and 2014. Patients undergoing revision for apparently aseptic reasons (fracture, instability, aseptic loosening) who then had positive results for intraoperative samples were excluded because they did not have the same antibiotic regimen and thorough débridement as those known preoperatively to be infected. We identified 21 patients, with 2 patients excluded due to retention of a well-fixed ulna component at the first stage, leaving 19 patients who underwent a first-stage revision procedure with removal of all implants. We recorded the indication for primary surgery, the time from primary surgery to the first-stage revision, whether the patient was diabetic or receiving treatment with steroids, whether the implants showed evidence of radiologic loosening, the organisms isolated from intraoperative specimens, and whether the patient remained free from infection at the most recent follow-up.

Preoperative assessment

A diagnosis of prosthetic joint infection was made using the guidelines of the Musculoskeletal Infection Society,[17] also adopted by the American Academy of Orthopaedic Surgeons:

A definite diagnosis of PJI can be made when the following conditions are met:

- *A sinus tract communicating with the prosthesis; or*
- *A pathogen is isolated by culture from two separate tissue or fluid samples obtained from the affected prosthetic joint; or*

Four of the following six criteria exist:

- *Elevated serum erythrocyte sedimentation rate (ESR) or serum C-reactive protein (CRP) concentration*
- *Elevated synovial white blood cell (WBC) count*
- *Elevated synovial neutrophil percentage (PMN%)*
- *Presence of purulence in the affected joint*
- *Isolation of a microorganism in one culture of periprosthetic tissue or fluid*
- *Greater than five neutrophils per high-power field in five high-power fields observed from histologic analysis of periprosthetic tissue at ×400 magnification*

However, *PJI may be present even if fewer than four of these criteria are met*.

Anteroposterior and lateral radiographs were obtained for all patients to assess for any evidence of loosening. Whenever possible, RA medications—including steroids, disease modifying anti-RA drugs, and biologic agents—were discontinued in the perioperative period. Diabetes control was optimized if necessary.

First stage

All operations were performed through a posterior approach with the patient in lateral decubitus. A thorough débridement was performed, including removal of all infected soft tissue and bone and excision of the sinus tract(s), if present. Multiple samples of fluid, soft tissue, and bone were sent for microscopy and culture. Once samples had been taken, empirical antibiotic treatment was started with intravenous Tazocin (Pfizer, Kent, UK), teicoplanin, and amikacin. Tazocin was withheld if the patient was allergic to penicillin.

All prosthetic components and cement were removed. Well-fixed implants were removed by using flexible osteotomes to loosen the implant from the cement mantle, and the cement was subsequently removed using cement splitting chisels, gouges, bone nibblers, a Midas Rex Legend High-Speed Burr (Medtronic, Minneapolis, MN, USA), and an Ultradrive-3 Ultrasonic Revision System (Biomet, Warsaw, IN, USA) if required. A proximal bone window for retrograde impacting of the implant was also required in some instances. Copious 0.9% saline irrigation fluid was used.

Antibiotic-loaded cement spacers were inserted, using Refobacin Revision Cement (Biomet) containing 1.8 g of gentamicin and 1.8 g of clindamycin per 80 g of cement. If the infective organism and sensitivities had been identified before the first stage, further antibiotics were added as necessary. The spacers were molded by hand to fill some or all of the medullary cavity of the humerus, the ulna, and any intervening space, depending on the exact anatomy after removal of implants. The wound was closed over a suction drain (removed at 24 hours postoperatively).

Antimicrobial treatment was continued postoperatively with intravenous Tazocin (4.5 g, thrice daily), teicoplanin (10 mg/kg, once daily) and amikacin (15 mg/kg, once daily). Amikacin was discontinued after 2 doses, and ongoing treatment was adjusted once microbiology results and sensitivities were available. If no samples were positive, then treatment was continued with teicoplanin alone to cover the gram-positive bacteria that are the most frequent infecting organisms. Antibiotics were administered on an outpatient basis using a peripherally inserted central catheter. Between the first and second stages, the arm was rested in a sling.

Patients were reviewed in the surgical clinic at 2 weeks and 6 weeks postoperatively, with monitoring of inflammatory markers (white cell count, erythrocyte sedimentation rate, and C-reactive protein). In addition, patients were monitored by the Out Patient Antimicrobial Therapy team, consisting of consultant microbiologists, clinical nurse specialists, and pharmacists, with weekly telephone consultations as well as being seen for clinical review. If there were no clinical signs of ongoing infection and inflammatory markers had returned to normal, the antibiotics were discontinued after 6 weeks. Two weeks after the cessation of antibiotics, patients underwent fluoroscopy-guided aspiration of the affected joint under aseptic conditions in the operating theater, with samples sent for analysis. If the aspirate analysis was negative, then the patient was deemed ready to proceed with a second-stage procedure.

If at the 6-week postoperative review there were clinical signs of ongoing infection or inflammatory markers had not normalized, an aspiration was performed (as described above). If the aspirate analysis was positive, then patients underwent a repeat first-stage