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Outcomes of infected revision knee arthroplasty managed by two-stage revision in a tertiary referral centre

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ABSTRACT

Background: A two-stage revision remains the gold standard to eradicate deep infection in total knee arthroplasty. Higher failure rates are associated with a number of factors including poly-microbial infections, multiresistant organisms and previous operations. The aims are to investigate [1] the overall success rate of a two-stage revision for infections in TKA, [2] the outcome of repeat two-stage revisions in recurrent infections and [3] the factors affecting the outcomes of such cases.
Methods: We present the outcomes of a consecutive, retrospective case series of 51 periprosthetic joint infections managed with a two-stage revision knee arthroplasty over a three year period.
Results: Forty-six (90%) of 51 were referred from other hospitals. Infection was successfully eradicated in 24 (65%) of 37 patients undergoing an initial two-stage procedure. Following a failed two-stage revision, a repeat two-stage revision was performed in 19 patients eradicating infection in 8 (42%). A third two-stage was performed in five of these patients eradicating infection in three with an average follow-up of 43 months. Multidrug resistance was present in 69%, and 47% of the patients were infected with multiple organisms. All unsuccessful outcomes involved at least one multidrug-resistant organism compared to 43% in the successful cohort ($P = 0.0002$). Serological markers prior to a second-stage procedure were not significantly different between successful and unsuccessful outcome groups.
Conclusion: Single or multiple two-stage revisions can eradicate infection despite previous failed attempts. In this series, failure is associated with multidrug resistance, previous failed attempts to eradicate infection and a less favourable host response.
Level of evidence: IV

1. Introduction

Total knee arthroplasty surgery is a commonly performed surgical procedure with almost 85,000 cases being in England and Wales in 2012. Based on joint registry data, 6009 revisions were performed in 2012 of which 22% were performed for infection. This included 255 single stage revisions and 706 two-stage revisions [1]. Two-stage revision arthroplasty remains the gold standard to eradicate deep infection in total knee arthroplasty (TKA) with quoted success rates of 80–100% [2]. Higher failure rates are associated with number of factors including medical co-morbidities, immunosuppressive states, poly-microbial infections, multiresistant organisms and previous operations [3]. [4,5]

Rates of infection after total knee arthroplasty are low, but with increasing life expectancy and the consequential increase in the number of procedures performed, this burden is likely to increase further [6,7]. The treatment options include irrigation and debridement with exchange of polyethylene liner, [8–10] single stage revision, [11,12], two-stage revision [3,4,9,13–15], resection arthroplasty [16], arthrodesis [17], long-term suppressive antibiotics [18] and above knee amputation (AKA). [19]

Repeat two-stage revision surgery can be undertaken where initial attempts to eradicate infection have failed. There is little evidence in the literature specific to deep chronic infection, with poor outcomes in small series [20–23]. A number of recent papers presenting series at tertiary units, where all patients are included regardless of prior treatment, particularly in the presence of multidrug resistance or after failed irrigation and debridement with prosthesis retention, are showing significantly worse results than previous papers. [24–27]

The aims of our study were to investigate [1] the overall success rate of a two-stage revision for infections in TKA [2], the outcome of repeat two-stage revisions in recurrent and persistent infections and [3] the factors associated with worse outcomes in such cases.

We hypothesised that cases involving multiple organisms or those that are infected with multidrug-resistant organisms would lead to a

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worse outcome. We also hypothesised that inflammatory markers prior to a second-stage procedure, age and gender would have no direct correlation with outcome.

1.1. Patients and methods

Between January 2006 and December 2008, 430 consecutive total knee arthroplasty revisions were performed for all causes at our unit. We reviewed all of these cases with the aim of identifying those that were performed for infection. Our criteria for infection were defined by at least one of these factors [28]: (1) a sinus communicating with the prosthesis, (2) pus within the joint and (3) documented pathogens from at least two samples of tissue or fluid culture following aspiration, washout or first-stage revision.

We used the Tsukayama system for classifying infection [29]. Where there was doubt, repeat tissue and fluid samples were taken having stopped all antibiotics for a period of at least two weeks.

We identified 58 revisions for infection. We excluded seven cases. This left us with 51 cases of infected knee arthroplasty that we had treated with a two-stage revision. Four patients had the primary TKA performed for bone tumour and three patients had primary TKA performed for infected internal fixation following open fractures. These cases were excluded from the study. Irrigation and debridement procedures were not included as a revision procedure in this study. This resulted in a total of 51 patients who underwent a two-stage revision surgery (27 male, 24 female) with a mean age of 72 years (range 23–89 years).

Case notes of all the patients were reviewed and data recorded on the date and the institution performing the primary arthroplasty, previous operations for infection, surgical treatment at our institution, microbiological results, ESR and CRP prior to the second-stage revision, follow-up and outcome.

Surgery was performed by multiple surgeons, but principles of infected revision surgery were constant. The first-stage revision surgery involved debriding all unhealthy tissue including sinuses, synovium and ligaments, tailored to each individual case. The implants were removed and the femoral and tibial bone surfaces were resected to healthy bone. Intra-medullary canals were cleared of all cement and membranes. Multiple tissue samples were taken again at this stage for culture and sensitivity prior to commencing antibiotics. The first-stage joint reconstruction was performed using an articulating cement spacer in the presence of minimal bone loss. When significant bone loss was encountered, a prosthesis (Stanmore Modular Individualised Lower Extremity System, SMILES, Stanmore Implants Worldwide, Middlesex, UK) wrapped in gentamicin and vancomycin cement was loosely implanted to maintain function and the soft tissue envelope between stages. Local flap coverage was performed in house in conjunction with plastic surgeons where required, or negative pressure dressings were applied for staged reconstructions at our regional plastic surgical unit. Although not a definite contraindication to two-stage revision if free tissue transfer was required for large soft tissue defects, arthrodesis was favoured.

Additional antibiotics were added to the cement in cases where microbiology results were known pre-operatively. Broad spectrum intravenous (IV) antibiotics were continued via a long line, guided by enrichment cultures and sensitivity results.

The second-stage procedure was performed after at least six weeks of IV antibiotics in correlation with clinical and serological assessments. In cases where infection was not eradicated the antibiotics were either prolonged or the patient was taken back to theatre for a repeat first-stage procedure on an individualised basis.

Bone loss was calculated using the Anderson Orthopaedic Research Institute (AORI) method [30] based on radiographs before a second-stage procedure (see Table 1). Results were independently assessed by two authors and the inter-observer variability calculated using Spearman's correlation coefficient.

Table 1
Anderson Orthopaedic Research Institute grading of bone loss.

Type	Severity of bone deficiency encountered
1	Minor femoral or tibial defects with intact metaphyseal bone, not compromising the stability of a revision component.
2	Damaged metaphyseal bone. Loss of cancellous metaphyseal femoral bone requiring reconstruction to provide stability to the revision component. A: Defects in one femoral or one tibial condyle. B: Defects in both femoral or both tibial condyles.
3	Deficient metaphyseal segment compromising a major portion of either femoral condyles or tibial plateau.

A successful outcome was defined as a functioning prosthesis with healed wounds, no sinuses or other clinical evidence of sepsis together with no radiographic evidence of infection. Unsuccessful outcomes included patients on long-term antibiotic suppression, those awaiting a further procedure due to ongoing infection or above knee amputation (AKA). Microbiological and serological investigations were added where there was clinical concern. A maximum likelihood of contingency tables was performed in JMP (SAS Inst. Inc. Cary, NC, USA) for microbiology data analysis and SPSS version 17 for all others (SPSS Inc., Chicago, IL, USA)

2. Results

A total of 51 patients who had revision TKA were managed with two-stage revision performed for infection over the study period of three years. Forty-six patients were referred from other hospitals, and five patients had primary TKA performed at our institution. There were six Tsukayama type III and 45 type IV infections.

2.1. Overall success rate

Overall, deep infection was successfully eradicated in 35 (69%) of 51 patients. Of the remaining 16 patients, seven are currently being treated by long-term suppressive antibiotics due to patient choice or lack of fitness for surgery, seven have undergone AKA and two are awaiting further surgery for ongoing infection. The results of our series are illustrated by Fig. 1.

2.2. Prior attempts to eradicate infection

Where patients were referred without any surgical intervention to eradicate infection and a two-stage procedure was subsequently performed at our institution, 24 (75%) of 32 were infection free. In the 14 cases where the referring hospital had attempted a single or two-stage procedure that failed prior to referral, only five were infection free (36%) after repeat two-stage revision at our institution.

2.3. Outcome of repeat two-stage revision surgery

A subgroup of 19 patients had a repeat two-stage procedure. Five of these were from a failed initial two-stage at our institution and 14 were referred from other institutions having undergone two-stage revision prior to referral. In this series of 19 patients undergoing a repeat two-stage procedure, 42% (8/19) were infection free. Where infection was not eradicated, four patients had AKA, one patient is on long-term antibiotics, one is awaiting a further procedure and five patients went on to a third two-stage procedure, eradicating infection in three. Following an unsuccessful third two-stage procedure, the remaining two patients had an AKA.

2.4. Factors associated with outcomes

From our initial hypothesis, we found that all members of the unsuccessful outcome group had at least one multidrug-resistant organism ($P = 0.0002$). Multiple organisms did have an effect, but this did not reach statistical significance ($P = 0.056$). There was no significant difference in gender (success 20 M/15, failure 7 M/9 F, $P = 0.55$); however, the unsuccessful group were significantly younger (mean failure 65, mean success 74, $P = 0.012$)

2.5. Microbiology

Following the first-stage revision, an organism was cultured from intra-operative fluid or tissue in 88% of cases (45/51). No organisms were grown in six patients, one in the unsuccessful cohort and five in the successful cohort. Despite being culture negative, frank pus was present at the time of the first-stage procedure. Table 2 summarises the organisms that were cultured.