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ORIGINAL PAPER

Similar outcomes between two-stage revisions for infection and aseptic hip revisions

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Abstract
Purpose Two-stage revision hip arthroplasty using an antibiotic-loaded spacer is the most widely performed procedure for infected hip arthroplasties. The clinical outcome of this type of surgery compared with aseptic joint revision with exchange of femoral and acetabular components is still controversial due to the relative lack of medium- to long-term follow-up. Therefore, we analysed clinical and radiological outcomes of septic two-stage revisions compared with aseptic hip revision surgeries.
Methods In this retrospective study we assessed 82 consecutive patients who underwent two-stage revision for septic total hip (45 patients) or one-stage aseptic revision arthroplasty (37 patients). The average follow-up was 53 months for the aseptic group and 55 months for the septic group. For clinical evaluation, we used the Harris Hip Score (HHS) and the Merle d'Aubigné and Postel score. The postoperative pain level was determined with the visual analogue pain scale.
Results The surgeries were performed 124 months (aseptic group) and 119 months (septic group) after primary total hip arthroplasty on average. The main indications for aseptic revision surgeries were aseptic loosening (96 %), dislocation (2.2 %), and periprosthetic fracture (2.2 %). In the clinical outcome patients achieved 75.5 points in the aseptic group and 73.4 points in the septic group in the Harris Hip Score. The Merle d'Aubigné and Postel Score revealed 12.5 points for the aseptic group and 13.1 points for the septic group. Mean level of persisting pain was 0.8 (aseptic group) and 0.4 (septic group) on the visual analogue scale (VAS). Overall survival in the aseptic group was 85.6 % at 9.8 years 82.7 % at 10.1 years for the septic group, with a repeat revision rate of 8.1 % and 6.7 %, respectively.
Conclusions Performing aseptic acetabular and femoral revision hip arthroplasty showed equal clinical outcomes in relation to septic two-stage revision hip surgeries. Our results showed a tendency for better outcome in comparison with the information given in the literature for septic and nonseptic exchange arthroplasties, including a lower rate of re-revisions.

Keywords Hip revision arthroplasty · Septic · Aseptic · Outcome

Introduction

In recent years, the total number of primary hip arthroplasties has increased rapidly [1]. Along with the higher implantation numbers, the quantity of revision hip surgeries is improving, with instability and aseptic loosening being the most common reasons for this type of arthroplasty [2]. Periprosthetic joint infections occur in <1 % of all patients but are the third most common reason for revision of artificial hips [3]. In early infections occurring within four weeks after implantation, the prosthesis is left in place and all modular components (e.g. inlay, head) are changed during revision [4]. Two-stage revision using an antibiotic-loaded spacer is the favoured treatment option in a chronically infected situation, with a survival rate up to 91 % and an infection eradication rate between 85 % and 100 % [1, 5–11]. Clinical and functional outcomes of aseptic revision surgery is reportedly higher than those following septic revisions and a higher complication rate in infected cases [9, 12, 13]. However, there are only very rare

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clinical reports directly comparing aseptic with septic revision hip arthroplasties. Most studies with higher patient numbers give short- to mid-term results or compare septic with all types of aseptic revision procedures [9, 13]. Because of these shortcomings, we investigated the clinical and radiological outcomes of cementless aseptic revision hip arthroplasties with femoral and acetabular revision in comparison with septic two-stage revision in a retrospective, single-centre consecutive study.

Patients and methods

From our institutional database we identified 82 patients who underwent a septic two-stage revision hip arthroplasty (45 patients) or aseptic revision with simultaneous exchange of the femoral and acetabular component (37 patients) from 2005 to 2011. Eleven patients were lost to follow-up (7 in the septic group and 4 in the aseptic group), and six patients died from non-implant-related reasons with the revision implants not revised (7.3 %, 3 in each group). Of the 65 patients analysed, 34 were women and 31 were men, and mean age was 73.7 (51–95) years. The major diagnosis leading to index total hip arthroplasty (THA) was primary osteoarthritis (79 % aseptic group, 74 % septic group), posttraumatic osteoarthritis (6 % aseptic group, 9 % septic group) and others (15 % aseptic group, 19 % septic group). Revision surgeries were performed on average 124 months (aseptic, 19–420) and 69 months (septic, 2–354) after primary THA. In all cases we used a lateral approach with lateral skin incision and excision of the old scar. Mean follow-up time was 55 (25–117) months for the septic group (35 patients) and 53 months for the aseptic group (24–111) (30 patients). Staphylococci were the most frequently cultured microorganisms in the septic group, 18 % of which were oxacillin resistant (Table 1).

Table 1 Organisms cultured in the septic group (n=45)

Microorganism	No. cases
Staphylococcus epidermis	12
Staphylococcus aureus	11
Oxacillin-resistant staphylococci	6
Enterococcus faecalis	4
Staphylococcus hominis	2
Staphylococcus capitis	2
Propionibacterium acnes	2
Corynebacterium striatum	1
Streptococcus mitis	1
Streptococcus agalactiae	1
Pseudomonas aeruginosa	1
Peptostreptococcus micros	1
Serratia marcescens	1

Clinical assessments included Harris Hip Score (HHS) and the Merle d'Aubigné and Postel score, and postoperative pain level was determined using the visual analogue pain scale (VAS). Patient satisfaction with surgery was assessed in a ternary fashion (satisfied, partly satisfied, not satisfied). Pre- and postoperative standard radiographs were available for all patients and were analysed for signs of implant loosening using criteria by Kavanagh and Fitzgerald [14] and by periprosthetic radiolucencies according to Gruen zones 1–7. Pre-operative femoral and acetabular defects were classified according to Pak et al. and Paprosky et al. [15, 16] (Table 2). Radiolucent lines around the acetabular components were classified in zones I, II and III as published by DeLee and Charnley [17]. We defined aseptic one-stage or two-stage septic revision as failure when patients underwent re-revision surgery for any reason.

All patients received a cementless MRP-TITAN® stem (Peter Brehm GmbH, Weisendorf, Germany) at revision surgery. In both groups, cementless, unconstrained, hemispheric, acetabular titanium components were used in all cases.

Statistical analysis

The main end point of this study was overall survival or revision hip arthroplasty in patients who underwent aseptic exchange of acetabular and femoral implants or septic two-stage revisions. Univariate analysis was performed using the Kaplan–Meier and log-rank tests, respectively. A p value <0.05 was considered statistically significant. For descriptive statistical analysis, we used SPSS 18.0 (SPSS Inc., USA).

Results

The main indications for aseptic revision were aseptic loosening of cup and stem (94 %), periprosthetic fracture (4 %) and fracture of the primary THA stem (2 %). Radiolucent lines around the cup were seen in DeLee and Charnley zone I in 4.6 %, zone II in 9.2 % and zone III in 4.6 % of patients in the septic group and in zone I in 15.3 %, zone II in 30.7 % and zone III in 51.4 % of aseptic cases. The type of failure (aseptic group) and pre-operatively defined bone defect revealed no significant difference in all parameters investigated. No spacer dislocations occurred in the septic group.

In the clinical outcome, patients in the aseptic group achieved 75.5 points (21–100) on the HHS, and those in the septic group achieved 73.4 points (18–100). Merle d'Aubigné and Postel score in the aseptic group was 12.5 points (5–18) and 13.1 points (4–18) in the septic group. Mean level of persisting pain was 0.7 in the aseptic group and 0.6 in the septic group (VAS; best 0, worst 10). The rate of patients without pain achieved 90.7 % in the septic group and 91.8 % in the aseptic group. In the aseptic group, 85.5 % of

Table 2 Distribution of bony defects

Paprosky type	Acetabulum aseptic group	Femur aseptic group	Paprosky type	Acetabulum septic group	Femur septic group
1	6.9 %	10.1 %	1	8.8 %	8.8 %
2A	48.5 %	59.4 %	2A	62.4 %	55.2 %
2B	8.4 %	8.1 %	2B	2.3 %	9.4 %
2C	29.4 %	3.3 %	2C	17.3 %	6.6 %
3A	4.6 %	15.8 %	3A	4.6 %	13.4 %
3B	2.2 %	3.3 %	3B	4.6 %	6.6 %
3C			3C		

patients were satisfied with their results, 12.1 % were partly satisfied and 2.4 % were not satisfied according their subjective responses. In the septic group 87.3 % were satisfied, 10.1 % were partly satisfied and 2.7 % were not satisfied. No clinical parameter investigated revealed statistically significant difference between groups. In the radiographic evaluation, all cases had stable stem ingrowth without radiolucencies or stem migration. According to Brookers' classification, 69.7 % of patients in the septic group had no periarticular ossifications, 23.4 % had Brooker type I, 4.6 % Brooker type II and 2.3 % Brooker type III [18]. In the aseptic group, type I ossifications were found in 24.4 %, type II in 4.8 % and type III in 2.3 % of cases.

Only one stem—in the septic group—was exchanged again because of recurrent infection. The calculated overall survival of revision arthroplasty in the aseptic group was 85.6 % at 9.8 years and 82.7 % at 10.1 years' follow-up for the septic group (Fig. 2) (Fig. 1).

Three of 35 (8.6 %) patients with septic two-stage revision were considered failures due to re-revision: one due to early postoperative superficial infection, which was treated with head and inlay exchange, meticulous debridement and antibiotic medication for four weeks postoperatively; one because of recurrent dislocation, with head and inlay exchange; and one with recurrent infection, who was treated with implant removal and revision with a secondary Girdlestone procedure. Repeat revision rate for the aseptic group was 10.0 %. Two patients were treated with inlay revision and femoral head exchange because of multiple dislocations, and one patient with early postoperative deep infection was operated with exchange of head and inlay, meticulous debridement and antibiotic medication for four weeks postoperatively. In both cases with deep infection, an oxacillin-resistant *Staphylococcus aureus* was isolated intra-operatively.

Discussion

Clinical outcome and patient satisfaction have been reported to be better after primary than after revision THA [19, 20]. Cementless two-stage revision hip arthroplasty using an antibiotic-impregnated cement spacer is the most frequently performed revision procedure for infected implants and has very different outcome reports. Recent papers revealed rates of aseptic loosening from 0 % to 18 % and stem subsidence in >30 % of the cases [4, 21, 22]. The reported subsidence rate (~4 %) was lower for the MRP stem used for all patients in our study [23–25]. Nevertheless, we found no stem subsidence or axial migration in either the aseptic or septic group after a mean follow-up of 53 and 55 months, respectively. These promising results are supported by findings of Wirtz et al., who show a 15-year survival rate of 85 %, with a revision rate of 6 % for this type of implant [23].

The majority of actual studies on aseptic hip revision arthroplasty use the HHS as primary outcome parameter, with an average score <90 points [26–29]. However, very different results have been shown for septic two-stage hip revisions in comparison to aseptic one-stage revision surgeries with short follow-ups or inconsistant inclusion criteria and using multiple implant types [9, 13, 30]. Boettner et al. reported a poor functional and clinical outcome of septic two-stage revision hip surgeries compared with aseptic revisions, reporting an average HHS of 73.2 for the aseptic group and 57.4 for the septic group [13]. In contrast, our study revealed an HHS of 75.5 points for the aseptic group and 73.4 for the septic group, with no statistically significant difference. These data are supported by a score of 74.0 and 71.2 points in the aseptic and septic groups, respectively by Romano et al., who showed no difference between aseptic and septic revisions[9]. Different single- and multicentre studies report slightly lower results for the HHS in larger patient cohorts, with 70–71.4 points for aseptic and septic groups, respectively, using the MRP stem [25, 31]. In contrast, Wirtz et al. reported an HHS of 79 points in a large multicentre study when using different designs of the MRP-TITAN stem for multiple revision indications [23].

In the clinical outcome, our patients had very promising results, with a Merle d'Aubigné and Postel score of 12.5 points for the aseptic group and 13.1 for septic revisions. Our findings are supported by Schuh et al., who reported 15.2 points for aseptic and septic revisions [24].

There was a promising revision rate of 8.1 % in the aseptic group (Kaplan–Meier survival rate 85.6 %) after 9.8 years,

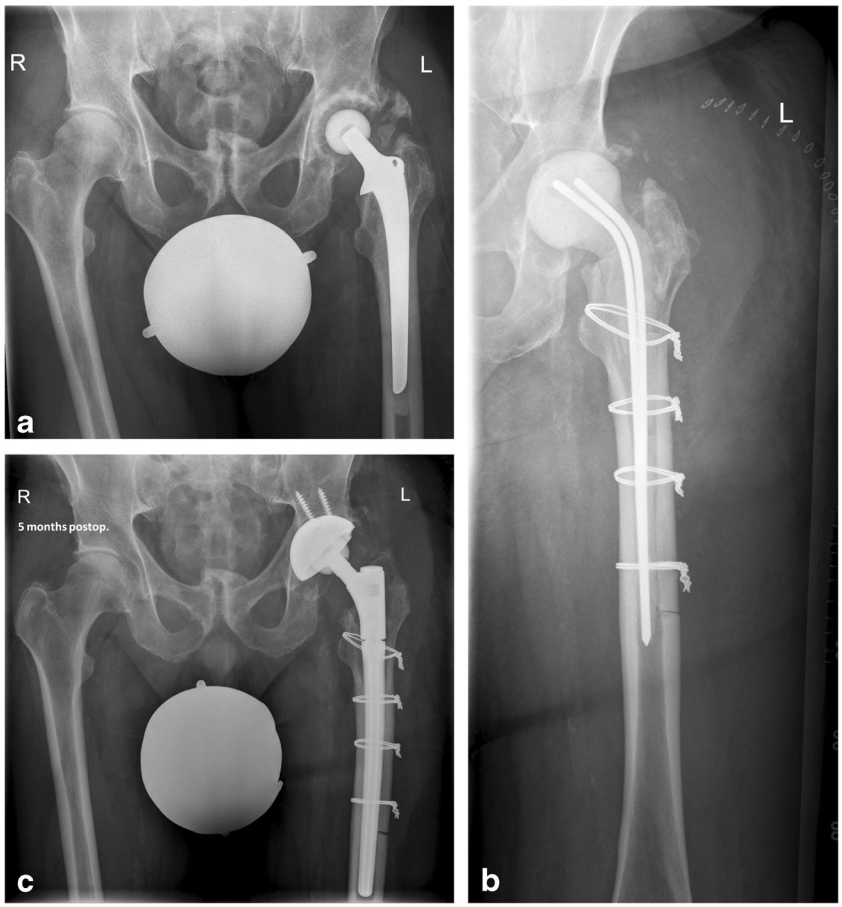

Fig. 1 **a–c** Periprosthetic infection in a 71-year-old man who presented 51 months after primary cemented hip arthroplasty and was treated with two-stage revision surgery using an antibiotic-loaded spacer. Femoral osteotomy was necessary to remove remaining cement, and wire cerclages were used for osteosynthesis. After three months, a cementless MRP-TITAN stem in combination with a Trilogy® cup (Zimmer, Warsaw, IN, USA) was implanted

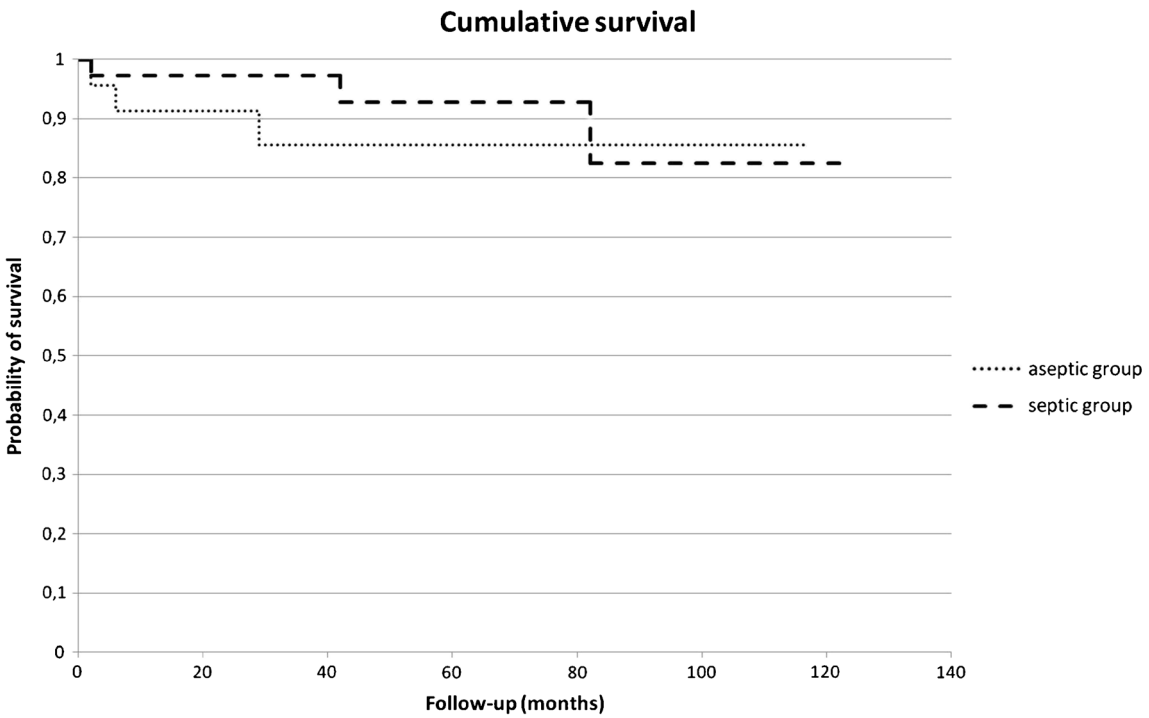

Fig. 2 Component survival during follow-up after aseptic and septic two-stage revision, with repeat revision of any reason as end point

and of 82.7 % at 10.1 years' follow-up for the septic group and a repeat revision rate of 6.7 %. Boettner et al. reported an overall revision rate of 17.4 % in an aseptic cohort after 61 months and 17.8 % re-visions in a septic group after four years' follow-up. Romano et al. [9, 13] reported a revision rate of 20.8 % for septic and 10 % for aseptic groups.

Recurrent dislocation is one of the common problems after revision THA. In our study, we found a rate of 2.3 % for the septic revision group and 5.4 % for the aseptic revision group. Wirtz et al. showed in their multicentre study a rate of 4–12 % for the MRP stem, with equivalent dislocations rates to other femoral stems [32–34].

Recurrent postoperative deep infection rate was one (2.3 %) in the septic group and one (2.7 %) in the aseptic group. In both cases, intraoperative isolation of oxacillin-resistant *S. aureus* was possible. These findings were similar to those reported by Romano et al., who showed a reinfection rate of 2.5 % in each group [9]. Nevertheless, a recurrent infection rate of 12.3 % for patients undergoing two-stage septic hip revision was reported by Boettner et al. [13]. An eradication rate of 100 % was reported by Fink et al., but the authors excluded oxacillin-resistant *Staphylococcus* infections because of the poor revision results induced by resistant bacteria [4, 35, 36].

We acknowledge the shortcomings of our study, including its design as a retrospective and descriptive study. Nonetheless, this is a monocentric study elucidating important issues related to two-stage septic and aseptic revision hip surgery and emphasises outcome and treatment in a demanding operative situation.

Conclusion

To our best knowledge, this is the largest consecutive, monocentric and retrospective study comparing cementless aseptic hip revision arthroplasty of femoral and acetabular components with two-stage septic revisions using the MRP-TITAN femoral-stem revision implant. Patients achieved equal outcomes in both septic and aseptic groups, with very promising clinical and radiological results.

Conflict of interest The authors declare that they have no conflict of interest.

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