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Two Stage Total Hip Revision in Treatment of Chronic Infection of Hip Prosthesis

Sayed El-Etewy Soudy* **and Mohsen Fawzy Omar**

Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt

***Corresponding author:** Soudy SEE, Assistant Professor, Orthopedic Surgery Department, Faculty of Medicine, Zagazig University, Egypt, Fax: 1005624590, Tel: 20-553668921; E-mail: yousufmmkh@gmail.com

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Introduction

The deep chronic infection of arthroplasty implants is a serious problem and requires great effort and cost for its treatment. Pharmacological and surgical options of treatment have been reported in the literature. The issues related to this situation are the route of administration and duration of antibiotics, stages of surgery, and the time of re-implantation of the new prosthesis [1,2]. There are different protocols of antibiotics regimens which range from no antibiotics [3,4] to a long course of parenteral antibiotic for 9 weeks, followed by oral administration. The costing, and side effects or toxicity of the antibiotic are the causes of these controversies. The surgical solutions also vary from resection arthroplasty (Girdlestone) [2-5], retention of the prosthesis with debridement [6], one-stage revision [7], and two-stage revision with hand-made cement spacer loaded with antibiotic [8], or with prefabricated spacer prosthesis [9].

It is well accepted that removing the foreign bodies is mandatory to eradicate chronic infections around the implant [6]. The resection arthroplasty technique is associated with loss of function and limited to non-cooperative patients and who are unfit to have an additional reconstructive surgery. The advantage of one-stage revision is the low cost, decrease period of patient recumbence, and preserves patient function. Preoperative identification of the infecting organism is mandatory and the antibiotics loaded to bone cement can be chosen according to culture sensitivity [1-3]. The mid- and long-term results of this cemented revision arthroplasty reported poor cement interdigitation [4,5]. Added to this the difficult reconstruction in patients with severe bone loss, and lower eradication rate in one-stage revision arthroplasty when compared to two-stage revision [6]. Due to all previous reports, the two-stage revision has become the standard approach for higher eradication rate of resistant organisms [7,8].

The two stages of revision are: first, removal of the infected prosthesis and bone cement, generous debridement to remove all infected and necrotic tissues, and implantation of a cement spacer. Open biopsy for culture sensitivity and histopathology are taken and antibiotics according to its result. During the second stage after 8-12 weeks consists of removal of the spacer, and implantation of the new prosthesis covered by a systemic antibiotic therapy. Many authors reported good results and fewer complications after the second operation when using the cement spacers [9-13]. Several factors can affect the results of two-stage technique as the general condition of the patients, the number and type of organisms, antibiotics sensitivity, and extension of infection.

The articulated spacer PROSTALAC (prosthesis of antibiotic-loaded acrylic cement) have shown good results in the latest reports of literature [11-14]. This system was available only in North America, but recently, different sizes of preformed spacers (Spacer-G1) have become available worldwide with good results [15-17].

The aim of this prospective study is to evaluate the results of two-stage revision arthroplasty technique using antibiotic-loaded spacers for the treatment of deep periprosthetic infections of hip prosthesis.

Patients and Methods

Thirty patients 20 males and 10 females with a mean age of 61 years (range: 38-72) had infected total hip arthroplasty (THA) were treated using two-stage revision operations. All the operations were performed in our institution in the period from May 2009 and May 2014. The diagnosed of infection was made through clinical, laboratory, and radiological evaluation. Clinically, the general health status, patient history, pain and wound condition were recorded. The laboratory investigations were ESR (erythrocyte sedimentation rate), CRP (C-reactive protein), WBC (white blood cell), and hip aspiration under complete aseptic conditions, or from fistula. Pre-operative plain x-rays included anterior-posterior view of the pelvis and lateral view of the hip joint were done to evaluate loosening, migration, or presence of any hidden sinus. The 99mTc-leukocyte-labeled scintigraphies were done for 20 patients. The remaining ten patients had sinuses discharging pus.

The cause of revision was septic total hip prosthesis. The ZMR® modular cement less distally locked prosthesis was used in all cases. The mean duration of the follow-up was 36 months (range: 24-60), and six cases were lost in follow-up and excluded from the study. All the operations were performed in our institution and by the same surgical team. The infected

prosthesis was total hip in 18 cases and hemiarthroplasty in twelve cases (10 bipolar, and 2 Thompson) (Figure 1).

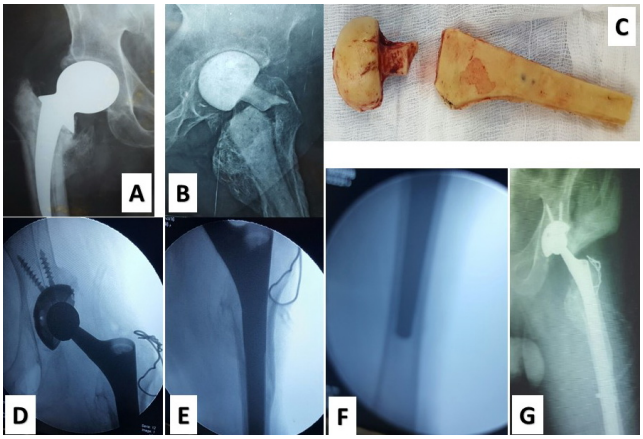

Figure 1: Male patient 62 years old with infected Thompson prosthesis; A) preoperative X-ray; B) X-ray before the second stage with Brocken cement spacer; C) intraoperative photo after extraction of spacer; D,E and F) intraoperative radiology after stem application to insure position and bone integrity; G) postoperative X-ray after revision cementless thr with calcar replacement long stem.

As the prognosis can be affected by the patient's risk factors, the Cierny-Mader [18] physiological classification was used for preoperative evaluation (Table 1). Operative technique: All operations were done in lateral position using lateral approach. Extended trochanteric osteotomies were needed in 22 cases of 30, but the remaining 8 prostheses were loose. Complete excision of the sinus was performed in 10 cases. Complete removal of the prosthesis including plug and cement followed by thorough debridement of all potentially infected soft tissue. In all cases, intraoperative open samples were taken for culture, from three sites separately (joint capsule, acetabulum, and femoral canal). Copious irrigation using a pulsed lavage system. Using acetabular and femoral reamers, both the acetabulum and femoral canal were reamed to get rid of all infected and necrotic tissues and to contain the antibiotic loaded cement spacer.

After completing the procedure, the wound was closed over suction drain and broad spectrum antibiotics of third generation cephalosporin were administrated until the result of culture sensitivity to give according to the organism sensitivity. The drain was removed on the second day after the operation, and then the patients were allowed to walk with toe-touch weight bearing through the duration between the two stages. Through the interval period, the antibiotic therapy duration ranged from 4 to 6 weeks followed by one week of antibiotic discontinuation at least. General and local conditions and laboratory tests were checked regularly. The lab investigations that were performed to monitor the response to infection are the ESR and CRP.

Table 1: Cierny-Mader Staging System.

Anatomic type	**Stage 1:** Medullary osteomyelitis **Stage 2:** Superficial osteomyelitis **Stage 3:** Localized osteomyelitis **Stage 4:** Diffuse osteomyelitis
Physiologic class	**A host:** Normal host **B host:** Systemic compromise (Bs)* Local compromise (Bl)* Systemic and local compromise (Bls)* **C host:** Treatment worse than the disease
Systemic or local factors that affect immune surveillance, metabolism, and local vascularity	
Systemic (Bs)	**Local (Bl)**
Malnutrition	Chronic lymphedema
Renal or hepatic failure	Venous stasis
Diabetes mellitus	Major-vessel compromise
Chronic hypoxia	Arteritis
Immune disease	Extensive scarring
Malignancy	Radiation fibrosis
Extremes of age	Small-vessel disease
Immunosuppression or neuropathy	Complete loss of sensation
Immune deficiency	Tobacco abuse

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In this work we used cement handmade spacer in all cases. The shape of the space was like the unipolar hemiarthroplasty (Figure 2).

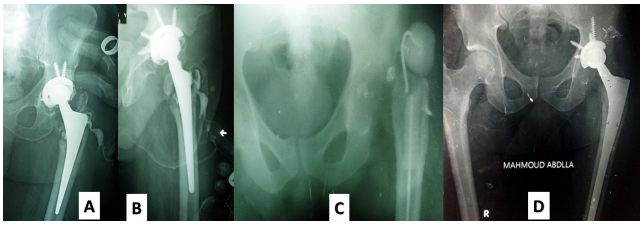

Figure 2: Male patient 38 years old with infected total hip; A and B) X-ray with sinogram showing infected total hip; C) X-ray before second operation; D) X-ray 3 years after revision with cement less long stem.

The second stage revision was performed once the CRP or ESR readings are normal. Hip joint aspiration needed in 10 cases of 30 before second stage. If the patients shifted from B-host to C-host during the interim period, a resection arthroplasty was performed according to Cierny-Mader [18].

In the second stage operation another debridement and irrigation using the pulsed lavage system after removal of the spacer. A parenteral prophylactic antibiotics were administrated until the results of intra-operative samples were proven to be negative. In two cases, the results of the intra-operative samples were positive and the recommended antibiotic therapy was administered for 3 weeks. Partial weight bearing was allowed in the first using axillary crutches 6 weeks postoperative and full weight bearing from 8 to 9 weeks with contralateral elbow crutch. The patients regularly underwent clinical, radiographic and laboratory tests. The functional outcome was evaluated before the first stage operation and at the time of the latest follow-up using the Harris Hip Score [19]. Other follow-up parameters are serial plain radiographs, ESR, CRP and full blood counts (FBC).

Radiographic evaluation was done using Engh et al. [20] system. Gruen et al. [21] for radiolucencies in the bone-prosthesis interface, and DeLee and Charnley [22] for acetabular evaluation was performed. Acetabular inclination angle of 35° to 55° was considered accepted. Implant migration, complete radiolucent line at the implant bone interface, or screws breakage were defined as signs of cup loosening. Brooker et al. [23] system was used for heterotopic ossification grading.

Results

After the first operation, the follow-up laboratory parameters to exclude recurrence were done ESR, CRP, WBC count. Eighteen patients were clinically improved and ESR, CRP normal value. Five patients needed aspiration from the hip and revealed no growth of organisms. During the interim period, five stems dislocated and seven breakage. Five patients with stem breakage needed second stage after 7 weeks and reimplantation of spacer. In two patients the spacer removed and left girdle stone until second stage operation. The inflammatory parameters (ESR +CRP+WBC) reached normal values in 18 patients after 4 weeks of removal of prosthesis. Other twelve patients delayed up to 8 weeks until normalization of inflammation parameters.

The reimplantation of the new cement less revision implant of revision was performed after a mean of 12 weeks (range: 8-24) after normalization of the inflammatory parameters. The samples that have been taken at the time of spacer removal and reimplantation were negative for bacterial growth in 24 patients. In six patients the samples were positive but no evidence of recurrence of infection was noted in these cases during follow-up. In the patients with positive sample results antibiotic treatment was administrated according to sensitivity for four to six weeks. After the second operation, clinical evaluation and laboratory tests were done for all patients regularly and through the duration of follow-up there was no recurrence of infection detected.

After the second stage operation, none of the patients had a dislocation of the prosthesis. Two patients had stem subsidence of 5-mm after 6 months from surgery, but the stems were stable and no clinical problems without additional subsidence during the follow-up period. The rest of stems had good fixation and bone-ingrowth.

Clinically, the Harris hip score was improved from a preoperative mean of 43 (28-62) to a postoperative mean of 87 (79-96) at final follow-up.

Postoperative follow-up X-rays (AP, Lateral views of hip joint with AP view of pelvis) were evaluated monthly for 6 months, and 6 monthly tell the last follow-up. There was no postoperative dislocations. Brooker grade II heterotopic ossification occurred in five patients (16.7%), and grade III in two patients (6.5%). The acetabular inclination was within the accepted range 40-50º in all hips. The femoral stem was in neutral position in 24 stems (79%), 4 stems (14.5%) in varus, and valgus position in 2 stems (6.5%).

According to Engh's criteria, 24 of 30 stems were stable and had bony ingrowth with no significant subsidence, 6 were stable fibrous. In six hips, there was 1 mm radiolucent line of acetabular component in 2 zones (21%), but these lucencies were not progressive. Gruen zones for femoral stem had revealed four stems with 3 mm radiolucency 3 zones but stems were stable.

Discussion

The results of our treatment protocol are satisfactory. All deep periprosthetic infections were eradicated, and forty of 41 patients had final reimplantation. For the deep periprosthetic infection, the two-stage revision hip arthroplasty is considered the gold standard for treatment [24]. The high cost of the two operations in contrast to one-stage revision arthroplasty is considered a disadvantage [25].

Hanssen and Rand [26] using antibiotic-loaded cement reported 83% success rate, and 60% success rate when using non antibiotic-loaded cement. Another two studies carried out by Raut et al. [25,27] on 57 hips with draining sinuses revised in one stage operation. They reported 86% success rate at 7.4

years average follow-up period, and 93.4% success rate in patients with gram-negative infections after 8 years average follow-up.

Many authors reported lower rate of eradication in one-stage revision operations than in two-stage operations for revision hip arthroplasty with highly virulent organisms that cause the infection. The cement less two-stage revisions of chronic infection of total hip lacks the advantage of local antibiotic loaded bone cement [28,29]. Authors who recommend one stage revision propose lower virulence organism and antibiotic-loaded cement should be used and the patients do not have severe bone loss.

Before final reimplantation of the revision prosthesis it is a challenge for the surgeon to get prove that infection has been completely eradicated and that may be difficult to diagnose. In this work, the two-stage revision arthroplasty was done for all patients doing the same protocol for follow-up in interval between the two operations. The protocol included regular (ESR, CRP, AND WBC count), hip aspiration in doubt, the 99mTc bone scan, and Cierny-Mader classification for the general condition and physiological stage. The patient's risk factors is very important to be taken into consideration. Cierny et al. [18] using an osteomyelitis classification system designed to stratify treatment selection according to patient risk factors reported the results of treatment of 43 patients with periprosthetic infection. In their study the survival rate of the implant in patients with three or more morbidities was recorded 0% after follow-up of two years. They concluded that the two most important variables in predicting outcomes in patients with prosthetic infections are the duration of infection and the host condition [30].

In this study, there were 12 patients class B-host having three or more morbidity, the final reimplantation of the prosthesis was performed with no recurrence of the infection during follow-up period [31,32]. As the resistant organisms has been increasing over the recent decades, the surgery complications increased in comparison to non-resistant organisms causing the infection. Volin et al. [33] used two-stage revision arthroplasty in the treatment of two groups of patients (a methicillin-sensitive group and a methicillin-resistant group) and compared the outcomes that was similar in the two groups.

In this study, we have 10 of 30 patients (33%) had a methicillin-resistant Staphylococcus, and no difference was found between the one-spacer group and the two-spacer group. Reinfection can occur in a period up to 5 years after operation, but usually observed within the first year after operation [34-36]. In this work the cement handmade spacer in all cases to give the shape of unipolar hemiarthroplasty. We used a high dose of vancomycin in the cement. Springer et al. [37] evaluated the potential complications resulting from the use of high doses of antibiotic loaded to bone cement spacer in two-stage resection arthroplasty of the knee. They found no systemic side-effects in the patients clinically. In this work we had no evidence of disease caused by antibiotics systemic side-effects.

The sensitivity and specificity of 99mTc bone scan was evaluated by Pelosi et al. [38] and reported 95.6%. Also Larikka et al. [39] reported improvement specificity of leucocyte imaging in the diagnosis of infected hip prostheses. In this study 99mTc bone scan was utilized in cases of confusion in the diagnosis. From the limitations of this study, the small number of cases and lake of control group managed with one-stage revision.

Conclusion

After evaluation of 30 cases we consider the use of two-stage revision protocol for treatment of infected hip arthroplasty is successful in eradication of the infection and stable joint reconstruction. In the strategy of infection eradication, the success rate depends on good protocol considering the risk factors of the patients and the proper evaluation of the diagnostic tests. The two-stage revision has the advantage of the assessment of the response to the selected antibiotics and the chance to change the antibiotic in the second stage if the organism changed or resistant. The possibility using cement less stems increased after eradication of infection.

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