

One-stage revision arthroplasty for management of periprosthetic hip infection

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Background One-stage revision arthroplasty has currently a limited use in treatment of a periprosthetic infection despite obvious economic benefits in comparison with two-stage revisions. This operation involves the removal of all implant components, radical surgical debridement, joint irrigation, installation of a new implant, and a long course of antibiotic therapy.

Purpose To evaluate the effectiveness of one-stage revision arthroplasty in the treatment of patients with periprosthetic infection of the hip joint. **Material and methods** Results of treatment of 14 patients with periprosthetic hip infection who underwent the procedure of a single-stage revision arthroplasty in the period from 2009 to 2018 were analyzed. The average follow-up was 2.7 years (range, 1 to 10 years). **Results** Twelve (86 %) out of 14 patients with periprosthetic infection of the hip joint completed one-stage treatment successfully. Two (14 %) patients developed recurrent infection and had a two-stage revision arthroplasty using an antibacterial spacer. In accordance with the Harris Hip Score scale, the functional state of the limbs at a one-years follow-up after treatment averaged 77.7 points (range, 36 to 95). **Conclusions** One-stage revision is quite a laborious medical procedure, for which sufficient experience of orthopedic surgeons and a specialized hospital service. This method of treatment provided suppression of infection in 86 % of our cases. Negative factors in using one-stage revision were polymicrobial infection and implant dislocation in the early postoperative period.

Keywords: arthroplasty, hip, periprosthetic infection, treatment, one stage revision

INTRODUCTION

Since the 70s of the last century, experts began to actively discuss possible treatment options for infectious complications after large joint arthroplasty [1]. In foreign clinics, the medical costs of treating one patient with an implant-associated infection are enormous and depend on the severity of the pathological process varying from \$ 25,000 to \$ 78,000 [2, 3].

Currently, one-stage revision arthroplasty is of limited use in the treatment of periprosthetic infection, despite the obvious economic benefits in comparison with two-stage revisions [4, 5, 6, 7, 8]. Foreign colleagues state that one-stage revision reduces the total intraoperative blood loss, decreases the negative impact on comorbidities and the death rate of patients and, in addition, does not yield to the

results of two-stage revision in terms of suppressing infection [9, 10, 11].

One-stage revision involves the removal of implant components, radical surgical debridement, joint irrigation, implantation of a new implant, and a long course of antibiotic therapy [12, 13, 14]. The success of such a procedure varies from 76 to 100 % [15, 16, 17, 18, 19]. According to various authors, contraindications for performing this operation are immunosuppression, pronounced purulent process, significant defects in the bone and soft tissues of the affected joint, as well as low-sensitivity microflora and /or polymicrobial infection [20, 21, 22].

Purpose of the study To evaluate the effectiveness of one-stage revision arthroplasty in the treatment of patients with periprosthetic infection of the hip joint

MATERIAL AND METHODS

Treatment results of 14 patients with periprosthetic hip joint infection who underwent a one-stage revision arthroplasty procedure in the period from 2009 to 2018 were analyzed. The average age of patients was 54.3 ± 15.1 years (from 36 to 79 years). The study was approved by the ethics committee in accordance with the standards

of the 1975 Helsinki Declaration, revised in 2008.

In the preoperative period, all patients underwent a comprehensive examination (clinical, radiological, hematological, microbiological, histological and cytological studied) according to the recommendations of the international consensus on periprosthetic infection [23, 24].

Surgical technique The operative field was treated with antiseptic solutions three times. A diluted solution of brilliant green was used to stain wounds and sinuses with the patient lying on his/her side. Lateral approach through the skin in the upper third of the thigh exposed the trochanteric and subtrochanteric area by layers (**Fig. 1**). The electrocutter cut the muscles anteriorly to the greater trochanter (anterolateral access was used in all patients). The anterior surface of the hip joint was mobilised and the neck of the implant was exposed from the scars. The infected tissues were harvested for bacteriological and histological studies (**Fig. 2**).

Protectors were installed above and below the implant neck, also in front of the acetabulum. The hip was dislocated and brought to the wound. The implant head was hammered off. Then, using the revision kit, the femoral and femoral components were removed (**Fig. 3**). Tissue was harvested from the acetabulum and the bone marrow canal of the femur for bacteriological study.

Curettage of the bone marrow canal of the femur and the bottom of the acetabulum was performed, and nonviable tissues were dissected out (**Fig. 4**).

The wound was washed with an irrigation system containing antiseptic solutions in the volume of 7–10 liters. Next, the wounds were tamponed with wipes soaked in Betadine or Prontosan solutions.

Next, operating linen and instruments as well as gloves and gowns of the surgical team were changed. The operative field was re-treated and wipes with antiseptics were removed.

At an angle of 40 degrees (with respect to the bispinal line) and 15 degrees of antetorsion, the acetabulum was treated with burrs to their necessary immersion. Following this, the pelvic component of the appropriate size was implanted (**Fig. 5, a**).

The proximal end of the femur was brought into the wound. Protectors were set under the greater trochanter. The medullary canal of the femur was treated in the torsion position 5. The stem and head of the required size were implanted (**Fig. 5, b**). The operation was completed with drainage of the joint and layer-by-layer suturing of the wound. The duration of the operation was $197, 5 \pm 36.2$ minutes (from 120 to 255 minutes), intraoperative blood loss was 853.5 ± 455.9 milliliters (from 300 to 1700 ml).



Fig. 1 Hip arthrotomy and fistula revision

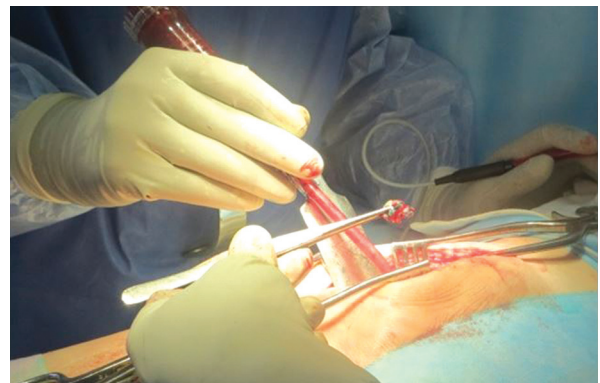


Fig. 2 Sampling infected tissue for study

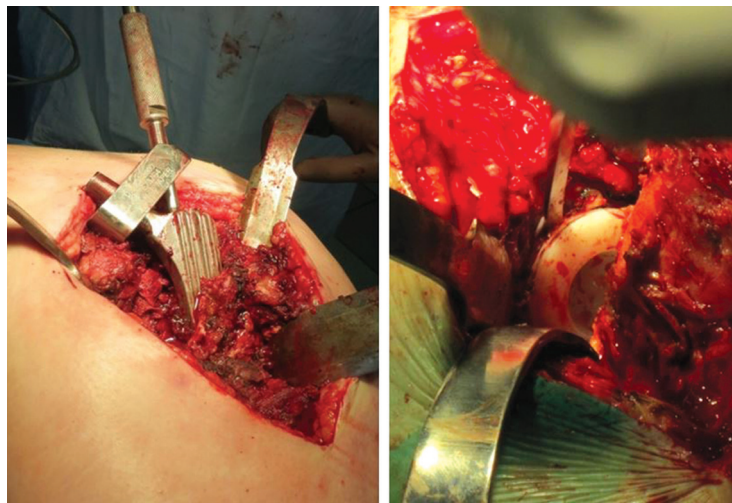


Fig. 3 Removal of the femoral and pelvic components

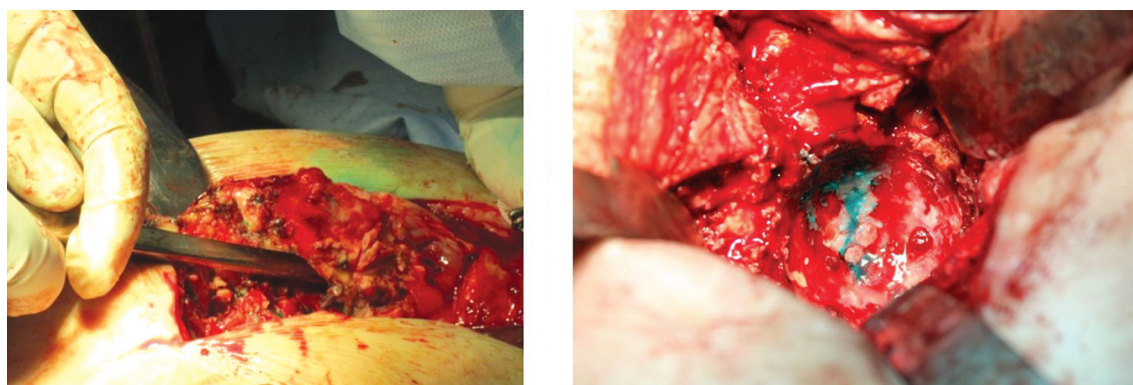


Fig. 4 Curettage of the bone marrow canal of the femur and the bottom of the acetabulum

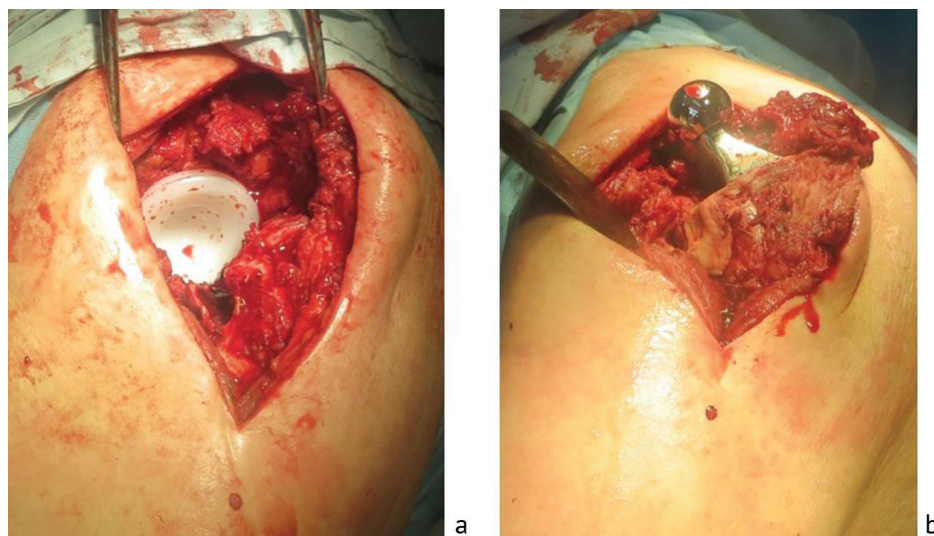


Fig. 5 Implantation: *a* cup; *b* stem

In the postoperative period, antimicrobial therapy was prescribed for 6 weeks (two weeks – parenteral administration and four weeks the oral ones). Rehabilitation exercise therapy under instructor's supervision started from days 2–3 post-surgery.

We managed to follow up the treatment results of all 14 patients; the average follow-up was 2.7 years (1–10 years). Statistical processing was performed using the software “Microsoft Excel” with the calculation of the mean value and statistical deviation.

RESULTS

The anamnesis revealed that eight (57 %) patients had acute postoperative infection, three (22 %) patients developed late chronic and two acute hematogenous (14 %) infection. Positive intraoperative culture was found in one (7 %) patient. At the place of their residence, seven (50 %) patients underwent unsuccessful attempts to stop the purulent process; six of them had debridement without replacing the components of the implants, and one had a two-stage revision using an antibacterial spacer.

At admission, more than 65 % of patients complained on sinuses with purulent discharge and more than 85 % of a sharp limitation of joint function. Harris Hip Score of the functional status of the affected limb at the time of admission was 44.14 ± 26.5 points (range from 3 to 91 points).

The condition of bone tissue was assessed according to W.G. Paprosky's classification, its characteristics are presented in Table 1.

According to the American Anaesthesiology Association, five (36 %) patients had compensated comorbidities and 6 (43 %) were subcompensated; the rest were somatically healthy.

The results of intraoperative microbiological studies are presented in Table 2.

The table shows that gram-positive microflora was found in monoculture in 9 (65 %) patients, gram-negative microflora in monoculture in one (7 %) patient, microbial associations in two (14 %) patients and no bacteria were detected in another two.

We have analyzed the results of treatment of patients which are presented in Table 3.

Table 1

Bone tissue condition after arthroplasty

Hip joint bone tissue damage type, W.G. Paprosky (1994)	Absolute number	% from the total of patients
1) acetabulum		
– type 1	5	36
– type 2	9	64
– type 3	–	–
Total	14	100
2) femur		
– type 1	7	50
– type 2	5	36
– type 3A	2	14
Total	14	100

Table 2

Microorganisms in patients with periprosthetic infection after hip arthroplasty

Family	Genus	Number	%, from the total
<i>Staphylococcaceae</i>	<i>MRSA, MRSE, MRSH, MRSC</i>	3	76 %
	<i>S. aureus</i>	6	
	<i>S. capitis</i>	2	
	<i>S. saprophyticus</i>	1	
<i>Enterococcaceae</i>	<i>Enterococcus faecalis</i>	1	6 %
	<i>Klebsiella pneumoniae BJPC</i>	1	6 %
<i>Pseudomonadaceae</i>	<i>Pseudomonas aeruginosa</i>	2	12 %
Total		16	100

Table 3

Treatment results in patients with periprosthetic infection using the method of one-stage revision arthroplasty

Patients data			Complications	Revision	Treatment outcomes		
Nº	Sex	Age, years			HHS, points	Follow-up, years	Infection arrest
1	f	49	Intraoperative femoral fracture of type A (Duncan, Marsi)	–	91	1	achieved
2	m	55	–	–	85	1	achieved
3	f	79	–	–	84	1	achieved
4	f	57	Infection recurrence	Two-stage	36	2	achieved
5	f	36	–	–	93	4	achieved
6	m	69	Implant dislocation, infection recurrence	Two-stage	51	3	achieved
7	m	39	–	–	66	8	achieved
8	f	38	–	–	78	1	achieved
9	m	36	Psoas muscle tear	Secondary stitching	87	1	achieved
10	m	54	–	–	89	1	achieved
11	m	78	–	–	70	3	achieved
12	f	65	–	–	84	1	achieved
13	f	65	Implant dislocation	Open reduction	79	10	achieved
14	m	41	Separation of wound edges	Secondary stitching	95	1	achieved

Twelve (86 %) patients out of 14 with periprosthetic infection of the hip joint underwent one-step treatment successfully. Two (14 %) patients with recurrent infection had a two-stage revision arthroplasty using an antibacterial spacer. Moreover, in one case, the recurrence was due to dislocation of the implant, in the other one due to a four-component polymicrobial infection (*P. aeruginosa*, *K. pneumoniae* BLRS, *S. epidermidis* MRSE and *E. faecalis*) and obesity of grade 3.

An intraoperative femoral fracture of type A according to Duncan and Marsi in one patient during the removal of the implant stem was successfully osteosynthesized with a cerclage wire. The complications in the postoperative period (dislocation of the implant, muscle rupture and wound failure) were local in nature, were eliminated during treatment and had no effect on its outcome.

The Harris Hip Score functional state of the operated limb a year after treatment was 77.71 ± 16.9 points (range from 36 to 95 points).

Here is a clinical case of patient M. 38 years old, who was admitted with a diagnosis of late chronic periprosthetic infection of the hip joint (according to D.T. Tsukayama). Radiographically, there was a deficit of bone tissue of the femur of type I and type I in the acetabulum according to Paprosky (**Fig. 6, a**). Functional state of the limb according to HHS was 31 points. The cause of the purulent process was polymicrobial infection (*S. saprophyticus* and *S. capitis*).

Considering the duration of the purulent process for more than 5 years, a one-stage revision arthroplasty with bone grafting of the acetabulum (allogenic graft) was performed at our clinic. The infection process was arrested (remission is one year), the HHS functional state is 78 points (**Fig. 6, b**).

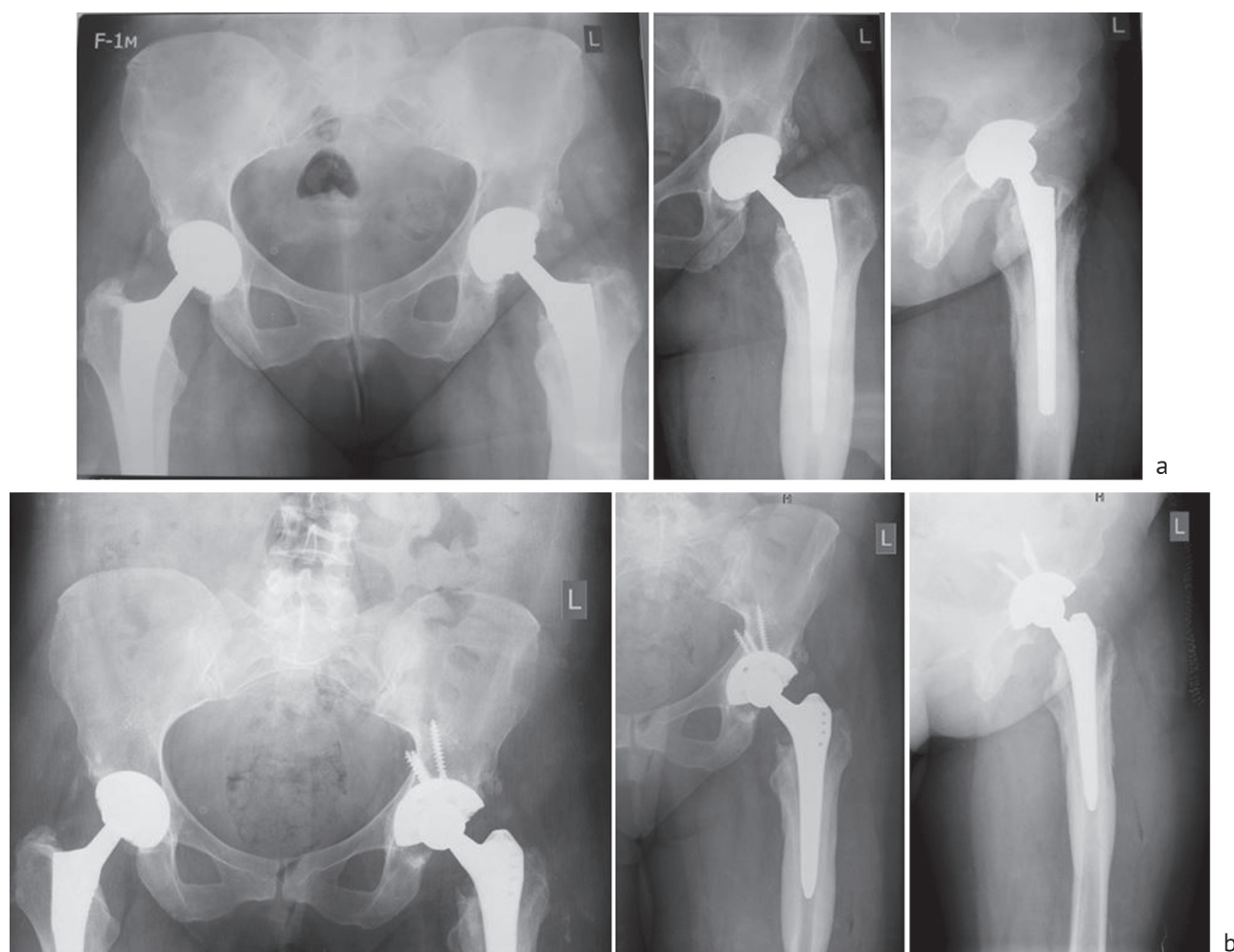


Fig. 6 Radiographs of the pelvis and hip joint: **a** before treatment: **b** after treatment

DISCUSSION

One-stage revision arthroplasty is a time-consuming medical procedure which requires sufficient experience of orthopedic surgeons in doing revision interventions and a specialized medical hospital [6]. The undoubted advantage of this operation is eradication of infection at one stage and rapid restoration of the lost limb function along with a single course of antibiotic therapy [8, 15]. Compared to two-stage revisions, the one-stage one significantly reduces the outpatient and inpatient costs but has a number of restrictions on its use in the conditions of polymicrobial infection, immunosuppression, and significant bone and soft tissue defects of the affected joint [4, 7, 11, 20, 21, 22].

We report foreign literature data for comparison with our results of treatment using the method of one-stage revision arthroplasty. These data are reflected in Table 4.

Choi and Jenny in their studies compared the results of one- and two-stage revisions, rates of suppression of the infectious process and the functional state of the operated limb, and found that the results of a one-stage operation were higher. However, the authors recommend a careful selection of patients with periprosthetic infection for a single-stage treatment, paying attention to the somatic condition of the patients and the type of pathogen identified.

Zeller and colleagues conducted a prospective analysis of the results of treatment of 157 patients who underwent a one-stage revision procedure with a twelve-week course of antibiotic therapy. Recurrence

of purulent process was observed in only 5 % of patients. Foreign orthopedists recommend using this operation to patients with minimal bone tissue defects, and believe that long-term intravenous etiotropic antibiotic therapy is a key factor for successful treatment.

Klatte studied the effectiveness of a one-stage revision in conditions of a fungal periprosthetic infection; it was possible to control the inflammatory process in 90 % of cases with a six-week course of etiotropic therapy. The European specialists started antifungal therapy three days before the operation and used implants only with cemented fixation.

Kendoff and the authors demonstrated a 100 % eradication of infectious process using cemented implants with high concentrations of antibiotics (vancomycin and gentamicin) in bone cement. Lange and Bori, on the other hand, recommend using cementless implants for single-stage revision arthroplasty. At the same time, the Spanish colleagues calculated the difference in financial costs for one-stage and two-stage revision interventions, which amounted to more than \$ 20,500 of savings for each patient.

In our clinic, the success of the above technique was 86 % with a recurrence rate of 14 %. At the same time, the course of antimicrobial therapy was at least six weeks. HHS functional state of the operated joint in three patients (21 %) was assessed as excellent, five patients (37 %) were good, three had fair results and three more had poor outcomes.

Table 4

Summary of one-stage revision arthroplasty technique effectiveness

Authors	Number of patients	Follow-up	Recurrence, %	Infection arrest, %
Choi et all (2013)	17	5	18	82
Zeller et all (2014)	157	3	5	95
Klatte et all (2014)	10	7	10	90
Jenny et all (2014)	65	5	16	84
Kendoff et all (2015)	20	5	0	100
Lange et all (2017)	56	5	11	89
Bori et all (2018)	17	3	6	94
Our results	14	2.7	14	86

CONCLUSIONS

One-stage revision arthroplasty is a time-consuming medical procedure, which requires sufficient experience from orthopedic surgeons in performing revision interventions and a specialized medical hospital. This method provided suppression of infectious process in 86 % of cases in our series. Polymicrobial infection and implant dislocation in the early postoperative period are negative factors by using a one-stage revision.

Conflict of interest: not claimed.

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