Clinical case
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Treatment of patients with periprosthetic infection and management of Paprosky type 2C cavitary defects at the stage of articulating spacer installation

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Abstract

Introduction Due to the constant increase in the number of primary and revision hip arthroplasties, the incidence of complications has been also increasing. Periprosthetic joint infection (PJI) is the most common and dangerous complication in joint arthroplasty, including PJI with cavitary defects of the acetabulum (Paprosky type 2C).

The **purpose** of the work was to demonstrate successful results of managing acetabular defects in patients with periprosthetic infection at the stage of installing an articulating spacer.

Materials and methods The patients underwent surgical management of cavitary defects of the acetabulum with allobone plastic material at the stage of installation of an articulating spacer impregnated with antibacterial drugs. A clinical and functional assessment of the effectiveness of treatment of patients with PJI of the hip joint, who underwent bone grafting of acetabular defects at the first stage of two-stage revision arthroplasty, was carried out. Remission of the infectious process was assessed according to the ICM 2013 (International Consensus Meeting), and the function of the affected limb was assessed according to the HHS (Harris Hip Score).

Results At a 6-month follow-up after implantation, there were no clinical and laboratory manifestations of PJI and radiological signs of instability of the implant components. Bone grafting was evaluated to be satisfactory; the function of the affected joint restored to 80–90 to HHS points. Remission of the infectious process according to ICM was achieved.

Discussion Clinical cases studied demonstrate a positive result of treatin PJI with plastic surgery of cavitary defects of the acetabular bottom at the stage of articulating spacer installation. Filling acetabular defects at the sanitizing stage (implantation of a spacer) subsequently provides improvement of primary fixation and osseointegration of the acetabular component when converting the spacer to a permanent implant. This is due to an increase in the contact area of the acetabular component with bone tissue (native bone and remodeled allobone material).

Conclusion The treatment of the first clinical case improved joint function from 24 to 85 HHS points, and in the second from 27 to 76 HHS points. The use of defect filling techniques enabled to stop the infection and improve functional results.

Keywords: clinical case, two-stage revision arthroplasty, hip joint, periprosthetic infection, osteomyelitis, acetabulum defects according to Paprosky

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INTRODUCTION

Along with the increasing number of scientific works on the topic of the study, the following factors indicate on the relevance of studying periprosthetic joint infection (PJI): an increase in life expectancy, an increase in the labor activity of the elderly population due to the available treatment conditions that improve the quality of life, the annual increase in the number of joint implants and, as a consequence, an increase in the number of infectious complications [1]. PJI is observed in 1–2 % of cases after primary arthroplasty and in 4 % of cases after revision interventions [2]. Two-stage revision arthroplasty remains the preferred treatment option for PJI [3]. However, the mortality rate in elderly patients after multiple surgeries remains high [4]. Moreover, relapses of infection are often observed in the presence of resistant strains of microorganisms, severe comorbidity in a patient and failures of revision interventions [5]. In chronic PJI, extensive defects of bone and soft tissues are formed after multiple sanitizing surgical interventions [6, 7]. Methods for filling bone defects depend on their size, the patient's bone density, the presence of cavitary defects of the acetabulum and the disrupted integrity of the pelvic ring, which determines the quality of fixation and the area of contact with the native bone [8].

Severe acetabular defects account for 1–5 % of the reasons for revisions of the acetabular component. The etiology of these defects is the result of osteolysis, mechanical loosening of the acetabular component, and infection [9]. Bori et al identified statistically the risk factors for the development of recurrent PJI in significant bone defects of the hip joint [10]. The complexity of filling acetabular defects during revision interventions on the hip joint is confirmed by the fact that there are many reconstruction options, none of which has a clear advantage over the others. During revision surgery, it is necessary to achieve reliable fixation of the endoprosthesis components and fill in the bone defect of the acetabular bottom [11].

Purpose: to demonstrate successful results of managing acetabular defects in patients with periprosthetic infection at the stage of installing an articulating spacer

MATERIALS AND METHODS

The series of clinical cases included patients who were treated in the clinic of bone and joint infection (purulent osteology) of the Ilizarov National Medical Research Center of Traumatology and Orthopaedics. The patients under study were diagnosed with chronic PJI according to Cheng Li [12] with Paprosky type 2C acetabular cavitary defects.

The bone tissue defect was preliminarily assessed using a series of X-ray images. X-ray signs of a defect in the medial wall and anterior column with a violation of the Kohler line and pronounced lysis shaped as a "teardrop" were noted. The patients underwent the first stage of surgical treatment with radical debridement of the infection site and filling cavitary defects with allobone material; an articulating spacer was installed for restoration of limb function.

The technique of bone defect filling was performed in the following sequence. The osteoplastic matrix in the form of blocks was soaked in a physiological solution and then crushed using surgical instruments. Antibacterial drugs (1 g of vancomycin and 1 g of ceftazidime) were added to the bone-plastic material; then dense impaction of the acetabulum defects was performed.

At the second stage of treatment, after the spacer was removed, the superficial layer of allograft bone was taken for bacteriological examination, which subsequently did not reveal any growth of pathogens. The plastic material turned to dense and intensely bleeding bone tissue of a pale yellow color, which was slightly inferior in density to the maternal bone. At the same time, no signs of necrosis, sequestration, or sclerosis were observed. The interval between operations of two-stage revision arthroplasty in the treatment of hip PJI was 5 months.

The patients were re-hospitalized and microbiological and cellular composition of the joint synovial fluid (the number of leukocytes and neutrophils), as well as an assessment of hematological inflammation markers (CRP, ESR and leukocytes) to control the suppression of the infectious process was performed. Based on the obtained laboratory data, a decision was made on the possibility of conducting the second stage of revision surgery with the installation of a permanent joint implant. Then, the dynamics of hematological, radiological, bacteriological examination indicators and the functional state of the involved limb were monitored.

Remission of the infection process was assessed according to ICM 2013 года (International Consensus Meeting) and Harris Hip Score (HHS) was used to assess limb function.

RESULTS

Case 1

Patient P., 49 years old, was admitted to the clinic of bone and joint infection (purulent osteology) with the diagnosis: chronic hematogenous PJI of the right hip joint (according to Cheng Li); chronic osteomyelitis of the right hip and pelvis, fistulous form; combined contracture of the right hip joint with shortening of the right lower limb by 2 cm; instability of the pelvic component of the endoprosthesis (Fig. 1). Concomitant disease: mild chronic iron deficiency anemia.

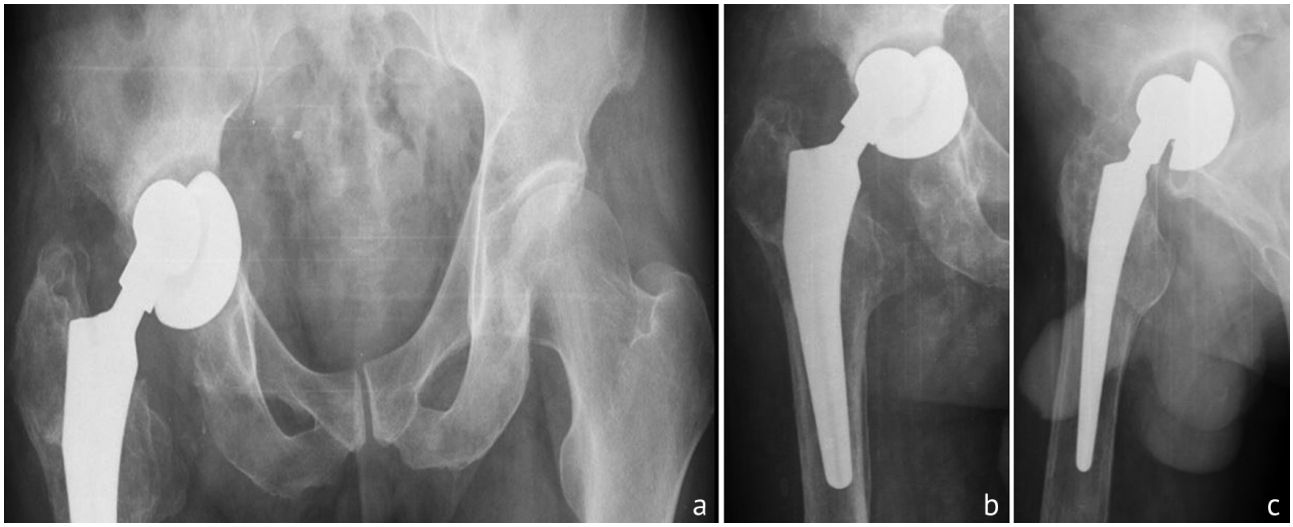

Fig. 1 AP view of the pelvis (*a*) and AP (*b*) and lateral (*c*) view of the right hip joint at 1-m focus before the intervention

Upon admission, the patient complained of a fistula in the upper third of the right thigh with purulent discharge, decreased weight-bearing capacity, shortening of the right lower limb and significant limitation of range of motion in the right hip joint due to pain.

From the medical history: total arthroplasty of the right hip joint in February 2021; swelling and severe pain in the right thigh developed after 3 months, a fistula with purulent discharge was functioning; conservative treatment was ineffective.

Local status: fistula in the area of the right hip communicating with the cavity of the hip joint (absolute sign of PJI according to ICM 2018); relative shortening of the right lower limb was 2 cm; the patient moved with crutches. At the time of admission, the functional state of the right hip joint was 24 HHS points.

Laboratory test results were mild anemia (Hb 91 g/l), increased ESR (97 mm/h) and CRP (30 mg/l); growth of *Staphylococcus aureus* was detected in the right hip joint puncture 104 CFU/ml.

The intervention was performed in 2023. The first stage of a two-stage revision total hip arthroplasty of the right joint: removal of the implant; debridement; installation of an articulating

spacer. A 50/32 cup was modeled from press molds using 1 packet of bone cement with antibiotics (1 g vancomycin and 1 g cefatoxime). The pelvic component of the 50 mm spacer was implanted using 1 packet of bone cement with antibiotics (2 g vancomycin and 1 g cefatoxime). A cemented stem was installed using 1 packet of bone cement with antibiotics (4 g vancomycin and 4 g cefatoxime). Intraoperatively, a Paprosky type 2C acetabular defect with total protrusion of the inner wall was detected which was filled with allobone chips. The operation was completed by installing drainage and layer-by-layer suturing of the wound. Radiographs of the pelvis and right hip joint in direct and lateral views with a focus of 1 m after the surgical intervention are shown in Fig. 2.

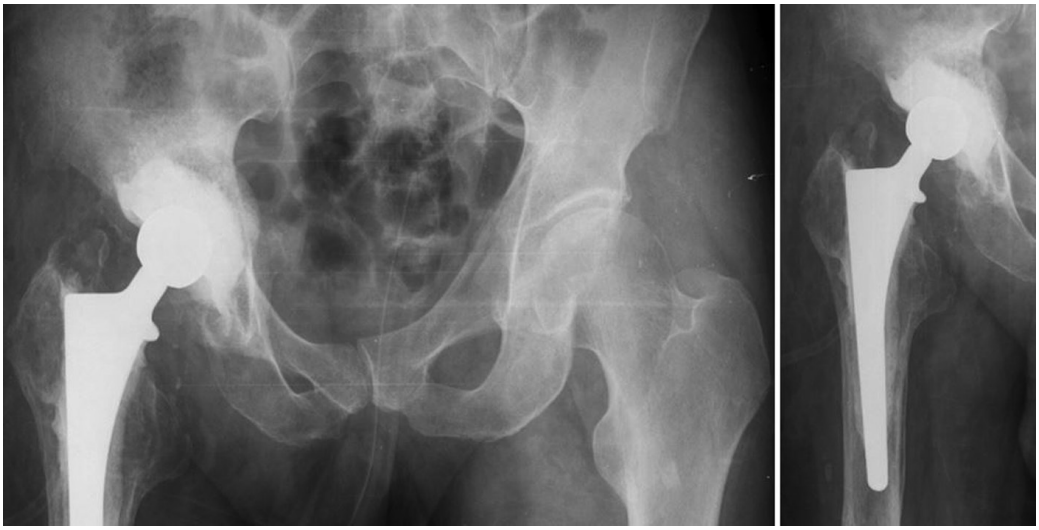

Fig. 2 Radiographs pelvis and of the right hip joint after surgical treatment with the defect filled with allograft bone and an installed articulating antibacterial spacer

Blood loss was 500 ml, intraoperative blood transfusion was 500 ml. Results of intraoperative microbiological testing: *Staphylococcus aureus* — 10^4 CFU/ml. *Psenudomoas aeruginosa* (S) — 10^4 CFU/ml was cultured from the implant. The wound healed by primary intention. The drainage was removed on the 6th day after the surgery.

After the first surgical stage, a course of etiotropic antibacterial therapy was administered for 6 weeks. In the hospital, the patient received amoxicillin + clavulanic acid 1.2 g three times a day intravenously and levofloxacin 100 ml twice a day for 2 weeks. In the outpatient stage of treatment, levofloxacin 500 mg twice a day and cefoperazone sulbactam 2.0 g twice a day were prescribed intramuscularly for 4 weeks.

The patient was recommended to use crutches for walking with limited load on the affected limb until the following stage of surgical treatment.

After one month, control studies of ESR and CRP and radiography of the pelvis and right hip joint were performed (Fig. 3). Results of laboratory tests: mild anemia (Hb 118 g/l), ESR 10 mm/h and CRP 2 mg/l. At the follow-up after one month, it was established that there were no clinical and laboratory signs of relapse of the disease (no wounds or fistulas); the spacer components were stable, the functional state of the right hip joint was 64 HHS points.

Five months later, the patient was admitted to the clinic again for further examination and the second stage of surgical treatment.

Local status: no fistulas, normotrophic scar in the right hip area. The patient moved with crutches. At the time of admission, the functional state of the right hip joint was 64 HHS points. Laboratory test results of complete blood count: Hb 130 g/l, ESR 20 mm/h and CRP 1.4 mg/l. No growth of the pathogen was detected in the puncture from the right hip joint.

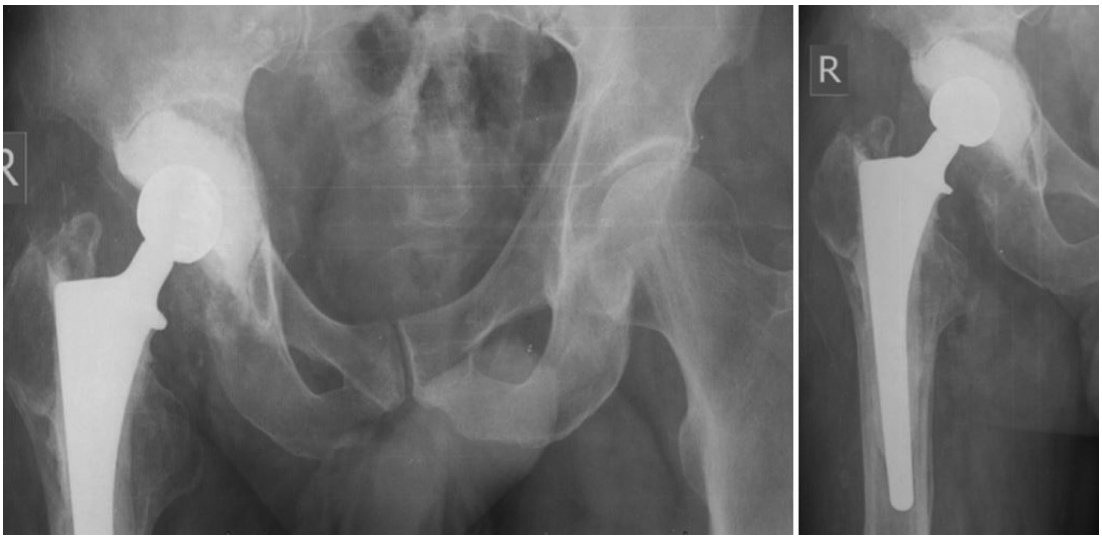

Fig. 3 Radiographs of the pelvis and right hip joint 1 month after the intervention

After the examination, the second stage of surgical treatment was performed: revision arthroplasty of the right hip joint; removal of the spacer; debridement; installation of a cementless hip joint implant. The intraoperatively repaired defect had dense bleeding bone tissue of a pale yellow color without signs of necrosis. The X-ray of the pelvis after surgery is shown in Figure 4. Blood loss was 250 ml; intraoperative blood transfusion was 250 ml. No growth of pathogens was detected on the removed spacer. The wound healed by primary intention. The drainage was removed on the sixth day after the surgery.

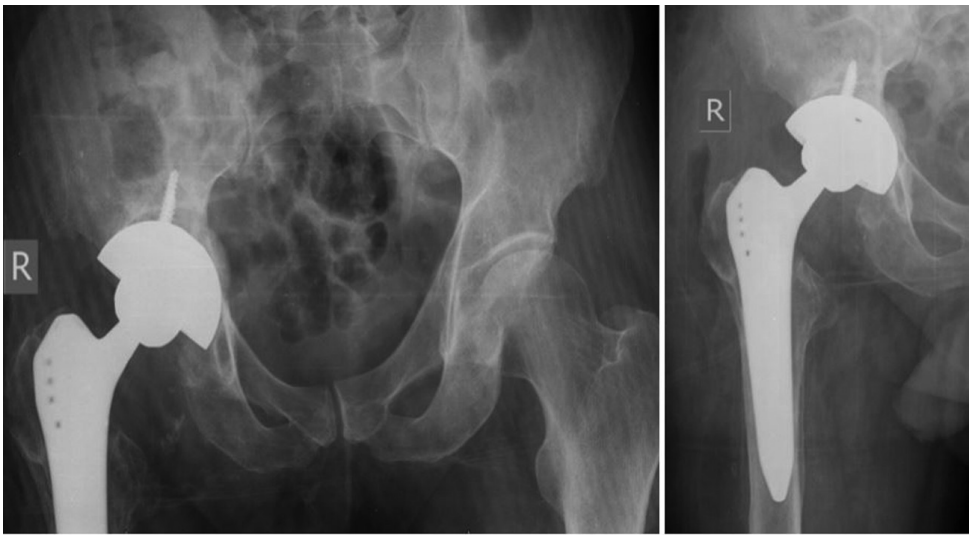

Fig. 4 AP radiographs of the pelvis and right hip joint with a focus of 1 m after the intervention

After the second stage of revision arthroplasty, a six-week course of antibacterial therapy was administered. In the hospital, the patient received vancomycin 1.0 g intravenously twice a day and meropenem 1.0 g three times a day for 2 weeks. At the outpatient stage of treatment, a course of oral antibiotics was prescribed for 4 weeks: levofloxacin 500 mg twice a day and doxycycline 100 mg twice a day. The patient was recommended to use crutches for walking with limited load on the affected limb for 3 months.

After 6 months, ESR and CRP levels were examined, and X-ray of the pelvis and right hip joint was performed (Fig. 5). Laboratory test results: mild anemia (Hb 120 g/l), ESR 15 mm/h, and CRP 3 mg/l. A follow-up examination revealed that there were no clinical and laboratory signs of disease recurrence (no fistulas, normotrophic scar), the implants components were stable, and the functional state of the right hip joint was 85 HHS points.

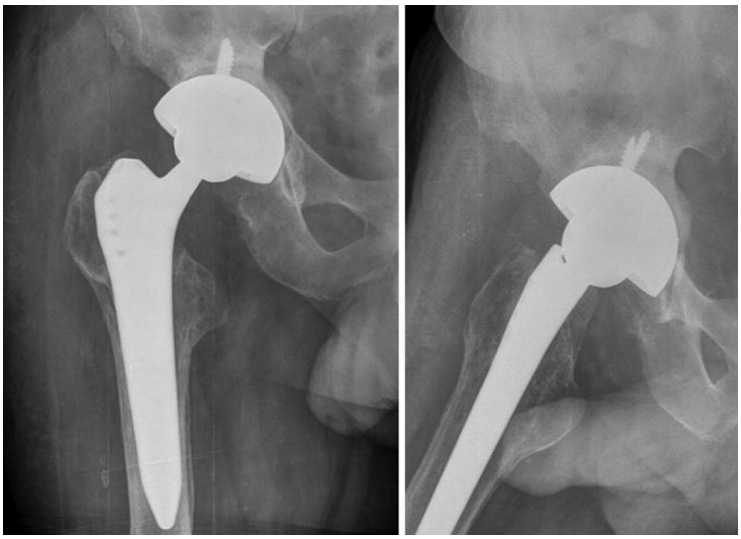

Fig. 5 Radiographs of the right hip joint 6 months after the revision intervention

Case 2

Patient Sh., 64 years old, was admitted to our clinic with the following diagnosis: chronic hematogenous PJI of the left hip joint (according to Cheng Li); chronic osteomyelitis of the left femur and pelvis, fistulous form; combined contracture of the left hip joint with shortening of the left lower limb by 2 cm (Fig. 6). Concomitant diseases: hypertension stage 2, risk 3, chronic heart insufficiency-0, FC-3; atherosclerosis of the arteries of the extremities.

At admission, the patient complained of a fistula in the left thigh with purulent discharge, decreased weight-bearing ability, shortening of the left lower limb and severe pain in the left hip joint.

According to the history of the disease, he was ill since 2020 as he sustained a fracture of the left femoral neck. Total arthroplasty of the left hip joint was performed at the place of his residence (Chita) on 27.02.2020 and at the end of 2020, a fistula appeared in the left hip joint.

Local status: fistula in the left femur communicating with the hip joint cavity (an absolute sign of PJI according to ICM 2018); relative shortening of the left lower limb by 2 cm; the patient moved with crutches. At the time of admission, the functional state of the left hip joint was 27 HHS points and VAS scale pain was 5 points.

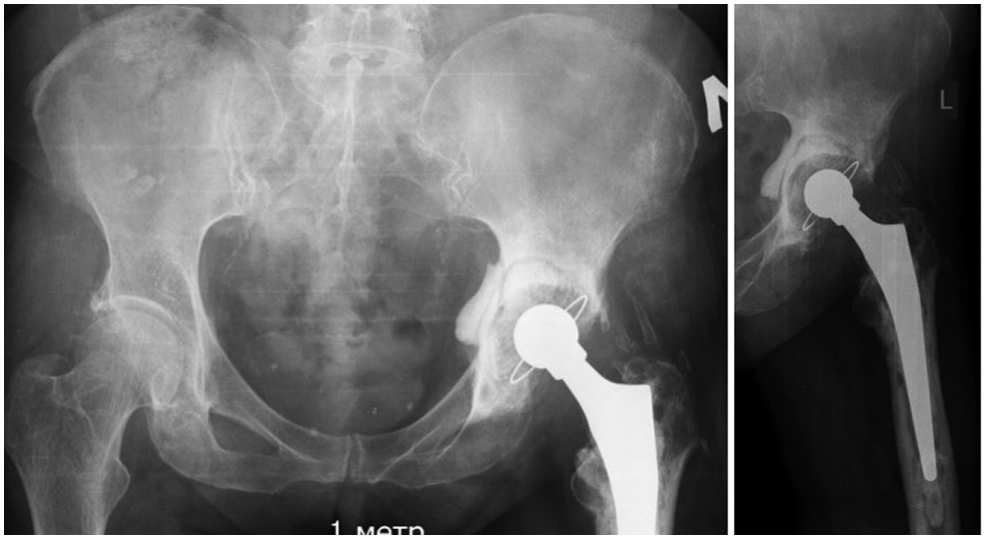

Fig. 6 Radiographs of the pelvis and left hip joint at 1-v focus before the operation

Laboratory test results: mild anemia (Hb 121 g/l), elevated ESR (93 mm/h) and CRP (30 mg/l). *Providence arustigianii* growth of 10^4 CFU/ml was detected in the left hip joint puncture material. The operation was performed in 2023. The first stage of a two-stage revision left hip arthroplasty: previous implant

removal; debridement; installation of an articulating spacer. A 50/32 cup was modeled from molds using 1 packet of bone cement with antibiotics (1 g vancomycin and 1 g cefotaxime). A 50 mm pelvic component of the spacer was implanted using 1 packet of bone cement with antibiotics (2 g vancomycin and 1 g cefotaxime). A cement stem was installed using 1 packet of bone cement with antibiotics (5 g vancomycin and 3 g cefotaxime). Intraoperatively, the acetabulum defect was assessed as Paprosky type 2C with a protrusion of the bottom, which was filled with allobone chips. The operation was completed by installing a drain and layer-by-layer suturing of the wound. Radiographs of the pelvis and left hip joint after surgery are shown in Figure 7. Blood loss was 250 ml, intraoperative blood transfusion was 250 ml. The results of intraoperative microbiological tests were *providence arustigianii* 10^6 CFU/ml, *finegoldiamagna* 10^3 CFU/ml. The wound healed by primary intention. The drain was removed on the 7th day after the operation.

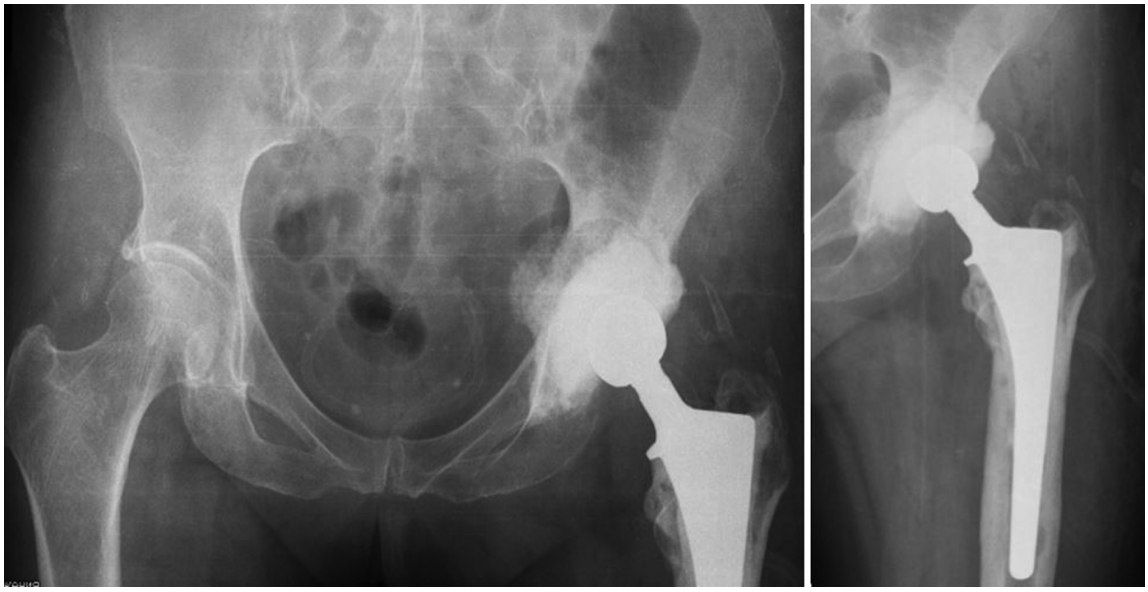

Fig. 7 Radiographs of the pelvis and left hip joint after surgical treatment that comprised defect filling with allobone and installation of an articulating antibacterial spacer

After the first stage of surgical intervention, a six-week course of etiotropic antibacterial therapy was administered: in the hospital for 2 weeks, intravenously vancomycin 1.0 g twice a day and cefoperazonsulbactam 2.0 g twice a day. In the outpatient stage of treatment, a course of oral and intramuscular antibiotics was prescribed for 4 weeks: amoxicillin + clavulanic acid 1000 mg twice a day in tablets and cefoperazonsulbactam 2.0 twice a day intramuscularly.

Further, it was recommended to use crutches for walking with limited load on the affected limb until the following stage of surgical treatment.

After one month, some tests (ESR and CRP) were checked and radiography of the pelvis and left hip joint was repeated (Fig. 8). Laboratory test results: mild anemia (Hb 118 g/l), ESR 20 mm/h and CRP 2 mg/l.

During the follow-up examination after one month, it was established that there were no clinical and laboratory signs of recurrence of the disease (no wounds or fistulas, normotrophic scar); the spacer components were stable; the functional state of the left hip joint was 57 HHS points.

After 4 months, the patient was admitted to the clinic again for additional examination and the second stage of surgical treatment. Local status: no fistulas; a normotrophic scar in the left hip area; the patient moved with crutches. At the time of admission, the functional state of the left hip joint was 57 HHS points. Laboratory test results: complete blood count (Hb 130 g/l), ESR 30 mm/h and CRP 5 mg/l. No growth of the pathogens was detected in the puncture material from the left hip joint.

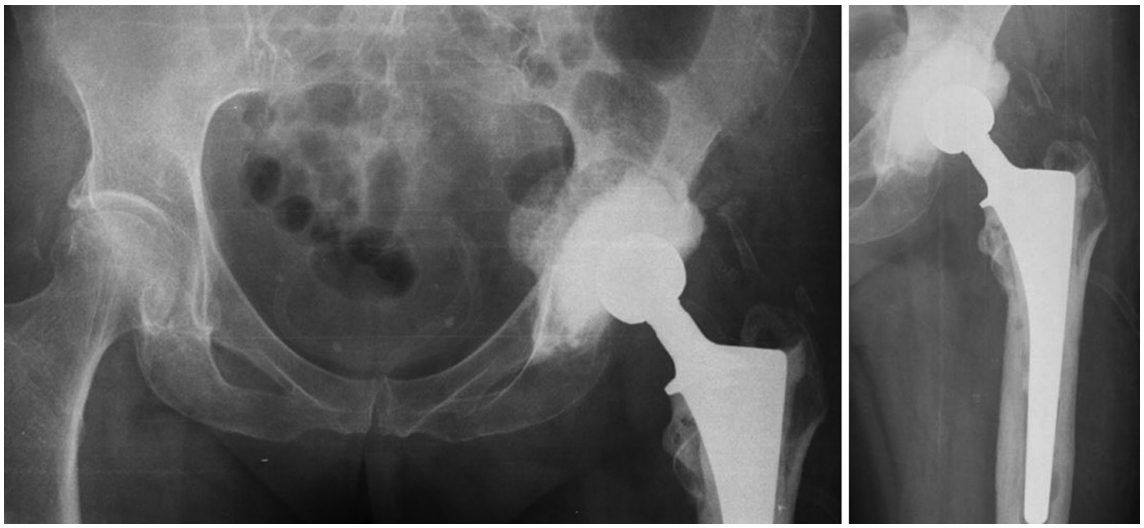

Fig. 8 Radiographs of the pelvis and left hip joint one month after the operation

In 2023, the second stage of a two-stage revision arthroplasty of the left hip joint was performed: removal of the spacer; debridement; installation of a cementless joint implant. The intraoperatively repaired defect was filled with dense bleeding bone tissue of a pale yellow color without signs of necrosis. Radiographs of the pelvis and left hip joint after surgery are shown in Figure 9. Blood loss was 300 ml, intraoperative blood transfusion was 250 ml. No growth of the pathogen from the implant was detected. The wound healed by primary intention. The drain was removed on the 5th day after the operation.

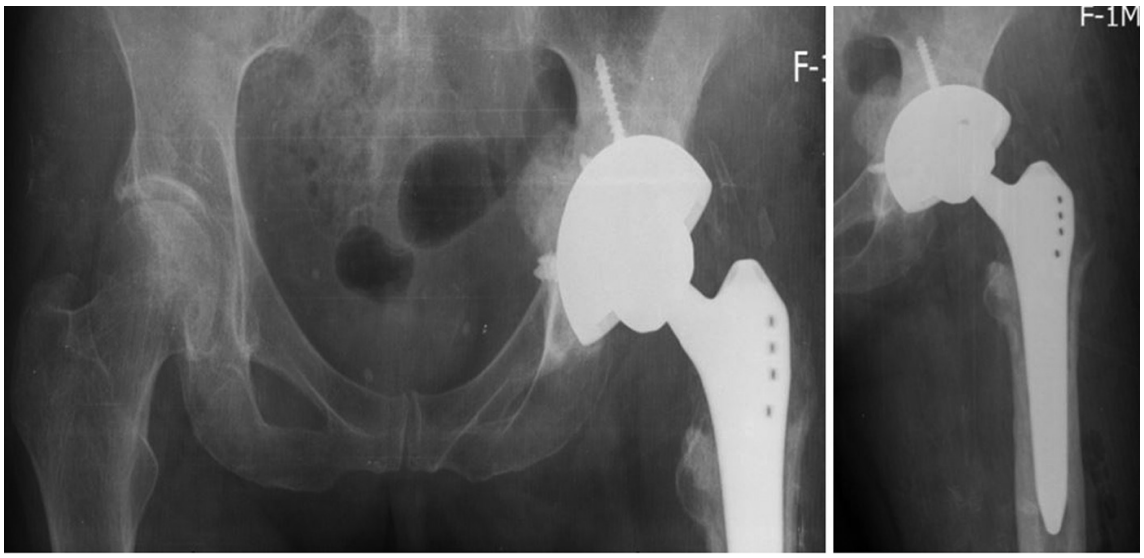

Fig. 9 Radiographs of the pelvis and left hip joint after surgical treatment

A 2-week course of antibacterial therapy was administered: intravenous linezolid 600 g twice a day and meropenem 1.0 g twice a day. At the outpatient stage of treatment, a 4-week course of oral antibiotics was prescribed: amoxicillin + clavulanic acid 1000 mg twice a day and levofloxacin 500 mg twice a day. The patient was recommended to use crutches for walking with limited load on the affected limb for 3 months. After 6 months, ESR and CRP studies and pelvic radiography were performed (Fig. 10). Laboratory test results: mild anemia (Hb 102 g/l), ESR 22 mm/h and CRP 6 mg/l.

At a follow-up examination after 6 months, it was established that there were no clinical and laboratory signs of recurrence of the disease (no wounds or fistulas, normotrophic scar), the components of the implant were stable, the functional state of the left hip joint was 76 HHS points.

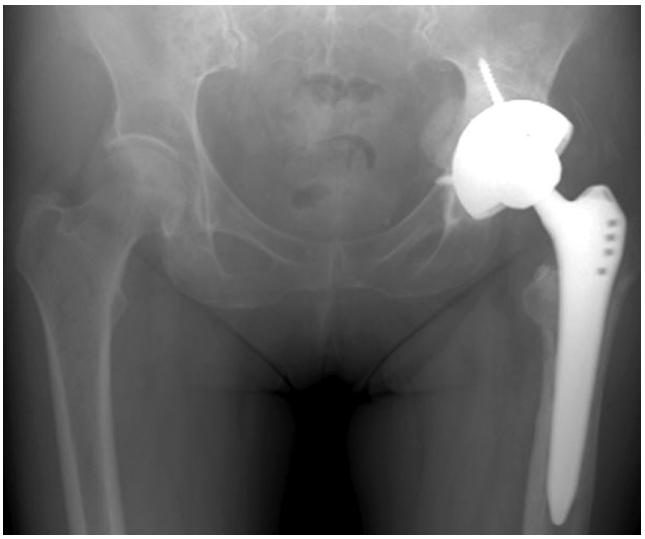

Fig. 10 Radiograph of the joint 6 months after the operation

DISCUSSION

Treatment of PJI usually requires several traumatic surgical interventions, long courses of etiotropic antibiotic therapy, which together affect the quality and duration of life of the patient [13, 14]. In the domestic literature, clinical examples of PJI treatment are not numerous [15]. In the case of recurrent PJI, persistent microflora and large bone defects, surgeons are often forced to use radical operations, such as resection arthroplasty and limb disarticulation [16]. In the clinical cases presented, we managed to avoid possible complications, including damage to the main vessels, which, according to literary data, occur in 0.25 % of cases [17].

There are many different types of spacers for the treatment of periprosthetic infection: block-shaped and articulating, preformed and custom-made, as well as those made in the operating room [18, 19]. Revision arthroplasty is often complicated by decreased tissue elasticity and the formation of dense scars. Large cavitary defects of the bottom and walls of the acetabulum due to a pronounced infectious process, as well as osteoporosis, affect the quality of osseointegration of the pelvic component when installing a permanent implant at the second stage of surgical revision. The main advantages of an articulating spacer after radical debridement are compensation for shortening and restoration of weight-bearing capacity, as well as filling the wound cavity and preventing tissue shrinkage.

In our clinical examples, cavitary defects were repaired and the function of the hip joint was restored at the sanitizing stage. Similar clinical data are not available in the literature. According to the literature, failures are often accompanied by aseptic loosening, recurrent infection, as well as dislocations and possible periprosthetic fractures [20, 21]. Reconstructive repair of large defects is a challenging task for surgeons. Multiple revision surgeries on the same joint impair the quantity and quality of bone tissue significantly. In large defects of the bottom, reconstructive implants are used, which increase the cost of patient treatment. The examples described above demonstrate the implementation of the second stage of revision intervention without the use of antiprotrusion rings, augments and columns with porous tantalum, which technologically simplifies the operation.

In general, the treatment of PJI is a complex clinical task, the solution of which requires comprehensive monitoring by various specialized specialists (orthopedist, pharmacologist, microbiologist, and others) and the development of personalized treatment and diagnostic measures with the optimal selection of etiotropic antibiotic therapy and technical means for implementing revision interventions (including implants) in each specific case [22]. All of the above factors have impact on the duration of inpatient treatment for patients with periprosthetic infection and the amount of financial costs [23, 24].

In the clinical examples presented above, the defects of the acetabulum were filled with bone-plastic material. As a result of treatment, in the first clinical case, it was possible to restore the joint function from 24 to 85 HHS points, in the second one from 27 to 76 points. These scores correspond to the literature data in the tactics of two-stage revision arthroplasty [25, 26].

The series of clinical cases was small. We believe that such methods of defect repair might gain popularity in patients with severe acetabular defects,.

CONCLUSION

The technique of defect compensation in the treatment of PJI shown in the presented above clinical cases is effective and cost-expedient. It enables to stop infection and improve functional results.

Conflict of interest *Not declared.*

Funding *Not declared.*

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