

Some aspects of revision hip arthroplasty. Bone defect plasty with spongy allografts**U.F. Mukhametov, F.F. Mukhametov, Ia.N. Suleimanov, R.Ia. Nagaev, R.T. Nigmatullin, O.R. Shangina**SBHI Kuvatov Republican Clinical Hospital of the RF Ministry of Health, Ufa, Russia
FSBI All-Russia Centre of Ophthalmic and Plastic Surgery of the RF Ministry of Health, Ufa, Russia

Purpose To compare the incidence of hip implant loosening in cemented and uncemented fixation, to work out the recommendations for bone cement removal from the femoral canal and to evaluate the efficiency of using spacers and the proposed technique of filling the bone defect of the acetabular components. **Materials and Methods** The authors present the analysis of indications for performing revision hip arthroplasty and the relative frequency of performance after using the implants with uncemented and cemented fixation. Twenty eight (84.8%) out of 33 patients with implant instability had implants with cemented fixation. The authors focus on the need of sparing removal of the primary implant. A technique of bone cement removal from the femoral canal with the preservation of the proximal femur is proposed. The use of allogenic spongy bone grafts produced from the utilized femoral heads at the FSBI All-Russia Centre of Ophthalmic and Plastic Surgery of the RF Ministry of Health (Ufa) is offered for bone defect plasty. **Results** Among 33 patients, good results were obtained in 23 patients (80-100 points according to W.H. Harris score) with the outcome of functional joints at follow-ups (range: 3 to 8 years), and fair outcomes in four (4) patients. The implant stem sinking developed in two patients within one year after surgery that required the replacement of the stem. The outcomes were good at follow-ups of five to seven years. **Conclusion** The presented technical solutions for performing revision hip arthroplasty can be used in orthopaedic practice.

Keywords Implant, instability, hip joint, approach, stem, revision arthroplasty, osteoplasty, cemented fixation, uncemented fixation

INTRODUCTION

The growth in the number of surgeries and orthopedic surgeons who perform primary joint arthroplasty has led to an increase in the number of complications that require revision arthroplasty. According to A. Michael and S. Sporer (2014), the number of revision arthroplasties has risen up to 10.7 % [2] from the total of hip replacement surgeries.

Loosening of the implant components that develops more frequently as a result of deep periprosthetic infection is the most often indication for a revision procedure [3]. The rates of instability after cemented and uncemented arthroplasties of the hip do not differ [1].

The success of revision arthroplasty largely depends on solving the problems related to a sparing removal of primary implant components, infection arrest, filling in bone defects [4], achievement of secure fixation, and re-integration of a

new joint implant. The removal of bone cement residues from the femoral canal without additional destruction of its walls is technically challenging. Various methods of transfemoral approach to the implant stem and bone mantle were proposed [5]. A proper preoperative planning is of great importance.

Various factors have an influence on the selection of the hip revision method. One-stage implant change is the method of choice in aseptic loosening. Most orthopedic surgeons prefer a two- or more-stage change using spacers [6].

The purpose of the study consisted in comparing the incidence of hip implant loosening in cemented and uncemented fixation, in developing recommendations for bone cement removal from the femoral canal, in evaluating the effectiveness of using spacers and the proposed method of filling bone defects of the acetabulum.

MATERIALS AND METHODS

In the period from 2007 to 2013, we studied 33 patients at the age range of 28 to 82 years who underwent a revision surgery for implant instability after hip arthroplasty. There were 19 males and 14 females.

Aseptic instability of the implant was diagnosed in 19 patients. Implant instability developed due to deep infection in 14 patients (two cases of deep infection were results of periprosthetic femoral fractures).

Initial hip arthroplasty in these patients with implant instability was performed due to primary (idiopathic) coxarthrosis in 22 (66.6 %) cases, rheumatoid polyarthritis in 4 (12.1 %), posttraumatic coxarthrosis in 3 (9.1 %), femoral neck

fracture in 2 (6.1 %), dysplastic coxarthrosis in 1 (3.05 %), and aseptic necrosis of the femoral head in 1 (3.05 %).

Table 1 shows the character of the developed implant instability as well as the types of the implants used for primary hip arthroplasty.

The Table shows that the largest number of patients underwent arthroplasty with cemented fixation – 28 cases (84.8 %). Bone cement free of any antibiotic was used in all these patients.

Instability of the acetabular component was observed in 10 patients and of the femoral component in 13 patients. Instability of both components was detected in 10 patients.

The periods at which hip implant instability developed are given in **Table 2**.

Implant instability within the first five years developed in 29 patients. Only 4 patients had it in the subsequent periods. Hence, the reason of instability in the mentioned group of patients is in the surgery itself (failure to observe the technique of performance or infection penetration).

The examination of patients with implant instability

included clinical examination, radiography, computed tomography of the hip and the proximal femur, aspirated biopsy or study of the wound content.

Once the indications for revision joint arthroplasty are determined, it is necessary to perform preoperative planning. Preoperative computed tomography and two X-ray views assist to determine the type and size of the required implant, indications for osteoplasty, and ways to avoid additional bone destruction.

Table 1

Character of hip implant instability. Types of implants used at primary arthroplasty

Implant type	Implant instability character						Total number of implant instability cases
	Aseptic instability			Instability due to deep infection			
	Acetabular component	Femoral component	Both components	Acetabular component	Femoral compo-nent	Both components	
Muller implant with a strengthening ring and cemented fixation	1	3	2	2	2	5	15
Implant with Muller strengthening ring, insert for cemented fixation and uncemented Avenir stem				1			1
Muller implant with cemented fixation and without a strengthening ring	2	4	1	2		2	11
Elite Plus implant with cemented fixation		1					1
Compamed implant with uncemented fixation	1						1
Biomet implant with uncemented fixation		1					1
Implant with uncemented fixation: Wagner cup and Spotorno stem	1						1
Yartez unipolar implant with uncemented fixation of the stem		2					2
TOTAL	5	11	3	5	2	7	33

Table 2

Periods of hip implant instability after primary arthroplasty

Implant type	Period of the implant instability development after surgery						Total number of implant instability cases
	Aseptic instability			Instability due to deep infection			
	< 5 years	After 5 years	After 10 years	< 5 years	After 5 years	After 10 years	
Implants with cemented fixation	14	—	—	10	1	3	28
Implants with uncemented fixation	5	—	—	—	—	—	5
TOTAL	19	—	—	10	1	3	33

In case of Type 2A and 2B defects of the acetabular walls [10] and preserved acetabular contours, the regular cups of the primary arthroplasty were preferable. For revision of the acetabular component with Type 3A or B bone defects of the posterior acetabular wall, the Burch-Schneider reconstructive rings were used (**Fig. 1**). Muller strengthening rings with tantalum augment were used for Type 3A defects of the acetabular roof.

In case of stem loosening with Type 1 bone tissue defect according to W.G. Paprosky (2004) and preserved bone tissue, it is possible to reuse the implant of the primary arthroplasty. However, it is a rare practice. The primary implant stem was used only in six out of 26 patients (**Fig. 2**).

An instable stem of the primary implant, as a rule, induces the formation of an irregular bone defect along the proximal femur. For this condition, in the presence

of Types 2 to 4 bone defects, we used the Wagner revision stem with distal fixation. Two X-ray views were obligatory to be done. Thereby, it was necessary to take the physiological curve of the femur into account as well as to determine correctly the length of the implant stem that should provide an extensive contact with the femur but should not extend beyond the femoral canal, should not cause the destruction of the cortical layer to exclude the possibility of a subsequent periprosthetic fracture (**Fig. 3**).

A sparing technique for removal of the primary stem was required in order to provide the stability of the implant revision stem.

Transfemoral removal of the primary implant stem, in any of its options, causes destruction of the proximal femur that requires additional subsequent fixation of its fragments and a longer revision stem. The integrity of femoral bone tissue and leg weight-bearing recovered within the periods of 4 to 6 months (**Fig. 4**).

Direct removal of the primary implant stem with preservation of the proximal femur and thorough osteoplasty of all the residual cavities in the femoral canal using cancellous allografts provided restoration of the proximal femoral bone tissue and limb weight-bearing in earlier periods – 3 months from the day of surgery (**Fig. 5**).



Fig. 1 AP pelvic X-rays of a female patient A., 27 years old. Diagnosis: rheumatoid polyarthritis, rhizomelic form, activity phase 2, JFD (Joint Function Disorder): Condition after total arthroplasty of both hips using Compomed implants. Instability of both implants, more marked on the right. Type 3B acetabular defect (**a**). The first stage after the removal of the implant from the right hip. Type 3B acetabular defect. Removal of the implant stem using the transfemoral approach. Spacer was not used (**b**). Two years after revision arthroplasty (**c**)

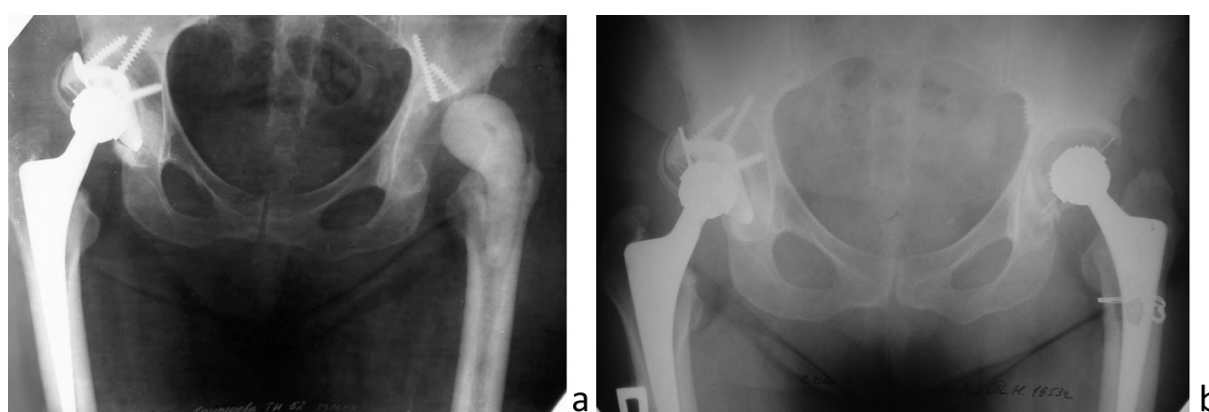


Fig. 2 AP pelvic X-rays in a male patient S., 62 years old: After the first stage: implant removal and cemented spacer placement. Type 2A acetabular defect, Type 1 femur defect (**a**). After the second stage: revision arthroplasty using the primary implant (**b**)

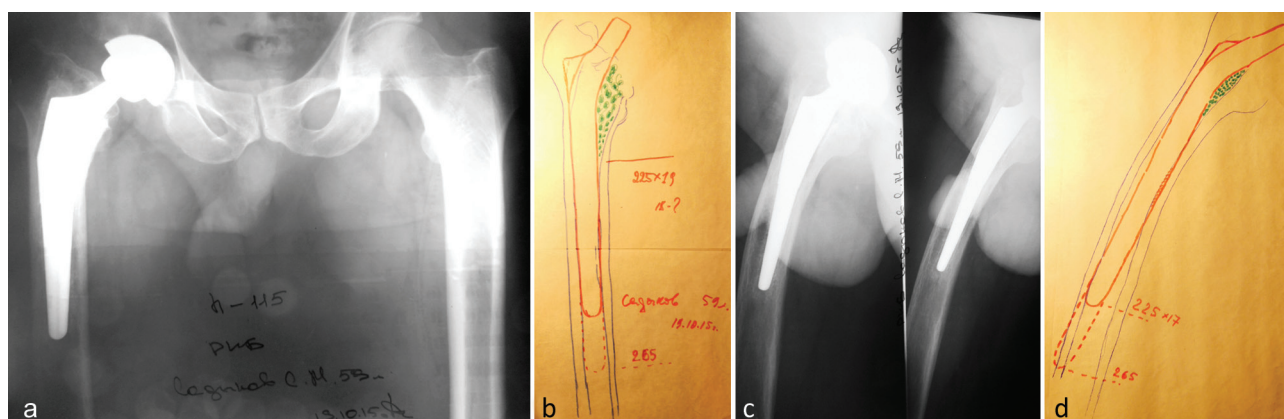


Fig. 3 Pelvic AP X-ray of a male patient C., 59 years old. Diagnosis: instability of the femoral component in the right hip accompanied by a 1.5-cm sinking of the stem. Type 2 defect of the femoral bone (a). Preoperative planning. The stem length, highlighted with a dotted line, is 265 mm. Osteoplasty zone is defined by green color (b). Lateral X-rays of the right hip (c). By planning with the use of the lateral X-ray it is evident that the implant stem of 262 mm in length perforates the femoral cortical layer. The stem length was corrected (d)



Fig. 4 AP hip X-rays in a female patient Kh., 26 years old: Instability of M. Muller implant femoral component with cemented fixation. Type 3A defect of the femoral bone tissue 3A (a). After one-stage change of the femoral component with the Wagner uncemented stem. Transfemoral approach. Osteosynthesis of the femoral fragments in the zone of the approach was performed (b)

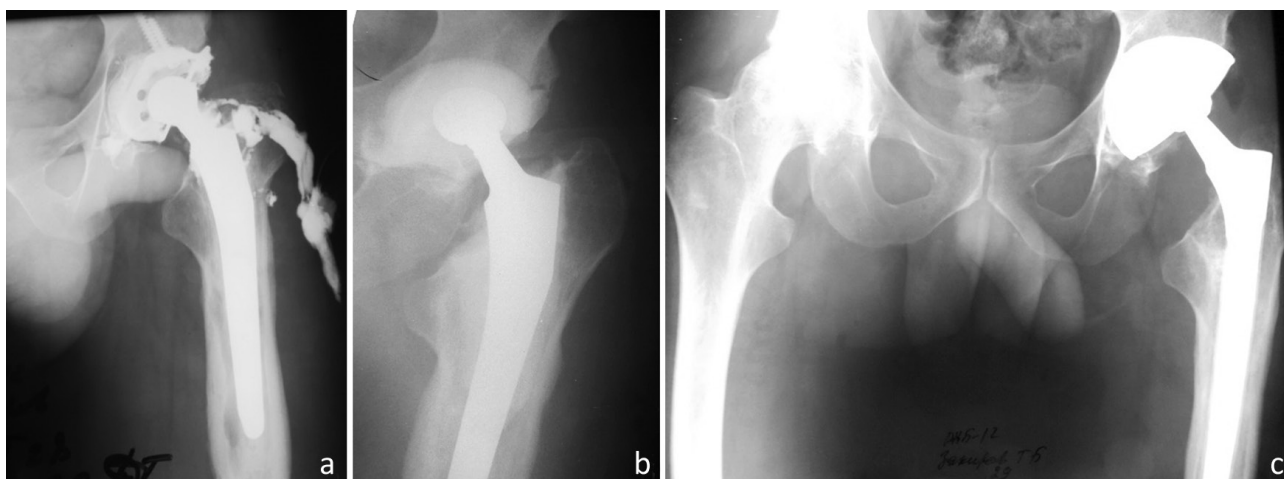


Fig. 5 AP hip X-rays of a male patient Z., 29 years old: Instability of the left hip implant due to deep periprosthetic infection. Type 1 acetabular defect. Type 3A defect of the femur (a). After the first stage: direct removal of the implant and placement of an articulating spacer. Bone defect filled in with bone cement is seen in the proximal femur (b). One year after the second stage: uncemented revision arthroplasty. The arrow indicates the zone of osteoplasty using a cancellous allograft. The filling of the medial proximal femur defect with homogenous bone tissue is observed (c)

Direct removal of the primary implant stem in significant implant loosening can be performed easily in uncemented fixation. As for cemented fixation of the primary implant stem, thorough removal of bone cement residues is challenging challenges while the removal of the stem itself does not cause difficulties.

We started to use a 2.5×1 -cm fenestrate osteotomy above the distal end of the implant stem for complete removal of bone cement residues (Fig. 6). Such an osteotomy provided the integrity of the proximal femur. The resulting small defect of the cortical layer of the femoral shaft and the light coming through it provided a complete control of

the femoral canal throughout the cement mantle as well as allowed a more accurate reaming of the distal bony plug.

If the defects formed in the femoral canal could not provide the contact of the implant stem with the bone tissue at extension of 9 to 10 cm, bone defects of the femoral canal were filled using plasty with 10×10 -mm allogenic cancellous bone grafts.

These cancellous allografts, 10×10 mm in size, were produced at a multi-profile tissue bank facility of the FSBI *All-Russia Centre of Ophthalmic and Plastic Surgery* of the RF Ministry of Health in Ufa from the femoral heads obtained during previous arthroplasties performed by us.

Bone parts sent to the bone bank were sawn into fragments of a cubic shape with a mean edge diameter of about 10 mm. Then the grafts were subjected to sequential physical and chemical treatments using detergents

according to the approved laboratory regulations. At the first stage after membranolysis, the extraction of cellular components was performed to reduce the biomaterial immunogenicity. Decontamination of the grafts was achieved using the original technology of selective radiation sterilization [7, 8, 9]. The grafts maintained their mechanical properties and biological activity.

The use of such cancellous allografts with their press fitting into all the existing cavities resulted in a rigid firm contact with the bone tissue along the implant stem. Both the primary stability of the implant and favorable conditions for its secondary stability were provided [4]. There were no infection complications or allergic reactions in the postoperative period. Homogenous bone tissue was observed in site of allograft placement on X-rays at one year after surgery (**Fig. 5c**).

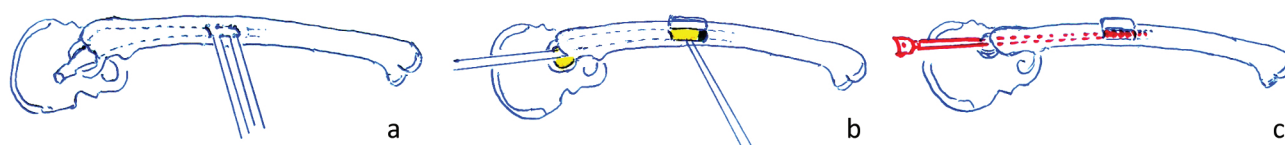


Fig. 6 Diagram of fenestrate osteotomy of the proximal femur: Fenestrate femoral osteotomy (a). Removal of bone cement from the proximal and distal ends of the implant stem (b). Reaming of the femoral canal and bony plug under visual control (c)

RESULTS

We performed revision arthroplasty for instability of the hip implant at one or more stages.

One-stage revision arthroplasty was performed in 14 patients with aseptic loosening of the primary implant. Two- and more-stage arthroplasty was used in 14 patients with the developed deep infection and in five patients with the aseptic implant instability when it was technically impossible to perform an acute surgery or there was doubt to avoid infection.

A spacer was placed after removal of instable implants in 15 patients. The Fitsek articulating spacer was used in six (6) patients (**Fig. 5b**). After the operation, those patients could walk weight bearing on the operated lower limb. It enabled an easier approach to the joint during revision arthroplasty. A free ball-shaped spacer was used in seven patients and a ball with a stem in two patients.

Final revision was performed four months or one year after elimination of the inflammatory process.

The ball-shaped spacers had to be removed two or four weeks later in four patients due to continued inflammation.

Spacers were not used after the implant removal in four patients that had two- or more-stage revision arthroplasty. The final implant placement in these patients was performed after 3 or 4 months when the inflammatory process had been arrested. They showed good results at a 5-year follow-up.

The acetabular component only was replaced during revision arthroplasty in 6 patients. The implant femoral

component was replaced in 11 patients. Both implant components were changed in 16 patients.

Uncemented cups of the primary arthroplasty were reused as an acetabular component in 7 patients, a cemented cup with a Muller strengthening ring in 6 patients, a cemented cup with a Muller strengthening ring and tantalum augment in one patient, a combined revision tantalum cup in 5 patients, and a cemented cup with the Burch-Schneider reconstructive cage in 10 patients.

Uncemented Wagner stem was used as a femoral component in 21 patients, Muller cemented stem in 5 patients, and the Spatorno uncemented stem in one patient.

Transfemoral approach was used for removal of the primary implant stem in 5 patients (among them, uncemented fixation was used in one patient). 22 patients underwent a direct removal of the stem, and among them an additional fenestrate osteotomy was done in 3 patients.

Additional osteoplasty with cancellous allografts was performed in 7 patients.

Good results with a functional joint that showed 80 to 100 points according to W.H. Harris scale [11] were achieved in 23 out of 33 patients after revision hip arthroplasty at follow-ups of 3 to 8 years, fair outcomes were obtained in 4 patients. The implant stem sinking occurred in 2 patients within a year after surgery that required the change of the stem that resulted in good outcomes at the follow-ups of 5 to 7 years.

Infection developed in 4 patients after revision arthroplasty. These patients did not have joint aspiration biopsy before the surgery. The implants were removed in

all of them. The revision procedure is planned for two of them. The other two patients remained with a “hanging leg” (non-weightbearing lower limb).

CONCLUSION

We studied 33 patients at the age from 28 to 82 years who underwent revision procedures for hip implant instability. Among them, 29 (87.9 %) patients underwent surgery within the first 5 years after the primary arthroplasty. In our opinion, the committed errors or joint infection during the primary arthroplasty were the main causes of the mentioned complications.

A comparative analysis of the incidence of hip implant instability including the instability due to deep infection shows that early implant loosening happened in 28 (87.5 %) patients after implantation with cemented fixation.

Revision arthroplasty of the hip is a complex surgical intervention that requires surgeon's training, special instrumentation and implants of different types in order to change the surgical technique, depending on the situation, during the operation as well as an available bone bank to fill in the defects of bone tissue. Unavailable spacer is not an obstacle for performing a two-stage revision.

Maximum preservation of the femur by removing the

primary implant was an important condition to achieve an early recovery of its bone tissue integrity. Fenestrate femoral osteotomy at the level of the implant distal stem by a direct removal of the cemented implant, proposed by us, enabled to completely remove the cement mantle and prepare the femoral canal, thus not damaging the proximal femur.

We used cancellous allogenic bone grafts produced at the FSBI *All-Russia Centre of Ophthalmic and Plastic Surgery* of the RF Ministry of Health in Ufa for bone tissue defect plasty in 8 patients. These grafts showed good plastic properties, reorganization in the early periods and absence of infection complications. The use of allogenic grafts from the femoral heads obtained during previous arthroplasties allowed us to solve the problems of obtaining donor material and legal difficulties of postmortem tissue donation.

Thus, the specific features of performing hip revision arthroplasty described above may be taken into account in orthopaedic practice.

REFERENCES

1. Prokhorenko V.M., Slobodskoi A.B., Mamedov A.A., Dunaev A.G., Voronin I.V., Badak I.S., Lezhnev A.G. Sravnitel'nyi analiz srednesrochnykh i otdalennykh rezul'tatov pervichnogo endoprotezirovaniia tazobedrennogo sustava seriinymi endoprotezami bestsementnoi i tsementnoi fiksatsii [A comparative analysis of intermediate and long-term results of hip arthroplasty using uncemented- and cemented-fixed serial implants]. *Vestn. Travmatol. Ortop. im. N.N. Priorova*. 2014. N 3. pp. 21-26
2. Dzhakofski D.Dzh., Khedli E.K. (Eds.) *Revision hip arthroplasty: a guide for physicians* (Russ. ed.: Zagorodnogo N.V. *Revizionnoe endoprotezirovanie tazobedrennogo sustava: ruk. dlia vrachei*. M.: GEOTAR-Media, 2014. 323 p.)
3. Murylev V.Iu., Kholodaev M.Iu., Rukin Ia.A., Lychagin A.V., Karpov V.V., Rimashevskii D.V., Elizarov P.M. Primenenie speisorov dlia lecheniia glubokoi periproteznoi infektsii tazobedrennogo i kolenного sustavov [The use of spacers for treatment of deep periprosthetic infection of the hip and knee]. *Vestn. Travmatol. Ortop. im. N.N. Priorova*. 2013. N 3. pp. 18-24
4. Zagorodnii N.V., Nuzhdin V.I., Bukhtin K.M., Kagramanov S.V. Rezul'taty primeneniia kostnoi plastiki allotransplantatami pri revizionnom endoprotezirovanii tazobedrennogo sustava [Results of using osteoplasty with allografts in revision hip arthroplasty]. *Vestn. Travmatol. Ortop. im. N.N. Priorova*. 2014. N 2. pp. 33-39
5. Zagorodnii N.V., Nuzhdin V.I., Nikolaev I.A., Kagramanov S.V. Rezul'taty primeneniia transfemoral'nogo dostupa pri revizionnom endoprotezirovanii tazobedrennogo sustava [Results of using transfemoral approach in revision hip arthroplasty]. *Vestn. Travmatol. Ortop. im. N.N. Priorova*. 2013. N 3. pp. 11-17
6. Voloshin V.P., Eremin A.V., Onoprienko G.A., Lekishvili M.V., Vasil'ev M.G. Dvukhetapnoe total'noe zameshchenie tazobedrennykh sustavov v usloviakh glubokoi periproteznoi infektsii [Two-staged total hip arthroplasty under deep periprosthetic infection]. *Vestn. Travmatol. Ortop. im. N.N. Priorova*. 2012. N 4. pp. 3-9
7. Shangina O.R. Radiatsionnaia sterilizatsiia soedinitel'notkannykh biomaterialov [Radiation sterilization of connective-tissue biomaterials]. *Bioimplantologiya na poroge XXI veka*. M., 2001. pp. 30-31
8. Shangina O.R. Sokhrannost' struktury biomaterialov v zavisimosti ot vida konservatsii i sterilizatsii: materialy dokl. Vseros. nauch. konf. «Reaktivnost' i plastichnost' gistologicheskikh struktur v normal'nykh, eksperimental'nykh i patologicheskikh usloviakh» [Biomaterial structure preservation depending on conservation and sterilization type: Materials of the reports of All-Russian Scientific Conference Reactivity and Plasticity of Histological Structures under Normal, Experimental, and Pathological Conditions]. *Morfologiya*. 2003. T. 124, N 5. p. 82
9. Shangina O.R., Nigmatullin R.T. Morfologicheskie i biofizicheskie kriterii radiatsionnoi ustoichivosti allostaticheskikh transplantatov : tez. dokl. VII kongr. Mezhdunar. Assotsiatsii morfologov [Morphological and biophysical criteria of radiation stability of allostatic grafts: Abstracts of VII Congress of Association of Morphologists]. *Morfologiya*. 2004. T. 126, N 4. p. 138

10. Paprosky W.G., Lawrence J.M., Cameron H.U. Classification and treatment of the failed acetabulum: a systematic approach. *Contemp. Orthop.* 1991. Vol. 22. pp. 121-129
11. Harris W.H. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J. Bone Joint Surg. Am.* 1969. Vol. 51, N 4. pp. 737-755

Received: 08.04.2016

Information about the authors:

1. Ural F. Mukhametov, M.D., Ph.D., Kuvатов Republican Clinical Hospital of the RF Ministry of Health, Ufa, Centre of Specialized Medical Care Traumatology and Orthopaedics (including Arthroplasty of Large Joints), Head of the Department of Traumatology and Orthopaedics; Corresponding author: farit1@ufanet.ru
2. Farit F. Mukhametov, M.D., Ph.D., Kuvатов Republican Clinical Hospital of the RF Ministry of Health, Ufa, Head of the Centre of Specialized Medical Care Traumatology and Orthopaedics (including Arthroplasty of Large Joints), Chief part-time traumatologist of the Ministry of Health of the Republic of Bashkortostan; e-mail: farit1@ufanet.ru
3. Iamil' N. Suleimanov, Kuvатов Republican Clinical Hospital of the RF Ministry of Health, Ufa, Centre of Specialized Medical Care Traumatology and Orthopaedics (including Arthroplasty of Large Joints), Department of Traumatology and Orthopaedics
4. Rinat Ia. Nagaev, M.D., Ph.D., Kuvатов Republican Clinical Hospital of the RF Ministry of Health, Ufa, Head physician
5. Rafik T. Nigmatullin – FSBI All-Russian Centre of Ophthalmic and Plastic Surgery of the RF Ministry of Health, Ufa, Deputy General Director for Science, Doctor of Medical Sciences, Professor
6. Ol'ga R. Shangina, M.D., Ph.D., All-Russian Centre of Ophthalmic and Plastic Surgery of the RF Ministry of Health, Ufa, Deputy General Director for Biomaterial Production, professor at the Department of Human Anatomy; e-mail: a.shangina@alloplant.ru