

Our experience in the management of periprosthetic knee joint infection

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Purpose Clinical substantiation of the effectiveness of the differentiated use of surgical techniques and technical means of fixation in the treatment of patients with periprosthetic infection that consider the local status of bone tissue and para-articular tissues. **Materials and methods** The work is based on the experience of surgical treatment of 97 patients with periprosthetic infection of the knee joint in the period from 2004 to 2016. Depending on the degree of bone damage after removal of implants, the patients were divided into three groups. The first one (n = 32; 33 %) had type F1 and T1 bone defects according to AORI classification (Anderson Orthopedic Research Institute, USA); the second one had type F2A and T2A (n = 16; 16.5 %), F2B and T2B (n = 26; 26.8 %); the third one had F3 and T3 (n = 23; 23.7 %). In the first group, only debridement was used. The second group patients underwent a two-stage revision with the installation of a spacer. The third group had arthroplasty in combination with osteosynthesis with the Ilizarov apparatus. **Results** Positive outcomes in patients of the first group were achieved in 100 % of cases, in patients of the second group in 82.5%, and in the third one in 92.2 %. **Complications** happened in 30.9 % of cases. **Conclusion** A differentiated approach with a multifactorial analysis of the infection causes, taking into account the risk factors, associated diseases that aggravate the infectious process, of the state of the implant and para-articular tissues, as well as the type of pathogen, its virulence and sensitivity to antibiotics is an effective rehabilitation option for managing patients with deep infection developed around the implant.

Keywords: knee joint, implant, infection, debridement, revision arthroplasty, joint replacement, Ilizarov apparatus, antibiotic therapy

INTRODUCTION

Total replacement procedures of large joints, including the knee, have been increasingly used every year in orthopedic clinics of the world. The need for this type of surgery has been steadily growing and amounts to 100 cases per 100,000 population [1]. However, there is a significant increase in the number of complications, among which periprosthetic infection is the most formidable as it significantly worsens the quality of life and requires long hospitalization and multiple surgical interventions, long-term and expensive antibiotic therapy [2]. The main reasons in the development of purulent complications are the invasiveness of the operation, insufficient experience of the surgeon, instability of the implant components, previous surgical interventions, intraoperative fractures, history of local infections, infections of internal organs and systems in combination with severe comorbidities [3, 4, 5].

Revision arthroplasty after infection arrest leads to a worsening of the limb support function in 30 % of cases, and the likelihood of infection recurrence is very high, reaching 4 to 8 %. The economic losses of the patient and society are enormous [6, 7].

Currently, there are two main methods of treating patients with periprosthetic infection.

Conservative treatment is used in the majority of cases in elderly and senile patients suffering from severe concomitant diseases in the stage of decompensation with stable components of the implant. Adequate antibiotic therapy, according to the basic principles of its purpose, is the method of choice for this category of patients, while maintaining the drainage of sinuses [8, 9, 10, 11].

Surgical treatment involves several techniques, among which debridement, one-stage or two-stage revision arthroplasty and arthrodesis of the knee joint. Amputation of the lower limb is an extreme measure in the treatment of the infectious process. Implementation of these techniques may be associated with secondary complications, including superficial and deep suppurations of the joint, noted in 0.2–9 % of cases [12, 13, 14, 15].

However, in some cases, the condition of the bones of the operated joint is not taken into account by using the known surgical methods of periprosthetic infection, which leads to excessive trauma, worsening the functional state of the limb, or incomplete sanitation of the infection site that result in recurrence of the inflammatory process. The consequence is the need to improve antibiotic therapy in terms of reducing

its volume and duration, as well as the possibility of combining various drugs. At the same time, this necessitates the use of technical means of fixation, that along with the creation of optimal conditions for arrest of the infectious process, have an active effect on the tissues of the affected limb, thus providing the full or partial compensation of the defect [16].

The **purpose** of the study is a clinical rationale for the effectiveness of the differentiated use of various surgical

techniques and technical fixation means in the treatment of patients with periprosthetic infection, taking into account the local status of bone and paraarticular tissues.

The work is based on the Yu.V. Ababkov's dissertation "Differentiated approach in the treatment of patients with periprosthetic infection of the knee joint" (defended on September 26, 2017 with the dissertation board of the Federal Russian Ilizarov Scientific Center for Restorative Traumatology and Orthopaedics).

MATERIAL AND METHODS

The material of the study was the results of surgical treatment of 97 patients with periprosthetic knee joint infection, treated in the RISC for RTO in the period from 2004 to 2016. Females were 73.2 % (71 patients) and males 26.8 % (26 patients). Age ranking was as follows: one patient younger than 30 years old (1.1 %), 43 (44.3 %) were in the age from 30 to 60 years and 53 patients (54.6 %) were over 60 years old.

The older age group prevailed (54.6 %) in the total number of patients, which is characteristic of articular pathology. Moreover, these patients had a significant number of concomitant diseases complicating the treatment process.

In 73 patients (75.3 %), suppuration occurred after primary arthroplasty. Twenty-four patients (24.7 %) developed it after revision. Indications for arthroplasty were idiopathic gonarthrosis in 48.4 % of cases (47 patients), post-traumatic gonarthrosis (31 patients) in 32.0 %, rheumatoid arthritis in 15.5 % (15 patients) and in 4.1 % (4 cases) it was post-infectious gonarthrosis.

Before arthroplasty, sixteen (16.5 %) patients underwent open surgery on the knee joint. Four patients (4.1 %) had corrective osteotomies in the lower leg bones aimed at unloading the joint; one (1.0 %) had osteosynthesis with a plate after a closed fracture in the lower third of the femur. Chondroprotectors and glucocorticosteroids were administered intra-articularly to eleven (11.3 %) patients in order to relieve inflammation and pain. Two patients (2.1 %) underwent closed transosseous osteosynthesis of the lower leg bones after closed intra-articular fractures. Two (2.1 %) patients had wire tract osteomyelitis of the tibia developed after osteosynthesis of the lower leg bones with the apparatus. These patients underwent tibial sequestr-/necrectomy and drainage. Remission of chronic purulent process in the lower legs was achieved. Bilateral arthroplasty of the knee joints was performed in 14 (14.4 %) patients. In all the cases, cement type fixation of implants was used.

Upon admission to our clinic, instability of the tibial component was detected in 26.8 % of cases

and instability of both components was found in 23.7 % of cases. Periprosthetic infection of the knee joint in 45.4 % of patients was observed with stable components of the implant. Four (4.1 %) patients were admitted for management having an exacerbation of the purulent process after the removal of the knee joint implant at their residence hospital and had cement spacers. One patient had a failure of knee joint arthrodesis.

Infection developed within a month in 39 admitted patients (40.2 %), from one to 6 months in 23 (23.7 %), from 6 to 12 months in 21 patients (21.7 %), after 1 to 2 years in 6 (6.2 %), after 2 years or more in 8 (8.2 %) patients. In general, infection during the first year after surgery was detected in 85.6 % of patients.

The study of the local condition showed that 15 (15.5 %) patients had neither wounds nor fistulas. Sinuses were found in 76 (78.3 %), and six (6.2 %) had wounds resulting from soft tissue necrosis in the area of sutures. Pronounced pain, restriction of motion, a significantly reduced range of movements in the affected joint were clinical manifestations. Knee contracture occurred in 87.6 % of cases (85 subjects).

Eighty-five (87.6 %) patients had comorbidities, which influenced the choice of methods and necessitated the need for additional therapeutic measures aimed at stabilizing the patients' general condition. The most serious complications should be expected in patients with cardiovascular pathology that was found in 47.4 % of cases, and endocrine disorders which were present in 26.8 % of patients (Table 1).

Table 1

Concomitant pathology

Pathology	Number	%
– diseases of cardiovascular system	46	47.4
– diseases of respiratory system	5	5.2
– diseases of digestion system	4	4.1
– diseases of urinary system	4	4.1
– diseases of endocrine system	26	26.8
– no concomitant pathology	12	12.4
Total	97	100

Only four subjects worked at the time of admission, 16 were retired, the rest had a disability group 1 (4 people, 4.1 %), group 2 (42 people, 43.3 %) or group 3 (31 people, 32.0 %).

Upon admission to the clinic and in the course of treatment, all patients underwent comprehensive studies of general and local status using clinical history (risk factors, previous surgical interventions, etc.), X-ray (type of implant fixation, its stability, location of purulent pockets by the introduction of a contrast agent through a fistula or a wound), microbiological (bacterial seeding of articular fluid from wounds and fistulas before surgery, from the focus of inflammation during surgical intervention, from fistulas and drains in the postoperative period), ultrasound (detection of purulent pockets and assessment of the viability of the tendons and ligaments) and laboratory tests (neutrophilic leukocytosis with a shift to the left, anisocytosis, anemia, a significant increase in ESR and SRB, hypoproteinemia, dysproteinemia

accompanied by a decrease in albumin content, hyperfibrinogenemia, severe thrombinemia).

Statistical data analysis included an assessment of the quantitative data of the research results. Data are presented as percentage, arithmetic mean, standard deviation and arithmetic mean error. The normality of the samples was evaluated with Shapiro-Wilk test. The significance of differences between the data obtained from patients after treatment and those obtained before treatment was calculated using Student's t-test.

The analysis of the results was conducted using descriptive statistics using "Microsoft Excel" of the "Microsoft Office" software.

All studies were carried out in accordance with the ethical standards of the Helsinki Declaration of the World Medical Association "Ethical principles of conducting scientific medical research with human participation" with amendments. Patients signed informed consent to the publication of the data obtained during the research, without identifying individuals.

RESULTS

Findings of radiography and fistulography obtained during the examination served for assessing the extent of bone damage. AORI (Anderson Orthopedic Research Institute, USA) classification of bone defects in the knee joint was used [9, 17]. Considering the fact that this classification was developed for revision arthroplasty in the absence of infection, the state of the bone fragments was finally assessed after removal of implants and radical necrectomy in our series.

According to this classification, several types of bone lesions were identified:

Type 1 (F1 and T1) is intact bone characterized by a relatively normal bone structure and the preservation of the cancellous and cortical bones of the metaphysis, the normal level of the articular line. With this type of lesion, X-ray studies allow to obtain a true picture of destructive changes in the bone tissue, and, as a rule, there are no discrepancies with the data of radiation diagnosis when performing surgery. In the revision surgery with this type of bone damage, the preserved spongy bone can serve as a support for both the primary and revision components. The decision on the possibility of placing a standard implant or the need to

use the revision model is made taking into account the state of the collateral ligaments of the knee joint;

Type 2 is a damaged bone characterized by loss of spongy and cortical bone tissue, which deficit should be restored for having the required joint gap. Angular migration of the implant components leads to a defect of one of the condyles (F2A or T2A), the bone of the opposite condyle or plateau remains unchanged. Symmetric bone loss and the involvement of two condyles or plateaus are referred to as F2B and T2B defects.

Type 3 is bone deficiency (F3 and T3) characterized by pronounced loss of spongy and cortical bone mass, which means that using standard implant models is impossible due to the lack of bone support.

In accordance with these types of bone defects, our patients were distributed as follows (Table 2).

Another fundamental factor in the choice of treatment tactics is the identification of pathogenic microflora and its sensitivity to antibiotic therapy. In our series of 97 patients, gram-positive microflora prevailed in 79.4 % of cases and the gram-negative flora was detected in only 5 (5.1 %) cases. Mixed culture was found in 15 patients (15.5 %) (Table 3).

Table 2

Bone tissue defects types in the patients studied

Knee bone defect type	Number	%
Type 1 (F1 и T1)	32	33.0
Type 2 (F2 A и T2 A)	16	16.5
Type 2 (F2 B и T2 B)	26	26.8
Type 3 (F3 и T3)	23	23.7
Total	97	100

Table 3
Microflora isolated in the patients studied

Agent	Number	%
<i>S. aureus</i>	38	39.2
MRSA	9	9.3
<i>S. epidermidis</i>	5	5.2
MRSE	18	18.5
<i>Enterococcus faecalis</i>	5	5.1
<i>Escherichia coli</i>	1	1.0
<i>Pseudomonas aeruginosa</i>	3	3.1
<i>Corynebacterium spp.</i>	2	2.1
<i>Acinetobacter baumannii</i>	1	1.0
Microbial associations	15	15.5
Total	97	100

Appropriate antibacterial agents were chosen in accordance with the obtained characteristic of antibiotic sensitivity. Each patient was prescribed two etiotropic, synergistically directed drugs. This ensured a reduction in the dosage and duration of antibacterial therapy, which in our series was only one course. Repeated course was administered only if infection recurred.

Taking into account the state of the implant components and paraarticular tissues, the principle of a differentiated approach to the implementation of various techniques and their variants was used. There were three groups. The first group comprised six patients (6.2 %) in which only the method of debridement (including the replacement of the liner) was used if the infection process was detected in the early periods (up to 3-4 weeks) with the first type (F1 and T1) of bone damage according to AORI. The second group included 40 patients (41.2 %) in which a two-stage revision technique was used with a spacer installed (including in combination with Ilizarov apparatus fixation) if the infection process

was detected after more than four weeks, with the first type (F1 and T1) of bone damage according to AORI with loss of spongy and cortical bone mass (types F2A and T2A and F2B and T2B), with preservation of the ligamentous apparatus of the knee joint and the joint space. The third group comprised 51 patients (52.6 %) in whom the arthroplasty technique was combined with transosseous osteosynthesis according to Ilizarov if it was impossible to install a standard implant due to a significant loss of the cancellous and cortical bone (type F3 and T3 according to AORI), and in combination with damage to the ligamentous apparatus of the knee joint.

The results of applying these techniques are illustrated by the following clinical cases.

Debridement technique

Case report 1 (Fig. 1) Patient T., 60 years old, was admitted to the hospital with a diagnosis of an infected implant of the right knee joint. Concomitant diagnosis: diabetes mellitus type 2 of moderate severity and subcompensation; hypertension disease in stage 2 (risk 4). Radiological findings: the implant was stable, the bone structure was intact with the preservation of the cancellous and cortical bone of the metaphysis, the normal level of the articular line, which corresponded to the first type of bone damage according to AORI (F1 and T1).

An operation of debridement of the right knee joint was performed with replacement of the prosthetic liner and drainage. Etiotropic antibiotic therapy was carried out for three weeks. The wound healed by first intention. The patient walked with crutches gradually increasing load on the operated limb. A posterior plaster cast was used for fixation of the right knee joint for a month. The duration of inpatient treatment was 79 days.

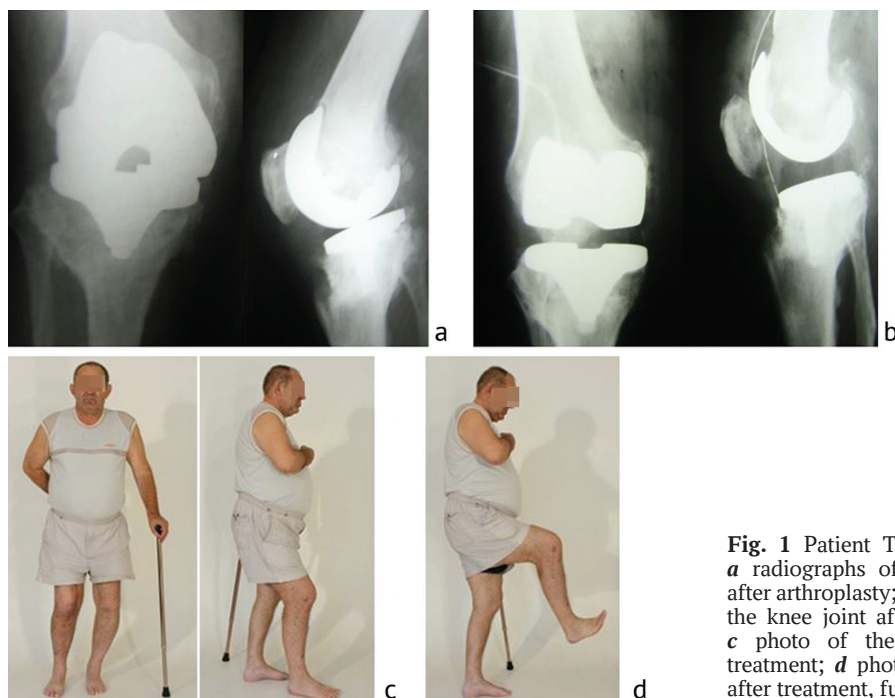


Fig. 1 Patient T., 60 years old: **a** radiographs of the knee joint after arthroplasty; **b** radiographs of the knee joint after debridement; **c** photo of the patient before treatment; **d** photo of the patient after treatment, functional result

The treatment resulted in arrest of infection, preservation of the function and supportability of the lower limb. At a one-year follow-up, the achieved result was preserved, there were no signs of disease recurrence. The patient walks without additional means of support, fully loading the limb, and his knee joint range of motion is full without pain.

Two-stage revision arthroplasty that includes installation of a spacer

Case report 2 Patient S., 38 years old, was admitted with pain in the area of the left knee joint, the presence of a fistula with purulent discharge, limited range of motion in the knee joint, increased body temperature to 37.5 °C.

In 2008, he sustained an open fracture of the lower third of the left femur with displacement in a traffic accident. Skeletal traction was performed for a month, followed by plate osteosynthesis. In May 2009, a fistula with purulent discharge opened in the thigh. In March 2010, the plate was removed. The fracture was complicated by osteomyelitis, a fistulous type. In December 2010, necrectomy of the femur was performed, and the fistula closed. Stable remission of the purulent process (2 years) was achieved (**Fig. 2**). Due to post-traumatic gonarthrosis of the left knee joint, a total cement knee joint replacement was performed.

The patient was diagnosed with a deep periprosthetic infection of the left knee joint,

caused by an exacerbation of chronic osteomyelitis (**Fig. 3 and 4**).

Intervention in the bone infection department comprised removal of the implant, radical necrectomy of the bones of the knee joint and paraarticular tissues with the installation of an articulating spacer and drainage. At revision, both components of the knee joint implant were stable. In the process of surgical intervention, samples were harvested (soft tissue samples of the knee joint, samples of granulation in the area of implant components and a polyethylene liner, etc.) for bacteriological tests in order to identify infectious agents and determine their sensitivity to antibiotics (**Fig. 5**).

Staphylococcus aureus was identified, sensitive to different groups of antibiotics (with the exception of penicillin). Intraoperatively, it was established that bone tissue damage corresponded to AORI type 2A. Given the history of chronic osteomyelitis of the femur, the implant was removed and an articulating spacer was installed in its place (**Fig. 6**).

In the postoperative period, antibiotic therapy included intravenous administration of two drugs (cefazolin 1.0 × 4 times a day, ciprofloxacin 200.0 × 2 times a day) according to the antibioticogram for 14 days. The drainage tube was removed on the 3rd day, the sutures were removed on the 16th day, primary healing of the postoperative wound was achieved (**Fig. 7**).

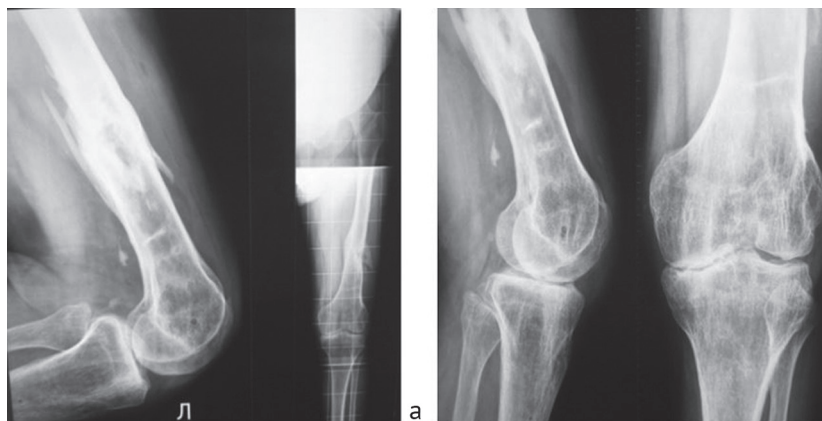


Fig. 2 Patient S.: **a** radiograph of the left femur after removing the plate. Consolidated fracture of the lower third of the femur; **b** radiograph of the knee joint before joint replacement



Fig. 3 Patient s knee joint and functioning fistula

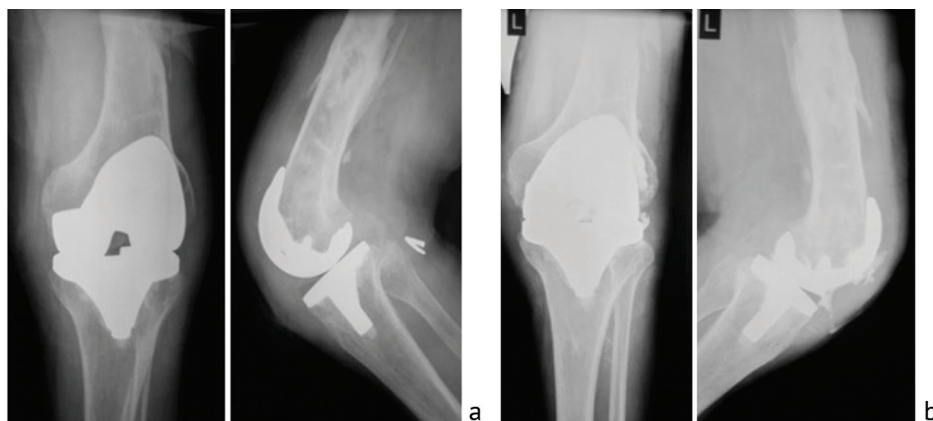


Fig. 4 Patient S.: **a** radiographs after knee joint arthroplasty in 2 projections; **b** fistulogram

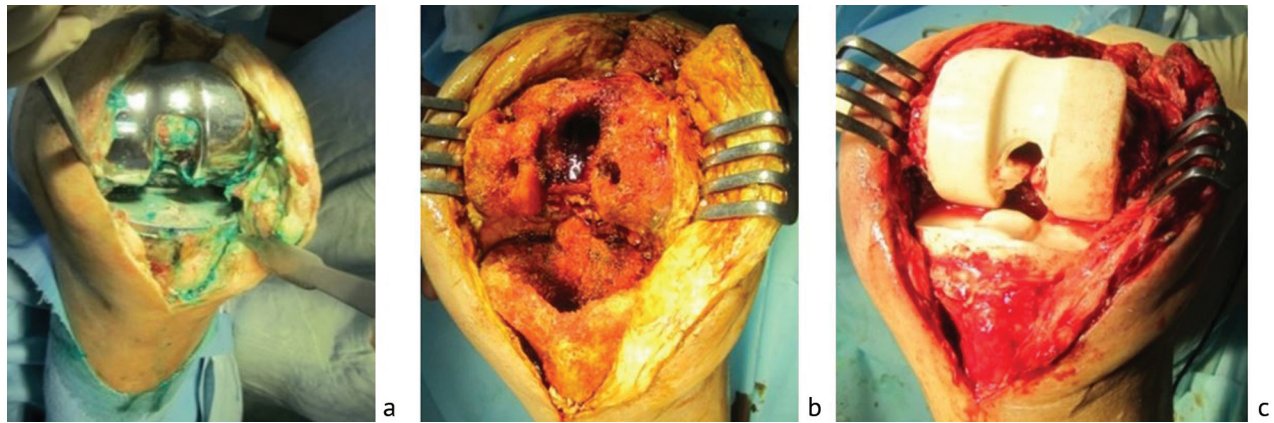


Fig. 5 Patient S.: *a* surgical wound before the removal of implant, nonviable soft tissues and components of the implant are stained; *b* after removal of the implant and debridement; *c* after installation of the temporary articulating spacer



Fig. 6 Radiographs of the knee joint of the patient S. after the installation of the articulating spacer

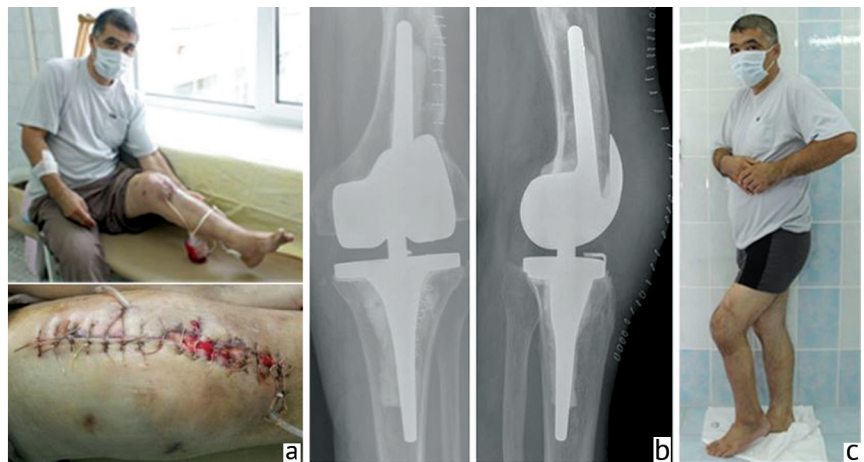


Fig. 7 Patient S.: *a* appearance after surgery, drainage stage; *b* radiographs of the knee after revision arthroplasty; *c* photo after treatment

On day 3 after surgery, the patient was active. He was recommended to walk under the guidance of an exercise therapy instructor, with the help of additional support means, gradually increasing load on the limb. The duration of inpatient treatment was 47 days. The patient was discharged for outpatient treatment at the hospital of his residence with the recommendations of re-replacement, which was performed five months later.

At a one-year follow-up, the patient walked without additional means of support with a full load on the operated limb and does not limp. There were no signs of disease recurrence. The result of treatment was rated as excellent.

The technique combining arthroplasty and osteosynthesis with the Ilizarov apparatus

Case report 3 Patient K., 34 years old, suffered from rheumatoid arthritis since childhood. He took prednisone 10 mg per day for 10 years. Due to rheumatoid gonarthrosis, total cemented arthroplasty of the right and after one month of the left knee joint, using the De

Puy system, was performed in Perm. The postoperative period on the right knee joint was uneventful, edema and hyperemia appeared on the left after 3 weeks. Conservative treatment with antibiotic therapy was administered. In March 2011, three fistulas with purulent discharge opened. He came for treatment at the RISC for RTO with diagnosis of deep periprosthetic infection of the left knee and phlegmon of the left tibia.

His general condition was of moderate severity with temperature of 37.5°C. There were no fistulas, wounds, hyperemia, or edema on the right knee joint. In the left limb, moderate hyperemia on the posteromedial lower leg surface, 5 × 15 cm in diameter, detachment of the skin like epidermal blisters was found at examination. There were two wounds: on the thigh in the lower third of 2 × 2 cm with purulent discharge, the wound in the knee joint on the front surface of the scar 3 × 6 cm, the bottom of the wound was the knee joint implant. A foreign body protruded into the wound (a screw in the tibial tuberosity) (**Fig. 8**).



Fig. 8 Patient K. Appearance of the knee and lower leg area at admission

Flexion-extension contractures of the upper and lower extremities were present (in the left knee joint, flexion of 160 degrees, extension of 170). Blood tests showed moderate leukocytosis with a shift to the left, ESR of 60 mm according to Vestergren; an increase in hepatic transaminases by one half as compared with the norm, hypoproteinemia, dysproteinemia. Bacteriological culture showed the growth of *S. aureus*, *Acinetobacter sp.*, sensitive to different groups of antibiotics. X-rays revealed instability of the tibial and femoral components of the left knee joint implant.

Revision of the purulent wounds of the left leg and knee joint, necrectomy, and secondary sutures were used (**Fig. 9**).



Fig. 9 Photos in the operating room: revision of the purulent wound

After the acute phenomena of the infectious process had subsided and the conditions for wire

insetion in the lower leg had been created, the implant was removed, the necrectomy of the bones of the left knee joint was performed and drained. Open osteosynthesis of the femur and tibia with the Ilizarov apparatus and bone defect grafting with the patella was used (**Fig. 10**).

The treatment of the disease was complicated by sepsis, septicemia (purulent arthritis of the right knee, left elbow and ankle joints). Purulent accumulation in the right knee joint was revised; the apparatus on the left lower limb was reassembled. A repeated course of antibiotic therapy was administered for 14 days. The right lower limb was fixed by a plaster cast. Purulent pocket in the left elbow and right ankle joints were opened. Healing of wounds occurred by secondary intention (**Fig. 11**). The total duration of inpatient treatment was 184 days. Fixation in the device continued 132 days. Bone ankylosis of the left knee joint was obtained with a shortening of the left lower extremity of 4 cm. The patient spent the period of outpatient rehabilitation at the hospital of his residence.

At one-year follow-up, the result achieved with treatment was maintained. The patient walks with a cane, loading the left lower limb and uses the shoe sole pad. There are no signs of disease recurrence. The patient is satisfied with the treatment.

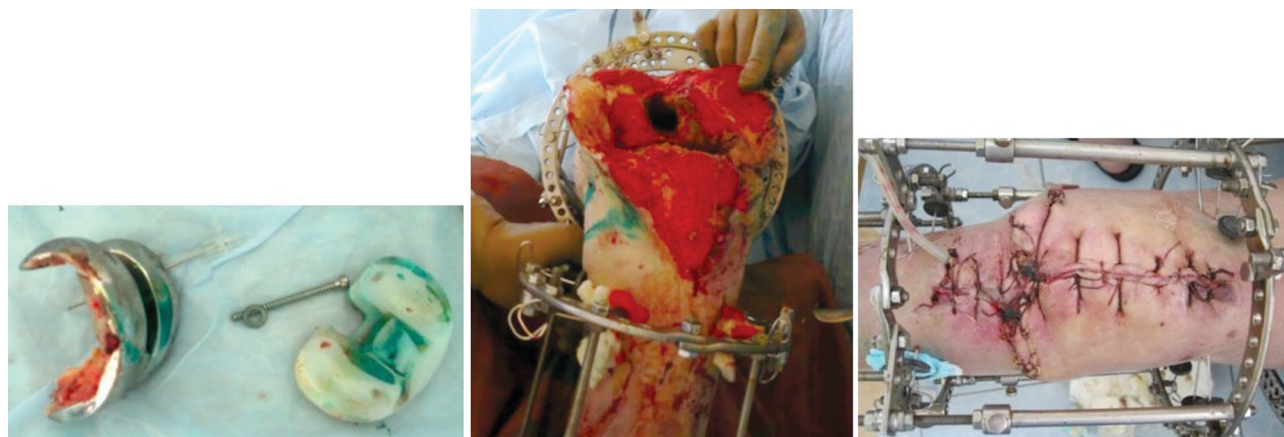


Fig. 10 Stages of surgical intervention



Fig. 11 Radiographs of the left knee joint (**a**) and a photo of patient K.'s limb (**b**) after dismantling the apparatus; wound and fistula healed

DISCUSSION

Despite the fact that periprosthetic infection is not the most frequent complication of arthroplasty (according to different authors, from 1 to 11 % [18, 19, 20, 21]) and takes the 3rd or 4th place among all causes of failures, its treatment is challenging due to high recurrence rates, often accompanied by sepsis and leading to death in some cases, as well as by formation of biofilms composed of microorganisms. Microorganisms in the biofilms have an increased resistance to most of the currently available antibiotics, reducing the drug's access to the inflammation site in the conditions of decreased blood flow and redistribution of antibiotic resistance genes as a result of genetic recombination processes in bacteria [5, 14, 22, 23]. In this situation, careful selection of a complex of synergistically acting antibacterial drugs with regard to the sensitivity of microorganisms is necessary [24, 25, 26, 27, 28], as well as a differentiated approach to the choice of debridement techniques, osteoplastic operations, options and osteosynthesis equipment, allowing, along with the creation of optimal conditions for infection arrest, an active impact on the tissues of the affected limb, thereby providing a full or partial filling of the defect. And from this point of view, it is difficult to overestimate the importance of the Ilizarov method and the apparatus in the treatment of the pathology of the musculoskeletal system complicated by purulent infection.

Our studies and the results obtained in treatment of periprosthetic infection are consistent with the data of other authors; however, to achieve positive outcomes, we were able to reduce the duration of antibiotic

therapy to a three- or 4-week course, which allowed us to avoid a number of specific complications associated with prolonged use of antibacterial drugs. Comparative data are shown in Table 4.

We used both conventional approaches like debridement, installation of a temporary articulating spacer followed by installation of the revision implant and the techniques developed at our Center, which turned out to be effective in cases with significant bone destruction. As the world experience shows (it is also evident from Table 4), specialists rarely use resection arthroplasty options and reconstructive plastic surgery for massive destruction of bone tissue under the conditions of purulent infection and prefer radical interventions. In our case series, it was possible to preserve a functional limb in 51 patients with significant bone deficiency and perform reconstruction which was the maximum possible in each specific clinical situation, including using local tissues, without auto- or allografting. The bactericidal effect of the Ilizarov apparatus that was proven in experimental and clinical conditions optimizes the duration of antibiotic therapy and provides the desired outcome. The resulting complications, observed at the stage of clinical trials, were analysed and taken into account in our further work.

A differentiated use of the complex of the techniques that considers the state of the tissues of the knee joint, assists in avoiding their excessive traumatization that can worsen the functional state of the limb, or insufficiently complete debridement of the infectious focus that may lead to re-infection.

Table 4

Treatment outcomes in patients with knee joint periprosthetic infection
(authors' results and literature data)

Authors	Duration of antibiotic therapy	Treatment methods, success rate		
		Debridement	Two-stage revision	Resection arthroplasty
Authors	3-4 weeks	100 (n = 6)	84.3 (n = 40) 7 complications	92.2 (n = 51) 4 complications
Parvizi, 2013	5-6 weeks	71	94	–
Trampuch, 2009	12 weeks	75	96	–
Hanssen AD, 2007	4-8 weeks	71	94	–
Silvestre A.C. et al., 2013	5-8 weeks	–	95.6	–
Geurts J.A.P et al., 2013	13 weeks	–	83.2	–
Hsieh P-H. et al., 2009	4-8 weeks	87	94	78

CONCLUSION

The differentiated approach that considers the causes of development, risk factors, associated diseases that aggravate the course of the infectious process, the state of the implant and paraarticular tissues, as well as the type of pathogen, its virulence and sensitivity to antibiotics is an effective rehabilitation protocol for patients with deep infection developed in the area of the implant. It provides arrest of the

disease in 84.3 % of cases by the end of the first year and in 100 % up to 5 years after the end of treatment. The proposed algorithm for performing each of the techniques used reduces the number of recurrences. The complications, encountered in 30.9 % of cases (data are consistent with the world statistics), were local in nature, were eradicated directly in the course of treatment and did not affect its outcome.

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