



Primary Data from the Local Registry of Periprosthetic Hip Infection at the National Ilizarov Medical Research Centre for Traumatology and Orthopaedics

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Abstract

Background. Obtaining accurate data on the epidemiology of periprosthetic joint infection (PJI) of the hip in the Russian Federation is a challenging task, which is associated with the peculiarities of statistical registration of complications and the lack of approved routing schemes.

The aim of the study – to provide the results of primary analysis of the data from the local registry of hip periprosthetic infection, which reflects all the treatment cases from 01.01.2020 to 31.12.2020.

Methods. Since 2021, the Center has been working on retrospective input of the data on patients PJI of the hip treated at the clinic into the electronic version of the registry. The information was collected by studying archived medical records and a medical information system, by examining patients in the outpatient clinic, and by interviewing patients via mobile phone and e-mail. During the period, we treated 449 patients with hip periprosthetic infection. The mean patients' age was 55.6 ± 12.6 years (Me – 57; 95% CI: 54.4-56.8). Male patients accounted for 61.6% (n = 277).

Results. We were able to evaluate the treatment results in 84% (n = 377) of patients. The mean follow-up period was 5.92 ± 2.55 years (Me – 6; 95% CI: 2.39-2.73). In more than 90% (n = 407) of cases, the infection was classified as chronic (more than 3 weeks of manifestation). At the admission 76,8% (n = 345) of patients had a fistula communicating with the joint cavity. The percentage of lethal outcomes due to sepsis was 1,7% (8/449); recurrences of hip PJI was observed in 6.2% (28/ 449) of cases. Resolution of infection has been achieved in 67% (300/449) of cases.

Conclusions. The primary analysis of the data from the local registry of hip periprosthetic infection of the national Ilizarov Center of Traumatology and Orthopedics showed that the average age of patients with hip PJI in our country is significantly lower than in the known national registries. At the same time, the infectious agents were similar: Gram-positive microorganisms accounted for more than 55%. The analysis of the registry data shows a significant decrease in the PJI recurrence rate over the last 5 years.

Keywords: periprosthetic infection, local registry, revision hip arthroplasty, fistula.

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Первичные данные локального регистра по перипротезной инфекции тазобедренного сустава Национального медицинского исследовательского центра травматологии и ортопедии им. академика Г.И. Илизарова

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Реферат

Актуальность. Точные данные об эпидемиологии перипротезной инфекции (ППИ) тазобедренного сустава в Российской Федерации получить сложно, что связано с особенностями статистической регистрации осложнений и отсутствием утвержденных схем маршрутизации пациентов.

Цель работы — представить результаты первичного анализа данных локального регистра ППИ тазобедренного сустава, в котором отражены все случаи лечения этой патологии с 01.01.2010 по 31.12.2020.

Материал и методы. С 2021 г. проводилась ретроспективная работа по внесению в электронную версию регистра данных о пациентах с ППИ тазобедренного сустава, получавших лечение в клинике Центра. Сбор информации осуществлялся посредством работы с архивными историями болезни и медицинской информационной системой, осмотра пациентов в поликлинике, опроса больных по мобильной связи и электронной почте. За указанный период были пролечены 449 пациентов с ППИ. Средний возраст пациентов составил $55,6 \pm 12,6$ лет (Me — 57; 95% ДИ: 54,4–56,8). Пациенты мужского пола составляли 61,6% ($n = 277$).

Результаты. Нам удалось оценить результаты лечения у 84% ($n = 377$) больных. Средний срок наблюдения за пациентами составил $5,92 \pm 2,55$ года (Me — 6; 95% ДИ: 2,39–2,73). В более чем 90% ($n = 407$) случаев инфекция была классифицирована как хроническая (более 3 нед. манифестации), 76,8% пациентов ($n = 345$) при поступлении имели свищевой ход, сообщающийся с полостью сустава. Летальный исход на фоне септического состояния зарегистрирован у 1,7% (8 из 449) больных, рецидив ППИ — в 6,2% (28 из 449) случаев, купирование инфекции — в 67% (300 из 449).

Заключение. Первичный анализ данных локального регистра ППИ тазобедренного сустава в центре Илизарова показал, что средний возраст пациентов с ППИ в нашей стране значительно ниже, чем в известных национальных регистрах. В то же время структура возбудителей инфекции была схожа: грамположительные микроорганизмы составляли более 55%. Анализ данных регистра демонстрирует значительное снижение частоты рецидивов ППИ за последние 5 лет.

Ключевые слова: перипротезная инфекция, локальный регистр, ревизионное эндопротезирование тазобедренного сустава, свищевой ход.

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BACKGROUND

Treatment of patients with periprosthetic joint infection (PJI) is a significant medical and social problem for the healthcare system [1, 2]. It is difficult to obtain accurate data on the epidemiology of PJI of the hip in the Russian Federation due to the peculiarities of statistical registration of complications and the lack of approved routing schemes [3].

To continuously collect information on the process and results of the treatment of PJI, in the National Ilizarov Medical Research Centre for Traumatology and Orthopaedics (hereinafter – the Centre) a local registry was organized. Treatment in the clinic of the Centre is carried out by one team according to common standards. This registry cannot track the results in particular population due to the above-mentioned reasons; however, the majority of patients with PJI are treated in the federal centers of St. Petersburg, Moscow, Kurgan, Nizhny Novgorod, and Novosibirsk [3]. In this regard, the analysis of information from this local registry allows us to draw certain conclusions about the state of the problem of PJI treatment in the country.

Aim of the study is to provide the results of primary data analysis of patients with periprosthetic joint infection from the local registry of the National Ilizarov Medical Research Centre for Traumatology and Orthopaedics.

METHODS

Since 2021, the Centre has been working on retrospective input of the data on patients with PJI of the hip treated at the clinic into the electronic version of the registry. The information was collected by studying archived medical records and medical information system, by examining patients in the outpatient clinic, and by interviewing patients via mobile phone and e-mail.

Statistical analysis

The data obtained from the registry were analyzed using Statistica 13.0 software (StatSoft). Quantitative variables were described using mean value and standard deviation ($M \pm SD$), 95% confidence interval (95% CI), and median (Me). Microsoft Excel and Statistica 13.0 (StatSoft) software were used to draw charts and box-and-whisker plots.

RESULTS

General structure of surgeries

According to the registry data for 2010-2020, 449 patients with PJI were treated in the clinic of bone and joint infection (septic osteology). The maximum increase was observed in 2016, when the number of surgeries increased by 410% relative to 2010, and in 2019 (an increase of 54%). In 2020, a regular decrease in the number of operations was registered due to the COVID-19 pandemic (Fig. 1).

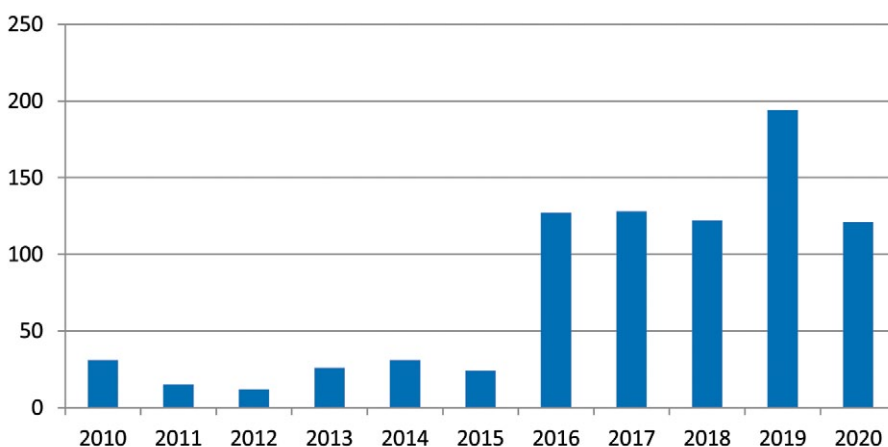


Fig. 1. Number of revision surgeries in patients with PJI of the hip

During the study period, there was an increase in the number of revision surgeries, which can be attributed to the organization and improvement of the clinic work, the increased experience of the staff and the allocation of additional treatment quotas.

Distribution of patients by age and gender

The mean patients' age was 55.6±12.6 years (Me – 57; 95% CI: 54.4-56.8). There was no clear trend toward an increase or decrease in the mean age (Fig. 2).

Patients in the 50-60 and 60-70 age groups predominated, together accounting for 54%.

The least common age group were patients over 80 years old (Table 1).

From 2010 to 2020, males accounted for 61.6% (n = 277) of patients with hip PJI, with the share of male patients ranging from 55-68% in the last 5 years. According to the New Zealand Arthroplasty Registry, male gender is a risk factor for revision for PJI [4]. Data from the Finnish and Swedish registries indicate that the risk of infection after primary arthroplasty is 1.2-1.7 times higher in males. The reason for the increased risk may lie in concomitant factors such as smoking and alcohol abuse, specific features of skin metabolism and hair growth [5, 6] (Fig. 3).

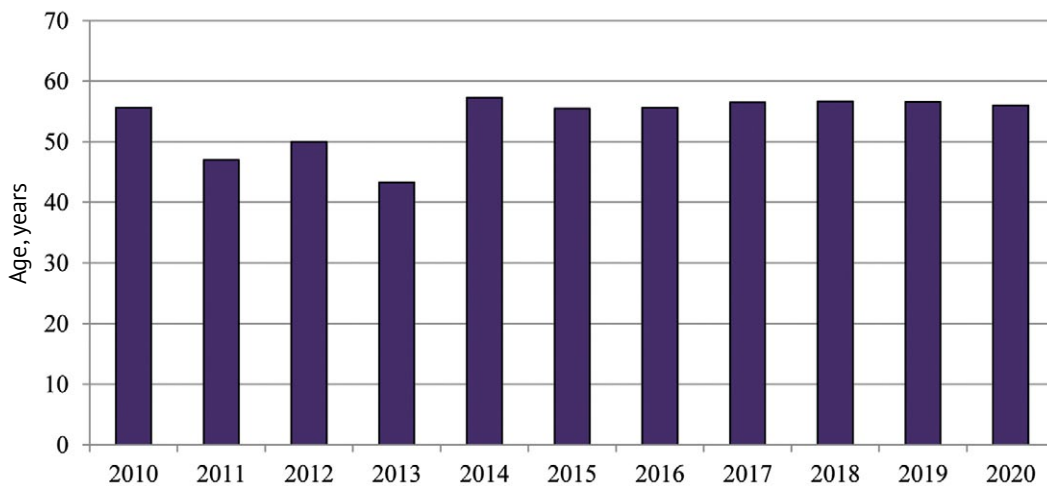


Fig. 2. Average age of patients with PJI of the hip, years

Table 1

Age structure of patients with hip PJI

Age, years	Abs. number	%
20–30	13	2.89
30–40	52	11.58
40–50	89	19.82
50–60	112	24.94
60–70	133	29.62
70–80	48	10.70
Over 80	2	0.44

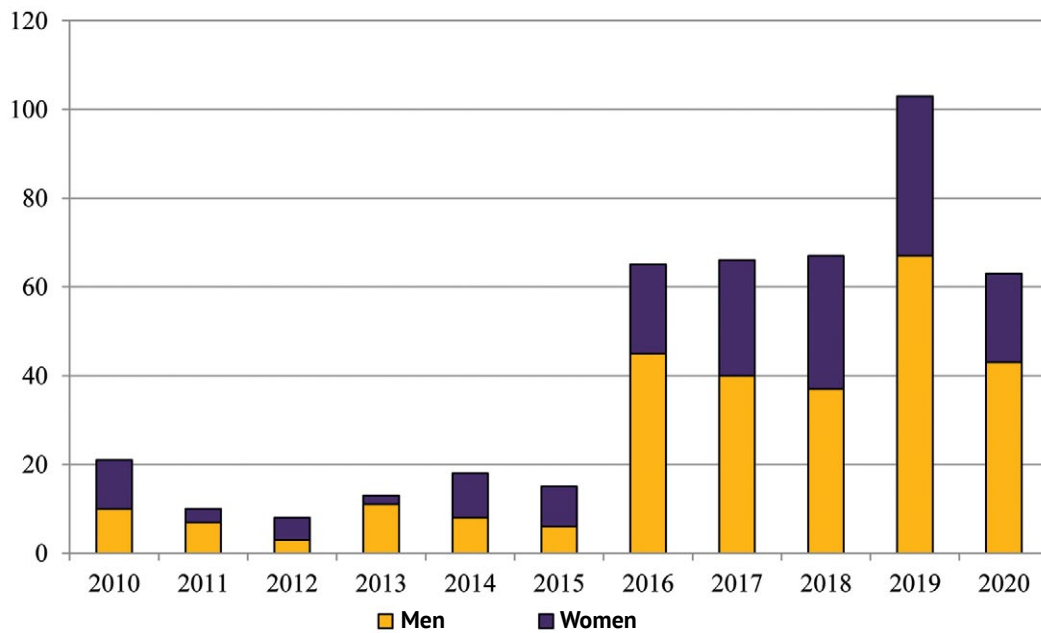


Fig. 3. Distribution of patients with PJI of the hip by gender

Structure of diagnoses that caused primary hip arthroplasty

Periprosthetic joint infection developed in patients both after primary hip arthroplasty – 45.6% (n = 205) and after revision arthroplasty – 54.4% (n = 244). Due to the absence of comprehensive discharge summaries with

anamnesis data and precise etiologic diagnosis in some patients, their distribution by etiologic diagnosis was difficult. However, based on available documents and thorough history taking, several groups of medical conditions that caused primary arthroplasty were identified (Fig. 4).

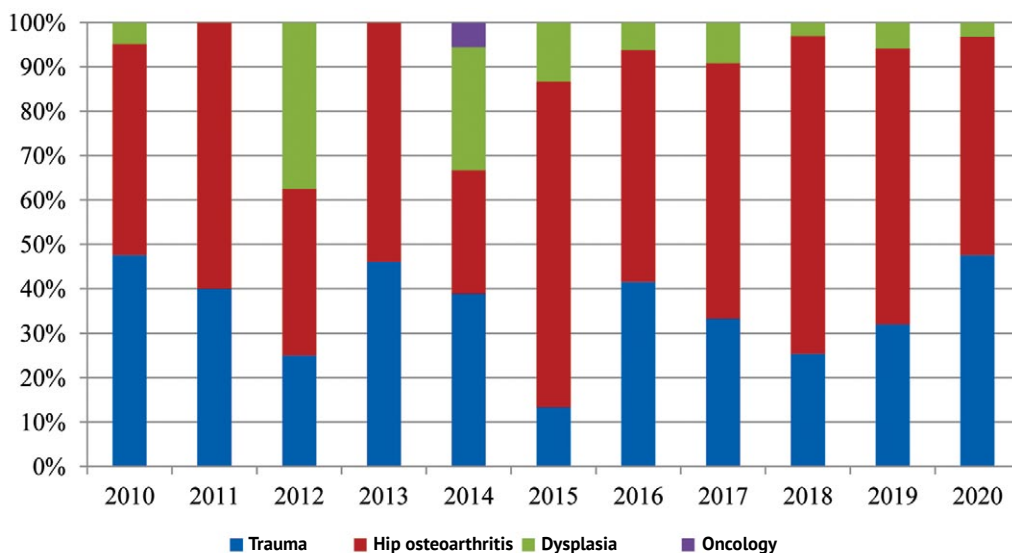


Fig. 4. Structure of patients by etiologic diagnosis at the time of primary arthroplasty

The predominant nosologic groups were hip osteoarthritis and trauma sequelae. There were isolated cases of PJI after implantation of oncologic prostheses; however, in our opinion, this is due to the fact that most of such patients are treated in hospitals where the implant has been placed.

Types of component fixation

The main types of component fixation in patients admitted to the clinic with PJI were cementless, hybrid, and cemented. Cementless acetabular components were represented by press-fit cups, augments, antiprotrusion rings, and double mobility cups. Cement fixation acetabular components included standard polyethylene cups as well as cemented double mobility components (Fig. 5).

Components of hybrid fixation were represented by combinations of cement stems and cementless cups, reverse-hybrid implants - cementless stems and cemented cups.

The influence of the type of prosthesis fixation on the risk of infection is usually evaluated after primary arthroplasty surgeries. The results of studies are contradictory.

Based on the data of Nordic Arthroplasty Register Association, cementless type of fixation and age over 75 years may increase the risk of PJI, but the impact is statistically insignificant [7]. According to the meta-analyses, the risk of PJI in the first 6 months was higher in patients with cementless implants, but in the long term the probability of inflammation increased in patients with cement fixation [8, 9]. This is probably related to a reduced amount of antibiotics being released from the cement over time.

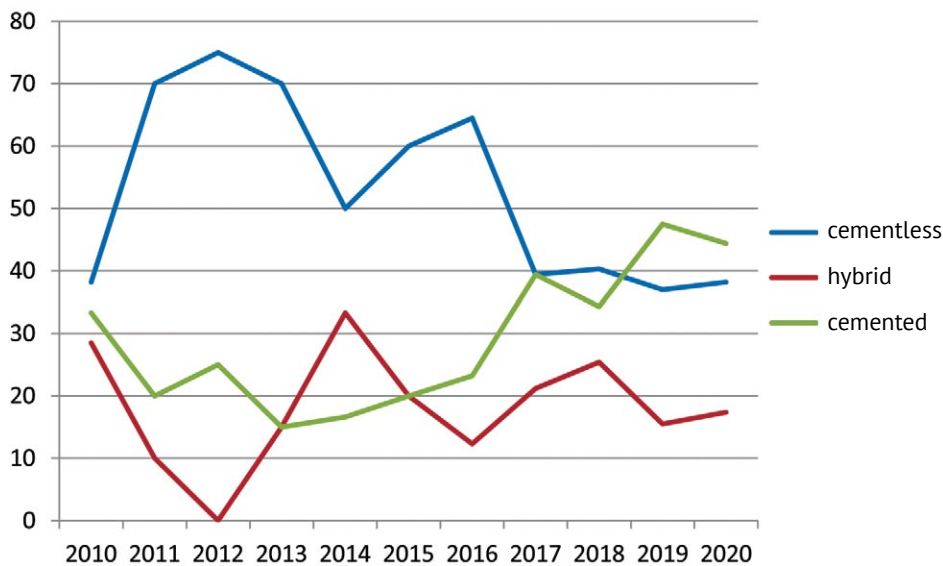


Fig. 5. Dynamics of implant distribution by fixation type at the admission of patients with PJI to the clinic

Classification of periprosthetic joint infection and *status localis*

To divide the infection into acute (less than 3 weeks of manifestation) and chronic (more than 3 weeks of manifestation), we used the W. Zimmerli classification (2014) with modifications of C. Li et al [10]. In 90.6% of cases the infection was classified as chronic, and only 9.6% of patients had an acute form of the infectious process. Figure 6 demonstrates a consistently small share

of patients with acute PJI, which did not exceed 5-10% in the last five years. The majority of patients (76.9%) had a fistula communicating with the joint cavity at the time of admission to the clinic, 13.3% of patients had no skin defects, a sutured wound was observed in 6.9% of patients. However, the most unfavorable variant was the presence of an open wound, which was encountered in 2.9% of cases (Fig. 7).

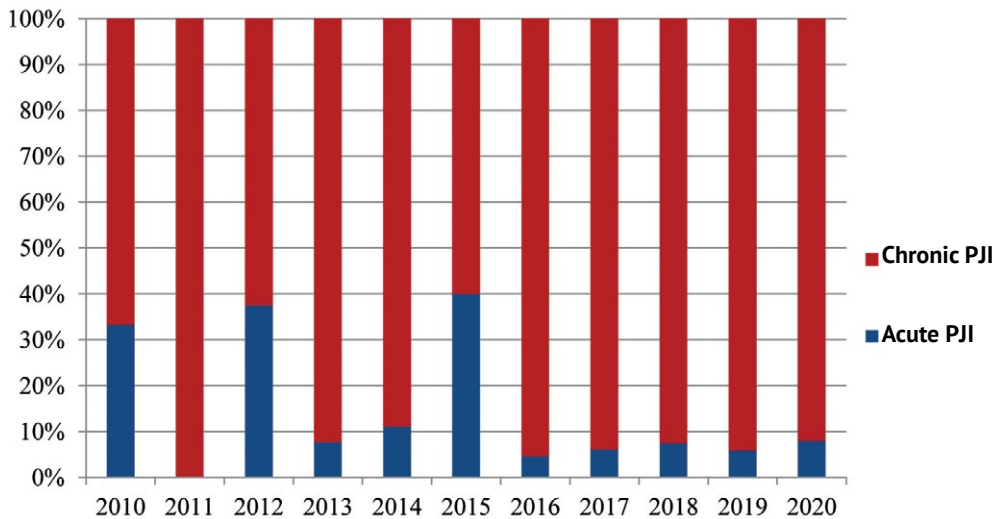


Fig. 6. Distribution of patients by the type of infection according to the W. Zimmerli classification with modifications of C. Li et al. [10]

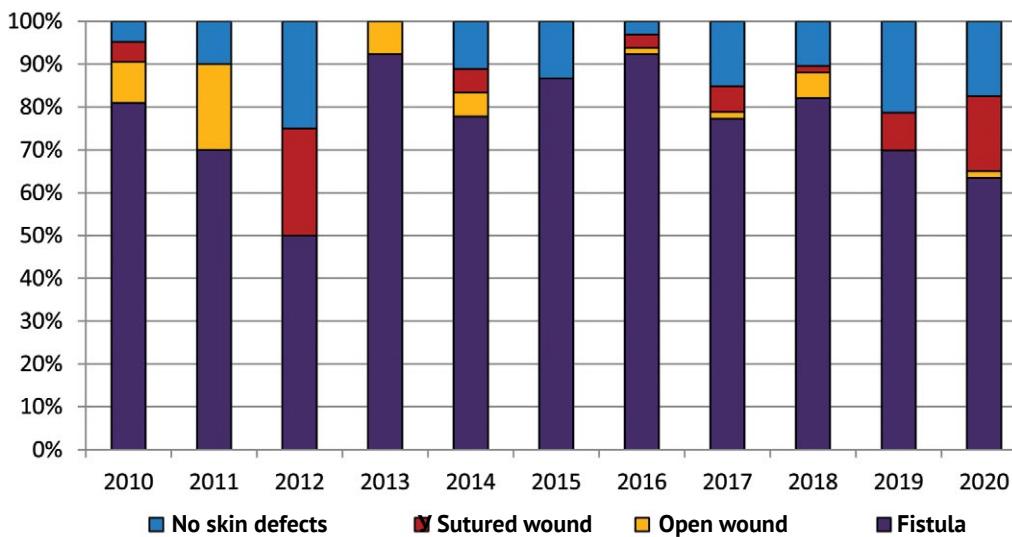


Fig. 7. Structure of patients by *status localis* at the admission to the clinic to perform the first (debridement) stage of surgery

Our data differ significantly from the Australian registry, where only 21% of patients had a fistula or duration of symptoms of more than 30 days, 24% had symptoms for less than 30 days, and the overall share of patients without a fistula was 65% [11]. These differences are probably associated with the long waiting time for a revision arthroplasty quota and the complex routing of patients with PJI.

Concomitant diseases

The mean BMI was 28.5±1.5 (Me – 28; 95% CI: 25.5-31.4). The share of obese patients (BMI>30) was 26.5% (n = 119) and increased from 2016 to 2020 (Fig. 8).

According to multivariate analyses of New Zealand and Swedish registry data, patients with

a BMI greater than 35 have a threefold greater risk of developing PJI after primary arthroplasty than patients with a BMI less than 35 [4, 12]. Obesity is not just an individual risk factor, but also has an indirect effect on such parameters as surgical complexity, blood loss, wound healing, and antibiotic penetration into tissues [4].

Diabetes mellitus is often associated with overweight, and these two factors combined affect the risk of infection. Based on the analysis of local registry data (7181 arthroplasty operations), the authors from Finland concluded that diabetes, regardless of obesity, more than doubles the risk of PJI [13]. In our study, diabetes mellitus was diagnosed in 75 (16.7%) patients, 36 patients (8%) had a combination of diabetes mellitus and obesity.

Viral hepatitis B and C or their combination were diagnosed in 19.3% (n = 87) of patients. Eight (1.78%) patients had HIV, and 6 of them (1.3%) had co-infection: viral hepatitis and HIV.

According to the data of multivariate analysis of 500,000 hip arthroplasties performed by

S.B. Sequeira et al., preoperative iron deficiency anemia increases the risk of early infection by 1.15 times [14]. The majority of patients (61%, n = 275) had anemia at the time of admission to our clinic. Over the last 7 years, there has been a significant increase in the number of patients with anemia (Fig. 9).

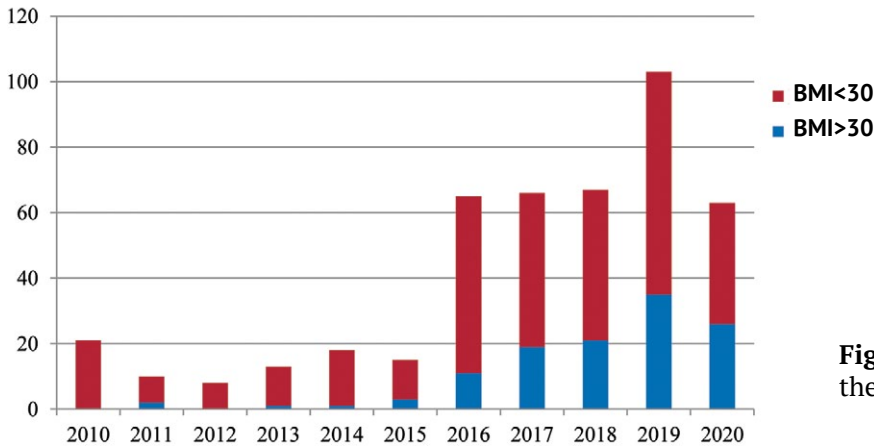


Fig. 8. Structure of patients with PJI of the hip depending on BMI

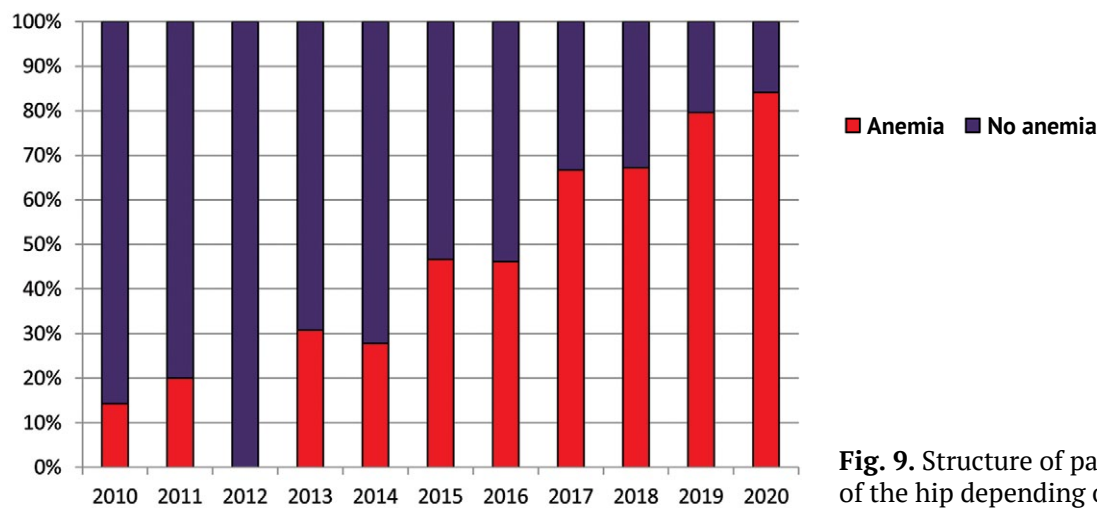


Fig. 9. Structure of patients with PJI of the hip depending on anemia

Characteristics of surgeries performed at the first stage of treatment

Removal of the infected implant with spacer implantation as the first stage of two-stage treatment was the most common operation, performed in 81.06% of cases (364 out of 449). One-stage revision arthroplasty was carried out much less frequently, in 6.23% of cases (28 out of 449). Implant retaining debridement and subsequent antibiotic therapy was performed in 6.46% of cases (29 of 449). Resection arthroplasty at the first stage was performed in 6.23% of cases (28 of 449).

The mean surgery duration when performing the first (debridement) stage was 181.6±60 minutes (Me – 170; 95% CI: 175.9-187.3), with a minimum time of 30 minutes and a maximum of 375 minutes.

From 2011 to 2014, the duration of surgery was more than 200 minutes, but a trend towards a decrease was clearly seen, and since 2016, the rate has been consistently below the 200 minutes level (Fig. 10). This can be explained by a combination of improvement of surgical technique, experience gained by surgeons, implementation of a unified

treatment algorithm according to ICM of 2013 [15], larger variety of surgical instruments and implant range.

There is also a decrease in the average intraoperative blood loss during the first stage of surgical intervention. The blood loss averaged 739 ± 321 ml (Me – 700 ml; 95% CI: 709.9-765.6),

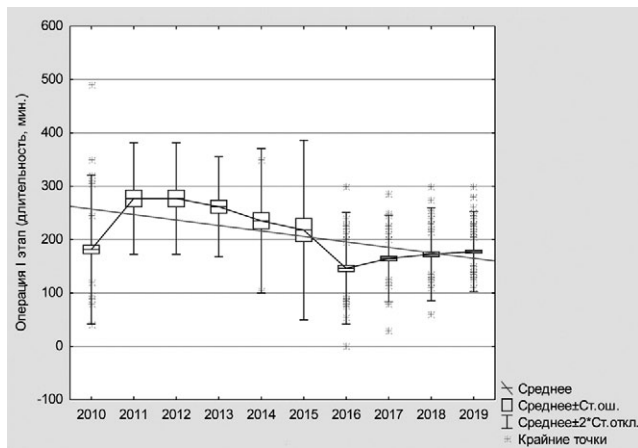


Fig. 10. Box-and-whisker plot of the surgery duration at the first stage of surgical treatment, minutes

with a minimum blood loss of 50 ml and a maximum blood loss of 2000 ml (Fig. 11).

At the time of the first stage of treatment, the acetabular and femoral bone defects were evaluated using radiologic methods and intraoperative data according to the classification of W. Paprosky [16]. Type 2 defects prevailed (Fig. 12).

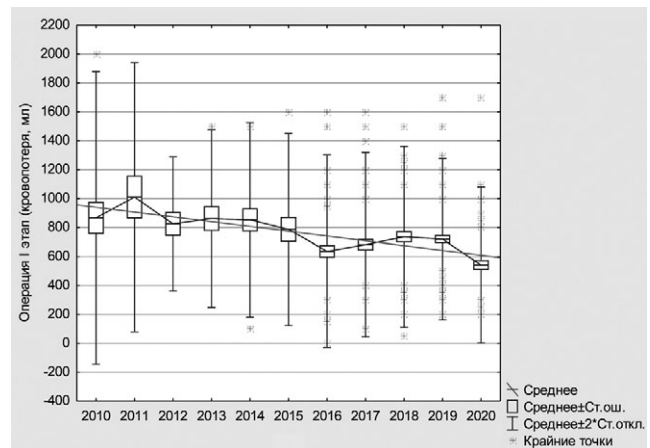


Fig. 11. Box-and-whisker plot of the blood loss at the first stage of surgical treatment, ml

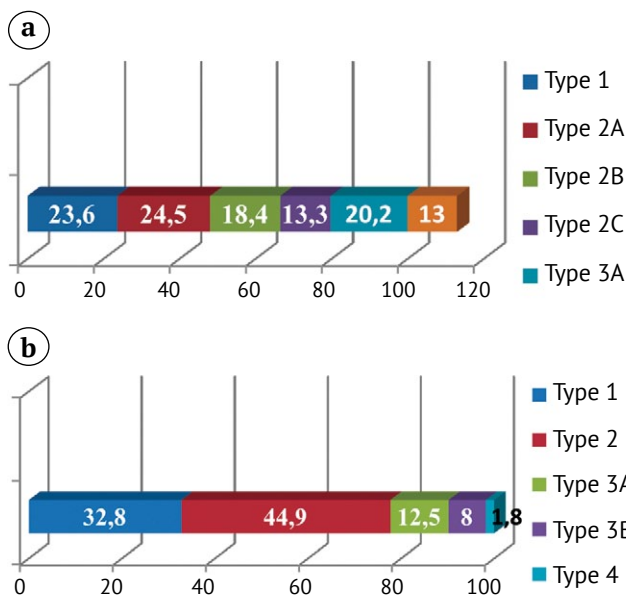


Fig. 12. Structure of patients with PJI of the hip, %: a – with acetabular defects (according to W. Paprosky); b – with femoral bone defects (according to W. Paprosky)

Etiology of the infectious process in patients with periprosthetic joint infection

During the first stage of treatment, the objects of microbiologic tests were aspirated synovial fluid, samples of excised soft and bone tissues, and

removed prosthetic components. The presence of the infectious agent was microbiologically confirmed in 91.8% (n = 412) of cases. Gram-positive microorganisms predominated among the pathogens – 55.7% (n = 250), Gram-negative microflora in monoculture was identified in 7.8% (n = 35) of cases, polymicrobial infection was found in 27.6% (n = 124) of patients, and fungal infection in 0.7% (n = 3). In 8.2% (n = 37) of patients, the causative agents could not be identified.

Annual reports from various registries do not include specific information on the number of surgeries for the PJI and on microbiologic tests. However, the following data have been reported

in some papers. P.H. Gundtoft, having analyzed 271 revisions for PJI performed in Denmark, showed that in 36% of cases the causative agent was *Staphylococcus aureus*, in 33% – coagulase-negative staphylococci. Pathogens of the *Enterobacteriaceae* family, *Enterococcus* spp. and *Streptococcus* spp. were also frequently encountered. [17]. Data from the Australian national registry for 2014-2017 also show the predominance of *S. aureus* (40%) and a large share of β -hemolytic streptococci (10.2%), while coagulase-negative staphylococci were found in only 5.6% of cases [11].

Characteristics of surgeries performed at the second stage of treatment

During the second stage of treatment, the mean surgery duration was 156.1±50.0 minutes (Me – 170; 95% CI: 150.8-161.5), with a minimum time of 55 minutes and a maximum of 490 minutes. The duration of the second stage remained stable being about 160 minutes over the past 5 years (Fig. 13).

In contrast to the average duration of surgery, the average intraoperative blood loss tended to decrease (Fig. 14). The mean blood loss was 614.5±316.0 ml (Me – 500; 95% CI: 578.2-650.7), with a minimum blood loss of 50 ml and a maximum blood loss of 2000 ml.

Results of periprosthetic joint infection treatment

Data were collected by examining patients in the outpatient clinic, interviewing them using mobile phones and e-mail. We analyzed short-term (within a year after the last revision) and long-term (a year or more after discharge from the hospital) treatment results.

According to the materials of the first consensus conference on PJI (2013) [15], to objectively control the inflammatory process after treatment, it is necessary to exclude recurrence of infection (presence of wounds and/or fistulas, drainage systems in the joint, persistent pain syndrome); repeated revisions for infection; and death due to sepsis.

Short-term results (within one year of the last revision). As a result of treatment, resolution of infection was achieved in 61.3% (n = 275) of cases, recurrence of infection after the first or the second stage was observed in 38.7% (n = 174) of patients (Fig. 15). Analyzing the data from 2010 to 2015, it can be noted that the recurrence rate varied from 30 to 40%. From 2016 to 2020, it decreased significantly, ranging from 10 to 20%.

Long-term results (mean follow-up 5.92±2.55 years; Me – 6; 95% CI: 2.39-2.73). We were able to evaluate the results of treatment in 84% (n = 377) of patients; in 16% (n = 72) of cases we were unable to contact the patient (Fig. 15).

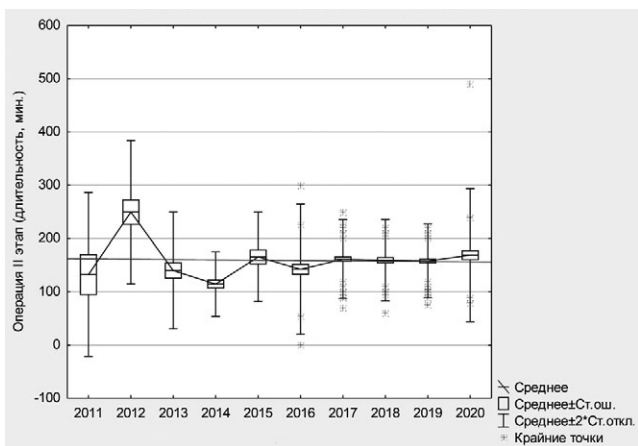


Fig. 13. Box-and-whisker plot of the surgery duration at the second stage of surgical treatment, minutes

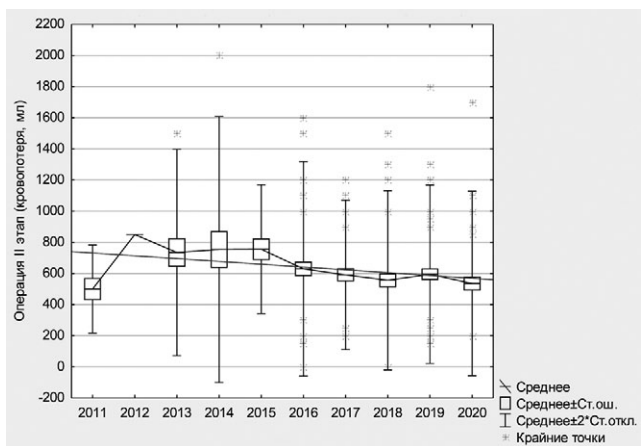


Fig. 14. Box-and-whisker plot of the blood loss at the second stage of surgical treatment, ml

It follows from the data of the diagram that lethal outcome on the background of septic state was identified in 1.7% (8 out of 449) of cases, recurrence of PJI was found in 6.2% (28 out of 449), death on the background of other diseases without signs of progression of the infectious process after revision interventions in our clinic

amounted to 9.1% (41 out of 449), resolution of infection was noted in 67% (300 out of 449). According to the ICM criteria (2013) [15], the cumulative success rate of PJI resolution was 76%, the overall lethality was 10.8%, with a mean follow-up period of 5 years.

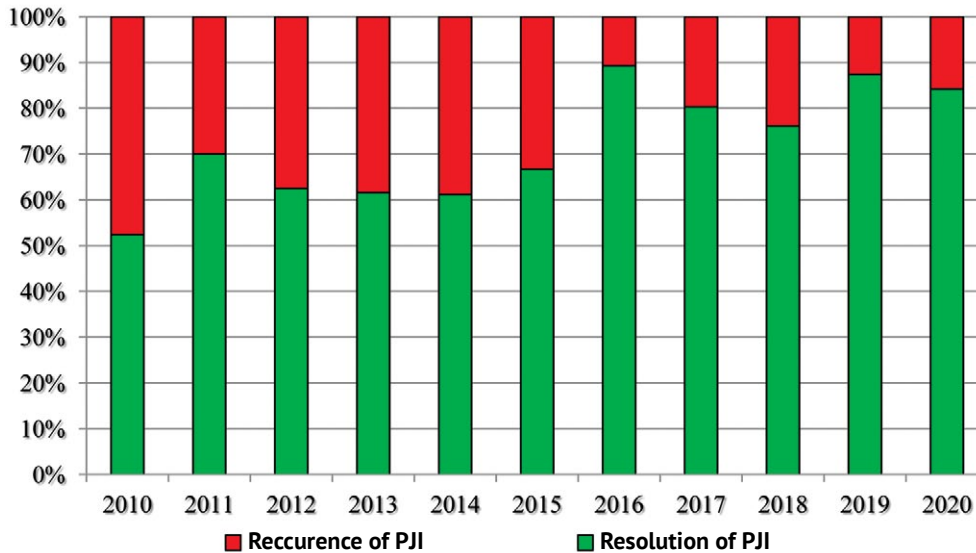


Fig. 15. Frequency of early recurrence of PJI

DISCUSSION

Different types of arthroplasty registries, including local and national ones, play an important role in the organization of treatment of patients with joint pathologies. Ineffective treatment, high rate of complications and consequently rising costs are the main problems faced by the health service. In order to improve the quality of joint replacement, arthroplasty registries have been established, which collect a limited amount of information from a specific medical facility, geographical region or the whole country. Implant registries are compiled basing on complication and survival rates for specific endoprostheses.

The PJI registry organized at the National Ilizarov Medical Research Centre for Traumatology and Orthopaedics has certain differences. The main purpose of the registry is to collect institutional data to analyze and draw statistically significant conclusions regarding the patient, surgical technique and implant-related risk factors that lead to good or bad outcomes. Therefore, there is no record of manufacturer-specific implants that were removed or implanted during treatment.

It should be noted that among the national registry reports that we found in public access, there are no documents in which the treatment of PJI was distinguished in a separate section. Moreover, when analyzing revision surgeries, the main emphasis is placed on specific prosthetic components of different manufacturers, friction pairs, head dimensions, other technical characteristics, and the period of its removal after implantation.

Analysis of the age of patients showed that the results of our study are close to the data of the largest national registry, which is conducted at the Vreden National Medical Research Center of Traumatology and Orthopedics for 2007-2012 [18]. But in comparison with the data of foreign national registries, some figures are different. Thus, according to the Swedish registry, the average age of patients in revision hip replacement is 73.5 years [19], in the UK for two-stage revisions – 70 years [20], in Denmark and Australia – 69 years [17].

Patients with viral hepatitis B and C made up a significant part of the patients in our registry. There are publications in which hepatitis is considered as a separate risk factor. H. Bedair and

colleagues compare two groups of patients with chronic hepatitis C: one group received proper treatment for hepatitis before hip replacement in contrast to the other one. The incidence of infection in the untreated group of patients was 14%, while no such complications were found in patients receiving interferon [21]. B. Kidow et al. discovered that viral hepatitis C increases the risk of PJI development during one and a half years after surgery almost twofold [22].

Human immunodeficiency virus can be considered as an independent factor that increases the risk of inflammation [23]. Studies have shown that the combination of viral hepatitis (B, C) and HIV increases the incidence of infection after joint replacement [22, 24].

In our study, 29 (6.5%) of 449 patients with PJI of hip received hormonal treatment for systemic connective tissue diseases (rheumatoid arthritis, systemic lupus erythematosus, etc.). Analysis of data from the New Zealand national registry indicates that rheumatoid arthritis more than doubles the risk of revision for PJI in the first year after surgery [4]. Another study based on the data from the Nordic Arthroplasty Register Association showed that the risk of revision for infection is 1.3 times higher in such patients [25].

More than 90% of patients in our centre had chronic PJI, and three quarters of patients had a fistula, which is significantly higher than in the above-mentioned registries.

CONCLUSIONS

The primary analysis of the data from the local registry of hip periprosthetic infection of the Ilizarov Centre showed that the average age of patients in our country is significantly lower than in the known national registries. At the same time, the infectious agents were similar: Gram-positive microorganisms accounted for more than 55%. The registry data shows a significant decrease in the PJI recurrence rate over the last 5 years.

A more profound and detailed analysis of the performed surgeries and risk factors for recurrence of infection is planned in our future studies.

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