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The Impact of Extended Preoperative Examination on the Treatment Tactics Choice before the Second Stage of Revision Hip Arthroplasty

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Abstract

Background. Reinfection and recurrence of periprosthetic infection rates during the second stage of revision hip arthroplasty (RHA) remain quite high. Performing preoperative diagnostic aspiration in patients with the installed hip spacer is a controversial issue.

Aims of the study: 1) to compare the diagnostic accuracy, specificity and sensitivity of the used infection markers as a part of preoperative diagnostic protocols in order to exclude reinfection in patients with installed hip spacer before the second stage of RHA; 2) to analyze and compare the microbiological spectrum obtained at the stages of RHA.

Methods. Diagnostic accuracy parameters of the used infection markers were assessed in order to exclude reinfection/recurrence in 107 patients with installed hip spacer. All patients were divided into two groups. In Group 1 (prospective), blood tests as well as diagnostic aspiration of synovial fluid were performed within the extended diagnostic protocol. In Group 2 (retrospective), the examination was performed according to the screening preoperative diagnostic protocol including blood tests. The used reference range of inflammatory biomarkers was based on the "small criteria" of ICM 2018. According to the results of the intraoperative microbiological examination of peri-implant tissue samples at the first and second stages of RHA, the analysis of detected microflora was conducted in order to assess probable reinfection/recurrence.

Results. According to the results of the intraoperative microbiologic examination during the second stage of RHA, reinfection was detected in 40% of cases: in Group 1–9 cases, in Group 2–31 case. Synovial fluid was obtained from 85% of cases when preoperative diagnostic aspiration was performed. Synovial fluid could not be obtained in 15% cases (dry joint).

Conclusions. Performing preoperative diagnostic aspiration before the second stage of RHA in patients with the installed spacer allowed choosing correct treatment tactics in 9% of cases. The parameters of diagnostic accuracy accounted for 82.6%. In the structure of detected pathogens in case of recurrence and reinfection, the representatives of Gram-positive coagulase-negative flora were the most frequent.

Keywords: diagnostics of hip periprosthetic infection, reinfection, recurrence of infection, synovial fluid aspiration, hip spacer, revision hip arthroplasty.

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Влияние расширенного предоперационного обследования на выбор тактики лечения перед вторым этапом ревизионного эндопротезирования тазобедренного сустава

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Реферат

Актуальность. Показатели реинфекции или рецидива перипротезной инфекции при выполнении второго этапа ревизионного эндопротезирования тазобедренного сустава (РЭТС) остаются достаточно высокими. Выполнение предоперационной диагностической аспирации у пациентов с установленным спейсером тазобедренного сустава является дискутабельным вопросом.

Цели исследования: 1) сравнить диагностическую точность, специфичность и чувствительность используемых маркеров инфекции в рамках предоперационных диагностических протоколов для исключения реинфекции у пациентов с установленным спейсером тазобедренного сустава перед вторым этапом ревизионного эндопротезирования тазобедренного сустава; 2) проанализировать и сравнить микробиологический пейзаж, полученный на этапах ревизионного эндопротезирования тазобедренного сустава.

Материал и методы. Проведена оценка показателей диагностической точности используемых маркеров инфекции с целью исключения реинфекции/рецидива у 107 пациентов с установленным спейсером тазобедренного сустава. Пациенты были разделены на две группы: 1-я группа — проспективная, в которой использовался расширенный диагностический протокол с выполнением диагностической аспирации синовиальной жидкости и анализов крови; 2-я группа — ретроспективная, в которой использовался скрининговый диагностический протокол с выполнением анализов крови. Используемые референсные значения биомаркеров реинфекции основывались на «малых критериях» протокола ICM (2018). По результатам интраоперационного микробиологического исследования образцов периимплантных тканей на первом и втором этапах РЭТС был проведен анализ полученной микрофлоры с целью оценки вероятного рецидива/реинфицирования.

Результаты. Реинфекция в обеих группах по результатам интраоперационного микробиологического исследования при выполнении второго этапа РЭТС диагностирована в 40% случаев: в 1-й группе пациентов — 9 случаев, во 2-й группе — 31 случай. Синовиальная жидкость при выполнении предоперационной аспирации была получена в 85% случаев, «сухой сустав» — в 15%.

Заключение. Выполнение предоперационной диагностической аспирации перед вторым этапом РЭТС у пациентов с установленным спейсером позволило в 9% случаев выбрать правильную тактику лечения, продемонстрировав показатель диагностической точности в 82,6%. Преобладающая микрофлора в структуре реинфекции тазобедренного сустава при выполнении второго этапа РЭТС представлена грамположительными коагулазонегативными микроорганизмами.

Ключевые слова: диагностика периимплантной инфекции тазобедренного сустава, реинфекция, рецидив инфекции, аспирация синовиальной жидкости, лабораторная диагностика периимплантной инфекции тазобедренного сустава, спейсер тазобедренного сустава, ревизионное эндопротезирование тазобедренного сустава.

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BACKGROUND

According to the data of the national arthroplasty registries, the number of hip arthroplasties is steadily increasing, resulting in a growing number of complications. Periprosthetic joint infection (PJI) of the hip is the most common and destructive complication of hip arthroplasty [1, 2, 3].

Progressive bone tissue deficit, as well as the need for prolonged hospital stay and repeated surgical interventions increase the risk of fatal complications and reduce patients' quality of life, often leading to disability and death [4, 5, 6]. According to K.M. Natsuhara et al., the mortality rate after two-stage revision intervention for PJI within a year is 4.22%, and within 5 years – more than 21% [7]. Moreover, there is a possibility of reinfection and recurrence of infectious process in the area of the operated hip. There are data on the incidence of recurrence of infection after revision surgeries, which is 10% one year after the intervention, 14% after 5 years and 15% after 15 years from the surgery [8]. There are several ways of treating PJI of the hip. To determine further treatment tactics, it is necessary to make a correct diagnosis.

C. Li et al. developed a classification of PJI based on the maturity of microbial biofilm on the surface of prosthetic components, dividing PJI into acute and chronic [9]. In their earlier work D.T. Tsukayama et al. proposed a classification of PJI based on the time of manifestation of clinical signs and the entry sites of infection [10].

It is not difficult to make a diagnosis if the local signs of inflammation, as well as the presence of a fistula with abundant discharge in the area of the hip clearly indicate PJI. It is much more challenging to distinguish between chronic PJI caused by low-virulent strains of microorganisms and aseptic loosening of prosthetic components. For this purpose, specialists all over the world use various protocols for PJI diagnostics, among them the most popular are EBJIS [11], ICM [12], WAIOT [13]. One way or another, the routine microbiological examination of synovial fluid and periprosthetic tissue samples remains the gold standard for PJI diagnostics [14].

In cases of PJI detection, specialists use such surgical treatment options as one- and two-stage revision hip arthroplasty (RHA) [15]. In one-stage RHA, all prosthetic components are removed, debridement of the joint is performed, and revision components are implanted, followed by prolonged antibiotic therapy [16].

When treating late deep hip PJI, a two-stage RHA is preferred [17, 18]. The advantage of this method is the local impact of antibacterial drugs directly in the focus of infection [19]. The first stage includes removal of prosthetic components, debridement, and installation of various types of antibiotic-impregnated spacers. At the second stage, when reinfection is excluded, spacer removal, debridement, and installation of revision prosthetic components are performed [16, 20].

The so-called desperate operation for chronic PJI is Girdlestone arthroplasty or limb amputation [21].

Nowadays, the problem of the necessity to perform diagnostic aspiration of synovial fluid of the hip before the second stage of revision arthroplasty is acute. Due to the peculiarities associated with the installed spacer, some specialists suggest proceeding to the second stage of RHA, bypassing diagnostic procedures and, moreover, aspiration of synovial fluid. In this case, the reinfection rate, according to different data, ranges from 8.4% to 33% [22, 23]. Q. Wang et al. in their study provide data on the reinfection rate of 22.5% already after the first stage of RHA [24].

Aims of the study: 1) to compare the diagnostic accuracy, specificity and sensitivity of the used infection markers as a part of preoperative diagnostic protocols in order to exclude reinfection in patients with installed hip spacer before the second stage of RHA; 2) to analyze and compare the microbiological spectrum obtained at the stages of RHA.

METHODS

Study design

Type of the study — prospective single-center with retrospective analysis.

The study was performed in 2018-2023 on the basis of the orthopedic department of Botkin City Clinical Hospital. It enrolled 107 patients.

Inclusion criteria:

- presence of a hip spacer inserted for the first time for PJI;

- absence of clinical signs of infectious process in the area of the planned operation (fistula, local hyperemia, hyperthermia);

- consent to perform the second stage of revision arthroplasty;
- written informed consent of the patient to participate in the study.

Non-inclusion criteria:
- active infectious process with a fistula in the hip joint area, local hyperemia, hyperthermia;
- previous Girdlestone surgery for PJI;
- objective contraindications to revision surgery due to somatic or mental status;
- HIV infection;
- repeated spacer implantation.

Exclusion criteria:
- appearance of a fistula in the area of the studied hip joint;
- patient's refusal of surgical intervention and further unwillingness to participate in the study;
- detection of reinfection during preoperative diagnostics;
- death of the patient before the second stage of RHA.

The scheme of patient enrollment is presented in Figure 1.

All patients were divided into two groups according to the retrospective or prospective nature of the data obtained and the scope of diagnostic measures performed.

Characteristics of the patients included in the study are presented in Table 1.

In Group 1 (prospective), blood tests for ESR, CRP, as well as diagnostic aspiration of synovial fluid of the hip with subsequent microbiological examination and determination of sensitivity to antibacterial drugs were performed within the extended diagnostic protocol at the preoperative stage. The obtained biomaterial was delivered to laboratory for microbiological analysis within 30 minutes. The obligatory condition was the refusal of local anesthesia, as well as the strict adherence to "antibacterial vacations" by patients at least 14 days before the planned aspiration. When the material was obtained, it was cultured on culture media (BD BACTEC Peds Plus, Becton Dickinson, USA) for up to 14 days, and the sensitivity to antibiotics was determined.

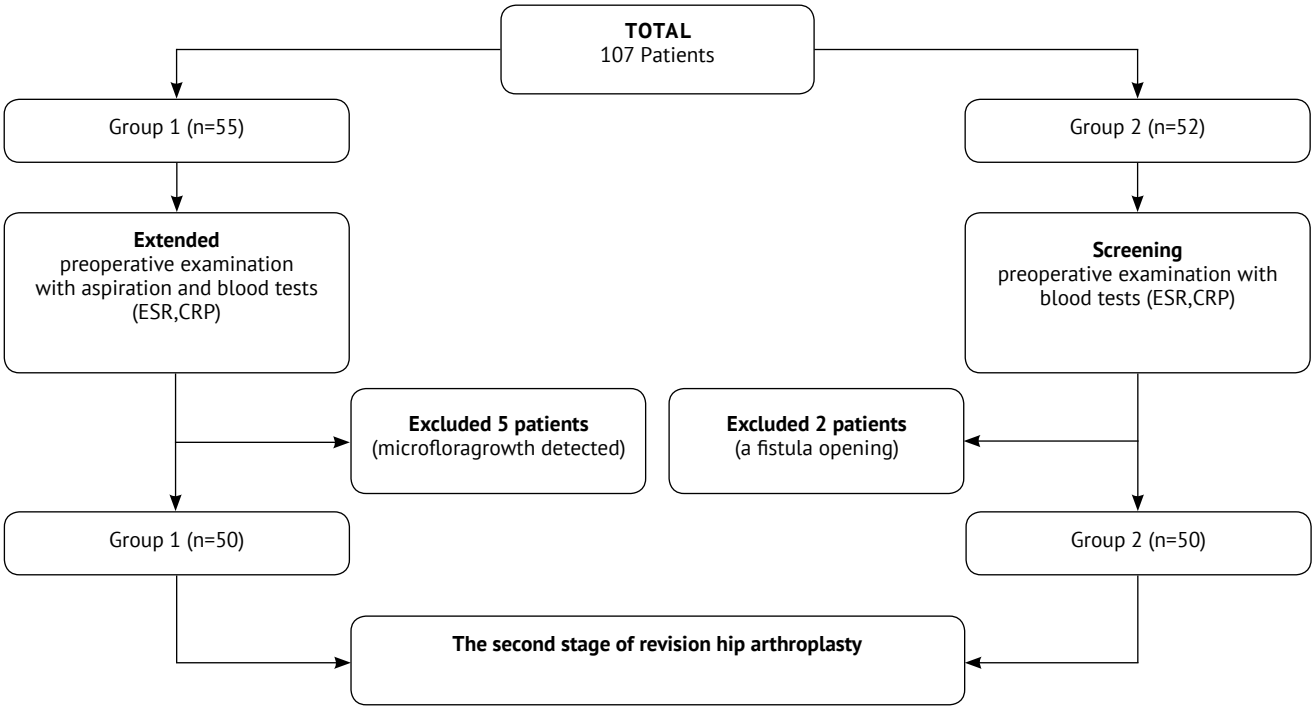

Fig.1. Flowchart of the study

Table 1

Charasteristics of patients in the study groups

Parameter	Group 1	Group 2
The number of patients	55	52
BMI	33.6 (29.2-36.4)	32.1 (28.2-34.3)
Age, years old	68 (49-85)	66 (42-77)
Gender:		
male	29	22
female	26	30
Time before performing the second stage, weeks	43 (16-147)	35 (8-152)

p>0,05

In case of aspirate absence (dry joint), the decision on further treatment tactics was made basing on the results of ESR and CRP serum biomarkers. If the values were within the reference range, according to the "small criteria" of the Second International Consensus Meeting on Musculoskeletal Infection (ICM 2018) [25], the situation was considered as the resolution of infection, and the patient was referred to the second stage.

In Group 2 (retrospective), the examination was performed according to the screening preoperative diagnostic protocol aiming to exclude reinfection. This protocol included retrospective analysis of the results of serum parameters of ESR and CRP inflammatory biomarkers. According to medical records, these patients had no signs of inflammation at the surgery site: local hyperemia, hyperthermia, fistula in the area of the studied hip joint. The threshold values of ESR and CRP serum parameters in patients of both groups corresponded to the threshold values of the "small criteria" of ICM 2018 [25].

Performing the second stage of RHA was recommended for patients in whom hip reinfection was excluded according to the results of the used preoperative diagnostic protocols. The second stage included spacer removal, debridement, and placement of revision prosthetic components.

Tissue sampling from the removed spacer components (from 3 to 6 samples) was performed in all patients at the stage of incision with subsequent microbiologic examination and determination of sensitivity to antibiotics. The result of the intraoperative microbiological examination of peri-implant tissue samples during the second stage of RHA was a reference one, on the basis of which the results of the preoperative diagnostics in patients of groups 1 and 2 were evaluated and analyzed.

Statistical analysis

Information was collected, processed, and systematized using Microsoft Office Excel 2016 spreadsheets. Comparative analysis of frequencies in groups 1 and 2 was performed using Fisher's angular transformation (test) and Student's t-test. Differences were considered statistically significant at the level of $p<0.05$.

Statistical data were analyzed using MedCalc 13.2.2 (MedCalc Software, Belgium) software. ROC-analysis was performed for all investigated biomarkers to determine the sensitivity, AUC and specificity of the used reinfection markers (Youden's index was used).

RESULTS

Synovial fluid was obtained from 47 (85%) of 55 patients in Group 1 when preoperative diagnostic aspiration was performed. Synovial fluid could not be obtained in 8 (15%) cases (dry joint). Serum markers (ESR, CRP) in all patients of Group 1 with dry joint did not exceed the threshold values specified in the ICM 2018 recommendations [25]. Therefore, they were recommended to perform the second stage of RHA.

In 5 (9%) patients of Group 1, according to the results of the preoperative microbiologic examination of synovial fluid, microflora growth was detected. These patients were excluded from the study and referred for revision arthroplasty, which included spacer removal, debridement, and reinsertion of the spacer.

During preoperative diagnostics, two (4%) patients of Group 2 were excluded from the study, as they were found to have fistula with serous

hemorrhagic discharge in the joint area. These patients were referred for further treatment (debridement, reinsertion of the spacer) to a septic surgery department.

According to the results of the intraoperative microbiologic examination during the second stage of RHA, reinfection was detected in 40 (40%) out of 100 patients in both groups. In Group 1, the number of patients with diagnosed infection according to the results of the intraoperative microbiologic examination when performing the second stage of RHA was lower: 9 (18%) *vs* 31 (62%) in the group of patients who had not undergone diagnostic aspiration ($p<0.05$). Microbial associations were detected in 4 (45%) patients of Group 1 according to the results of the intraoperative microbiologic examination when performing the second stage of RHA. Four (45%) representatives of Gram-positive microorganisms (*S. haemoliticus*, MRSE, MSSE) and 1 (10%) representative of Gram-negative microflora (*E. coli*) were also detected.

According to the results of the intraoperative microbiologic examination during the second stage of RHA in 19 (62%) patients of Group 2, the detected microflora was represented by various Gram-positive microorganisms: MRSE – 7 (36%), *E. faecalis* – 3 (16%), MSSE – 2 (10%), *C. acnes* – 2 (10%), other species – 5 (28%), as well as microbial associations – 10 (32%). The spectrum of detected microorganisms also included representatives of Gram-negative flora: *K. pneumoniae* — 1 (3%), as well as growth of yeast-like fungi (*C. auris* — 1 (3%).

According to the results of ROC-analysis we determined the parameters of diagnostic accuracy, sensitivity, AUC and specificity of the used diagnostic methods in patients of both groups (Tables 2, 3).

Detection of microflora growth based on the results of the preoperative aspiration in 5 patients of Group 1 allowed to diagnose the infection in time and to change the tactics of further treatment by referring the patients for repeated spacer implantation.

Despite the low sensitivity indices of ESR, CRP and aspiration, the specificity indices showed high values for CRP and aspiration. Differences between the results of diagnostic parameters of ESR and CRP biomarkers in both groups were not statistically significant ($p>0.05$).

We also analyzed and compared the results of the microbiological examination in patients with diagnosed infection after the first and the second stages of RHA to assess probable recurrence/reinfection. The following results were obtained:

Table 2

Diagnostic parameteres of the markers used in Group 1

A marker	Threshold value	Sensitivity, % (95% CI)	Specificity, % (95% CI)	AUC	Accuracy, %
ESR, mm/h	30	44.44 (29.6–60.0)	66.67 (51.0-80.0)	0.561	55.5
CRP, mg/l	10	37.78 (23.8-53.5)	95.35 (84.2-99.4)	0.625	65.5
Aspiration	Abscence of microflora growth	35.71 (12.8-64.9)*	100 (91.4-100.0)*	0.679*	82.6*

* including cases of microflora detection in the preoperative period.

Table 3

Diagnostic parameteres of the markers used in Group 2

A marker	Threshold value	Sensitivity, % (95% CI)	Specificity, % (95% CI)	AUC	Accuracy, %
ESR, mm/h	30	42.15 (24.6–59.1)	62.23 (48.1–78.2)	0.542	53.2
CRP, mg/l	10	38.88 (24.7–55.9)	93.22 (81.6–98.5)	0.611	64.7

out of 40 patients with detected infection (in both groups) according to the results of the intraoperative microbiological examination of peri-implant tissue samples at the second stage of RHA, recurrence of infection (at least one microorganism obtained at the first stage was verified) was diagnosed in 10 (10%) cases, reinfection (microorganism detected at the second stage of RHA was different from the one obtained at the first stage) was diagnosed in 30 (30%) cases. No microflora growth (the situation is interpreted as an infection resolution) according to the results of the microbiological examination of peri-implant tissues samples at the second stage was observed in 60 (60%) cases.

One (2%) case of recurrence (methicillin-sensitive *Staphylococcus epidermidis*) in the microbial association was detected in Group 1. In Group 2, 9 (18%) cases of recurrent infection were detected. The predominant flora was represented by methicillin-resistant Gram-positive coagulase-negative staphylococci (MRSE – 25%), other representatives of Gram-positive microflora (20%), and microbial associations (55%).

Microflora analysis in patients with recurrent infection revealed that the most frequent pathogens were MRSE (40%) and other various Gram-positive microorganisms: *S. warneri* (10%), *S. capitis* (20%), MSSE (10%), *E. faecalis* (10%), MRSA (10%), including in microbial associations. It is worth noting that in 4 out of 10 patients (40%) with recurrent infection, growth of at least one of several pathogens obtained during the first stage of RHA was found. Two patients out of 10 (20%) showed complete recurrence of the microorganism/s, as in the first stage of RHA (at spacer placement stage).

It is important to mention that the majority of cases (9 out of 10) of PJI recurrence was observed in patients of Group 2. The number of patients with diagnosed recurrence of infection in Group 1 was statistically significantly lower than in Group 2: one case *vs* 9 cases, respectively ($p<0.05$).

Reinfection with the newly diagnosed microorganism according to the results of the intraoperative microbiological examination of peri-implant tissue samples during the second stage of RHA among patients of both groups was detected in 30 cases (30%). In Group 1, 8 (16%) cases of reinfection were detected. Gram-positive coagulase-negative staphylococcus (MSSE – 2 (25%), *S. haemoliticus* – 2 (25%) and microbial associations – 3 (38%) prevailed in the structure of the detected microflora. In Group 2, 22 (44%) cases of microflora growth were detected according to the results of the intraoperative microbiologic examination when performing the second stage of RHA. The predominant flora were: Gram-positive coagulase-negative staphylococcus – 15 (65%) (*S. epidermidis* (20%) and other representatives of Gram-positive flora – 45%), Gram-negative flora (*K. pneumoniae* (5%), various microbial associations (25%), and also growth of yeast-like fungi was detected (5%). Cases of detected reinfection in Group 1 were statistically significantly less frequent than in Group 2: 8 cases *vs* 22 cases, respectively ($p<0.05$).

Among 40 patients of both groups with detected infection according to the results of the intraoperative microbiological examination of peri-implant tissue samples during the second stage of RHA, 13 (32.5%) different microbial associations were obtained. Gram-positive staphylococcus prevailed in the microbial associations – 23 (82%): mainly MRSE (21%), *S. capitis* (17%) and other species (62%). There were also representatives of Gram-negative flora – 4 (14%), yeast-like fungi – 1 (2%).

DISCUSSION

Preoperative ruling out of reinfection is a rather controversial issue despite its high rates in patients with implanted hip spacer.

M. Sukeik et al. decided to perform the second stage of RHA basing on the results of the microbiological examination of synovial fluid obtained during preoperative aspiration of the hip joint. The authors also relied on the results of the serum values of ESR (less than 30 mm/hour) and CRP (less than 10 mg/l). Preoperative aspiration was performed at least 4 weeks after the end of the antibiotic therapy [26].

Timely and accurate diagnostics of PJI is extremely important and allows early verification of the causative agent and selection of the best treatment tactics. Various algorithms have been developed for these purposes. However, is it acceptable to use the same algorithms in patients with a hip spacer before the second stage of RHA?

Reinfection diagnostics in patients with hip spacer is extremely challenging. Even protocols for the diagnostics and treatment of PJI, such as MSIS [27] and ICM [25], lack recommendations

for diagnostic aspiration after the first stage of RHA.

In a study on the specific effects of articulating spacers on periprosthetic tissues, it was found that the spacers made of polymethylmethacrylate (PMMA) promote immunomodulatory effects on the synovial membrane and peri-implant tissues. The membrane formed at the spacer-bone interface is induced by various immune cells through abrasion of the cement, formation of cement debris, and migration of cellular immunity components [28]. Also, when performing diagnostic aspiration of the synovial fluid of the hip joint, it is important to realize that the antibiotics included in the spacer, being released into the synovial fluid, contribute to false-negative microbiologic results [29]. The issue of the duration of antibiotics release from the spacer is quite controversial, and in this regard, the accuracy of synovial biomarkers in case of synovial fluid aspiration in patients with a spacer in different time periods may differ. S.P. Boelch et al. presented data according to which the local concentration of antibiotics can remain elevated for more than 6 weeks after surgery. The authors note that the said data were obtained *in vitro*, while the duration of antibiotic release may differ *in vivo* [30]. Thus, the presence of increased concentration of immune cells and antibacterial agents in the joint cavity may contribute to false results of reinfection diagnostics when performing synovial fluid studies.

There are not so many available publications in which the authors show the results of the analysis of the diagnostic accuracy of different infection markers in order to exclude reinfection in patients before the second stage of RHA. Some specialists, such as S. Hoell et al. do not recommend performing aspiration before revision arthroplasty and suggest searching for new biomarkers to diagnose reinfection in patients with a hip spacer [31].

H.M.L. Mühlhofer et al. in their study evaluated the diagnostic parameters of serum (ESR, CRP) and synovial (polymorphonuclear neutrophil count) markers of infection in patients after the first stage of RHA. Based on the data obtained by the authors, none of the biomarkers used allows verification of long-term persistent infection. On the other hand, the authors also note that performing a microbiologic examination of synovial fluid as a part of the preoperative diagnostics of PJI often shows false-positive results (contamination), which leads to an inappropriate choice of treatment tactics. H.M.L. Mühlhofer et al. recommend using a multidisciplinary approach to the treatment of PJI and suggest proceeding to the second stage of RHA without interrupting the course of antibacterial therapy between stages [32].

S.P. Boelch et al. also believe that performing diagnostic hip joint aspiration with microbiological examination of synovial fluid and synovial fluid leukocyte count in patients with a spacer is not a reliable diagnostic standard to verify persistent infection. Just like H.M.L. Mühlhofer et al., they also suggest proceeding to the second stage of RHA without interruption of antibiotic therapy, and elevated serum CRP values should be considered only as an additional risk factor for the development of infectious complications [33].

It is worth discussing the question when we should proceed to the second stage of RHA. To date, this question remains unanswered. Despite numerous studies, there is currently no universally accepted protocol regarding the timing of the second stage of RHA [34]. In turn, we believe that the optimal time to perform it is the period of compensation and recovery of the patient's general condition after the first stage, taking into account a highly traumatic intervention, and after the exclusion of reinfection based on the results of a comprehensive preoperative diagnostic algorithm with diagnostic aspiration of the joint.

Some authors suggest that the second stage of RHA should be performed 4-11 weeks after the spacer implantation, since the operations performed during this period, in their opinion, have the highest efficacy. According to the same authors, RHA performed up to 4 weeks after the spacer insertion had a 100% risk of reinfection, and after 11 weeks the risk of reinfection was 47.8%. The authors also reported a 30% recurrence rate of infection caused by the same infectious agent [35].

Unfortunately, recurrence of infection after the second stage of revision arthroplasty is not uncommon. According to some reports, the rate of infection recurrence within 15 years after RHA is 17% [36]. E. Kozaily et al. found a 49% reinfection rate after performing two-stage RHA at a follow-up of up to 2 years. The decision to

perform the second stage was taken considering the condition of the postoperative wound, as well as the tendency of proinflammatory serum biomarkers to decrease by 80%. Preoperative diagnostic aspiration was not performed during the study [37]. On the other hand, it remains unclear whether the microorganism detected is actually a recurrence of an infection that has not been cured after the spacer placement or it is already a new pathogen. In our study, the rate of recurrence of infection was 10%. In 30% of cases, a completely different microorganism or microbial association (reinfection) was detected.

In the study, we also encountered the problem of dry joint. Synovial fluid was absent in 15% of cases when performing preoperative aspiration in patients with a hip spacer. S.A. Bozhkova et al. in their study, performing preoperative aspiration in patients before revision intervention, faced dry joint in 21.4% of cases. The authors also believe that performing preoperative joint aspiration is not sufficient for the diagnostics of PJI, but detection of a positive culture of microorganisms is one of the factors in choosing further treatment tactics [38]. Unfortunately, the authors do not mention whether aspiration was performed in patients with a spacer, which may make it difficult to analyze the data. S. Huguet et al. analyzed the efficacy of preoperative aspiration of 20 hip joints. According to the results obtained, the sensitivity of the method was 0% [39].

Remarkably, we were able to find few available studies analyzing a large number of aspirations in patients with an implanted hip spacer [29, 31, 32, 33, 39].

CONCLUSIONS

The use of the extended preoperative diagnostic protocol allowed us to detect reinfection as early as at the preoperative stage, which influenced further treatment tactics.

According to our ideas about detailed preoperative diagnostics, before performing the second stage of revision hip arthroplasty it is necessary to perform diagnostic aspiration of synovial fluid of the hip joint in all patients having a spacer. This procedure allows to significantly reduce the risk of intraoperative detection of infection during the second stage of RHA.

Despite the routine use of ESR and CRP serum biomarkers, the best diagnostic accuracy rate among the tests used was demonstrated when the preoperative diagnostic aspiration was performed.

In the structure of detected pathogens in case of recurrence and reinfection, the representatives of Gram-positive coagulase-negative flora were the most frequent.

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