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Outcomes of Revision Hip Replacement After Resection Arthroplasty With a Non-Free Muscle Flap Transfer for Difficult-To-Treat Periprosthetic Infection

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Background. Resection arthroplasty with non-free muscle flap transfer allows to quickly eliminate the infection, but resulting in functional impairment of hip joint. To date, there are only a few publications with a small number of observations, where the proportion of patients who underwent the second stage of the revision hip arthroplasty (rTHA) is extremely small.

The aim of the study was to evaluate the effect of resection arthroplasty on the functional outcomes and incidence of adverse outcomes in patients with difficult-to-treat (DTT) periprosthetic infection who had previously undergone resection arthroplasty with a non-free transfer of the axial flap fom the vastus lateralis muscle.

Methods. The prospective study included 24 patients. During the period 2011–2021, at the first stage of the treatment for chronic recurrent DTT PJI of the hip, resection arthroplasty was performed with a non-free transfer of an island flap from the vastus lateralis muscle. Subsequent reimplantation of the endoprosthesis was performed in at least 1 year after the infection remission. The functional outcomes, degree of the lower limb shortening immediately before and in two or more years after revision arthroplasty (rTHA), the results of the microbiological cultures at the first and second stages of PJI treatment, technical aspects of the surgery as well as the postoperative period and long-term PJI remission were studied.

Results. Revision arthroplasty resulted in a statistically significant improvement of the postoperative functional outcome and quality of life in patients. The average Harris score agter rTHA increased from 53 to 83 points after surgery, EQ-5D degree of the quality of life increased from 50 points to 80, the overall score from 0.61 to 0.74 and average intensity of pain via VAS decreased from 3 points to 1 point in 3.1 years after rTHA ($p<0.05$). After reEP, complete restoration of the limb length was achieved in 29.1% of cases (n = 7) with an average compensation of the limb length for 4.5 cm. In 66.7% of patients (n = 16), the results of the intraoperative tissue biopsy microbiological analysis during reEP were culture negative. The recurrence rate of PJI was 12.5% (n = 3) up to 30 days after rTHA and 4.2% (n = 1) with a follow-up period of 3.1 years (IQR 2.1–4.1). With a single revision surgery performed without a delay, stable remission of DTT PJI was 95.8%.

Conclusion. Complex two-stage surgical treatment using resection arthroplasty with a non-free muscle flap transfer at the stage of debridement and subsequent revision has demonstrated high efficiency in eliminating the infectious process as well as restoring weight-bearing capacity and extremity function. It could be recommended as a method of choice in the treatment of patients with DTT PJI of hip joint.

Keywords: difficult-to-treat periprosthetic infection, muscle flap, resection arthroplasty, persistent infection remission, revision arthroplasty, long-term functional outcomes.

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Исходы ревизионного эндопротезирования тазобедренного сустава после резекционной артропластики с несвободной пересадкой мышечного лоскута у пациентов с трудноизлечимой перипротезной инфекцией

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Актуальность. Операцией выбора в случае трудноизлечимой перипротезной инфекции (ТИ ППИ) тазобедренного сустава (ТБС) может быть резекционная артропластика с несвободной пересадкой мышечного лоскута, которая характеризуется высокой эффективностью купирования инфекции, но ведет к ухудшению функции оперированного сустава. На сегодняшний день представлены только единичные публикации с малым количеством наблюдений, в которых доля пациентов, которым был выполнен второй этап реэндопротезирования (реЭП), крайне невелика.

Цель исследования — оценить влияние ревизионного эндопротезирования на функциональные результаты и частоту неблагоприятных исходов у пациентов, перенесших ранее резекционную артропластику с несвободной пересадкой осевого мышечного лоскута из латеральной широкой мышцы бедра по поводу трудноизлечимой перипротезной инфекции.

Материал и методы. В проспективное исследование были включены 24 пациента, которым с 2011 по 2021 г. на первом этапе лечения хронической рецидивирующей ТИ ППИ области ТБС была выполнена резекционная артропластика с несвободной пересадкой островкового лоскута из *m. vastus lateralis*. По достижении длительной, не менее года, ремиссии инфекционного процесса вторым этапом было выполнено реЭП. Изучали функциональные результаты по шкале Харриса, степень укорочения нижней конечности до и не ранее двух лет после реЭП, результаты культурального исследования на первом и втором этапах лечения ППИ, а также технические особенности выполнения оперативного вмешательства, течение послеоперационного периода и наличие ремиссии ППИ в отдаленные сроки после реЭП.

Результаты. РеЭП привело к статистически значимому улучшению функциональных результатов и качества жизни пациентов по сравнению с дооперационными показателями. Средний балл по шкале Харриса увеличился с 53 до операции до 83 после операции, согласно шкале EQ-5D удовлетворенность качеством жизни пациентами повысилась при индивидуальной оценке с 50 баллов до 80, по общему баллу-коэффициенту с 0,61 до 0,74, а средняя интенсивность болевого синдрома по ВАШ снизилась с 3 до 1 балла через 3,1 года после выполнения реЭП (p<0,05). Полное восстановление длины конечности было достигнуто в 29,1% случаев (n = 7) при средней компенсации укорочения длины конечности 4,5 см. У 66,7% больных (n = 16) результаты микробиологического исследования интраоперационных тканевых биоптатов при выполнении реЭП были культуронегативными. Частота рецидивов ППИ составила 12,5% (n = 3) в сроки до 30 дней после реЭП и 4,2% (n = 1) — при сроке наблюдения 3,1 года (МКИ 2,1–4,1). Проведение своевременных однократных ревизионных вмешательств позволило достичь стойкой ремиссии ТИ ППИ в 95,8% случаев.

Заключение. Комплексное двухэтапное хирургическое лечение с применением на этапе санации резекционной артропластики с пересадкой осевого мышечного лоскута из латеральной широкой мышцы бедра и последующим реЭП продемонстрировало высокую эффективность в отношении купирования инфекционного процесса, а также восстановления опороспособности и функции конечности. Предложенная методика может быть рекомендована как метод выбора при лечении пациентов с ТИ ППИ в области ТБС.

Ключевые слова: ревизионное эндопротезирование тазобедренного сустава, трудноизлечимая перипротезная инфекция, мышечный лоскут, резекционная артропластика, этиология перипротезной инфекции.

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BACKGROUND

Difficult-to-treat periprosthetic joint infection (DTT PJI) caused by difficultly-to-eradicate (DTE) pathogens is characterized by a chronic relapsing course [1, 2, 3, 4, 5]. The efficiency of the two-staged technique with an antimicrobial spacer installation in PJI caused by DTE pathogens is extremely low according to our data and publications by international authors, and excision arthroplasty with non-free muscle flap grafting may be the surgery of choice in such cases [6, 7, 8, 9, 10]. Radical surgical debridement with muscle flap transplantation, which is highly effective in stopping the infectious process, has been the gold standard for the treatment of chronic osteomyelitis of any localization, although for a long time, and this technique is used extremely rarely in the hip [11, 12]. This is due not only to the lack of technical skills and the ability to perform the plastic stage of the surgery in most orthopedists but also to the predictably low functional result of excision arthroplasty, according to a few publications [13, 14, 15]. Limb shortening, hip pain, lack of lower limb support ability, and the inevitable need for additional support and assistance when walking worsen not only the functional outcome but also the quality of life [16, 17, 18]. Therefore, some patients are not ready to accept excision arthroplasty as the outcome of the surgical treatment for infectious process and insist on a subsequent stage of revision total hip arthroplasty (rTHA) [19].

Moreover, extensive HJ bone defects, the risk of infection recurrence, and/or the poor general condition of patients are often objective reasons for refusing further endoprosthesis reimplantation [17, 20]. Hence, to date, only a few publications with a small number of cases were reported, with an extremely small proportion of patients who underwent stage 2 rTHA. The rTHA was performed only in 4 out of 18 (22%) patients according to Sharma et al. [16] and in 4 out of 26 (15.4%) patients according to Stoklas et al. [19]. Concurrently, the risk of infectious process resumption after endoprosthesis reimplantation in this category of patients is extremely high, and the recurrence rate of PJI can reach 43% [21, 22]. For example, Rittmeister et al. revealed prolonged healing of the postoperative wound in 17 out of 39 patients who underwent rTHA after excision arthroplasty, which required repeated surgical intervention [23].

Expectedly, the functional results of rTHA were predictably worse after multiple sanitizing surgeries than after primary arthroplasty. The difference in the length of the lower limbs cannot be immediately eliminated in all cases due to the pronounced cicatricial process, the presence of defects of hip bones, and the high risk of sciatic nerve neuropathy. Therefore, up to 39% of patients have persistent lameness [22]. Rittmeister et al. revealed that the mean Harris Hip Score (HHS) after rTHA was 62 (24–93), and only 11.5% of the results were rated as very good, while 88.5% were rated as poor. Concurrently, the causative agent of PJI, the age of the patient, the disease duration, and the number of previous surgical interventions did not correlate in any way with the functional outcome after rTHA [23].

The literature analysis did not reveal published studies on the changes over time in long-term and functional treatment results of patients with PJI after rTHA in the HJ by DTE agents using the hip excision arthroplasty in combination with non-free musculoplasty (NMP) in the history, which determined the aim of our study.

The study aimed to evaluate the impact of revision arthroplasty on functional outcomes and the incidence of adverse outcomes in patients who had previously undergone excision arthroplasty with non-free transplantation of an axial muscle flap from the *m. vastus lateralis* due to DTT PJI.

METHODS

Study design

The single-center prospective study was conducted from 2011 to 2021.

Inclusion criteria were the following:

– chronic DTT PJI caused by DTE pathogens, namely rifampicin-resistant staphylococci, ciprofloxacin-resistant gram-negative bacteria, and Candida genus fungi;

– performance of excision arthroplasty with non-free transplantation of an island flap from *m. vastus lateralis* at stage 1 of the two-staged treatment of PJI (RF patent for the invention 2299031);

– remission of the infectious process for >1 year;

– technical feasibility of performing rTHA (selection of revision systems depending on bone defects that form the hip);

– the absence of contraindications to rTHA following concomitant pathology.

Of the 57 patients who underwent excision arthroplasty with non-free transplantation of the island flap from *m. vastus lateralis* for recurrent chronic DTT PJI in the hip area, 24 (42%) met the inclusion criteria, including 75% males (n = 18) and 25% females (n = 6). The mean age of patients at the time of rTHA was 53 years (IQR [interquartile range]: 47–64). Lesions of the left and right hip were registered in 45.8% (n = 11) and 54.2% (n = 13) of cases.

Evaluation of results

Functional results were immediately assessed before the excision arthroplasty and not earlier than 2 years postoperatively. The functional results were assessed using the Harris Hip score; the quality of life of patients was assessed using the EQ-5D scale developed by the EuroQol Group Association [24]; the degree of pain syndrome was assessed using the visual analog scale (VAS) [25]. Additionally, the subjective satisfaction of patients with the treatment result was assessed (answer "yes" or "no").

During the rTHA, at least five tissue biopsies were taken from different paraarticular tissue areas for a culture test and compared with the previous treatment stage.

Additionally, the proportion of patients with early and delayed adverse outcomes of rTHA was assessed. Early complications (30 days postoperatively) included cases that required repeated revision surgery due to a hematoma in the surgical site and/or in case of wound exudate for >7 days and other manifestations of PJI recurrence. Late complications included any signs of an infectious and inflammatory process in the operated joint area during the entire follow-up period, but not earlier than 1 month postoperatively.

Statistical analysis

The obtained data were recorded in the form of spreadsheets; the data structure was visualized and analyzed using Microsoft Office Excel 2007 (Microsoft, USA) and Statistica for Windows (v. 10) software. The median (Me) was used as a measure of the central tendency for the studied attributes due to the small number of cases, and the lower (Q1) and upper (Q3) quartiles (IQR 25–75%) were used as dispersion measures. A comparison of quantitative characteristics between comparison groups was performed using the Mann-Whitney test. $\chi 2$ was used to analyze relative indicators. Differences in indicators between the groups were considered statistically significant at p-values of <0.05.

RESULTS

The average interval between excision arthroplasty with NMP and rTHA in patients with DTT PJI was 18.6 months (IQR: 12.2–29.3).

All patients used additional support while walking upon admission for endoprosthesis reimplantation, and most of them (87.5%) used two crutches (n = 21). One (4.2%) patient used two canes while walking and two (8.3%) patients used one cane all the time.

All the included patients had a history of more than three surgeries (Me 6, IQR: 5–7), which induced the formation of significant bone defects in the acetabulum and proximal femur. In 29.2% of cases (n = 7), the identified defects of the acetabulum corresponded to type IIIA and types IIA-IIC in other cases; whereas, the defects of the femur corresponded to types III and IV in 66.7% (n = 16) of cases, according to the Paprosky classification and to types I and II in other cases.

The long duration of revision arthroplasty in the studied group of patients (Me 140 min, IQR: 100–160) was due to several technical difficulties associated with the altered joint anatomy. The array of dense cicatricial tissue formed from a long course of infectious processes and numerous surgical interventions, and the need to maintain a rotated muscle flap significantly hindered access to the acetabulum. Surgical access was made along the existing postoperative scar. Most often, the access was made between the anterior edge of the acetabulum and the muscle flap, which was pushed posteriorly with Hofmann retractors. After endoprosthesis implantation, the flap was returned to its place, wrapping it around the endoprosthesis neck, thereby reducing the hip cavity. In variant 2, the access was made between the flap and the posterior edge of the acetabulum and pushed anteriorly. Femoral components with a cemented type of fixation were used only in 3 out of 24 (12.5%) patients, while cementless femoral components, mostly conical with distal fixation, were installed in the remaining 87.5% of cases (n = 21). Therefore, trabecular metal components with a large number of holes were implanted into the acetabulum. Tantalum acetabular augments

or allogenic bone with an antibiotic were used to replace extensive acetabular defects. A cup-cage system was used with an antiprotrusion ring installation in three cases and an individual hemispherical acetabular component in one case. The supply of soft tissues between the fascia and the femur due to the muscle flap prevented the endoprosthesis dislocation, which enabled the use of the dual mobility system only in 6 (25%) cases, despite a significant number of patients with a type III-IV proximal femoral defect according to the Paprosky classification (n = 16).

Long-term functional treatment results after rTHA were assessed after an average of 3.1 years (IQR: 2.1–4.1). The weight-bearing function of the limb was restored in all patients. Concurrently, the proportion of patients who used two crutches decreased by >5 times compared to the preoperative period ($p < 0.05$), and 70.7% of patients used one cane or used no additional support while walking (Fig. 1).

A complete restoration of the limb length was achieved in 29.1% of cases after the endoprosthesis reimplantation (n = 7). On average, compensation for limb shortening was 4.5 cm, namely from 6.5 cm (IQR: 5.0–8.0) to 2.0 cm (IQR: 0–3.8) ($p < 0.05$). The main reasons for the impossibility of complete restoration of the operated limb length were the lower limb shortening by >6 cm, the pronounced cicatricial process of the paraarticular tissues, and the high risk of sciatic nerve neuropathy. Concurrently, gait disturbance of varying degrees was noted in all patients. Additionally, almost all patients compensated for the limb length with orthopedic shoes. Staged limb lengthening by 7 cm using the apparatus of external fixation was performed only in 1 (4.2%) case.

The study of long-term functional results after rTHA using the HHS, EQ-5D, and VAS questionnaires showed statistically significant improvement compared to the preoperative level ($p < 0.05$) (Table 1).

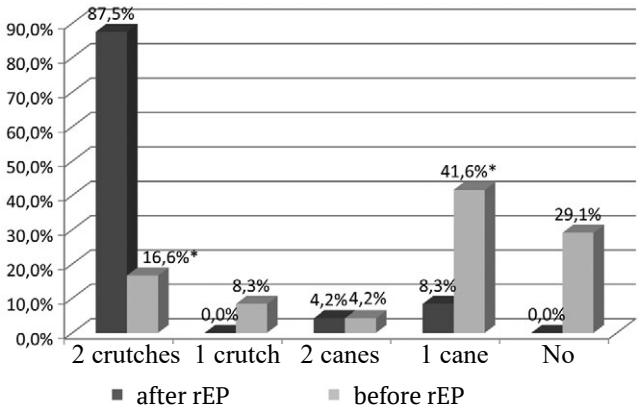


Fig. 1. Distirbution of patients depending on the used tools for additional support before and after rTHA
* $p<0,05$

Table 1

Functional results before and after revision hip arthroplasty, Me (IQR)

Indicator	Before rTHA	After rTHA
EQ-5D (total score factor)	0.61 (0.54–0.65)	0.74 (0.65–0.85)
EQ-5D (individual), points	50 (40–73)	80 (79–85)
HHS, points	53 (50–57)	83 (78–85)
VAS, points	3 (2–3)	1 (1–2)
Shortening, cm	6.5 (5.0–8.0)	2 (0–3.5)
Satisfied, n (%)	17 (70.8)	23 (95.8)

$p < 0.05$.

The Harris questionnaire in all patients admitted for rTHA after excision arthroplasty with NMP revealed poor functional results. Endoprosthesis reimplantation provided a statistically significant ($p < 0.05$) improvement in the functional state of the operated joints in the vast majority of patients 2 years postoperatively (Fig. 2).

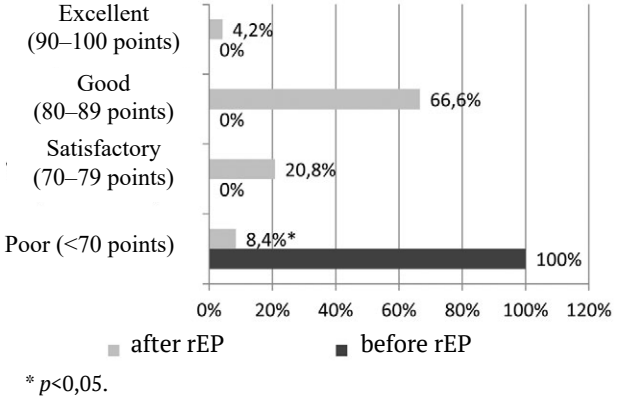
On average, the degree of satisfaction with the quality of life of patients after rTHA increased statistically significantly according to individual assessment and overall score-coefficient based on the EQ-5D questionnaire responses. A significant proportion of patients noted an increased satisfaction for most of the analyzed indicators. Preoperatively, 8.3% (n = 2) of patients had no difficulty in mobility, and 41.7% of patients had no difficulty postoperatively ($p < 0.05$). The proportion of patients who noted positive dynamics concerning pain, anxiety, and depression also increased (Table 2).

Similar results were obtained during the pain syndrome assessment according to VAS. The average intensity of the pain syndrome decreased from 3 points (IQR: 2–3) upon admission to stage 2 of treatment to 1 point (IQR: 1–2) 3.1 years after rTHA ($p < 0.05$). Concurrently, the majority of patients (79.2%) noted a complete absence of pain or minimal pain postoperatively (1–2 points) (Table 1). The pain syndrome was regarded as moderate by 5 (20.8%) patients postoperatively and 12 (50%) preoperatively ($p < 0.05$).

All patients restored the ability to self-service, performed independently light housekeeping, and did not need assistance from others after rTHA.

Of the 24 patients surveyed after rTHA, 23 (95.8%) were satisfied with the treatment results (answer "yes" or "no"). Only one patient has a better condition after excision arthroplasty with NMP. A detailed examination revealed that the pain syndrome was not arrested in the operated joint area, which caused the forced use of two crutches as additional support, thereby indirectly indicating the possible vertebrogenic genesis of the latter, although the patient noted a moderate level of pain syndrome according to VAS.

Notably, patient satisfaction was determined by the relief of the infectious process after long-term treatment of repeatedly recurrent PJI, namely the absence of a fistulous tract with purulent discharge and the need for further staged sanitizing manipulations, while dissatisfaction was associated with impaired limb function due to the lack of support ability.



* $p<0,05$.

Fig. 2. Distribution of patients depending on the functional outcomes from the modified Harris hip score before and after rTHA

Table 2

Functional results according to the EQ-5D before and after revision hip arthroplasty, n (%)

Category EQ-5D	Answer option	Before rTHA (n = 24)	After rTHA (n = 24)	p
Mobility	No difficulties	2 (8.3)	10 (41.7)	<0.05
	Minor difficulty	6 (25)	12 (50)	>0.05
	Moderately difficult	10 (41.7)	2 (8.3)	<0.05
	Great difficulty	6 (25)	–	>0.05
	Inability to walk	–	–	–

End of Table 2

Category EQ-5D	Answer option	Before rTHA (n = 24)	After rTHA (n = 24)	p
Self-care	No difficulties	3 (12.5)	6 (25)	>0.05
	Minor difficulty	5 (20.8)	14 (58.3)	<0.05
	Moderately difficult	11 (45.8)	4 (16.7)	>0.05
	Great difficulty	5 (20.8)	–	>0.05
	Unable to wash/dress	–	–	–
Habitual daily activities	No difficulties	1 (4.2)	4 (16.7)	>0.05
	Minor difficulty	8 (33.3)	18 (75)	>0.05
	Moderately difficult	13 (54.1)	2 (8.3)	<0.05
	Very difficult	2 (8.3)	–	>0.05
	Unable to be engaged in usual activities	–	–	–
Pain, discomfort	No pain	3 (12.5)	13 (54.1)	<0.05
	Minor pain	14 (58.3)	10 (41.7)	>0.05
	Moderate pain	7 (29.2)	1 (4.2)	<0.05
	Strong pain	–	–	–
	Extreme pain	–	–	–
Anxiety, depression	No anxiety	16 (66.7)	22 (91.7)	<0.05
	Minor anxiety	5 (20.8)	2 (8.3)	>0.05
	Moderate anxiety	3 (12.5)	–	>0.05
	Severe anxiety	–	–	–
	Extreme anxiety	–	–	–

Statistically significant results are highlighted in bold.

Table 3

Results of bacteriological examination of intraoperative materials at stages 1 and 2 of surgical treatment of patients

Coincidence rate of bacteriological examination	Pathogen	
	Stage 1 (excision arthroplasty with NMP)	Stage 2 (rTHA)
Complete coincidence	Mycobacterium abscessus	MSSA
	Candida parapsilosis + MRSA + Klebsiella pneumoniae	MRSE
	MRSE	MSSE
Partial coincidence	Pseudomonas aeruginosa	Pseudomonas aeruginosa + MRSE
	Klebsiella pneumoniae + MRSA	Klebsiella pneumoniae
	MRSE + Pseudomonas aeruginosa	MRSE

Microbiological examination of intraoperative tissue biopsies after rTHA in 16 out of 24 (66.7%) patients showed negative results. The causative agent of PJI isolated earlier at the stage of NMP was confirmed in 2 (8.3%) patients. The bacteriological examination results did not coincide completely in 3 (12.5%) patients, while they partially coincide in 3 (12.5%) patients (Table 3).

Postoperatively (11 and 21 days), an early revision with endoprosthesis preservation and the mobile component replacement was performed due to PJI recurrence in 2 (8.3%) patients after rTHA. Concurrently, MSSE strain was isolated from tissue biopsy specimens taken during the revision with the endoprosthesis preservation, while initial DTT PJI was caused by MRSA, and the bacteriological examination results of tissues were negative during rTHA in one case. The causative agent of PJI was MRSA in another patient, which was also confirmed during rTHA and revision with preservation. No signs of infectious process recurrence were detected in these patients at the control examination from 3.0 to 3.6 years.

A fistulous tract occurred in another patient (4.2%) with negative tissue biopsy sample culture test results at the stage of rTHA within 30 days. He underwent a one-stage replacement of endoprosthesis 44 days after rTHA. Concurrently, tissue biopsy specimens were culture-negative.

In the long-term (1.5 years after rTHA), a permanent fistulous tract developed in one case (4.2%); however, the patient refused surgery. A revision intervention was performed and a dual mobility system was installed in 2 (8.4%) more cases, due to repeated endoprosthesis dislocations.

DISCUSSION

Until the present, chronic PJI cannot be considered cured because bacteria can remain latent for many years [26]. In our study, at least five tissue biopsy specimens were taken from all patients for bacteriological examination during rTHA. The results were negative only in 66.7% of cases, which coincides with the findings of Engelbrecht et al., who detected a positive growth of microorganisms in 31.5% of cases, when performing rTHA in a similar cohort of patients [27].

The incidence of early relapses of PJI up to 30 days after rTHA that was performed after excision arthroplasty with NMP for DTT PJI was 12.5% in our study (n = 3). Concurrently, timely single revision interventions enabled the achievement of a stable arrest of the infectious process in all cases. Only one case (4.2%) of PJI recurrence was identified with a median follow-up period of 3.1 years (IQR: 2.1–4.1), which is comparable to the frequency of infectious complications after "clean" revision interventions for HJ, which is 4.5%–7.0%, according to several authors [28, 29, 30, 31]. According to the literature, the recurrence rate of infection during rTHA after excision arthroplasty ranges from 2.3% to 43.0% [22, 23]. Notably, these studies did not consider the nature of the pathogen when forming the study groups. In our study, persistent remission of PJI caused by DE agents remained after repeated endoprosthesis implantation in 95.8% patients with previous excision arthroplasty with NMP.

The rTHA that we performed had statistically significantly improved the long-term functional results and quality of life of patients compared with preoperative indicators. According to the survey results, 95.8% of the respondents were satisfied with the treatment results. The medium-term functional results after repeated endoprosthesis implantation, obtained according to the HHS, were unsatisfactory only in 8.4% of cases despite the initial extremely low level of functionality after excision arthroplasty with NMP. Similar treatment results are demonstrated by Engelbrecht et al., who received 9% of unsatisfactory results on the HHS in their work [27]. According to Charlton et al., the average HHS after rTHA in a similar category of patients increased from 40 points preoperatively to 78 points postoperatively [22], and from 53 to 83 points in our study, respectively. Notably, the functional results that we obtained are comparable with the results of rTHA for non-infectious reasons, which vary from 80 to 91 points on the HHS according to the literature [32, 33, 34].

Klima et al. revealed that the difference in the length of the lower extremities as a result of rTHA decreased on average from 6.8 cm to 1.0 cm [35]. Our study revealed the possibility to restore the length of the operated limb by an average of 4.5 cm. The average intensity of pain syndrome according to VAS decreased from 3 (IQR: 2–3)

points upon admission to stage 2 of treatment to 1 (IQR: 1–2) point 2 years after the rTHA completion. The supporting function of the limb was restored in all patients. Preoperatively, 85% of patients used two crutches, then postoperatively, only 25% ($p < 0.05$) used one or two crutches as additional support, 29.1% of patients walked independently without means of additional support, and 45.8% of patients used a cane constantly or when walking for a long time.

CONCLUSION

Complex two-staged surgical treatment with excision arthroplasty with NMP at the stage of sanitation and subsequent revision arthroplasty demonstrated high efficiency in terms of arresting the infectious process, as well as restoring weight-bearing capacity and limb function. The obtained results enable us to recommend this technique as a method of choice in the treatment of patients with DTT PJI in the hip area, despite certain technical difficulties in performing surgical interventions.

DISCLAIMERS

Author contribution

Liventsov V.N. — data collection and analysis, data statistical processing, manuscript writing.

Bozhkova S.A. — research concept and design, manuscript writing and editing.

Tikhilov R.M. — research concept.

Artyukh V.A. — treatment the patients, manuscript editing.

All authors have read and approved the final version of the manuscript of the article. All authors agree to bear responsibility for all aspects of the study to ensure proper consideration and resolution of all possible issues related to the correctness and reliability of any part of the work.

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