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THE ROLE OF ARTHROPLASTY IN THE COMBINED TREATMENT OF OSTEOARTHRITIS OF THE KNEE JOINT

Scientific specialty – 3.1.8. Traumatology and orthopaedics

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INTRODUCTION

Relevance of the Research Topic. The replacement of the knee joint with an arthroplasty in advanced stages of osteoarthritis is currently a standard procedure (Kornilov N.N. et al., 2015; Steinhaus M.E. et al., 2017). However, knee joint arthroplasty (KJA) can sometimes lead to unsatisfactory results. Even with positive outcomes, the lifespan of the arthroplasty is limited (Vorokov A.A. et al., 2020). In recent years, there have been increasing publications addressing the limitations of indications for arthroplasty in cases of knee osteoarthritis (Lyachagin A.V. et al., 2019; Mansurov D.Sh. et al., 2021; Baranovsky A.A. et al., 2023; Canovas F., Dagneaux L., 2018).

The results of knee joint arthroplasty are directly influenced by factors such as patient age, body mass index, comorbidities, and many others (Zagorodniy N.V. et al., 2014; Mironov S.P. et al., 2014; Paxton E.W. et al., 2015). Complications from KJA range from 1.5% to 25% (Bozhkova S.A. et al., 2018; Blanco J.F. et al., 2020; Pomeroy E. et al., 2020). Complications include implant instability, surgical site infections, wear of structural components, and others. Some specialists report an increasing number of patients dissatisfied with the outcomes of knee arthroplasty both shortly after the surgery and years later due to natural wear of the implant (Kavalersky G.M. et al., 2021; Neuprez A. et al., 2016; Halawi M.J. et al., 2019).

Research findings indicate that knee arthroplasty is often performed prematurely or without sufficient justification. Currently, therapeutic options for treating knee osteoarthritis have significantly expanded. The use of SYSADOA drugs, structural-modifying medications, PRP therapy, autologous chondrocyte transplantation, local therapies, and physiotherapeutic treatments, as well as minimally invasive surgery, offers patients a chance to maintain their joint's functional activity and potentially avoid or significantly postpone the need for arthroplasty (Vakulenko O.Yu., Zhilyaev E.V., 2016; Kosareva M.A. et al., 2018; Golovach I.Yu. et al., 2019; Minshull C. et al., 2011; Wang H., Ma B., 2022). However, conservative treatment methods are not being fully utilized at present

(Lila A.M. et al., 2019). The role of KJA in the multidisciplinary management of knee osteoarthritis remains a topic of lively discussion in recent medical literature and scientific forums.

Many contemporary researchers believe that the indications for knee arthroplasty (KJA) require clarification (Mansurov D.Sh. et al., 2021; Ghomrawi H.M. et al., 2012; Hawker G. et al., 2015). KJA is recommended when all possible non-operative treatment methods have proven ineffective (Dowsey M.M. et al., 2016; Dabare C. et al., 2017; Bannuru R.R. et al., 2019).

Thus, in some cases, knee joint replacement with an implant is performed prematurely. The current trend towards increasing the frequency of KJA is leading to a rise in complications associated with the procedure. At the same time, the number of patients dissatisfied with the long-term outcomes and low quality of life is increasing. There are few publications addressing the role of KJA in the multidisciplinary management of knee osteoarthritis (KOA) in modern literature. It is evident that there is a need for scientific research to clarify the indications for KJA in accordance with the principles of evidence-based medicine.

Degree of Development of the Research Topic. In the Russian Federation, as in other developed countries, clinical and experimental studies are being conducted to explore non-operative and surgical treatment methods for osteoarthritis. However, despite undeniable scientific advancements, the pace of implementing organizational and technological innovations in practical activities cannot be deemed satisfactory. The precise role of arthroplasty in the comprehensive treatment algorithm for patients with knee osteoarthritis has not yet been definitively established. This issue continues to be discussed at scientific forums and in publications, yet the tasks of justifying ways to improve treatment outcomes for knee osteoarthritis often remain without substantiated solutions.

Objective of the Study: To improve treatment outcomes for patients with stage 3 knee osteoarthritis based on the role of arthroplasty within a comprehensive approach to medical care.

Research Objectives:

1. To analyze the immediate and long-term outcomes of treatment for patients with knee osteoarthritis who have undergone arthroplasty. To assess functional results in patients at various time points after surgery.
2. To study the pathological morphological features of the synovial membrane of the excised knee joint to explore the potential for predicting the course of the postoperative period following knee arthroplasty.
3. To determine the role of comorbidity in predicting excellent and good functional outcomes in patients over the long term after knee arthroplasty.
4. To scientifically justify and develop an algorithm that defines the role of arthroplasty in a comprehensive approach to treating patients with knee osteoarthritis. To evaluate its effectiveness.

Scientific Novelty:

As a result of the research, for the first time in Russia, the immediate and long-term outcomes of knee arthroplasty for osteoarthritis have been analyzed using Kaplan–Meier survival analysis methods. Risk factors for the development of negative functional outcomes and quality of life in patients after arthroplasty have been identified.

New data on the results of studying various morphological parameters have been presented from the perspective of predicting the course of the postoperative period following knee joint replacement with an implant.

An algorithm for the comprehensive treatment of knee osteoarthritis has been developed, incorporating conservative and organ-preserving surgical methods and defining the role of arthroplasty within the treatment framework.

Theoretical and Practical Significance of the Work:

The study has expanded the understanding of the patterns in the early and late postoperative periods for patients with knee osteoarthritis who have undergone arthroplasty.

The research conducted has led to the development of practical recommendations for selecting treatment methods for patients with knee osteoarthritis.

The implementation of the developed algorithm for the comprehensive treatment of knee osteoarthritis, considering both conservative and surgical methods, allows for improved treatment outcomes by providing the opportunity to postpone knee arthroplasty.

Methodology and Research Methods:

The study was based on the principles and guidelines of evidence-based medicine. Clinical, functional, morphological, and statistical methods were employed in the research. The subjects of the study were patients aged 43 to 83 years, hospitalized with the diagnosis of "Idiopathic knee osteoarthritis" for arthroplasty. The focus of the research was on the risk factors for the development of unsatisfactory functional outcomes and quality of life in patients with knee osteoarthritis.

A retrospective-prospective cohort clinical study was conducted. Inclusion criteria included the diagnosis (idiopathic knee osteoarthritis) and the timing and location of treatment for knee osteoarthritis. The exclusion criterion was the death of the patient during their hospital stay.

Positions to be Defended:

1. Among the local intraoperative complications of knee arthroplasty, damage to the posterior cruciate ligament is predominant. In the early postoperative period, hematomas and infections at the surgical site prevail. In the long term after surgery, wear and loosening of the arthroplasty components and

infectious complications are most commonly observed. The number of patients with excellent and good functional outcomes and quality of life decreases with each passing year after arthroplasty.

2. Histological examination of the synovial membrane of the knee joint reveals varying degrees of inflammatory changes. In cases of pronounced infiltration, the risk of developing inflammatory changes at the surgical site in the early postoperative period increases.

3. Functional outcomes in patients with significant comorbidities and low levels of comorbidity after knee arthroplasty for osteoarthritis do not differ significantly over a 5-year period.

4. A multidisciplinary approach to treating patients with knee osteoarthritis combines surgical and non-operative treatment strategies. It is based on objective indications, appropriate timing, and optimal sequencing of therapeutic interventions, following a developed algorithm that incorporates both non-operative methods and arthroplasty.

Main Scientific Results:

The analysis of current views on the role of arthroplasty in the treatment of knee osteoarthritis, considering modern trends, is presented in a literature review. Data from recent publications have been analyzed and categorized based on the opinions of various authors. It has been concluded that many specialists currently advocate for an individualized approach to treating knee osteoarthritis, which involves a combination of non-operative and surgical methods.

In the early postoperative period, complications were noted in 17.3% of patients. Among these complications, the most common were infections at the surgical site (4.8%), hematomas (4.5%), and lymphorrhea (3.7%). In the long term after arthroplasty, excellent and good functional outcomes and quality of life decreased by 23% over five years compared to the results from the first year.

A weak degree of infiltrative changes in the synovial membrane of the knee joint (at the time of arthroplasty) was observed in 23.3% of cases. Moderate

infiltration was verified in 40% of cases, while 36.7% of patients exhibited intense synovial infiltration. In 71.4% of cases, local complications at the surgical site after knee arthroplasty developed in patients with pronounced inflammatory changes in the synovium.

Five years after knee joint replacement with an implant, excellent and good functional outcomes were observed in 78% of patients with low comorbidity and in 74% of patients with high comorbidity ($p < 0.05$). This allows for the postponement of arthroplasty and provides specialists the opportunity to extend conservative treatment of knee osteoarthritis, achieving good results without focusing on the severity of comorbid conditions.

The use of the algorithm for the comprehensive treatment of knee osteoarthritis allows for an increase in the percentage of excellent and good functional outcomes from 76% to 90% five years after surgery. The proposed algorithm includes a sustainable interaction of conservative methods, organ-preserving surgery, and arthroplasty performed according to strict indications, as well as rehabilitation measures. As a result, the frequency of satisfactory and unsatisfactory outcomes is reduced by more than twofold (according to five-year observations).

List of Published Works Related to the Dissertation Topic:

1. Vantsovich, D.Yu., "Application of Electrostatic Fields of Electrets in the Surgical Treatment of Patients with Gonarthrosis" / D.Yu. Vantsovich, M.S. Serdobintsev, V.V. Usikov, Y.B. Tsololo, D.Sh. Mansurov, A.A. Spichko, B.G. Aliyev, A.A. Vorokov // Puls. – 2021. – Vol. 23, No. 3. – pp. 24-30. doi.org/10.26787/nydha-2686-6838-2021-23-3-24-30.

2. Aliyev, B.G., "Long-Term Results of Arthroplasty of the Hip and Knee Joints" / B.G. Aliyev, A.A. Spichko, E.A. Murzin, A.A. Vorokov, D.Sh. Mansurov, V.M. Khaidarov, A.N. Tkachenko // In: Medical Assistance for Injuries. Innovations in Organization and Technologies. The Role of the National Public Professional Organization of Traumatologists in the Healthcare System of

the Russian Federation. Sixth All-Russian Congress with International Participation: Abstracts. St. Petersburg, – 2021. – pp. 4-5.

3. Mansurov, D.Sh., "Limitations on Indications for Primary Knee Arthroplasty" / D.Sh. Mansurov, A.A. Spichko, A.N. Tkachenko, V.M. Khaidarov, A.G. Balglei // In: Proceedings of the V International Congress of the Association of Rheumatology and Orthopedics. Editorial Board: M.A. Makarov [et al.]. Voronezh, – 2021. – pp. 75-77.

4. Spichko, A.A., "Long-Term Results of Knee Arthroplasty" / A.A. Spichko, D.Sh. Mansurov, A.N. Tkachenko, V.M. Khaidarov, A.G. Balglei, B.G. Aliyev // In: Proceedings of the V International Congress of the Association of Rheumatology and Orthopedics. Editorial Board: M.A. Makarov [et al.]. Voronezh, – 2021. – pp. 89-90.

5. Vorokov, A.A., "Possibilities for Predicting Local Infectious Complications in Hip and Knee Arthroplasty" / A.A. Vorokov, E.M. Fadeev, A.A. Spichko, B.G. Aliyev, E.A. Murzin, V.M. Khaidarov, D.Sh. Mansurov, A.N. Tkachenko // Puls. – 2020. – Vol. 22, No. 12. – pp. 106-111. doi.org/10.26787/nydha-2686-6838-2020-22-12-106-111.

6. Khaidarov, V.M., "Results of Combined Treatment for Knee Joint Injuries with Concurrent Varicose Veins in Middle-Aged and Elderly Patients" / V.M. Khaidarov, D.Sh. Mansurov, A.A. Spichko, B.M. Mamasoliev, A.N. Tkachenko, A.G. Balglei, B.G. Aliyev // In: Proceedings of the V International Congress of the Association of Rheumatology and Orthopedics. Editorial Board: M.A. Makarov [et al.]. Voronezh, – 2021. – pp. 96-97.

7. Mazurov, V.I., "Prevalence of Osteoarthritis and Problems of Its Statistical Accounting" / S.A. Saiganov, A.N. Tkachenko, O.V. Inamova, I.L. Urazovskaya, D.Sh. Mansurov, V.M. Khaidarov, B.G. Aliyev, A.A. Spichko, A.G. Balglei // Health as the Foundation of Human Potential: Problems and Solutions. – 2021. – Vol. 16. – No. 2. – pp. 764-770.

8. Tkachenko, A.N., "Causes of Unsatisfactory Outcomes of Arthroplasty for Knee Osteoarthritis in the Long-Term Postoperative Period: A

Literature Review" / A.N. Tkachenko, A.K. Dulayev, A.A. Spichko, D.Sh. Mansurov, V.M. Khaidarov, A.G. Balglei, I.L. Urazovskaya, A.A. Khromov, E. Ulkhak, Y.B. Tsololo // Bulletin of Traumatology and Orthopedics Named After N.N. Priorov. – 2022. – Vol. 29, No. 3. – pp. 317-328.

9. Tkachenko, A.N., "Quality of Life in the Long-Term After Knee Arthroplasty" / A.N. Tkachenko, D.Sh. Mansurov, A.A. Spichko, A.A. Korneenkov, S.A. Saiganov, V.I. Mazurov, I.L. Urazovskaya, B.M. Mamasoliev, Zh.A. Turdumata // Surgery. Eastern Europe. – 2023. – Vol. 12, No. 1. – pp. 9-17. (From Scopus)

10. Aliyev, B.G., "Frequency and Structure of Negative Consequences of Hip Joint Arthroplasty in the Long-Term" / B.G. Aliyev, A. Ismael, I.L. Urazovskaya, D.Sh. Mansurov, A.N. Tkachenko, V.M. Khaidarov, A.A. Spichko // News of Surgery. – 2022. – Vol. 30. – No. 4. – pp. 392-400.

11. Aliyev, B.G., "Long-Term Results of Hip and Knee Arthroplasty in Patients with Polymorbidity" / B.G. Aliyev, A.A. Spichko, A.A. Korneenkov, D.Sh. Mansurov, V.M. Khaidarov, I.L. Urazovskaya, I. Abbas, A.N. Tkachenko // Department of Traumatology and Orthopedics. – 2022. – No. 4 (41). – pp. 7-14.

12. Aliyev, B.G., "Assessment of Quality of Life Dynamics After Hip and Knee Arthroplasty in Comorbid Patients" / B.G. Aliyev, A.A. Spichko, S.A. Saiganov, V.I. Mazurov, A.A. Korneenkov, D.Sh. Mansurov, V.M. Khaidarov, I.L. Urazovskaya, A.N. Tkachenko // Bulletin of the Northwest State Medical University Named After I.I. Mechnikov. – 2023. – Vol. 15, No. 1. – pp. 33-42.

13. Tkachenko, A.N., "Morphological Features of the Synovial Membrane in Osteoarthritis in Patients Undergoing Knee Arthroplasty" / A.N. Tkachenko, R.V. Deev, A.A. Spichko, D.Sh. Mansurov, I.L. Urazovskaya, D.S. Melchenko, E.V. Presnyakov, S.S. Galkov, N.S. Gladyshev, V.V. Magdalinov // Bulletin of the Northwest State Medical University Named After I.I. Mechnikov. – 2024. – Vol. 16, No. 2. – pp. 87-96.

Degree of Validity and Testing of Results

To assess the outcomes of the dissertation research, data from patients who underwent knee arthroplasty due to osteoarthritis and received inpatient conservative treatment at different time points were compared. The contemporary methods used in the treatment of osteoarthritis, along with statistical data processing techniques, ensure the reliability of the findings and substantiate the results of the study.

The results of the research have been presented at several scientific forums: the VI All-Russian Congress with international participation "Medical Assistance in Trauma: New Approaches in Organization and Technology" (Saint Petersburg, 2021); the V International Congress of the Association of Rheumatologists and Orthopedists (Moscow, 2021); and the XVI Annual All-Russian Scientific and Practical Conference with international participation "Health as the Foundation of Human Potential: Challenges and Solutions" (Saint Petersburg, 2021).

The results of the dissertation are being utilized in several healthcare institutions, including the State Budgetary Healthcare Institution of the Republic of Karelia "Republican Hospital named after V.A. Baranov" (Petrozavodsk); the Traumatology and Orthopedics Clinic of the North-Western State Medical University named after I.I. Mechnikov; the Saint Petersburg State Budgetary Healthcare Institution "Hospital for War Veterans"; and the State Budgetary Institution of Saint Petersburg "Research Institute of Emergency Medicine named after I.I. Dzhanelidze." Additionally, these results are integrated into the educational process at the Department of Traumatology, Orthopedics, and Military Field Surgery of the North-Western State Medical University.

Author's Personal Involvement in Obtaining Results

The author studied contemporary data from domestic and international medical sources related to the research topic, established the objectives and formulated the tasks of the scientific work, created a plan, and allocated time for completion. Statistical materials were collected, and methods for obtaining

statistical information were developed. The author participated directly in knee arthroplasties or supervised the procedures. The author's involvement in collecting statistical data was 90%, in database management 100%, in evaluating and analyzing the treatment conducted 85%, in statistical data processing 90%, and in summarizing and analyzing research results 100%.

Volume and Structure of the Dissertation

The dissertation is presented on 147 pages of typed text. Its structure includes an introduction, 6 chapters, a conclusion, findings, practical recommendations, and an appendix. The dissertation is illustrated with 19 tables and 16 figures. The reference list contains 277 sources, including 194 in foreign languages.

CHAPTER 1. WAYS TO IMPROVE THE OUTCOMES OF KNEE JOINT ARTHROPLASTY (LITERATURE REVIEW)

Worldwide, including in Russia, there has been an increase in the number of large joint arthroplasty surgeries (Borisov D.B., Kirov M.Yu., 2013; Tikhilov R.M. et al., 2014; Kavalersky G.M. et al., 2014; Kornilov H.H. et al., 2015; Logvinov N.L. et al., 2020; Zhou V.Y. et al., 2021; Tung K.K. et al., 2021). The improvement in implant quality, advancements in arthroplasty technologies, and the accumulation of practical experience among surgeons have not led to a reduction in the percentage of complications and unsatisfactory outcomes (Mitroshin A.N., Kosmyanin D.A., 2016; Uzbikov R.M., 2017; Ruzibaev D.R. et al., 2020; Chugaev D.V. et al., 2020; Koh I.J. et al., 2019; Goshima K. et al., 2020; Yin Y. et al., 2020; Ucan V. et al., 2021).

Manifestations of degenerative damage to the knee joint are observed in 33.3% of cases within the structure of degenerative-dystrophic joint diseases (Andreeva T.M. et al., 2005). Both knee joints are affected in every third patient. Patients with late (II and III) stages who present for the first time account for up to 75% of observations (Popova L.A., Sazonova P.V., 2009; Mironov S.P. et al., 2010). The prevalence of OA (osteoarthritis) is 10.0–14.3% among individuals aged 45–50 years, and among patients over 60 years old, it is about 80% (Brandt K.D. et al., 2008; Tejwani N.C., Immerman I., 2008; Sowers M.F. et al., 2009). Women are nearly twice as likely to suffer from OA compared to men. Two-thirds of patients are of working age, from 40 to 60 years (Kovalenko V.N., Bortkevich O.P., 2005). Radiologically, OA of the knee joint is identified in 25–30% of cases among individuals aged 45 to 64 years and in 85% of cases among those aged 65 and older (Matveev R.P., Bragina S.V., 2012).Movement restrictions in the joint caused by prolonged pain syndrome lead to the formation of flexion contractures, which, in turn, cause muscle overstrain and increased load on the damaged area of the joint (Shavlovskaya O.A. et al., 2020).

1.1. Results of Knee Joint Arthroplasty

Degenerative-dystrophic changes in weight-bearing joints are more commonly found in the knee joint. In North America, knee joints account for approximately 1 million surgical interventions (Jenkins K. et al., 2002; Kearon C., 2003; Lutzner J. et al., 2011). In our country, out of 100,000 cases of knee osteoarthritis, at least 40% are knee replacement surgeries (Khelo M.D. et al., 2018; Tkachenko A.N. et al., 2022).

The primary objective of total knee arthroplasty (TKA) is to restore its motor function as fully as possible. The main advantages of TKA include mobility, stability, and painlessness. These are undeniable benefits compared to other traditional methods of treating altered joints. For example, arthrodesis provides stability and painlessness but results in loss of joint mobility, which is unacceptable for patients with rheumatoid arthritis who suffer from dysfunction in multiple joints (Hutchison R.E. et al., 2019).

Regarding absolute contraindications of local origin, some researchers consider chronic infection to be among them. Relative contraindications include significant post-traumatic or post-operative scarring in the joint area, as well as marked weakening of the function of the muscles involved in knee movement (Clarke M.J.H. et al., 2021). Despite clear progress in implant manufacturing technologies and the growing experience of orthopedic surgeons, the complication rate for TKAs shows no consistent trend toward reduction, with reported rates ranging from 3 to 12% (Tkachenko A.N. et al., 2022; Kim C.W. et al., 2020; Mühlenfeld M. et al., 2021; Miller A.O. et al., 2013).

Complications during TKA are usually due to insufficient surgical planning, intraoperative bleeding, fractures of the femoral and tibial condyles, and tearing of the anterior or posterior cruciate ligaments, among others (Windhager R. et al., 2006; Slullitel P.A. et al., 2020). After knee arthroplasty, various complications may also develop: implant dislocation, periprosthetic fractures, hematomas, lymphorrhea, infectious complications, neuropathies, thromboembolism, polyethylene wear, etc. Early complications are typically of infectious origin, while

late complications include aseptic instability of the implant components, joint contractures, periprosthetic fractures, and wear of the prosthetic components (Tkachenko A.N. et al., 2022; Yamanaka H. et al., 2012).

Key criteria predisposing to complications include the complexity of surgical techniques, previous interventions on the knee joint, and lack of adequate rehabilitation after TKA (Liu Y. et al., 2021). For example, knee arthroplasty in patients with significant flexion contractures requires substantial resection of the joint ends of the femur and tibia. Additionally, simultaneous correction of a flexion contracture poses a risk of complications involving the neurovascular bundle due to overstretching (Matsui Y. et al., 2019; Chai W. et al., 2021). The positive effects of arthroplasty are indisputable, yet it is also associated with severe complications. Aseptic loosening, wear of prosthetic components, and purulent-septic processes dominate the list of complications from this surgery, and their frequency shows no significant trend toward reduction (Zanirato A. et al., 2018; Blanco J.F. et al., 2020; Pomeroy E. et al., 2020). Disorders of immune function may also underlie negative outcomes of knee arthroplasty (Liu Y. et al., 2021).

Both the degenerative-dystrophic disease of the joint and the surgical stress affect the immune system. This creates conditions for secondary immunosuppression, which can lead to infections at the surgical site or aseptic loosening of the implant components (Zhou K. et al., 2018).

Knee arthroplasty can be accompanied by thromboembolic complications, for which prophylactic measures such as anticoagulant therapy, early patient mobilization, physical therapy, and the use of compression garments are recommended. Special emphasis is placed on exercises and the use of additional devices to improve venous outflow. A serious complication like pulmonary embolism may occur in 0.9–28% of patients, with a fatal outcome in 0.1–2% of cases (Yershov D.S. et al., 2015; Bozhkova S.A. et al., 2018).

Preventive measures and the use of direct thrombin inhibitors help reduce the risk of thromboembolic complications (Kopenkin S.S., Skoroglyadov A.V., 2009; Minasov T.B. et al., 2011; Cohen A.T. et al., 2008; Badimon L., Vilahur G.,

2015). It is also noteworthy that significant bleeding, sometimes reaching 20–40% of the circulating blood volume, can occur during TKA (Nakopiya V.B. et al., 2017). During knee arthroplasty, blood loss can range from 570 to 2500 ml (Chugaev D.V. et al., 2017).

Annually, implant designs are improved with consideration of the biomechanics of the knee joint. Researchers propose new design solutions for creating prostheses using modern advancements (Higuera C.A., Deirmengian C., 2012; Hoffart H.E. et al., 2015; Patrick N.J. et al., 2021).

Current requirements for modern implant designs include the feasibility of maximum bone preservation; alignment of the range of motion in the prosthesis with the biomechanics of knee movements; a minimal coefficient of friction; bioinertness of materials, etc. (Tkachenko A.N. et al., 2022; Kim Y.H. et al., 2012; Keyes B.J. et al., 2013; Jones C.W., Jerabek S.A., 2018).

The success of knee prosthesis depends on restoring its kinematics as closely as possible to normal; the proper placement of the prosthesis; and restoring muscle balance. The duration of the prosthesis's functioning primarily depends on the correspondence of the prosthetic elements to the anatomical structure of the joint, without causing significant adaptive remodeling of the bone and soft tissues during loads and movements (Steiger R.N. et al., 2015).

D.H. Lin et al. (2008) report on faster recovery of knee function and walking after minimally invasive interventions compared to standard TKA methods, highlighting differences in muscle strength and walking speed between patients with minimally invasive arthroplasty and those who underwent anterolateral access (Lin D.H. et al., 2007; Kim K.T. et al., 2015).

During the first year after surgery, patients with mini-incisions exhibited significantly greater muscle strength and walking speed, and other functional outcomes were also better. After one year, these characteristics were statistically equivalent. According to the authors, although the mini-incision is a more complex intervention than the conventional technique, its use by experienced surgeons facilitates faster recovery (Lin D.H. et al., 2007).

In contrast, research by D. Bennett et al. (2007) conducted two days post-surgery shows no functional advantages of minimally invasive incisions (n = 43) compared to standard incisions (n = 52) regarding early ambulation (Bennett D., 2007).

Additional tissue trauma negatively impacts further joint function and increases the risk of infectious complications by disrupting blood circulation, forming soft tissue cavities, and causing tissue necrosis (Petersen M.K. et al., 2011; Lenguerrand E. et al., 2016; Trevisan C. et al., 2017; Chughtai M. et al., 2019; Winther S.B. et al., 2019). Active discussions in the literature are ongoing regarding the advantages of specific approaches in terms of better stability of the arthroplasty (Bouchet R. et al., 2011; Hailer N.P. et al., 2012; Maratt J.D., 2016).

1.2. Premature Knee Joint Replacement as One of the Causes of Negative Long-Term Outcomes After Surgery

The outcomes of knee arthroplasty depend on many factors: the age of the patient, the presence of excess body weight, significant comorbidities, the type of implant, the method of fixation, and others (Zagorodny N.V. et al., 2011; Mironov S.P. et al., 2014; Khaidarov V.M. et al., 2021; Aliev B.G. et al., 2022; Paxton E.W. et al., 2015).

The results of knee arthroplasty, particularly the development of postoperative knee joint contractures, are influenced by preoperative structural and functional changes in the joint, as well as patient-related extrajoint factors such as age, sex, patient expectations from surgical treatment, and comorbidities. To date, none of these factors have been proven to be guaranteed predictors of residual pain, the development of postoperative contracture, or improvement in the functional capabilities of the operated joint. Female sex is considered a factor that potentiates postoperative knee joint stiffness and pain. Several studies have shown that complications that worsen surgical outcomes occur significantly more often in female patients after knee arthroplasty. For instance, two years after knee

arthroplasty, women experience pain syndrome 45% more frequently than men (Bonnin M.P. et al., 2011; Cherian J.J. et al., 2015; Choi Y-J., Ra H.J., 2016).

Reviews of data on the frequency and structure of complications from knee arthroplasty have been published in the open literature (Aliev B.G. et al., 2021; Tkachenko A.N. et al., 2022). Some authors consider the age of patients to be a risk factor for the development of complications from knee arthroplasty. The procedure is usually performed in older age: the average age of patients with deforming osteoarthritis of the knee joint is about 70 years (Carr A.J. et al., 2012). Such patients are generally characterized by a sedentary lifestyle; nearly half of them are overweight or obese and suffer from hypertension, with up to 16% having diabetes (Murphy L., Helmick C.G., 2012; Shan L. et al., 2015).

However, despite older patients (over 75 years) being significantly more likely to have comorbidities and longer hospital stays after knee arthroplasty, and this age group also showing higher mortality rates, meta-analysis results have not revealed significant differences in the frequency of pain syndrome and functional outcomes between patients with varying degrees of comorbidity (Kuperman E.F. et al., 2016). In the study by J.F. Maempel et al. (2015), it was demonstrated that patients over 80 years old after primary knee arthroplasty experience recovery of joint function and quality of life much faster than younger patients.

A high frequency of negative outcomes from knee arthroplasty associated with idiopathic osteoarthritis was noted in 661 patients of average age (about 54 years) by J. Parvizi et al. (2014). More than a third of the operated patients experienced persistent pain syndrome, joint swelling, and clicking during movement. Contracture was determined in more than 40% of patients.

In the study by J. Klit et al. (2014), it was found that among 136 patients under the age of 60, the satisfaction level with the surgical treatment, i.e., alignment with expectations, was only 68%. Consequently, the indications for primary knee arthroplasty in young and/or active patients need to be adjusted to limit them (Canovas F., Dagneaux L., 2018).

Patients with a high body mass index (BMI) present a particular problem in knee arthroplasty. A significant number of researchers report unsatisfactory functional results and quality of life in patients with a BMI over 40 kg/m² (Hofstede S.N. et al., 2016; Romero J.A. et al., 2017).

In patients with obesity not exceeding grade I, knee arthroplasty usually shows more significant functional improvement than in patients with normal body weight (Bin Abd Razak H.R. et al., 2013; Parratte S. et al., 2014). Moreover, in two-thirds of patients (2090 out of 3036), a decrease in BMI was noted during the postoperative period, positively impacting functional outcomes. Predictors of weight loss included female sex, high preoperative BMI, and the surgery itself. Interestingly, in the group of patients after primary knee arthroplasty, postoperative weight loss was observed in only 17% of cases (2850 out of 3893 patients) (Ast M.P. et al., 2015).

Similar data on the influence of increased body weight and obesity on functional outcomes of knee arthroplasty were obtained by H.B. Si et al. (2015). The authors conducted a meta-analysis of 28 studies involving 20,988 patients. In the postoperative period, there was a trend towards a decrease in the Knee Society Score (KSS) in obese patients (BMI ≥ 30 kg/m²), which was not observed in patients without obesity (BMI < 30 kg/m²). However, in the long-term after surgery (≥ 5 years), patients with grade III obesity developed deep vein thrombosis and superficial soft tissue infections significantly more often than those with normal body weight. In patients with grade III obesity (BMI ≥ 40 kg/m²), the incidence of deep soft tissue infections was significantly higher. At the same time, the presence of obesity did not affect the frequency of aseptic instability of the prosthesis, pulmonary embolism, and postoperative mortality within the follow-up period of ≥ 5 years (Si H. et al., 2015). Some authors regard grade III obesity as a prognostically unfavorable factor for knee arthroplasty (Dowsey M.M. et al., 2016).

As criteria for predicting negative outcomes of knee arthroplasty, some specialists note issues related to the psycho-emotional status of the patient

(Giesinger K. et al., 2014; Dowsey M.M. et al., 2016; Van Onsem S. et al., 2016). Patients with a high level of preoperative depression tend to experience a subjective lack of clinical effect despite good objective results (Ellis H.B. et al., 2012).

At the same time, the function of the operated joint influences the state of the musculoskeletal system (Coulter C.L. et al., 2009). Despite successful outcomes from postoperative kinesitherapy, restoring the strength of the quadriceps muscle to nearly the level of healthy subjects in the control group, many patients retained a pathological movement pattern with asymmetry in gait parameters on flat surfaces and during stair climbing, and incorrect execution of the sit-to-stand test (Yoshida Y. et al., 2008; Alnahdi A.H. et al., 2011). These asymmetrical movement patterns are associated with increased load on the unoperated knee joint, potentially leading to clinically significant progressive osteoarthritis of the contralateral knee joint. In the absence of correction of the pathological movement pattern, even patients with initially clinically healthy contralateral knee joints may require further arthroplasty (Milner C.E., O'Bryan M.E., 2008; Yoshida Y. et al., 2008; McClelland J. et al., 2012) as early as 5 years after the first surgery.

Within 10 years after primary knee arthroplasty, 40% of patients require arthroplasty of the contralateral knee joint (Santana D.C. et al., 2020). Therefore, an important marker of long-term functionality of the contralateral knee joint is the preservation of its functional capabilities, especially in the first 3 years after arthroplasty (Alnahdi A.H. et al., 2011; Bayrama U. et al., 2014).

According to the research by T.A. Kilmetov et al. (2015), in cases of surgical site infection after large joint arthroplasty, it is advisable to investigate the immune status of patients (immunoglobulins A, G, percentage of phagocytes, and phagocytic index) with subsequent pharmacological correction of immune status (Kilmetov T.A. et al., 2015). N.M. Klyushin et al. (2015) report that acute-phase clinical and biochemical indicators (specifically, C-reactive protein) allow for monitoring and predicting the course of the reparative process in patients with

surgical site infections. This can help prevent recurrence of the infectious-inflammatory process due to timely interventions (Klyushin N.M. et al., 2015).

According to S.G. Kim et al. (2017), for the diagnosis of periprosthetic infection, parameters such as the number of leukocytes in the synovial fluid and C-reactive protein levels in serum may be useful between the 1st and 3rd weeks after primary knee arthroplasty (Kim S.G. et al., 2017). C-reactive protein, procalcitonin, interleukin-6, and immunoglobulin G are used as biochemical markers of inflammation in periprosthetic infection; however, there is no literature on the informativeness of indicators of inflammatory process activity and cartilage tissue destruction (glycoproteins, chondroitin sulfate, colloidal sediment tests) for early diagnosis of periprosthetic infection.

It is essential to consider that a patient (even in the absence of complications) may be dissatisfied with the outcome of arthroplasty for various reasons: due to persistent syndrome, incomplete functional recovery, or inflated expectations regarding outcomes (Reva M.A., Chegurov O.K., 2013; Kavalersky G.M. et al., 2018; Aliev B.G. et al., 2023; Neuprez A. et al., 2016; Halawi M.J. et al., 2019).

Orthopedic trauma surgeons, in their daily practice, take into account many factors (often subjective) when deciding to perform knee arthroplasty: the stage of osteoarthritis, the duration and intensity of pain syndrome, its sensitivity to therapy, comorbidities, degrees of limitation in daily activities, patient desires, the surgeon's experience, and others (Hawker G. et al., 2015; Hofstede S.N. et al., 2016). In the presence of immune system dysfunction, some specialists do not recommend performing knee arthroplasty (Vorokov A.A. et al., 2020; Mansurov D.Sh. et al., 2021). L.B. Gaikova et al. (2018) demonstrated that a reduced number of B-lymphocytes is a prognostically unfavorable criterion for developing surgical site infections in orthopedic surgeries. J.A. Singh et al. (2013) recommended limiting knee arthroplasty in patients with rheumatoid arthritis while expanding indications for idiopathic osteoarthritis (Singh J.A. et al., 2013). Similar

recommendations have been made by other researchers (MacKenzie R.C. et al., 2018).

A number of researchers (cited by Tkachenko A.N. et al., 2022) concluded, after studying the economic efficiency of arthroplasty, that economic effectiveness is achieved only in patients with end-stage osteoarthritis (Kamaruzaman H. et al., 2017). Methods for assessing the results of arthroplasty are currently ambiguous, determined by differing approaches to the procedures, various types of implants used, and the lack of a universally accepted method for evaluating treatment outcomes (Kavalersky G.M. et al., 2015; Moisov A., Sereda A., 2018; Parvizi J. et al., 2011; Paxton E.W. et al., 2015).

British researchers A. Moorhouse and G. Giddins (2018) emphasize the current predominance of subjective criteria determining indications for arthroplasty in osteoarthritis (Moorhouse A., Giddins G., 2018). Similar findings have been presented by New Zealand specialists (Maillefert J.F. et al., 2008).

Domestic researchers also present similar data. A.V. Lychagin et al. (2019), studying the justification for performing knee arthroplasty in older patients, believe that in 40% of cases, the surgery was unjustified, indicating excessively aggressive surgical tactics. These specialists developed their method for determining indications for knee arthroplasty based on assessing the degree of the dislocation syndrome (scoring from 0 to 20). Based on the score, indications for knee arthroplasty are determined: surgery is recommended for scores of 13 and above, while scores of 12 or less suggest conservative treatment. Similar results have been published abroad. The percentage of unjustified knee arthroplasties in the USA is around 30% (Riddle D.L. et al., 2014). There are also other studies on this issue: according to these specialists, knee arthroplasty is unjustified in 7–34% of cases (Ghomrawi H.M. et al., 2014; Franklin P. et al., 2015). On the other hand, some authors report that 82% of patients who underwent hip and knee arthroplasty do not restore physical activity. Their lifestyle remains "sedentary" (Arthursson A.J. et al., 2007; Harding P. et al., 2014).

A.M. Lila et al. (2021) consider that knee arthroplasty is a multidisciplinary problem that should involve specialists from various fields. The coordinating role in this belongs to primary healthcare specialists, whose responsibilities include first contact with the patient and organizing interaction with other specialists.

Currently, many researchers believe that joint replacement with an implant should be postponed as much as possible, especially for young and middle-aged individuals. These authors recommend increasing attention to modern non-operative techniques and organ-preserving surgeries (Nazaro E.A. et al., 2016; Fedorov R.E. et al., 2018; Lychagin A.V. et al., 2019; Aliev B.G. et al., 2021; Dabare C. et al., 2017). A year after knee arthroplasty, 12–30% of patients are dissatisfied with the outcome. This is generally explained by inflated patient expectations. The longer the time that passes since the arthroplasty, the worse the functional outcomes and the lower the quality of life of the patient (Halawi M.J. et al., 2019).

A large number of surgeons believe that conservative treatment methods for patients with joint diseases are underutilized (Selten E.M. et al., 2016; Dabare C. et al., 2017; Abbate L.M. et al., 2018). In the UK, a national registry has been created for patients who have undergone organ-preserving interventions on joints (without arthroplasty) (15th Annual Report, 2018). The authors provide data on the effectiveness of organ-preserving interventions in improving functional outcomes and the quality of life of patients (Humphrey J.A. et al., 2018). According to these specialists, arthroscopic interventions, tunneling, the use of electrostatic fields of electrets, and other operations slow the progression of osteoarthritis and make it possible to postpone arthroplasty (Vansovich D.Yu. et al., 2021; Yasunaga Y. et al., 2016).

Thus, modern prostheses and computer navigation have been developed. On the other hand, the number of patients dissatisfied with the long-term results of knee arthroplasty is increasing. The primary reason for this is premature joint replacement, unjustified expansion of indications for this type of surgical intervention, which, in turn, leads to an increasing number of complications. The

number of revision surgeries is increasing, as is the frequency of forming a vicious circle, leading to a decline in the quality of life of the patient. All of the above confirms the need for research to determine the role of arthroplasty in the treatment of patients with knee osteoarthritis.

1.3. Ways to Improve the Outcomes of Knee Joint Replacement with Implants in Osteoarthritis

Unsatisfactory outcomes of knee arthroplasty are due to many factors, including insufficient surgical planning, intraoperative and postoperative complications, the development of infections, non-compliance with rehabilitation protocols by patients, aseptic instability, and others (Dzhigkaev A.Kh., 2013; Kavalersky G.M. et al., 2017; Smetanin S.M., Kavalersky G.M., 2017).

Currently, in 92% of cases, knee arthroplasty is associated with the elimination of pain syndrome, increased range of motion, and improved quality of life for patients for more than 15 years (Argenson J.-N. et al., 2013; Putman S. et al., 2018). However, even with highly professional surgical interventions, the number of complications and unsatisfactory outcomes of knee arthroplasty remains significant, reaching 3.3–13.2% (Petukhov A.I., 2010; Reilly K. et al., 2007; Siebold R. et al., 2007; Murphy L., Helmick C.G. et al., 2012; Harding P. et al., 2014; Lutzner C. et al., 2016).

The number of revision surgeries for knee joints is also increasing, accounting for 3.3–10.8% of the total number of arthroplasty operations performed (Zagorodniy N.V. et al., 2011; Voss B. et al., 2016; Gwam C.U. et al., 2018; AbuMoussa S. et al., 2019). Every fifth patient remains dissatisfied with the results of knee arthroplasty (Abdel M.P. et al., 2014). Typically, physical activity after knee arthroplasty decreases (Loughead J.M. et al., 2008; Messier S.P. et al., 2015; Gaffney B.M. et al., 2016; Van der Wees P.J. et al., 2017).

Objective indicators of the functional state of the musculoskeletal system, such as walking distance over a specific time, transitioning from rest to movement (standing up from a chair), and walking characteristics while climbing stairs,

improve only slightly after surgery (Belova A.N., Shchepetilova O.N., 2002; Smetanin S.M., Kavalersky G.M. et al., 2017; Stratford P.W., Kennedy D.M., 2006; Mizner R.L. et al., 2011).

At the same time, patients after arthroplasty still experience limitations in knee joint function (Abelevech O.M. et al., 2018; Ellis H.B. et al., 2012; Sanguineti F. et al., 2014). A year after knee arthroplasty, walking speed on flat surfaces decreases by 15% (Walsh M. et al., 2008; Bayrama U. et al., 2014), and by 50% while climbing stairs (Milner C.E. 2009; Lindberg M.F. et al., 2017) compared to an age-matched control group without clinical symptoms. These changes in the functional capabilities of patients after knee arthroplasty are directly related to chronic reductions in lower limb muscle strength, especially the extensor muscles of the affected knee joint (Meier W. et al., 2008; Stevens-Lapsley J.E. et al., 2010; Yoshida Y. et al., 2013).

Muscle weakness in the lower limbs is characteristic of patients with knee osteoarthritis, and this is exacerbated in the postoperative period, with a 60% decrease in quadriceps strength during the first month after surgery (Stevens J.E. et al., 2003; Bade M.J. et al., 2010). Additionally, there is a verified loss of about 20% of quadriceps strength due to limited mobility and, consequently, reduced physical activity of patients in the early postoperative period (Rossi M.D. et al., 2006). This muscle dysfunction can persist for up to one year after the operation (Bayrama U. et al., 2014; Henderson K.G. et al., 2018).

Subsequently, lower limb muscle strength may increase; however, recovery to the level of the contralateral limb or that of orthopedically healthy peers is rare (Christensen J.C. et al., 2018). Nevertheless, alleviating pain syndrome allows for increased physical activity among patients after knee arthroplasty. Regular physical activity is one of the most important outcomes of joint replacement, potentially enhancing the prognosis of comorbid conditions such as obesity, diabetes, and hypertension (Da Silva R.R. et al., 2014). Increased physical activity may also potentially improve overall health (Kane R.L. et al., 2005).

Currently, an important component in evaluating surgical outcomes is the patients' perceptions of their functional capabilities after surgery, changes in quality of life post-arthroplasty, and their level of satisfaction with preoperative expectations. The latter is assessed using the Hospital for Special Surgery (HSS) Knee Replacement Expectations Survey and the Forgotten Joint Score (FJS-12) scale to evaluate the outcomes of knee arthroplasty and patients' expectations from the surgical intervention (Behrend H. et al., 2012).

Most patients undergoing primary knee arthroplasty have significant limitations in joint function and the overall musculoskeletal system. Typically, patients have much greater expectations from arthroplasty than the surgeons performing the procedure. This discrepancy between expected outcomes and the actual results of surgical treatment necessitates clarification before surgery to ensure a sufficient level of postoperative satisfaction from patients, which can be achieved, in part, through preoperative education (Westby M.D. et al., 2010; Pua Y.H. et al., 2016; Lindberg M.F. et al., 2017).

However, in cases where patients are informed about the possibility of residual functional limitations, their expectations from the surgery are usually higher than their postoperative satisfaction. This thesis is supported by research results indicating that 87.3% of patients were satisfied with the outcome of knee arthroplasty one year after the operation, a similar percentage of patients were satisfied with pain intensity reduction (86.2%), while a lesser number were satisfied with the improvement of the operated knee joint function (79.0%) (Baker P.N. et al., 2007; Bourne R.B. et al., 2010; Scott C.E. et al., 2010).

Patients often expect to forget about the artificial joint and return to their usual lifestyle. The FJS-12 scale allows for a fairly accurate assessment of a patient's return to normal physical activity. This scale exhibits high probability and sensitivity indicators, as well as consistency in questions, and thus effectively captures functional changes in patients after knee arthroplasty. It allows for monitoring long-term outcomes of joint replacement, especially in groups with favorable surgical treatment results (Hamilton D.F. et al., 2017).

Among the various assessed factors affecting quality of life, the functional capabilities of the knee joint and, accordingly, the musculoskeletal system as a whole are prioritized by most patients. The results of assessing knee joint function using WOMAC and quality of life assessments with SF-36/SF-12 questionnaires in the preoperative and immediate postoperative periods are generally encouraging. Significant improvements in joint function occur as early as four weeks after knee arthroplasty with active use of the operated lower limb in locomotor activities (walking, climbing stairs, standing, body turns) (Gaweł J. et al., 2010).

O. Bruyère et al. (2012) noted a continuous improvement in physical function and emotional state from 6 weeks to 7 years (the end of the observation period) after surgery (Bruyère O. et al., 2012). E. Kilic et al. (2009) also observed progressive improvement in joint function at 6 weeks and 6 months post-surgery based on KSCRS and SF-36 questionnaires.

A positive correlation was found between the increase in functional capabilities and the improvement in quality of life, as well as improvements in dynamic postural balance parameters (Schwartz I. et al., 2012). However, despite improvements in function and excellent clinical outcomes for most patients, many do not reach the level of physical activity seen in healthy individuals (Brandes M. et al., 2011). The level of physical activity among patients after surgical treatment is more closely related to regular physical activity before the operation than to the prosthetic procedure itself (Da Silva R.R. et al., 2014).

It is possible that a sedentary lifestyle prior to surgery contributes to significant declines in functional capacity post-knee arthroplasty, even with reduced pain intensity and depression levels in some patients (Fitzgerald J.D. et al., 2004; Papakostidou I. et al., 2012), which increased their dependence on others, primarily family support (Fitzgerald J.D. et al., 2004). Reduced pain intensity is another factor that significantly affects the improvement of quality of life indicators (Kilic E. et al., 2009; Nunez M. et al., 2009; Ko Y. et al., 2011; Papakostidou I. et al., 2012). Pain relief is observed as early as 1 (Fitzgerald J.D. et al., 2004), 4 (Argenson J.N. et al., 2013), or 6 (Papakostidou I. et al., 2012) weeks

after surgery, and this effect persists for up to seven years after knee arthroplasty (Nunez M. et al., 2009). However, in some cases, after impeccably performed procedures, patients report pain in the knee joint during the postoperative period. One of the most significant predictors of persistent pain syndrome is the intensity of preoperative pain (regardless of the severity of clinical-radiological manifestations of knee osteoarthritis), as well as arthralgia in other locations (Ackerman I.N. et al., 2012; Messier S.P. et al., 2015).

It should be noted that the causes of residual pain and unsatisfactory knee function in the postoperative period are not only orthopedic factors (structural-functional changes in the knee joint under load) (Nunez M. et al., 2009) but also the presence of depression (McHugh G.A. et al., 2008), the level of social support (Ko Y. et al., 2011), and regular physical activity in the preoperative period (Nunez M. et al., 2009; Ackerman I.N. et al., 2012).

The presence of postoperative knee pain can be recorded throughout the observation period with considerable variability. Six months after knee arthroplasty, 25.1% of 792 patients reported maintaining preoperative pain levels on the WOMAC scale, with a result uncertainty of 24.1% (the number of patients not participating in the follow-up survey) (Quintana J.M. et al., 2006). Other researchers also using the WOMAC scale after primary knee arthroplasty reported the following results: 13.9% of 411 patients had persistent pain after 26 months (with a result uncertainty of 19.7%) (Czurda T. et al., 2010); 8.0% of 88 patients after 36 months, with 23.9% respectively (Nunez M. et al., 2007); and 14.3% and 54.7% of 1394 patients respectively after 41 months post-surgery (Wylde V. et al., 2011).

In studies on total knee arthroplasty using other indices reflecting pain intensity, heterogeneous results have also been obtained. Using KOOS, after 60 months post-surgery, 26.5% of 102 patients (with an uncertain result of 27.5%) reported pain of equal or greater intensity than before surgical treatment (Nilsdotter A.K. et al., 2009).

The largest sample was noted in a study by V.A. Brander et al. (2003) using VAS: among 36,116 patients, 12.9% reported persistent pain in the operated knee joint after 12 months, with an uncertain result of 2.7%. Approximately 1 in 8 patients report significant pain intensity one year after surgery, despite the absence of clinically and/or radiologically significant changes in the operated joint (Brander V.A. et al., 2003). Thus, the frequency of pain syndrome after knee arthroplasty varies widely—from 8.0% to 26.5% of observations (Beswick A.D. et al., 2012).

However, standard definitions of pain syndrome indicators are complicated (MacKichan F. et al., 2008) because the literature investigates various characteristics: lack of positive dynamics in postoperative pain intensity; presence of pain at rest; presence of persistent pain; presence of night pain. As noted, the absence or significant reduction in postoperative pain intensity significantly influences the outcome of surgical treatment and determines patient satisfaction with the results of knee arthroplasty.

Moreover, patient satisfaction with their expectations is closely linked to their ability to carry out daily activities. In addition to the aforementioned capabilities, preoperative patient expectations correlate with the ability to walk up and down stairs (correlation coefficient F = 7.66), get in and out of a car (F = 7.53), walk and stand (F = 10.70), move sideways (F = 7.23), and squat (F = 11.98) (Nakahara H. et al., 2015). The realization of these expectations is especially important for younger and more active patients (Canovas F., Dagneaux L., 2018).

According to several authors, the development of complications is predisposed by complex surgical techniques, previous surgical interventions on the knee joint, and the inability to conduct comprehensive postoperative rehabilitation, among other factors (de Carvalho Júnior L.H. et al., 2013; Patel R. et al., 2016; Rothenberg A.C. et al., 2017; Goh G.S., 2021).

For instance, knee arthroplasty in patients with significant flexion contractures requires substantial resection of the articular ends of the femur and tibia. Additionally, simultaneously correcting a flexion contracture poses a risk of

complications related to vascular-nervous bundles due to overstretching (Liu H.X. et al., 2016).

A direct relationship has been established between the degree of inflammatory activity and the presence of severe joint deformities in the extremities, indicating the need for functional activity studies of peripheral blood phagocytes in patients indicated for joint arthroplasty (Marchand R.C. et al., 2018).

This suggests that to prevent postoperative complications, particularly purulent-septic complications of arthroplasty, careful surgical and rationally planned immunological examination of patients is necessary, aimed at identifying and analyzing mechanisms of immune imbalance.

Properly selected immunocorrective therapy contributes to improved surgical treatment outcomes by reducing the rate of postoperative complications and enhancing patients' quality of life. K. Maniwa et al. (2013) reported the development of purulent complications in 9% of patients, while component instability of the prosthesis occurred in 5.8% of patients within the first 5 years post-surgery (Maniwa K. et al., 2013).

A literature review by P.P. Purudappa et al. (2020) shows that the incidence of purulent complications after knee arthroplasty ranges from 2% to 4%, with 67% of cases of suppuration developing in the late postoperative period (Purudappa P.P. et al., 2020). Implant instability is one of the most common complications of knee arthroplasty. The frequency of aseptic implant instability increases significantly after 10 years post-surgery, reaching 8% (Schwartz C. et al., 2019). Femoro-tibial instability is a cause of instability in 10–30% of cases (Kuriyama S. et al., 2017; Gu S. et al., 2019). Biomechanical and inflammatory causes of prosthetic loosening are considered to be of utmost importance (Koronilov N.N. et al., 2018; Solarino G. et al., 2014; Abdel M.P. et al., 2018; Purudappa P.P., 2019).

In rheumatoid arthritis, knee joint damage manifests as contracture formation and the development of discordant deformities of the lower limbs, leading to a reduction or loss of lower limb function (Zhizhenkova T.V. et al., 2015). Valgus and varus deformities of the knee are among the complex frontal

deformities of the lower limb. Over time (depending on the degree of deformation), frontal deformities lead to the destruction of the outer or inner pair of knee condyles (femur and tibia), resulting in patient disability (Galashina E.A. et al., 2018; Allahverdyan S.A. et al., 2020).

The presence of a functional component of the knee joint (healthy or functioning) ensures stable support and promotes the possibility of rehabilitation measures. The functional asymmetry of the knee joint reflects the functional performance of the lower limb, which is often associated with deformations and dysfunctions in adjacent structures. Therefore, restoration of the leg axis is an important step towards effective rehabilitation and improvement of the patient's quality of life (Fayazi M. et al., 2019).

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A literature review by P.P. Purudappa et al. (2020) shows that the incidence of purulent complications after knee arthroplasty ranges from 2% to 4%, with 67% of cases of suppuration developing in the late postoperative period (Purudappa P.P. et al., 2020). Implant instability is one of the most common complications of knee arthroplasty. The frequency of aseptic implant instability increases significantly after 10 years post-surgery, reaching 8% (Schwartz C. et al., 2019). Femoro-tibial instability is a cause of instability in 10–30% of cases (Kuriyama S. et al., 2017; Gu S. et al., 2019). Biomechanical and inflammatory causes of prosthetic loosening are considered to be of utmost importance (Koronilov N.N. et al., 2018; Solarino G. et al., 2014; Abdel M.P. et al., 2018; Purudappa P.P., 2019).

In rheumatoid arthritis, knee joint damage manifests as contracture formation and the development of discordant deformities of the lower limbs, leading to a reduction or loss of lower limb function (Zhizhenkova T.V. et al., 2015). Valgus and varus deformities of the knee are among the complex frontal deformities of the lower limb. Over time (depending on the degree of deformation), frontal deformities lead to the destruction of the outer or inner pair of knee condyles (femur and tibia), resulting in patient disability (Galashina E.A. et al., 2018; Allahverdyan S.A. et al., 2020).

The etiological factors for the onset and progression of valgus and varus deformities are diverse. However, as noted by many researchers, in recent years, the most common cause of frontal deformities of the knee joint (KJ) is the imbalance between the biological resilience of tissues and mechanical load. The state of the joint tissues depends more on the magnitude of the load than on metabolic factors, as confirmed by several researchers (Avrunin A.S., Doktorov A.A., 2016; Lisitsyna E.M. et al., 2016; Marchand R.C. et al., 2018).

Both Russian and international studies have demonstrated that the role of surgical intervention significantly increases with the development of functionally unfavorable deformities of the KJ. In the later stages of the disease, eliminating numerous deformities and restoring the load-bearing function of the knee joints and lower limbs is only possible through arthroplasty (Chou P.H. et al., 2012; Skyttä E.T. et al., 2012; Niki Y. et al., 2015).

A review of the literature indicates that issues surrounding unsatisfactory outcomes of total knee arthroplasty (TKA) are actively discussed by researchers worldwide. Several main causes are identified that accelerate the development of aseptic instability of the prosthetic components: excess body weight, osteoporosis, and young patient age (Putman S. et al., 2019; Doman D.M. et al., 2021).

Significant attention is given to joint lesions of rheumatic origin. A substantial reduction in bone mineral density has been observed in patients with rheumatoid arthritis even at a young age. The risk of fractures due to osteoporosis

increases in 11.34% of patients with rheumatoid arthritis (Danylyak V.V. et al., 2015).

Factors influencing the state of bone tissue in patients with rheumatoid arthritis include the intake of glucocorticoid medications; the age at which the disease began; the degree of functional impairment of the musculoskeletal system; and disease activity (Gavrilov M.A., 2012).

Choosing the optimal surgical approach during knee joint arthroplasty is crucial, especially in cases of significant movement limitation, reduced elasticity of soft tissues, as the standard anterior approach can limit the surgical field. There are many methods for assessing the outcomes of knee arthroplasty; however, none is perfect or universally accepted.

One such method was adopted by the Knee Society (Abdel M.P., Haas S.B., 2014; Haidukewych G.J. et al., 2014). Another international classification of functional outcomes for knee arthroplasty was established at an international symposium in Vienna (Ahmed G.O. et al., 2020). The 100-point scale for knee arthroplasty outcomes is also widely used (Riddle D.L., Perera R.A., 2017).

Most orthopedic surgeons agree that good long-term results range from 75% to 90%. T. Griffin et al. reported on a long-term study of knee joints following arthroplasty (Griffin T. et al., 2007). The survival rate of prosthetics beyond 10 years was documented in 85-95% of patients.

An analysis of prosthetic survival in 11,606 cases at the Mayo Clinic showed that after 10 years, good results were noted in 91%, after 15 years in 84%, and after 20 years in 78% of cases. For patients under 55 years old, the survival rate after 10 years was 83%, while for those over 70, it was 94%. Cemented prosthetics maintained functionality in 92% of cases, while cementless prosthetics had a 61% survival rate (Rand J.A. et al., 2003). According to M.A. Mont et al. (2017), patients undergoing total knee arthroplasty with cementation may be at risk of lower implant survival and higher revision rates due to the prevalence of aseptic loosening and instability in this cohort (cited by A.N. Tkachenko et al., 2022).

Literature analysis shows that knee arthroplasty is one of the most effective and promising methods for restoring knee function. Despite significant advancements in knee arthroplasty, many questions remain unresolved. The most common complications of TKA include infection at the surgical site, implant instability, component wear, and the progression of degenerative-dystrophic changes in bone tissue (Vorokov A.A. et al., 2020). The development of complications is also facilitated by the progression of osteoporosis, periprosthetic fractures, infections, and pain syndromes. The main types of revision surgeries are total arthroplasty and tibial component replacement.

At the same time, the literature insufficiently addresses the possibilities for predicting and preventing negative outcomes of TKA. Thus, the relevance of knee arthroplasty in cases of significant flexion contractures and axial deformities in the knee joint becomes critical, requiring in-depth study of the structural-functional state of bone tissue and preventive measures aimed at improving its condition.

Thus, according to several specialists, TKA is advisable only when modern non-operative treatment methods are ineffective and after utilizing the potential of organ-preserving interventions (Dabare C. et al., 2017; Bannuru R.R. et al., 2019). In summary, modern views on treating OA of the knee joint suggest an individualized approach that combines conservative and surgical methods. Replacing the knee joint with a prosthetic is not considered an organ-preserving intervention, and some authors believe that total TKA is a disabling operation (Baranovsky A.A. et al., 2023; Tkachenko A.N. et al., 2023).

Many researchers agree that in the absence of significant structural changes in the joint that cause instability, comprehensive treatment should begin with conservative methods, which would allow for delaying TKA. Further, in the treatment process, in cases of pronounced pain syndrome, joint deformity, or persistent contracture (especially in young, physically active patients), it is recommended to transition to organ-preserving surgical methods (arthroscopy, tunneling, osteotomy, etc.). In this context, replacing the knee joint with an implant should be considered a last resort, primarily for older patients with significant

comorbidities that limit the use of conservative methods. At the same time, the criteria for selecting patients for surgical treatment of knee osteoarthritis need further specification.

CHAPTER 2 GENERAL CHARACTERISTICS OF CLINICAL OBSERVATIONS AND RESEARCH METHODS

2.1 General Characteristics of Clinical Observations

In this dissertation research, four tasks were set, for the resolution of which data from several groups of patients were studied. At the V.A. Baranov Republican Hospital in Petrozavodsk (hereinafter referred to as the hospital), primary total knee arthroplasty due to idiopathic osteoarthritis was performed on 378 patients aged 43 to 83 years (mean age 65.4 ± 5.5 years) from 2016 to 2019. The early postoperative mortality rate was 0.5% (2 cases out of 378). The dissertation analyzes data on all 376 patients who were discharged from the hospital. For inpatient conservative treatment of knee osteoarthritis (prior to hospitalization for arthroplasty), 107 patients (28.5%) were admitted to both therapeutic and orthopedic-traumatology departments. The remaining 269 patients (71.5%) received non-systematic outpatient treatment. All clinical observations, taking into account the age at the time of surgery, are divided into three groups (Table 2.1) (Spichko A.A. et al., 2021).

Table 2.1 – Classification of Patients Who Underwent Arthroplasty Due to Idiopathic Osteoarthritis of the Knee, Considering Age

Group	Patient Age (years)	Number of Observations, n (abs. %)
Young	18–44	1 (0.3)
Middle Age	45–64	154 (41)
Elderly	65 and older	221 (58.7)
Total		**376 (100)**

The majority of patients—155 (41.3%)—were of working age. Long-term outcomes after arthroplasty were evaluated from 2 to 8 years post-operation.

At the same time (from 2016 to 2019), the hospital treated 174 patients diagnosed with "knee osteoarthritis" using conservative methods, aged from 44 to

87 years (mean age 59.3 ± 7.3 years). Data on the age groups of patients with knee osteoarthritis are presented in Table 2.2.

Table 2.2 – Classification of Patients Undergoing Non-Surgical Treatment for Knee Osteoarthritis, Considering Age

Group	Patient Age (years)	Number of Observations, n (abs. %)
Young	18–44	20 (11.5)
Middle Age	45–64	83 (47.7)
Elderly	65 and older	71 (40.8)
Total		174 (100)

The number of working-age patients (59.2%) was higher than that of non-working-age patients (40.8%) (Table 2.2). However, these differences compared to the group of patients who underwent knee arthroplasty were not statistically significant ($p > 0.05$). Overall, both study groups (knee arthroplasty and conservative treatment for knee osteoarthritis) were comparable in age.

At the Peter the Great Hospital (the clinical base of the Department of Traumatology, Orthopedics, and Vascular Surgery at the North-Western State Medical University named after I.I. Mechnikov, Ministry of Health of Russia, hereinafter referred to as the clinic), 187 knee arthroplasty surgeries were performed in 2022 on patients with knee osteoarthritis. In 30 of these cases, a morphological study of the synovial membrane removed during arthroplasty was conducted. Histological examination of the removed elements was carried out on patients aged 40 to 76 years (19 women and 11 men) with knee osteoarthritis. All were selected using a complete sampling method.

In total, the study investigated data from several patient groups (Table 2.3). The number of clinical observations was sufficient, allowing the sample to be considered representative and the results reliable.

Table 2.3 – Data on the Main Groups of Clinical Observations Analyzed in the Study, Considering Its Objectives

No.	Clinical Observation Groups	Research Objectives	Number of Observations, abs.
1	Patients who underwent primary total knee arthroplasty at the V.A. Baranov Republican Hospital from 2016 to 2019	Analysis of functional outcomes and quality of life of patients	376
2	Patients who underwent conservative treatment for knee osteoarthritis at the V.A. Baranov Republican Hospital from 2016 to 2019	Study of long-term functional outcomes and quality of life of patients	174
3	Patients who underwent primary total knee arthroplasty at the Trauma and Orthopedics Clinic of the North-Western State Medical University named after I.I. Mechnikov in 2022	Morphological study of knee joint surfaces	30

2.2 Research Methods

All patients hospitalized in the hospital from 2016 to 2019 for primary total knee arthroplasty due to idiopathic osteoarthritis underwent a standard comprehensive clinical examination in accordance with federal and regional standards and recommendations.

Laboratory Research Methods

Laboratory studies of biological fluids were conducted for all patients in the retrospective group at the laboratory diagnostics department of the V.A. Baranov Republican Hospital (Petrozavodsk) (Table 2.4) (Spichko A.A. et al., 2021).

Table 2.4 – Laboratory Studies in Patients Who Underwent Primary Total Knee Arthroplasty

Analyzed Subject	Analysis Parameters	Research Method
Blood	General clinical analysis	Hematology analyzers Siemens Advia 1800 (Germany), Mindray BC6800 (China)
	Coagulogram (blood clotting time, fibrinogen level combined with fibrinolytic activity, prothrombin activity, plasma recalcification time)	Hemostasis analyzer Sysmex XN-1000 (Germany), Sysmex ACLTOP 500 (Germany)
	Biochemical analysis (glucose, urea, total protein, bilirubin, ALT, AST, amylase, alkaline phosphatase, creatinine, electrolytes: K+, Na+)	Beckman Coulter DxC 700AU analyzer (Japan)
	Blood loss volume	Gravimetric method to determine the amount of blood in the intraoperative surgical aspirator (Lebedeva M.N. et al., 2015)
Biological fluids or tissues from infection focus	Identification of microorganisms and their sensitivity to antibiotics	Growth on nutrient media, microscopy
Urine	Urinalysis, biochemical analysis	Urine analyzer Sysmex uc3500 (China)

Instrumental Research Methods

Before undergoing knee arthroplasty, all patients with knee osteoarthritis underwent X-rays of the knee joints. If necessary for differential diagnosis or to clarify the planned volume of surgery, as well as to assess the degree of joint destruction, CT or MRI was performed. To assess the condition of the gastric mucosa and the duodenum, all patients underwent esophagogastroduodenoscopy (EGDS). Ultrasound of the lower extremity vessels was performed to assess the condition of the deep veins of the lower extremities. Individual indications were used for abdominal ultrasound, ultrasound of the surgical area, and other studies (Table 2.5).

Table 2.5 – Instrumental Studies in Patients When Planning Knee Arthroplasty

Research Object	Type of Study	Research Method
Bones and joints, chest	X-ray	AXIOM Luminos dRF – X-ray system by Siemens (Germany), Shimadzu X-ray system (Japan)
Heart	Resting electrocardiography in 12 leads, functional stress tests if necessary	Nihon Konden ECG 1350K – 6-channel ECG by NIHON KOHDEN Corporation (Japan)
Abdominal cavity, joints, lower extremity vessels, neoplasms, soft tissues, surgical area	Ultrasound	Philips Ultrasound (USA)
Vessels	Duplex scanning of lower extremity veins	Philips Healthcare (USA)
Hollow organs	Esophagogastroduodenoscopy, Colonofibroscopy, Fibrobronchoscopy	FUJIFILM (Japan), Olympus BF-UC180F (video bronchoscope for upper respiratory tract diagnostics)
Bones, joints, soft tissues	Tomography	Canon Aquilion Prime SP CT (Japan)

Radiological examination evaluated the correctness of implant placement, signs of stability, degree of bone tissue resorption, and presence of debris syndrome. Clinical-radiological classification by N.S. Kosinskaya (1961) was used for staging the pathological process. Special attention was paid to studying the interaction between implant and bone, as well as implant migration. Changes in bones and soft tissues in cases of peri-implant infection were also studied. Fistulography was performed in cases of periprosthetic infection.

Other studies were conducted to clarify the nature and severity of comorbidities.

Methodologies for Assessing Results of Knee Arthroplasty in the Postoperative Period

Functional Outcomes. Clinical assessment (pain, stiffness, function, and health status) of results from knee arthroplasty and conservative treatment for knee osteoarthritis was performed using the WOMAC scale (Western Ontario and McMaster University Osteoarthritis Index) (Bellamy N. et al., 1988). The WOMAC questionnaire is designed for patient completion and consists of 24 items divided into three subscales: pain (5 questions), stiffness (2 questions), and physical function (17 questions). The responses reflect the patient's condition over the previous two days on a five-point scale: 0 – none; 1 – mild; 2 – moderate; 3 – severe; 4 – very severe. The total score range is: for the “Pain” subscale – 0 to 20; for the “Stiffness” subscale – 0 to 8; for the “Physical Function” subscale – 0 to 68. The maximum possible score is 96, indicating severe pain, maximal stiffness, and significant functional limitations of the knee joint.

A higher total score indicates worse functional status of the knee joint. A score close to 96 indicates maximum pain, increased stiffness, and significant limitations in knee function. The interpretation of survey results is as follows:

- Excellent result: 0–14 points;
- Good result: 15–28 points;
- Satisfactory result: 29–38 points;
- Unsatisfactory result: more than 38 points.

The minimum possible score is 0, indicating no pain, stiffness, or functional limitations of the knee joint (Irzhansky A.A. et al., 2018; Giesinger J.M. et al., 2015).

Quality of Life Assessment. The quality of life of patients after primary total knee arthroplasty was calculated according to the "International Classification of Functioning, Disability, and Health" by WHO (2001). A scoring system was used, followed by coding and conversion to an evaluative scale of “excellent – good – satisfactory – unsatisfactory” (Table 2.6).

A series of criteria characterizing life functions was developed for assessing the quality of life in patients after knee arthroplasty (Table 2.7). Each indicator from the list was assigned 1 point if applicable, followed by summation.

Table 2.6 – Coding of Life Activity Limitation Parameters (%) Based on Their Characteristics

Points	Barriers	Limitation Indicators
0	None	0–4
1	Minor	5–24
2	Moderate	25–49
3	Severe	50–95
4	Absolute	96–100

Table 2.7 – The range of possible limitations of vital functions in elderly patients who have undergone TKA

Vital Functions	Indicators of disability and health
The feeling of pain	b280.0.1
Joint movement functions	b710.0.1
Joint stability functions	b715.0.1
Functions of the mobility of the bone apparatus	b720.0.1
The structure of the pelvic area	s 740.0.1
The structure of the lower limb	s 750.0.1
Performing individual tasks	d 210.0.1
Performing multi-faceted tasks	d 220.0.1.2.3
Performing a daily routine	d 230.0.1
Changing the body position	d 410.0.1
Maintaining body position	d 415.0.1
Moving the body	d 420.0.1
Lifting and moving objects	d 430.0.1
Moving objects with your feet	d 435.0.1
Walking	d 450.0.1.2
Movement by means of technical means	d 465.0.1.2
Body parts Care	d 520.0.1
Physiological shipments	d 530.0.1.2
Dressing up	d 540.0.1.2
Doing housework	d 640.0.1.2

The interpretation of survey results is as follows:

- Excellent result: 16–20 points;
- Good result: 11–15 points;
- Satisfactory result: 6–10 points;
- Unsatisfactory result: 0–5 points.

Methodologies for Morphological Study

In the Trauma and Orthopedics Clinic of the North-Western State Medical University named after I.I. Mechnikov, 30 out of 187 operated patients underwent morphological studies of the removed synovial membrane in 2022. Informed consent for the study was obtained from all patients, and this was recorded in the protocol of the local ethical committee, ensuring compliance with ethical standards in accordance with the Helsinki Declaration.

Synovial membrane fragments were fixed in a 10% buffered formalin solution for no less than 24 hours. Histological processing, embedding, and microtomy were performed using standard techniques (Sarkisov D.S., Perov Yu.L., 1996). The thickness of the sections was 3 μm. The specimens were stained with hematoxylin and eosin. For immunohistochemical reactions, antibodies to CD68 (168M-95, mouse monoclonal antibodies), CD3 (103-R94, rabbit monoclonal antibodies, USA), CD20 (PBM-5C3 mouse monoclonal antibodies), CD138 (138M-14, rabbit monoclonal antibodies, USA), and Ki-67 (mouse monoclonal antibodies, clone GM0010, USA) were used. Morphometry was performed using light microscopy at a magnification of ×400, with a field of view area of 0.25 mm². The tissue composition of the synovial membrane, the state of blood vessels, and the immunophenotypic composition of the inflammatory leukocyte infiltrate were evaluated.

Statistical Research Methodologies

Statistical data processing was conducted according to the planned design. In the first phase, a plan and program were developed. In the second phase, data collection for subsequent analysis was carried out. For this, a specially designed patient examination card for those with idiopathic osteoarthritis was used, which

was submitted for primary total arthroplasty (see appendix). This statistical document included both retrospective and prospective (including long-term) results. In the third phase, a database was created and analyzed using conventional statistical methods, conducted in the applied program "STATISTICA 10."

All classical indicators were considered: arithmetic mean, standard error of the arithmetic mean, standard deviation, and confidence interval of the true mean at a probability of 95% (p=0.05). The significance of differences between the compared indicators was determined using the Student's t-test and confidence probability (p). A difference between the average values was considered significant at $p<0.05$ (Andersen P.K., Niels A., 2014; Jawad Z. et al., 2019).

When creating the database, a questionnaire—a formalized card—was used, which included 84 items. To address the tasks set forth in the dissertation, it was necessary to study and evaluate the long-term outcomes of arthroplasty. For this purpose, a non-parametric analysis method was employed—the Kaplan-Meier method (Kaplan E.L., Meier P., 1958). An undeniable advantage of this method is its ability to account for censored observations, i.e., cases where a patient dropped out of the study (due to death or loss of contact). Quality of life was studied at intervals from 2 to 6 years post-surgery. To compare the effects of factors on maintaining a satisfactory quality of life assessment (QoL), the log-rank test was applied.

During the study, the survival function was identified: S(t) – the probability that a satisfactory QoL assessment will be observed at time t. The log-rank test was used to compare the probability of maintaining a satisfactory QoL assessment throughout the entire observation period across several groups (Kaplan E.L., Meier P., 1958).

Thus, the methods used in the study classify it as an active dynamic retrospective-prospective randomized clinical study. The results were assessed in groups formed through random allocation, and the effectiveness of therapeutic and diagnostic interventions was confirmed using modern medical statistical methods.

CHAPTER 3. RESULTS OF KNEE ARTHROPLASTY IN PATIENTS WITH OSTEOARTHRITIS

As mentioned in Chapter 2 (see Table 2.1), the retrospective study included 376 patients who underwent primary total knee arthroplasty due to idiopathic osteoarthritis and were discharged from the GBUZ RK "Republican Hospital named after V.A. Baranov" (Petrozavodsk) from 2016 to 2019 (inclusive). Data on the age and gender of the 376 patients who underwent knee arthroplasty in the hospital are presented in Table 3.1.

Table 3.1 – Distribution of Patients Undergoing Primary Total Knee Arthroplasty Due to Osteoarthritis, by Age and Gender

Age groups, years	Number of patients					
	Men's		Women's		In total	
	abs.	%	abs.	%	abs.	%
18–44	1	0,3	0	0	1	0,3
45–64	37	9,8	117	31,1	154	40,9
65 or more	37	9,8	184	48,9	221	58,8
Total	75	19,9	301	80,1	376	100

As seen from the data in Table 3.1, women predominated in the overall structure, comprising 301 (80.1%) of the patients. Among male patients, the ratio of those of working age (38 patients – 10.1%) to those of retirement age (37 patients – 9.8%) was 1:1. The largest group was women of retirement age—almost half of all observations (184 patients – 48.9%). The ratio of men to women in the group of patients aged 65 and older was 1:5 (9.8% and 48.9%, respectively). Data on examinations and treatments prior to hospitalization for arthroplasty are presented in Figure 3.1.

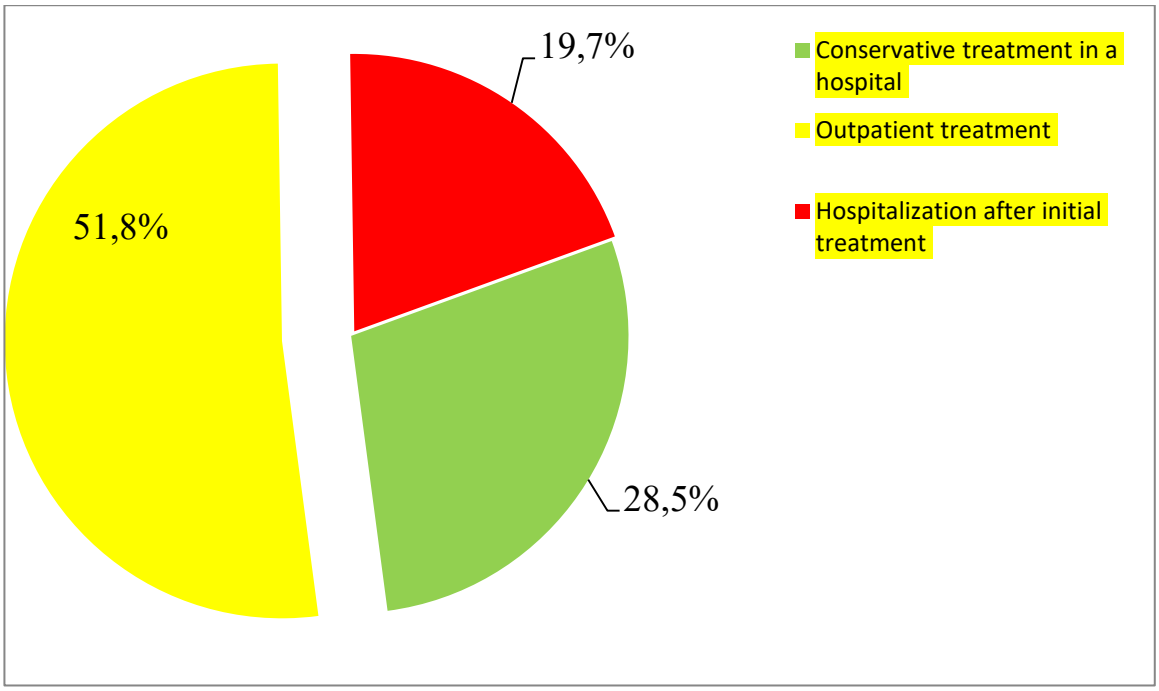

Figure 3.1. Anamnestic Information on Prior Conservative Treatment of Knee Osteoarthritis Before Joint Replacement with an Implant

As shown in Figure 3.1, in the history, only 107 (28.5%) patients underwent conservative treatment for knee osteoarthritis (before hospitalization for arthroplasty) in therapeutic or orthopedic-traumatological settings, meaning almost one in four. The majority of patients—269 (71.5%)—received treatment in an unsystematic and exclusively outpatient manner. In nearly every fifth case (74 clinical observations – 19.7%), the patient was hospitalized for arthroplasty after their first visit to a polyclinic doctor regarding osteoarthritis.

3.1. Immediate Results of Knee Arthroplasty

Intraoperatively, local and general complications were identified during arthroplasty. The same groups of complications were verified in the early postoperative period after knee replacement with an implant (Spichko A.A. et al., 2021). In the 12 months following knee arthroplasty, infections at the surgical site were diagnosed in some cases (Table 3.2).

Table 3.2 – Complications Identified During Knee Arthroplasty

Types of complications	Number of observations	
	abs.	(%)
Intraoperative	22	5,8
Local:	10	2,7
rupture of the medial collateral ligament	1	0,3
rupture of the lateral collateral ligament	1	0,3
posterior cruciate ligament injury	5	1,3
bleeding from large vessels	2	0,5
Other	1	0,3
General:	12	3,2
respiratory complications	3	0,8
cardiovascular insufficiency	6	1,6
complications from the central nervous system	2	0,5
Other		0,3
Postoperative complications	65	17,3
local:	53	14,1
Lymphorrhea	14	3,7
Hematoma	17	4,5
surface infection	13	3,5
deep infection	5	1,3
instability of the femoral-patellar joint	4	1,1
general:	12	3,2
respiratory complications	2	0,5
from the cardiovascular system.	6	1,6
complications from the central nervous system	3	0,8
Other		0,3
Total complications	87	23,1
Total patients with complications	45*	12
Total patients	376	100

The majority of patients did not experience intra- or postoperative complications, and the results of arthroplasty were assessed positively. In 45 (12%) cases, 87 intra- and postoperative complications were verified.

Analysis of the frequency and structure of complications revealed that most were related to cardiovascular pathology—6 (1.6%). Among local intraoperative

complications, posterior cruciate ligament injuries predominated—5 patients (1.3%). In the structure of postoperative complications, superficial surgical site infections (18 cases – 4.8%), hematomas (17 cases – 4.5%), and lymphorrhea (14 observations – 3.7%) were most common (Table 3.2).

During the first year of observation, there were no fatalities among the 376 patients discharged from the hospital.

Most patients (351 patients – 93.4%) hospitalized at the V.A. Baranov Hospital for arthroplasty had comorbidities of varying severity (Table 3.3). Among them, 234 (62.2%) patients were classified with disabilities of groups I–III, usually due to chronic diseases.

Table 3.3 – Comorbidities in Patients Undergoing Knee Arthroplasty

Concomitant diseases	Number of observations	
	abs.	%
Cardiovascular system (arterial hypertension, angina pectoris, functional class I–III, cardiac arrhythmias and conduction disorders, a history of acute myocardial infarction, varicose veins, etc.)	246	65,4
Respiratory system (chronic obstructive pulmonary disease, bronchial asthma, etc.)	105	28,3
Nervous system (osteochondrosis of the spine, transient ischemic attack in the anamnesis, acute cerebrovascular accident in the anamnesis, etc.)	232	62,6
Urinary system (urolithiasis, chronic kidney disease of stage I–III, chronic pyelonephritis, etc.)	36	9,5
Digestive system (chronic gastroduodenitis, peptic ulcer of the stomach or duodenum in remission, gallstone disease without exacerbation, etc.)	129	34,3
Fatness	137	36,4
Diabetes mellitus	79	21,0
Total patients with concomitant diseases	351	93,3
Total patients	376	100

Comorbidity was verified in 351 (93.4%) patients, with each diagnosed with 1 to 5 comorbidities.

Conditionally, all patients can be divided into two groups regarding comorbidity. The cohort with low comorbidity (LC) consisted of practically healthy individuals or patients with mild therapeutic pathologies—122 (32.4%)

individuals. The group with high comorbidity (HC) included patients with multiple mild conditions or one severe somatic pathology. Among patients who underwent knee arthroplasty, those with a high degree of comorbidity predominated—254 (67.6%).

In the structure of diagnosed comorbidities, cardiovascular diseases (hypertension, ischemic heart disease, peripheral venous diseases, obliterating peripheral artery diseases, arrhythmias, etc.) predominated—246 (65.4%).

Neurological disorders were noted somewhat less frequently: cerebrovascular disease and osteochondrosis were present in 232 (62.6%) patients. Increased body mass index was recorded in 216 (57.4%) cases. Respiratory organ pathologies were verified in 105 (28.3%) patients, most commonly chronic obstructive pulmonary disease, with emphysema, asthma, and pneumofibrosis occurring

In the first stage of the study, data from primary medical documentation (outpatient records, case histories) were transferred to an interim document—a formalized card. This card included information on personal data, medical history, results of objective examinations, laboratory and instrumental studies, as well as details on treatment and follow-ups—a total of 84 items from both the retrospective and prospective phases of the study (appendix). Subsequently, a database was created based on this card.

One of the indicators characterizing the degree of comorbidity was the physical status of patients according to the updated classification of the American Society of Anesthesiologists—ASA (2020). The updated ASA classification of patient physical status, 2020, is demonstrated in Table 3.4, which determined the degree of anesthetic risk (cited from: Levin I.Y., Koryachkin V.A., 2021).

Intraoperatively and in the immediate postoperative period, some patients developed local complications: hematoma, lymphorrhea, surgical site infection (SSI), bone fracture at the implant site, ligament injuries. Data on the frequency and structure of complications are presented in Table 3.5.

Table 3.4 – Updated Classification of Patient Physical Status by the

Class	Definition	Adults
ASA* I	A normal, healthy patient	A healthy, non-smoker, non-alcoholic or minimally alcoholic patient
ASA* II	A patient with a minor systemic disease	Minor diseases without significant functional abnormalities. The patient smokes and drinks alcohol moderately. Obesity (30 <BMI). Well-controlled diabetes mellitus / hypertension. Minor pulmonary disease
ASA* III	A patient with a severe systemic disease	Significant functional limitations; one or more moderate to severe diseases. Untreated diabetes mellitus or hypertension, chronic obstructive pulmonary disease, morbid obesity (BMI ≥40 kg/m2), active hepatitis, alcohol dependence or alcohol abuse, implanted pacemaker, moderate decrease in ejection fraction, terminal renal failure with regularly scheduled dialysis, history (>3 months) of myocardial infarction, stroke, transient ischemic attack, or coronary stenting
ASA* IV	A patient with a severe systemic disease that poses a real threat to life	Recent (less than 3 months) myocardial infarction, stroke, transient ischemic attack or coronary stenting, persistent cardiac ischemia or severe dysfunction of the heart valves, significant decrease in ejection fraction, shock, sepsis, disseminated intravascular coagulation syndrome, respiratory distress syndrome or terminal renal failure with irregular dialysis

*American Society of Anesthesiologists (ASA), 2020

Table 3.5 – Frequency and Structure of Local (Intraoperative and Early Postoperative) Complications of Knee Arthroplasty

Types of complications	Number of observations, abs. (%)
Hematoma of the postoperative wound	17 (4,5)
Infection of the surgical area	18 (4,8)
Surface Deep	13 (3,5) 5 (1,3)
Collateral ligament damage	2(0,5)
Lymphorrhea	14 (3,7)
Instability of the implant	4 (1,1)
Posterior cruciate ligament injury	5 (1,3)
Others (damage to the main vessels, bone fractures)	3 (0,3)
Total complications	63 (16,7)
Total operations	376 (100)

As indicated by the data in Table 3.5, the most common complication was surgical site infection (SSI), which was noted in 18 (4.8%) cases.

Thus, the results of knee arthroplasty conducted due to idiopathic osteoarthritis cannot be deemed unequivocally positive. In 45 (12%) patients, 87 complications (intraoperative and postoperative) were diagnosed. Among cardiovascular complications, 6 (1.6%) cases were verified. Among local intraoperative complications, damage to the posterior cruciate ligament prevailed—5 patients (1.3%). In the structure of postoperative complications, surgical site infection (18 patients – 4.8%), hematoma (17 cases – 4.5%), and lymphorrhea (14 observations – 3.7%) were most prevalent.

The results of knee arthroplasty in the immediate postoperative period were taken into account when determining joint function and the quality of life of patients, serving as a baseline for assessing further dynamics.

3.2. Long-Term Results of Knee Arthroplasty in Patients with Osteoarthritis

Quality of Life of Patients in the Long Term Post-Operation Using Survival Analysis

To study the quality of life at different time points post-operation, the Kaplan-Meier survival analysis method was chosen (Korneenko A.A. et al., 2019). The results of the study have been published in several sources (Aliyev B.G. et al., 2022; Aliyev B.G. et al., 2023; Tkachenko A.N. et al., 2023). In everyday clinical practice, orthopedic trauma surgeons often encounter situations where contact with the patient is lost after a certain period. Such cases are classified as "censored." The observation period for these patients should be considered for a more comprehensive statistical study. The Kaplan-Meier method allows for the processing of data from censored cases. Currently, the survival analysis method in relation to describing the dynamics of the postoperative period in traumatology and orthopedics is not widely used; such publications are rare (Tkachenko A.N. et al., 2021).

Many specialists believe that the presence of comorbidities is one of the factors influencing the unfavorable course and outcomes of the postoperative

period. The issues surrounding arthroplasty of major joints in patients with comorbidities are subjects of discussion at scientific forums and in medical literature in Russia and worldwide. However, consensus among researchers on this matter has not been reached.

At this stage of the work, a study of the long-term outcomes of knee arthroplasty was conducted. Outcomes of knee arthroplasty were compared among patients in the studied groups. To this end, a graphical model of the probability of the postoperative period was constructed using the statistical programming environment R. Prognosis of outcomes (using the analysis of quality of life dynamics based on the presence or absence of comorbidities) was determined for a period of up to 5 years post-surgery (Aliyev B.G. et al., 2022, 2023; Tkachenko A.N. et al., 2023).

Overall, severe knee osteoarthritis is considered by many authors to be a pathology with a high degree of comorbidity (Fonturenko A.Yu. et al., 2020). Among the diseases that commonly accompany knee osteoarthritis, ischemic heart disease, hypertension, chronic obstructive pulmonary disease, type 2 diabetes, high BMI, and urolithiasis are frequently verified (Mazurov V.I. et al., 2021; Aliyev B.G. et al., 2023).

When analyzing data from patients who underwent knee arthroplasty, several types of variables were used: 1) "time" (dependent variable) – time until the end of observation or the appearance of an unsatisfactory quality of life assessment (QoL); 2) "status" (censoring status variable) – status at the end of the 5-year observation (0 – no unsatisfactory QoL assessment or lost contact with the patient; 1 – unsatisfactory QoL assessment was recorded during the observation); 3) comorbidity (explanatory or factor variable), a qualitative indicator determining the presence or absence of concomitant pathology ("low" or "high" level).

The nonparametric analysis method—the Kaplan-Meier method—was used to evaluate the probability of the absence of symptoms at a specific moment in the observation (Kaplan E.L., Meier P., 1958). The log-rank test was used to compare

the effects of factors on maintaining a satisfactory QoL assessment (Aliyev B.G. et al., 2023; Tkachenko A.N. et al., 2023).

Table 3.6 – Physical Status of Patients Who Underwent Knee Arthroplasty (According to ASA Classification, 2020)

Physical (ASA), 2020	Number of patients	
	абс.	%
I	43	11,4
II	191	50,8
III	135	35,9
IV	7	1,9
Total	376	100

When stating ASA I, the level of comorbidity was considered low; ASA II was below average; ASA III was above average; and ASA IV was classified as high comorbidity. Among the patients who underwent knee arthroplasty, those classified as ASA III and ASA IV totaled 142 (37.8%).

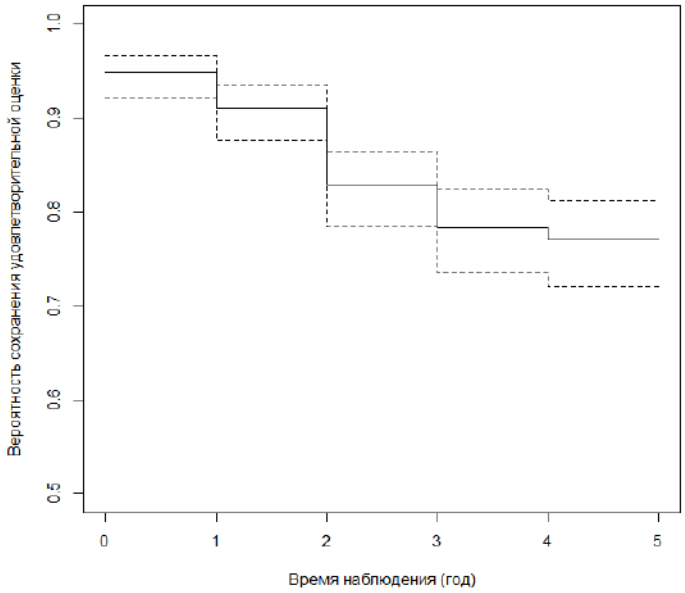

Figure 3.2. Overall curve of excellent and good quality of life results over 5 years after knee arthroplasty. By the end of the fifth year of observation, this indicator was at 0.77 (0.72; 0.81).

Figure 3.2 presents the overall curve of excellent and good QoL results for patients after knee arthroplasty over a 5-year period. The rate of excellent and good QoL at the end of the fifth year of observation was 0.77 (0.72; 0.81), meaning that 77% of patients reported excellent and good quality of life. Satisfactory and unsatisfactory QoL was observed in 23% of patients.

The outcomes of knee arthroplasty with an implant depend on many parameters: the patient's age, the specifics of the clinical picture of knee osteoarthritis, body mass index, radiological stage of the disease, presence of comorbidities, nature of ligament injuries, and others.Regarding gender, some researchers suggest that negative outcomes after knee arthroplasty are more common in women than in men.

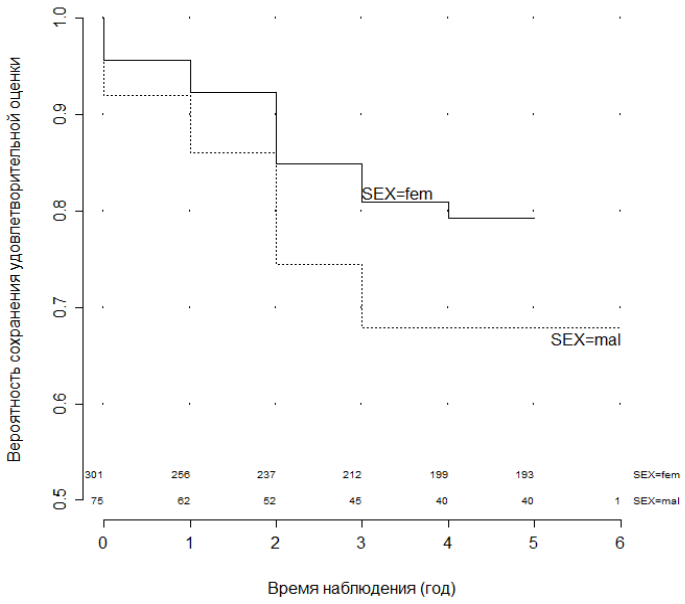

Figure 3.3. Curve of excellent and good quality of life results based on the patient’s gender with a 95% confidence interval (SEX female – quality of life in women; SEX male – quality of life in men).

The results of knee arthroplasty in men (SEX male) and women (SEX female) were analyzed separately. The probability of maintaining excellent and good quality of life was determined based on the corresponding curves at any time during the observation period (see Figure 3.3). It was found that excellent and good quality of life was preserved in 67% of men and 79% of women five years after

surgery ($p<0.05$). The long-term results of knee arthroplasty in terms of quality of life were significantly better for women (see Figure 3.3). By the end of the fifth year of observation, the probability of maintaining excellent and good quality of life in women was 0.79 (0.72; 0.84), whereas in male patients, this indicator was 0.67 (0.63; 0.76). Thus, there are differences in survival curves between groups of patients of different genders, as indicated by the log-rank test ($Z=2.0347$; p-value = 0.0445).The degree of comorbidity in patients with knee osteoarthritis was assessed based on information provided by the anesthesiologist during the preoperative examination.

When analyzing five-year outcomes based on physical status in four patient groups (four levels of comorbidity: ASA I – "low," ASA II – "below average," ASA III – "above average," and ASA IV – "high"), some features were identified (see Figure 3.4).

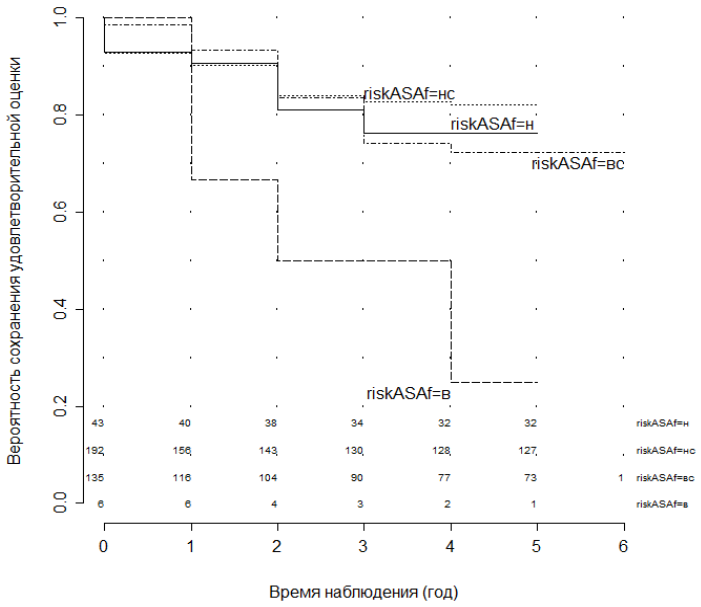

Figure 3.4. Curve of excellent and good quality of life results depending on the level of comorbidity with a 95% confidence interval (risk ASA f=н – low level of comorbidity; ASA I; risk ASA f=нс – below average level of comorbidity; ASA II; risk ASA f=вс – above average level of comorbidity ASA III; risk ASA f=в – high level of comorbidity ASA IV).

Long-term results of knee arthroplasty in patients with anesthetic risk ASA I–III did not differ significantly (see Figure 3.4). The probability of maintaining excellent and good quality of life in the fifth year of observation was 0.76 (0.65; 0.87) for ASA I; 0.82 (0.75; 0.87) for ASA II; and 0.72 (0.63; 0.80) for ASA III. Quality of life indicators in patients with ASA IV were significantly worse. Excellent and good quality of life at the fifth year of observation was verified in these patients with a probability of 0.25 (0.12; 0.65).

The log-rank test confirms statistically significant differences in survival curves between groups only in patients with high comorbidity (ASA IV). Log-rank test indicators: $\chi^2 = 0.93551$, significance level p-value = 0.0283. Despite these results being statistically valid from an evidence-based medicine perspective, there were only 7 patients (1.9%) with ASA IV out of 376.

Therefore, an excellent and good quality of life can be expected in an average of 77% of patients by the end of the fifth year of observation after knee arthroplasty, with satisfactory and unsatisfactory quality of life noted in 23% of patients. As shown by the Kaplan-Meier method (survival analysis), after 5 years following knee arthroplasty, the number of patients with excellent and good quality of life among those with ASA I–III does not differ significantly ($p>0.05$). Significant differences in quality of life after knee arthroplasty are found only when analyzing results in patients with severe comorbidities – ASA IV ($p<0.05$); however, the overall number of such patients is minimal, at 1.9% (Aliyev B.G. et al., 2023; Tkachenko A.N. et al., 2023).

The number of patients with comorbidity is increasing worldwide due to the growing life expectancy of the population. The intensive development of medicine, particularly anesthesiology and intensive care, allows for surgeries on patients with initially low functional reserves, significant comorbidity, and homeostatic instability. On the other hand, in developed countries, the volume of knee arthroplasty is rising, including in younger and middle-aged patients. These factors, along with the lack of a unified opinion among specialists regarding the role of arthroplasty in treating knee osteoarthritis (KOA), justify the need to

continue research and explore long-term outcomes (10–15 years post-arthroplasty) and the characteristics of this period in different patient groups.

Long-term Functional Outcomes after Knee Arthroplasty

One of the risk factors for adverse long-term outcomes after knee arthroplasty is high comorbidity, meaning the severity of comorbid conditions in patients. In most cases, knee arthroplasty is performed in older age. Many patients in the older age group have comorbid diseases such as hypertension, diabetes, obesity, chronic obstructive pulmonary disease, and urolithiasis. Several researchers believe that comorbidity negatively impacts functional outcomes and the quality of life of patients. However, as noted in the previous section, no statistically significant effect of comorbidity in patients classified as ASA I, ASA II, and ASA III on long-term outcomes of knee arthroplasty was identified. Only in cases of significant comorbidity resulting in low functional reserves, categorized as ASA IV, can it be stated that the long-term outcomes for such patients will be significantly worse.

When assessing functional outcomes (using the WOMAC scale) in patients 2 to 6 years post-knee arthroplasty, excellent and good results were considered (data published: Aliyev B.G. et al., 2023). The overall dynamics of these results are reflected in Table 3.7.

Table 3.7 – Functional results in patients who underwent knee arthroplasty (using the WOMAC scale) over 5 years after surgery

Indicators	Year of observation				
	1	2	3	4	5
Excellent and good results, abs. (%)	349 (95,6)	328 (91,9)	294 (86,0)	185 (78,4)	101 (77,1)
Satisfactory and unsatisfactory results, abs. (%)	16 (4,4)	48 (8,1)	48 (14,0)	51 (21,6)	30 (22,9)
The number of patients with known long-term results, abs. (100%)	365 (100)	357 (100)	342 (100)	236 (100)	131 (100)

According to Table 3.7, by the end of the fifth year of observation (among patients with whom contact was maintained and who had undergone the specified

time post-surgery), excellent and good results were noted in 77.1% of the examined patients who underwent knee arthroplasty.

The outcomes of knee arthroplasty were analyzed in two groups: the first group consisted of patients with low comorbidity (practically healthy clinical observations and those with mild systemic disease), while the second group included patients with high comorbidity (cases of combining multiple mild or one severe systemic disease) (see Table 3.8).

Table 3.8 – Distribution of patients who underwent knee arthroplasty based on the level of comorbidity

Degree of comorbidity	Number of patients	
	abs.	%
Low	122	32,4
High	254	67,6
Total	376	100

As shown in Table 3.8, among patients who underwent knee arthroplasty, cases with high comorbidity were predominant: 254 (67.6%).

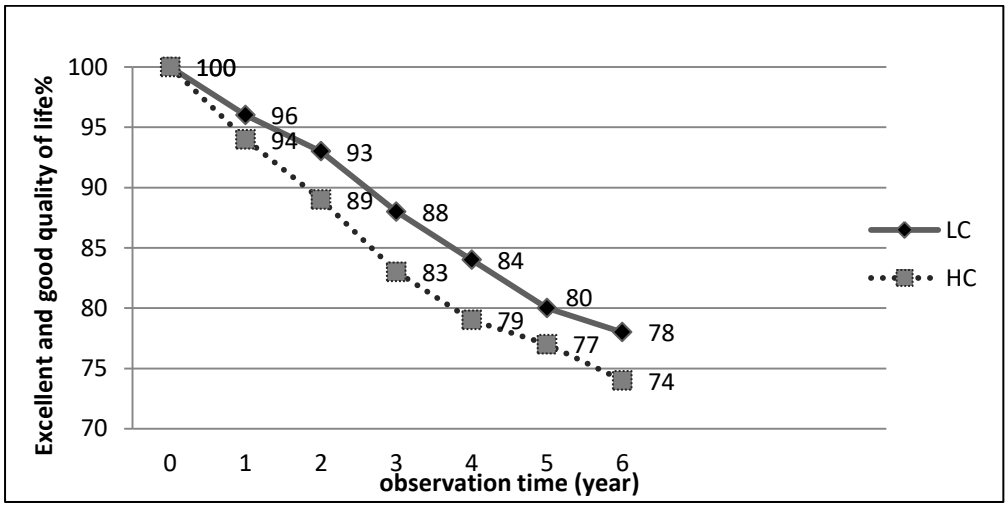

Figure 3.5. Curve of changes in the assessment of the risk of maintaining excellent and good functional outcomes (WOMAC) after knee arthroplasty depending on comorbidity with a 95% confidence interval (LC – low comorbidity; HC – high comorbidity).

When analyzing functional outcomes (using the WOMAC scale) in patients who underwent knee arthroplasty, the results were studied in two groups: low comorbidity (LC) and high comorbidity (HC) (see Figure 3.5).

The results were studied using survival analysis methods, accounting for censored observations.

Figure 3.5 shows the long-term outcomes of knee arthroplasty among patients with low and high comorbidity. These outcomes did not differ significantly ($p>0.05$).

The probability of achieving excellent and good functional outcomes (using the WOMAC scale) by the sixth year of observation was 0.78 (0.67;0.88) for the low comorbidity group (LC) and 0.74 (0.65;0.81) for the high comorbidity group (HC). There were no statistically significant differences in survival curves between the groups with different comorbidity levels among patients after knee arthroplasty. The log-rank test ($Z = 0.94$, p-value = 0.28) did not allow us to consider the differences in functional outcomes statistically significant. Only a trend was noted, which requires further investigation of the long-term results of knee arthroplasty over 10 and 15 years (Aliyev B.G. et al., 2023; Tkachenko A.N. et al., 2023).

The analysis of the five-year outcomes for the entire group (n=376) indicates that excellent and good functional results were achieved in 76% of patients. In 24% of cases, functional outcomes by the end of the fifth year of observation were assessed as satisfactory or unsatisfactory. The results of knee arthroplasty after five years do not differ significantly between the groups of patients with high and low comorbidity ($p>0.05$).

Overall, the functional results identified through both traditional statistical methods with personalized data consideration (see Table 3.7) and survival analysis (see Figure 3.5) are identical.

Clinical Cases

***

Patient A, female, 63 years old. She presented as an outpatient in November 2015. Diagnosed with stage III osteoarthritis of the left knee (see Figure 3.6, a, b). Comorbidities: coronary heart disease, hypertension stage II. Home treatment was ineffective, and pain intensity increased. She was hospitalized at V.A. Baranov Hospital in February 2016. The patient was examined, and no absolute contraindications to surgical treatment were found. Preoperative assessment indicated an ASA risk of 2.

Figures 3.6 A, B: X-rays of Patient A, 63 years old: A, B — stage III osteoarthritis of the left knee; C, D — total knee arthroplasty; E, F — control X-rays after 5 years – satisfactory joint alignment.

Total knee arthroplasty (with cement fixation) was performed (see Figures 3.6 C, D). Duration of the procedure was 1 hour and 40 minutes. Intraoperative blood loss was 300 ml. The stitches were removed on the 14th day. The rehabilitation period was satisfactory. The patient was examined five years after the surgery (see Figures 3.6 E, F). Functional results and quality of life were excellent.

Patient I, female, 74 years old. She was admitted in 2017 due to stage III osteoarthritis of the left knee (see Figure 3.7, A, B). The hospitalization was planned. Comorbidities included coronary heart disease, hypertension stage II, and grade 3. Surgical risk was classified as ASA 3. Type 2 diabetes, insulin-dependent. Diabetic nephropathy. Chronic kidney disease stage 3a. The patient is unemployed and a pensioner, with no disability. Height 167 cm, weight 85 kg, BMI 30.5 (obesity grade I).

Figures 3.7 A, B: X-rays of Patient I, 74 years old: A, B – stage III osteoarthritis of the left knee; C – total knee arthroplasty; D – removal of prosthesis components; E, F, G – extra-focal osteosynthesis for knee

arthrodesis; H – control X-rays after 1 year in an orthosis, signs of bone-fibrous ankylosis.

Total knee arthroplasty was performed (see Figure 3.7 C), lasting 120 minutes with an intraoperative blood loss of 350 ml. There were no intraoperative complications. In the early postoperative period, significant pain was noted. The dressing was saturated daily with hemorrhagic fluid. The surgical wound healed without signs of inflammation, and stitches were removed on the 15th day post-surgery. The patient was discharged for continued treatment.

Two months later, an infectious-inflammatory process developed, leading to a fistula with purulent discharge, for which she was hospitalized. Components of the prosthesis were removed, and the purulent focus was sanitized. A block-shaped antimicrobial spacer was installed (see Figure 3.7 D). After 1.5 months post-discharge, there was a recurrence of the infectious-inflammatory process, and she was rehospitalized. Chronic osteomyelitis and osteonecrosis of the distal femur and proximal tibia were identified. Four days after hospitalization, radical surgical treatment of the inflammation focus and extra-focal osteosynthesis for knee arthrodesis were performed (see Figures 3.7 E, F, G). The infectious-inflammatory process was resolved. A month later, she was discharged for outpatient treatment in satisfactory condition. The external fixation device was removed six months later.

She was examined 12 months after the surgery. Signs of bone-fibrous ankylosis were noted (see Figure 3.7 H). Functional results and quality of life were unsatisfactory.

As demonstrated in these clinical cases, the outcomes of knee arthroplasty performed due to osteoarthritis vary widely. The quality of life and joint function five years after arthroplasty can be either excellent or unsatisfactory. Many authors consider the presence of comorbidities as one of the main prognostic adverse criteria for the risk of developing unsatisfactory results after knee arthroplasty. However, some researchers do not share this view. Data regarding comorbidity are contradictory. Studies have shown that functional outcomes and quality of life in patients after knee arthroplasty do not significantly differ from those in patients with significant comorbidities.

The Kaplan–Meier method (survival analysis) is particularly interesting for studying long-term outcomes, as it allows for the inclusion of data from patients who have lost contact. Based on the presented clinical examples and interpreting

the obtained data with the interests of the practicing physician in mind, the following conclusions can be made:

Excellent and good functional outcomes five years after knee arthroplasty are observed in 78% of patients with low comorbidity and in 74% of clinical observations with significant comorbidities. There are no statistically significant differences from an evidence-based medicine perspective ($p>0.05$). Only a trend is noted. The absence of a unified viewpoint in the literature regarding the impact of comorbidity on the course of the long-term postoperative period is a motivating factor for continuing research and studying long-term outcomes over 10–15 years (Aliyev B.G. et al., 2023; Tkachenko A.N. et al., 2023).

According to several authors, adverse outcomes of arthroplasty may be due to inflammation of the synovial membrane. Other researchers consider reactive synovitis as a complication of knee arthroplasty and a risk factor for periprosthetic infection. The next chapter of the dissertation presents the results of the morphological study of the synovial membrane of the knee joint in osteoarthritis.

CHAPTER 4. MORPHOLOGICAL FEATURES OF THE SYNOVIAL MEMBRANE IN OSTEOARTHRITIS IN PATIENTS WHO HAVE UNDERGONE KNEE ARTHROPLASTY

Osteoarthritis affects approximately 300 million people worldwide (Allen K.D. et al., 2022). In our country, osteoarthritis has been diagnosed in more than 4 million people, which accounts for over half of all patients with rheumatic diseases, and the number of individuals with osteoarthritis shows a steady increasing trend (Balabanova R.M., Dubinina T.V., 2019). In St. Petersburg alone, more than 250,000 individuals are registered with osteoarthritis (Mazurov V.I. et al., 2021).

The knee joint is one of the most common sites for osteoarthritis. Treatment of patients with knee osteoarthritis is carried out by specialists from various fields: orthopedic traumatologists, therapists, rheumatologists, rehabilitation specialists, etc. For advanced stages of osteoarthritis, knee arthroplasty is the surgical intervention of choice. However, the outcomes of knee arthroplasty are not always positive. The course of knee osteoarthritis is often accompanied by inflammation of the synovial membrane. According to several researchers, reactive synovitis negatively affects the postoperative period after knee arthroplasty (Klyushin N.M. et al., 2015; Kosareva M.A. et al., 2018; Marchand R.C. et al., 2018).

Other authors believe that inflammation of the synovial membrane can itself be a complication of arthroplasty in the long term after the operation (Custers R.J. et al., 2007; Yamanaka H. et al., 2012). Some researchers consider such a complication to be a prognostic adverse factor for the development of periprosthetic infection (Kim S.G. et al., 2017; Blanco, J.F. et al., 2020). The study of the condition of the synovial membrane when planning surgical treatment for knee osteoarthritis is deemed advisable by many authors (Mayr H.O., Stoehr A., 2016). When planning knee arthroplasty as the treatment of choice for osteoarthritis, various factors were taken into account, including the clinical picture of the disease, its clinical and radiological stage, the nature and degree of

comorbidity, the patient's preferences, and several other factors. However, the issue of assessing the degree of synovitis at the time of surgery is often overlooked.

The aim of the study was to conduct a histological examination of the excised synovial membrane of the knee joint and a retrospective study of the risks of developing local postoperative complications with the identification of clinical-morphological correlations. The results were published (Tkachenko A.N. et al., 2024).

In the trauma and orthopedics clinic of the North-Western State Medical University named after I.I. Mechnikov, 187 knee replacements were performed in 2022 for patients with idiopathic knee osteoarthritis. The patients' ages ranged from 40 to 76 years (mean age 59.3±6.7 years).

Analysis of age and gender data revealed that among the young patients (ages 18 to 44), there were 15 individuals (8%), with men being half that number: 8 (4.3%). Among middle-aged and older groups, female patients also predominated. In the young and elderly age groups, the male-to-female ratio was 1:2, while in the middle-aged group (ages 45 to 64), it was 1:3 (11.8% and 28.3%, respectively) (see Table 4.1).

Table 4.1 – Distribution of patients who underwent primary total knee arthroplasty due to osteoarthritis, by age and gender

Age groups, years	Number of patients, abs. (%)		
	Men's	Women's	in total
18–44	8 (4,3)	15 (8,0)	23 (12,3)
45–64	32 (17,1)	57 (30,5)	89 (47,6)
65 or more	22 (11,8)	53 (28,3)	75 (40,1)
Total	62 (33,2)	125 (66,8)	187 (100)

According to medical history, only 48 patients (25.7%) had undergone a course of inpatient non-operative treatment or organ-preserving interventions related to knee osteoarthritis prior to arthroplasty. The majority of patients (139 observations – 74.3%) had received treatment at home or on an outpatient basis, typically taking nonsteroidal anti-inflammatory drugs when pain intensified. The findings of the pathomorphological study were published in open literature.

The synovial membrane of the knee joint was studied in 30 (out of 187) patients who underwent knee arthroplasty in June-July 2022, selected for study using a continuous sampling method. Histological preparations were made according to standard techniques (Sarkisov D.S., Perov Yu.L., 1996).

Pathohistological Characteristics of Synovial Membrane Biopsies

It should be noted that out of 30 conducted morphological studies, weak inflammatory infiltration was verified semi-quantitatively in 8 cases (26.7%) (based on all cells in the inflammatory infiltrate) (see Figure 4.1 A), moderate infiltration was found in 12 cases (40%) (see Figure 4.1 B), and severe infiltration was observed in 10 cases (33.3%) (see Figure 4.1 C).

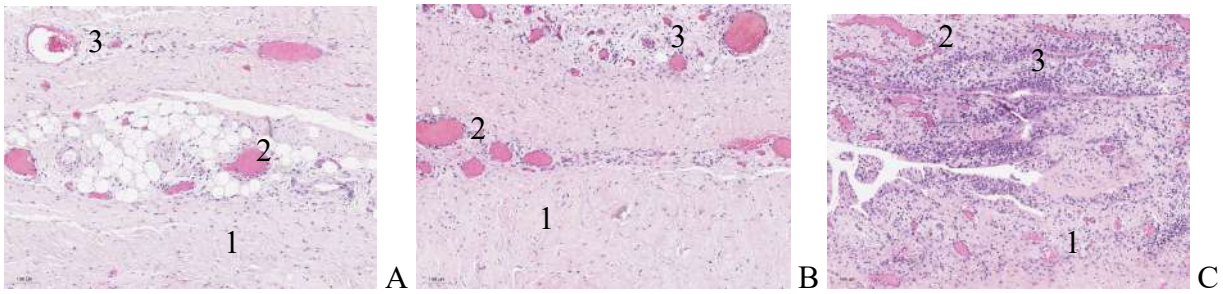

Figure 4.1. A – Weak infiltration. B) – Moderate infiltration C) – Intensive infiltration. 1 – connective tissue of the synovial membrane; 2 – full–blooded blood vessels; 3 - inflammatory lymphocytic infiltrate with an admixture of neutrophils. The scale segment is 100 microns. Color: hematoxylin and eosin

Immunohistochemical reactions with antibodies to lymphocytes and macrophages revealed varying degrees of connective tissue infiltration in the synovial membrane (see Figure 4.2). The cellular infiltrate was predominantly uniform and exhibited a histiocytic-lymphocytic character.

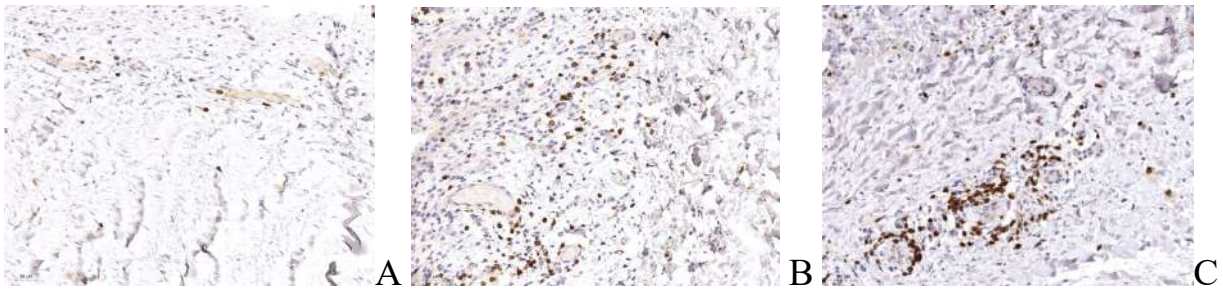

Figure 4.2. A – Weak infiltration. B) – Moderate infiltration, C) – Intensive infiltration. An example of an immunohistochemical reaction is with antibodies to CD3 (T lymphocytes). The reaction product is brown in color. The scale segment is 50 microns. Staining with Mayer's hematoxylin

Graph displaying correlations between immunohistochemically stained cells in 10 fields of view at 400x magnification (field area was 0.25 mm²) is shown in Figure 4.3. As indicated in Figure 4.3, the number of T-lymphocytes (CD3+) correlates with the number of B-lymphocytes (CD20+) ($r = 0.69$, p-value < 0.05), and M1-macrophages (CD68+) correlate with plasma cells (CD138+) ($r = 0.66$, p-value < 0.05). Despite the significance of these correlations, this analysis does not convey the intensity and specificity of the inflammatory infiltration.

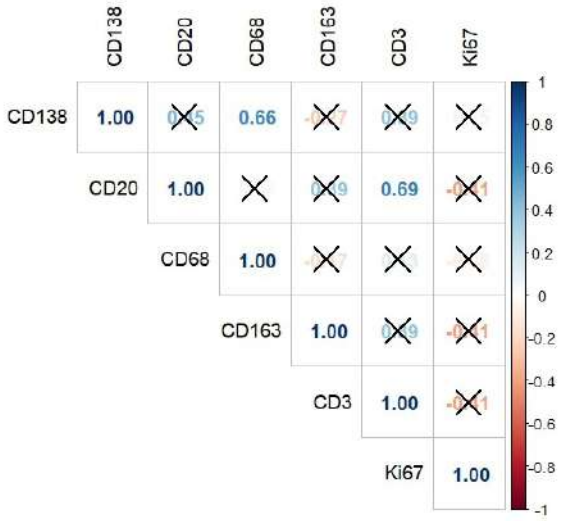

Figure 4.3. Correlation matrix. X – correlation coefficients, $P < 0.05$

To classify the synovial membranes by the degree of inflammatory infiltrate and describe its characteristics, a heat map was constructed (Figure 4.4).

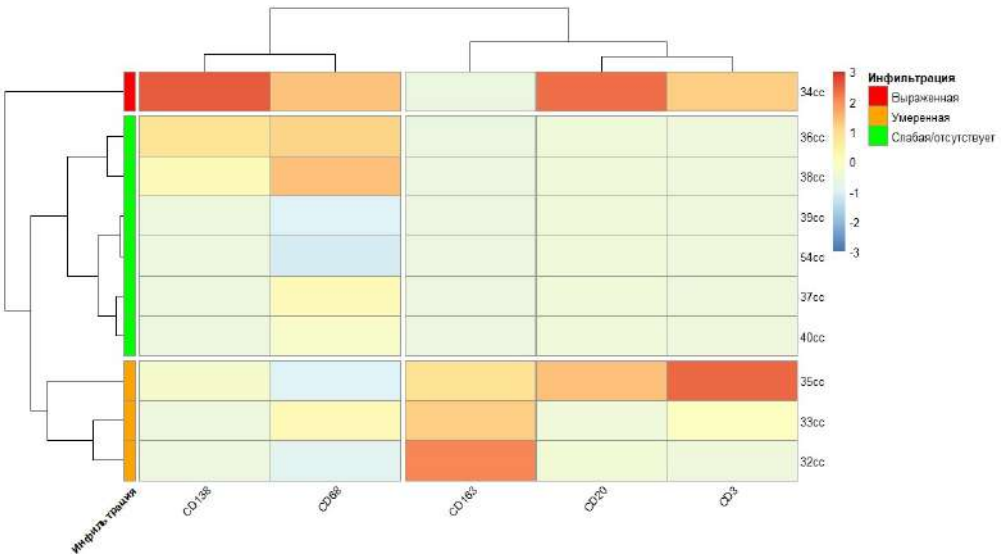

Figure 4.4. Heat map reflecting clusters of infiltration (severe, moderate, mild/absent)

Severe inflammatory infiltration was characterized in 10% of synovial membranes, moderate in 30%, and mild/absent infiltration in 60%. There is also a correlation between T-lymphocytes (CD3+) and B-lymphocytes (CD20+), plasma cells (CD138+), and M1-macrophages (CD68+), which aligns with the data from the correlation analysis. At the same time, M2-macrophage infiltration (CD163+) showed less dependence on other inflammatory infiltrate cells. To analyze the impact of inflammatory infiltrate cells on the intensity of inflammation, a principal component analysis method was used (Figure 4.5).

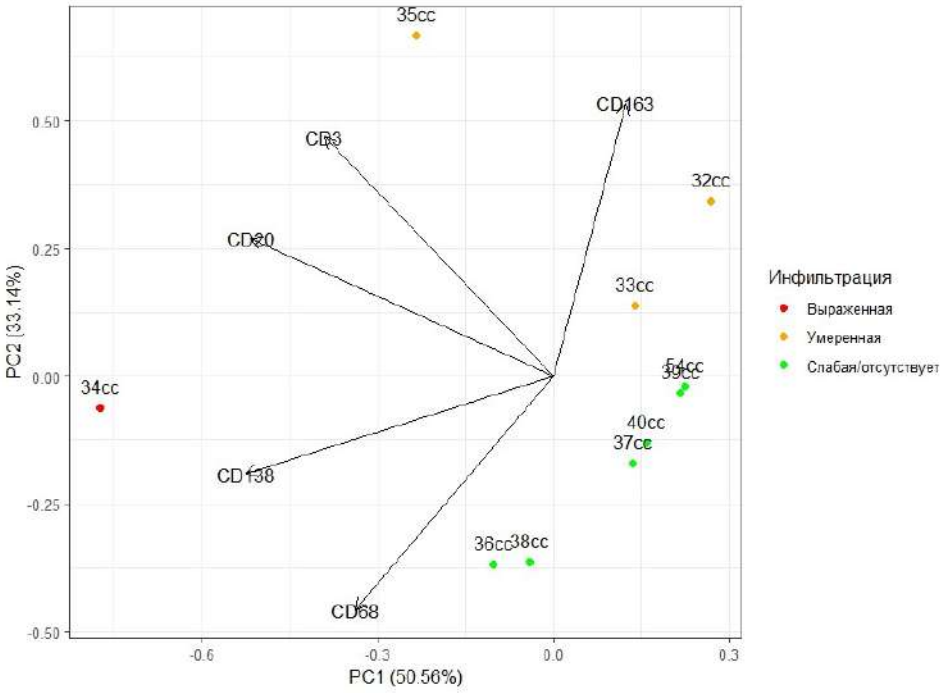

Figure 4.5. Principal component analysis. Arrows indicate the influence of the number of stained cells on the position of points on the coordinates

From the graph (Figure 4.5), it can be seen that T-lymphocytes (CD3+), B-lymphocytes (CD20+), plasma cells (CD138+), and M1-macrophages (CD68+) make a significant contribution in the case of 34cc. Meanwhile, the structure of the infiltrate characterized by moderate infiltration (35cc) differs from 32cc and 33cc, where M2-macrophages (CD163+) have a greater influence. A higher number of M1-macrophages (CD68+) were found in cases 36cc and 38cc from the cluster with mild/absent infiltration. The remaining synovial membranes were characterized by minimal inflammatory infiltration.

The proliferative activity index of synovial membrane cells was also measured (Figure 4.6).

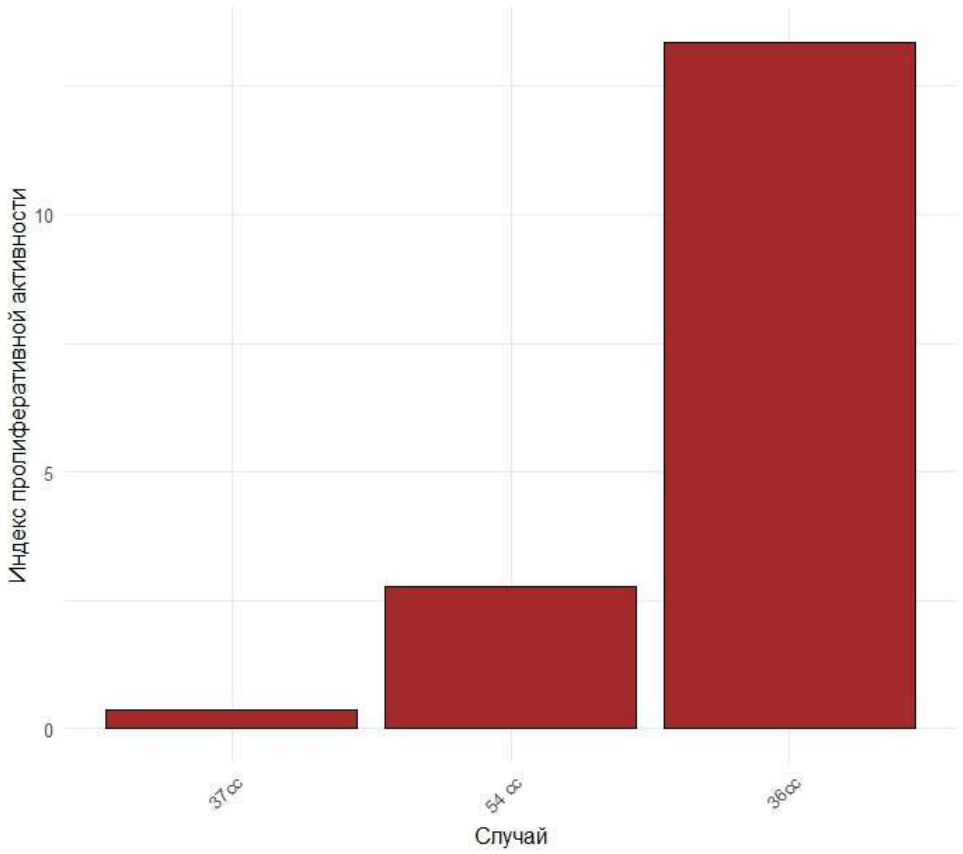

Figure 4.6. Proliferative activity index in synovial membranes

Among the samples studied, 30% showed Ki67-positive staining, all of which were in the cluster with mild/absent infiltration. As seen from the data in Figure 4.6, the highest proliferative activity index was found in case 36cc, in which plasma cells (CD138+) and M1-macrophages (CD68+) were present in the inflammatory infiltrate. A case with a similar inflammatory infiltrate composition (38cc) did not stain for Ki67.

Undoubtedly, when performing knee arthroplasty, orthopedic traumatologists considered not only radiological or tomographic findings and the presumed stage of osteoarthritis but also the specifics of the clinical picture (intensity of pain syndrome, effectiveness of conservative treatment, duration of the disease), the results of knee stability assessments, and data on the state of the ligamentous apparatus, among others. However, intraoperative findings, such as

pronounced reactive synovitis, led to adjustments in surgical and medical treatment (Tkachenko A.N. et al., 2024).

Overall, there were no intraoperative complications in any of the 30 patients. The most common early postoperative complication was lymphorrhea, occurring in 6 cases (20%). Among patients with verified mild synovial membrane infiltration (8 observations), this complication was not noted. In 12 cases with moderate infiltrative changes in the synovium, lymphorrhea was diagnosed in 2 patients (16.7%). The prolonged drainage of serous fluid was most frequently observed in patients with pronounced infiltrative changes in the synovial membrane of the knee joint—4 cases (40%).

The study revealed significant correlations between T-lymphocytes and B-lymphocytes, as well as M1-macrophages and plasma cells. The intensity of inflammatory infiltration was divided into three clusters. The greatest impact on pronounced inflammation came from T-lymphocytes (CD3+), B-lymphocytes (CD20+), plasma cells (CD138+), and M1-macrophages (CD68+). M2-macrophages characterized some cases of mild infiltration and were associated with a high proliferative activity index. In 33.3% of cases with moderate infiltration, the most significant contribution to its structure came from plasma cells, T-lymphocytes, and M2-macrophages.

Knee arthroplasty is a highly complex surgery. Arthroplasty can be accompanied by intra- or postoperative complications, including potentially fatal outcomes. Patients do not always adhere to the physician's recommendations regarding movement restrictions in the operated joint and special regimes, leading to various complications. The lifespan of the implant is not unlimited, and the results of re-arthroplasty are often unsatisfactory. Moreover, the indications for arthroplasty are imperfect and continuously subject to refinement and limitation. On the other hand, the healthcare system in the Russian Federation does not provide for a monitoring system for patients with osteoarthritis; inpatient treatment for such patients under mandatory health insurance has the lowest tariffs, and the interaction of therapists, orthopedic surgeons, rheumatologists, rehabilitation

specialists, and recovery medicine specialists is not governed by a strict algorithm. A similar situation is observed in the USA, EU countries, and Asia.

Currently, there is a trend toward an increasing number of publications stating that knee arthroplasty for osteoarthritis is often performed prematurely, without utilizing the potential of minimally invasive surgical techniques.

Based on the data from the morphological study, it can be hypothesized that in 6 cases (20%) with confirmed increased serous fluid output, there is an elevated risk of developing an infection at the surgical site. Morphological examination of the synovial membrane prior to knee arthroplasty may be advisable to assess the risk of developing periprosthetic infection and to adjust preoperative preparations concerning synovitis treatment. Sanation-diagnostic arthroscopy could be the procedure of choice in this case, as it allows for sanitation of the knee joint cavity, reducing the severity of synovitis, and enables biopsy of the synovium for histological examination.

The results presented serve as an impetus for conducting a dedicated scientific study focused on correcting the treatment strategy for patients with knee osteoarthritis, aimed at enhancing the role of arthroscopic (organ-preserving) methods in the treatment of knee osteoarthritis. The study is informational-descriptive in nature. The research results will be considered baseline and used in statistical analysis as a control group after the development and implementation of a comprehensive treatment algorithm for knee osteoarthritis.

To correct the treatment strategy for patients with knee osteoarthritis, it is advisable to strengthen the role of arthroscopic methods in the diagnostic and therapeutic processes involved in managing these patients.

Thus, the presence of pronounced inflammatory changes in the synovial membrane can be regarded as a prognostically unfavorable criterion for the development of complications in the surgical area, which, according to many researchers, may lead to deep infection at the surgical site (Tkachenko A.N. et al., 2024).

Based on the data from the morphological study, it can be hypothesized that in 12 cases (40%) of patients with knee osteoarthritis and diagnosed intensely infiltrated synovial membrane and inflammatory changes in the joint, arthroplasty was performed prematurely, without prior anti-inflammatory treatment and without the application of conservative or minimally invasive surgical techniques aimed at preventing local postoperative complications.

CHAPTER 5. NON-OPERATIVE METHODS IN THE TREATMENT OF KNEE OSTEOARTHRITIS

At the GBUZ RK "V.A. Baranova Republican Hospital," from 2016 to 2019, 174 patients with knee osteoarthritis aged 44 to 87 years received conservative treatment. The average age of patients was 59.3±7.3 years. Data on the gender and age distribution of patients are presented in Table 5.1.

Table 5.1. – Distribution of Patients by Age and Gender

Age groups, years	Number of patients					
	Men's		Women's		in total	
	abs.	%	abs.	%	abs.	%
18–44	6	3,4	14	8,1	20	11,5
45–64	29	16,7	54	31,0	83	47,7
65 or more	21	12,1	50	28,7	71	40,8
Total	56	32,2	118	67,8	174	100

As seen in Table 5.1, the gender distribution of patients undergoing conservative treatment was comparable to that of patients who underwent joint replacement surgery. The ratio of women to men was 2:1 (67.8% and 32.2%, respectively). However, unlike the group of patients who underwent joint replacement surgery, those aged 65 and older were in the minority, comprising 71 individuals (40.8%). Patients of working age (up to 64 years inclusive) made up the majority, totaling 103 individuals (59.2%).

Patients with knee osteoarthritis Stage I (Kosinskaya N.S., 1961) accounted for 18 cases (10.3%). Stage II was verified in 67 individuals (38.5%). In the majority of clinical observations—89 patients (51.1%)—Stage III osteoarthritis was recorded. Throughout the observation period, 97 patients (55.7%) were hospitalized once; 77 individuals (44.3%) underwent treatment two or more times.

From 2016 to 2019, 174 patients underwent non-operative inpatient treatment (Table 5.2).

Table 5.2. – Non-Operative Treatment Methods for Knee Osteoarthritis

Types of non-surgical treatment	Number of patients, abs. (%)
Physical therapy: muscle strengthening exercises (isometric and isotonic), range of motion, stretching, aerobic exercises	174 (100)
Physiotherapy methods: electromagnetic field of ultrahigh and high frequencies, ultrasound therapy, electrophoresis of anti-inflammatory drugs, laser therapy, applications of heat carriers, hydrotherapy	151 (86,8)
X-ray therapy	23 (13,2)
Medical treatment: nonsteroidal anti-inflammatory drugs (under the guise of gastroprotectors) Medical treatment: nonsteroidal anti-inflammatory drugs (under the guise of gastroprotectors)	168 (96,6)
B vitamins	160 (92,0)
intraarticular injection of synovial fluid protectors (Fermatron, ostenil, etc.)	29 (16,7)
drugs that improve microcirculation (pentoxifylline, dipyridamole)	85 (48,9)
antioxidant therapy (α-tocopherol acetate – vitamin E)	53 (30,5)
antihistamine therapy (suprastin, tavegil)	43 (24,7)
SYSADOA (Symptomatic Slow-Acting Drug in Osteoarthritis)	31 (17,8)
PRP (Platelet rich plasma)	22 (12,6)
Total patients	174 (100)

Non-pharmacological treatment methods for knee osteoarthritis were applied to all these patients. Therapeutic physical training was a mandatory component of the treatment schemes. Given the lack of standardized treatment programs for OA in Russia, Western Europe, and the USA, the treatment programs utilized those accepted at the GBUZ RK "V.A. Baranova Republican Hospital," characterized by proven long-term practical effectiveness. In patients with OA, isotonic and isometric exercises were individually applied based on the patient's age, comorbidities, severity of osteoarthritis, and other factors.

In most cases, physical exercises (151 patients – 86.8%) were used in conjunction with physiotherapeutic methods. Among the physiotherapeutic procedures used were electromagnetic fields, ultrasound therapy (including phonophoresis), electrophoresis, laser therapy, heat applications (paraffin,

ozocerite), and hydrotherapy. In 23 cases (13.2%), physiotherapeutic treatment was contraindicated. For these patients, courses of radiotherapy were conducted.

In 22 patients (12.6%), PRP (Platelet Rich Plasma) therapy was used—intra-articular injection of plasma enriched with platelets. The basic chondroprotective therapy with SYSADOA was applied alongside therapeutic physical training (individual exercise regimen and daily walking) for 31 patients (17.8%). Researchers note that SYSADOA may slow the progression of the disease and recommend such treatment for all patients with OA.

Functional outcomes were assessed over periods of 3 to 6 years using the WOMAC scale, which allows for determining outcomes not only after knee joint replacement but also after courses of conservative treatment (Table 5.3, Figure 5.1).

Table 5.3 – Information about Patients Under Observation After Conservative Treatment

Indicators	Year of observation					
	1	2	3	4	5	6
Number of patients, abs. (%)	174 (100)	166 (95,4)	161 (92,5)	115 (66,9)	84 (48,3)	66 (37,9)
Excellent and good results, abs. (%)	114 (65,5)	107 (64,5)	100 (62,1)	73 (63,4)	51 (60,7)	40 (60,6)
Satisfactory and unsatisfactory results, abs. (%)	60 (34,5)	59 (35,5)	61 (37,9)	42 (36,6)	33 (39,3)	26 (39,4)

According to the data presented in Figure 5.1, excellent and good results after conservative treatment of osteoarthritis decreased by the fifth year of observation from 66% to 60%, which is statistically insignificant ($p>0.05$). Assessment of knee joint arthroplasty results shows a more pronounced decrease—from 95% of excellent and good results in the first year of observation to 76% in the fifth.

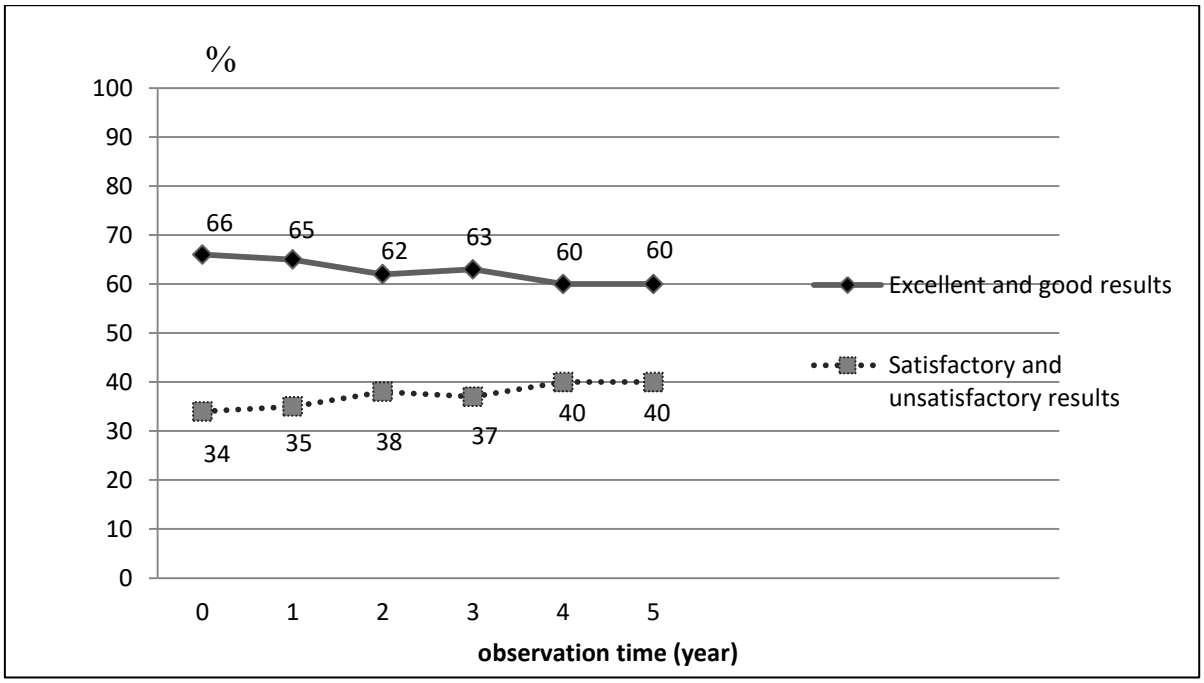

Figure 5.1. Curve of Changes in Functional Outcome Assessment (WOMAC) After Conservative Treatment of Knee Osteoarthritis

Excellent and good results (according to the WOMAC scale) at the fifth year of observation with low comorbidity rates were observed with a probability of 0.78 (0.67; 0.88); with high comorbidity rates, this was 0.74 (0.65; 0.81). There were no significant differences between survival curves for conservative treatment and joint replacement surgery. However, the trend of decreasing excellent and good results was more pronounced in patients who underwent joint replacement surgery. It is likely that after 3–5 years, the functional outcome indicators of arthroplasty and conservative treatment of OA will converge. This circumstance requires further study of the long-term outcomes of different methods of OA treatment.

The study of the results of non-operative inpatient treatment of OA over 5 years allows us to conclude that positive (excellent and good) functional outcomes can be expected in 60% of patients. In 40% of patients, functional outcomes by the end of the fifth year of observation are assessed as negative (satisfactory or unsatisfactory). The conducted study shows that the negative dynamics of functional outcomes are less pronounced in patients receiving non-operative treatment compared to those with OA who underwent arthroplasty.

CHAPTER 6. RATIONALE FOR A MULTIDISCIPLINARY TREATMENT ALGORITHM FOR KNEE OSTEOARTHRITIS

In developing a comprehensive treatment algorithm for patients with knee osteoarthritis (OA), several aspects were considered.

First, prior to knee arthroplasty (KA), 107 (28.5%) patients underwent non-operative inpatient treatment. In contrast, 269 (71.5%) patients were treated on an outpatient basis without a structured approach. In 74 (19.7%) cases, KA was performed after the first visit to a polyclinic for osteoarthritis, leading to a referral for specialized inpatient treatment.

Pathomorphological studies indicated that in 40% of cases, KA is performed against a background of significant inflammatory changes in the synovial membrane, increasing the incidence of local inflammatory complications in the surgical area. Preliminary anti-inflammatory treatment (using conservative or organ-preserving surgical techniques) could potentially prevent local postoperative complications.

Numerous publications in the medical literature highlight the unjustified and premature performance of KA. There is also a growing body of articles on modern non-operative treatment methods for OA. However, a unified, widely accepted treatment strategy based on a comprehensive multidisciplinary approach is still lacking.

The developed algorithm is based on the idea that KA is seen as the final stage of OA treatment (Spichko A.A. et al., 2021; Khaidarov V.M. et al., 2021). KA should only be considered after the use of non-operative and minimally invasive surgical methods (see Fig. 6.1).

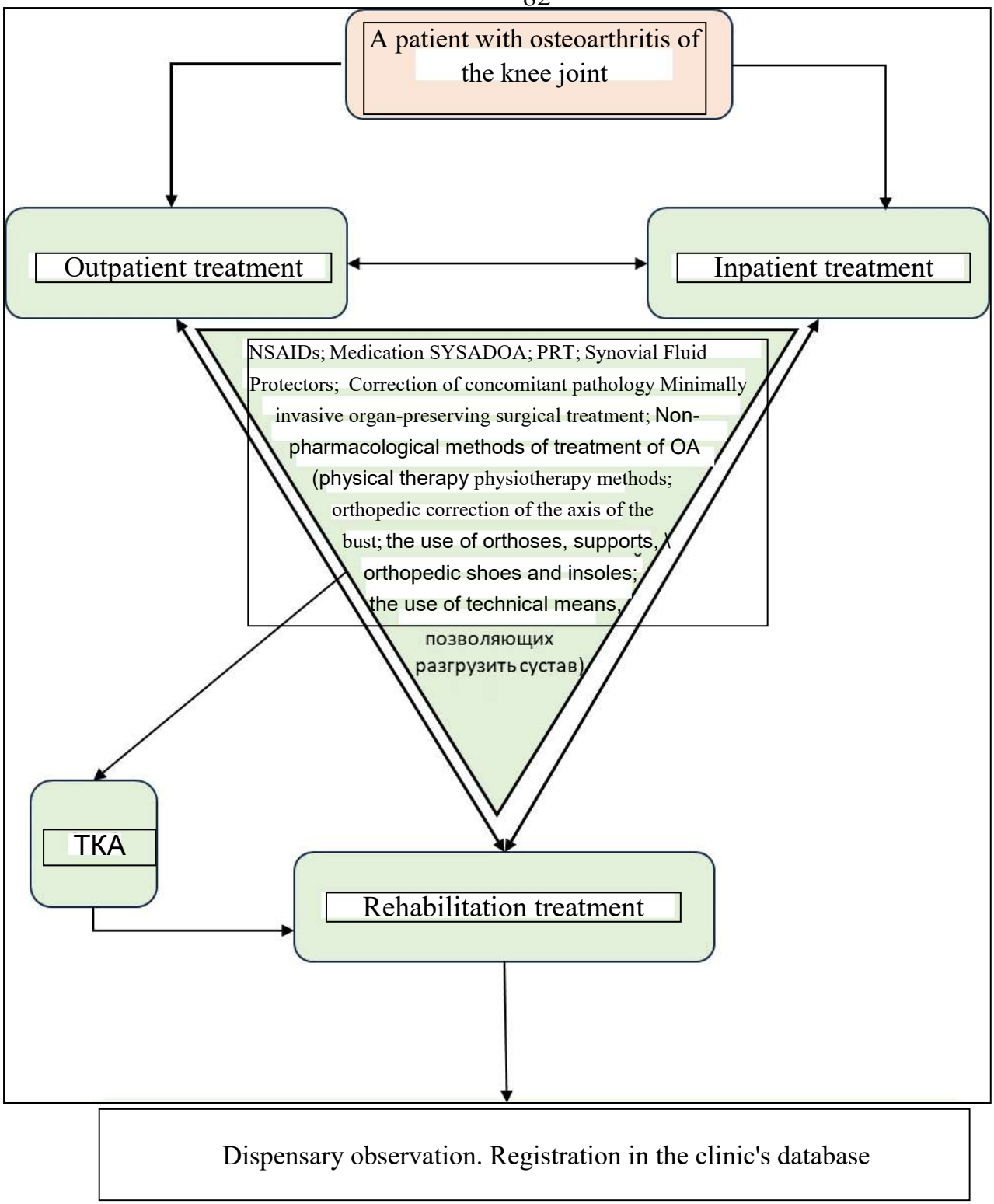

Figure 6.1. Multidisciplinary Treatment Algorithm for Knee Osteoarthritis.

Exclusions may only apply to cases of joint instability and observed Stage III OA with significant pain syndrome unresponsive to therapy. The created algorithm could serve as the foundation for developing a comprehensive treatment

concept for patients with knee OA. The diagnostic and therapeutic measures consist of sequential outpatient assessment and treatment, inpatient conservative treatment, organ-preserving surgeries, and culminating in KA. Each stage of the treatment process can be accompanied by rehabilitation activities.

To form a treatment strategy for patients with knee OA, it is advisable to develop an algorithm ensuring stable interaction among specialists, including orthopedic surgeons, therapists, physiotherapists, rheumatologists, rehabilitation specialists, and others.

The algorithm was tested retrospectively on a group of patients based on the principle of "what if." Prospective validation is currently being conducted at the clinic and is expected to continue for at least 10 years to gather clinical data.

To demonstrate the effectiveness of the algorithm, we present several retrospective cases.

Patient G., Female, 67 Years Old. First visited the polyclinic in January 2018. Diagnosed with Stage III osteoarthritis of the right knee (see Fig. 6.2 A).

Comorbidities: Stage III hypertension. Cardiovascular risk score — 4. The patient is not employed and has no disability. General condition — satisfactory. Height 168 cm, weight 75 kg. BMI 26.6 (overweight). Treatment consisted of self-administered NSAIDs during exacerbations of pain syndrome.

Admitted in July 2019 for examination. No absolute contraindications for surgical treatment were found. Preoperative evaluation was performed, and the anesthesiologist assessed anesthesia risk as ASA 2. Planned anesthesia was spinal.


А


Б


В

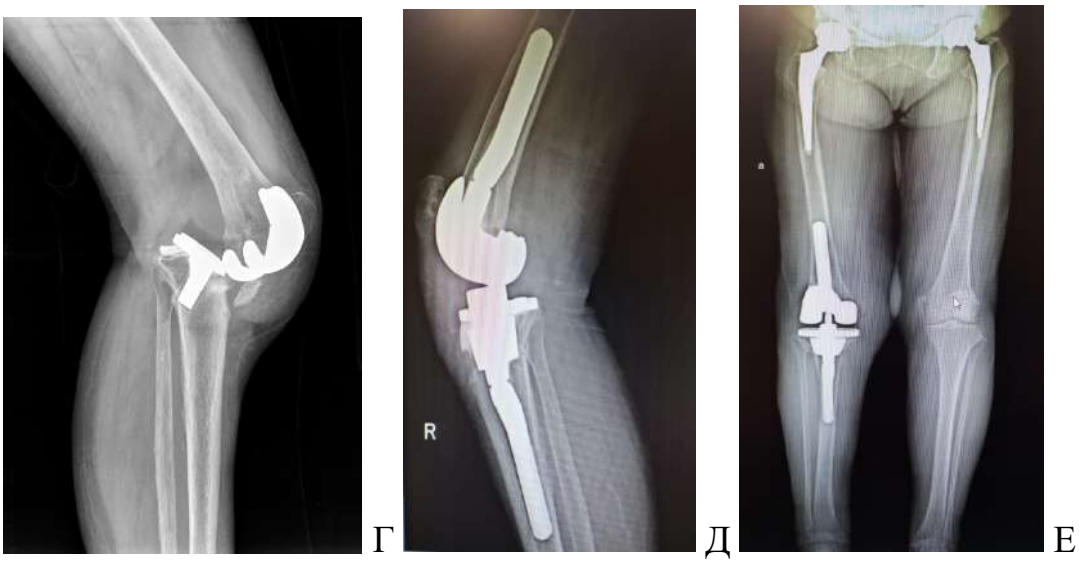

Figure 6.2. X-rays of patient G., 67 years old. A — osteoarthritis of the right knee joint 3 art . B — total arthroplasty of the right CS. Cement fixation. C, D — X-rays after 12 months – fracture of the tibial plateau, dislocation of the tibia posteriorly. D, E — revision arthroplasty of the right knee joint

Preoperative planning was conducted, and total cemented arthroplasty with preservation of the posterior cruciate ligament was performed (see Fig. 6.2 B). The preoperative preparation period was 1 day. Signs of osteoporosis were noted during the operation. Duration of surgery was 1 hour and 20 minutes. Blood loss was 250 ml. The wound healed by primary intention. Stitches were removed on the 14th day.

One year after KA, severe pain in the surgical area occurred without any apparent cause (no trauma). Diagnosed with a fracture of the tibial plateau and instability of the tibial component of the prosthesis (see Fig. 6.2 C, D). Six months later, revision KA was performed at the R.R. Vreden Research Institute in St. Petersburg (see Fig. 6.2 E, F). The patient was assessed one year post-revision. During the subsequent 24-month follow-up, there were no signs of infection or instability. Quality of life and functional outcomes were satisfactory.

Patient B., Male, 56 Years Old. Hospitalized in 2018. Diagnosed with Stage III osteoarthritis of the left knee (see Fig. 6.3 A). Comorbidities: Stage II hypertension. Height 175 cm, weight 78 kg. BMI 25.5. Anesthesia risk according to ASA – 2. Spinal anesthesia was used. The operation was total arthroplasty of the left knee. Duration of the surgery was 1 hour and 30 minutes (see Fig. 6.3 B, C, D). Intraoperative blood loss was 300 ml. The wound healed by primary intention, and stitches were removed on the 14th day.

Six months post-surgery, aseptic instability of the prosthesis was identified (see Fig. 6.3 C, D). Following outpatient assessment and three joint aspirations, clinical signs of inflammation were not found. The patient was hospitalized, and

the implant components were removed. Revision arthroplasty with an LSSC prosthesis was performed (see Fig. 6.3 E, F), and the postoperative wound healed by primary intention. Two years later, the patient was examined in the hospital. During the 24-month follow-up, there were no signs of infection or instability. Functional outcomes and quality of life were rated as "good."

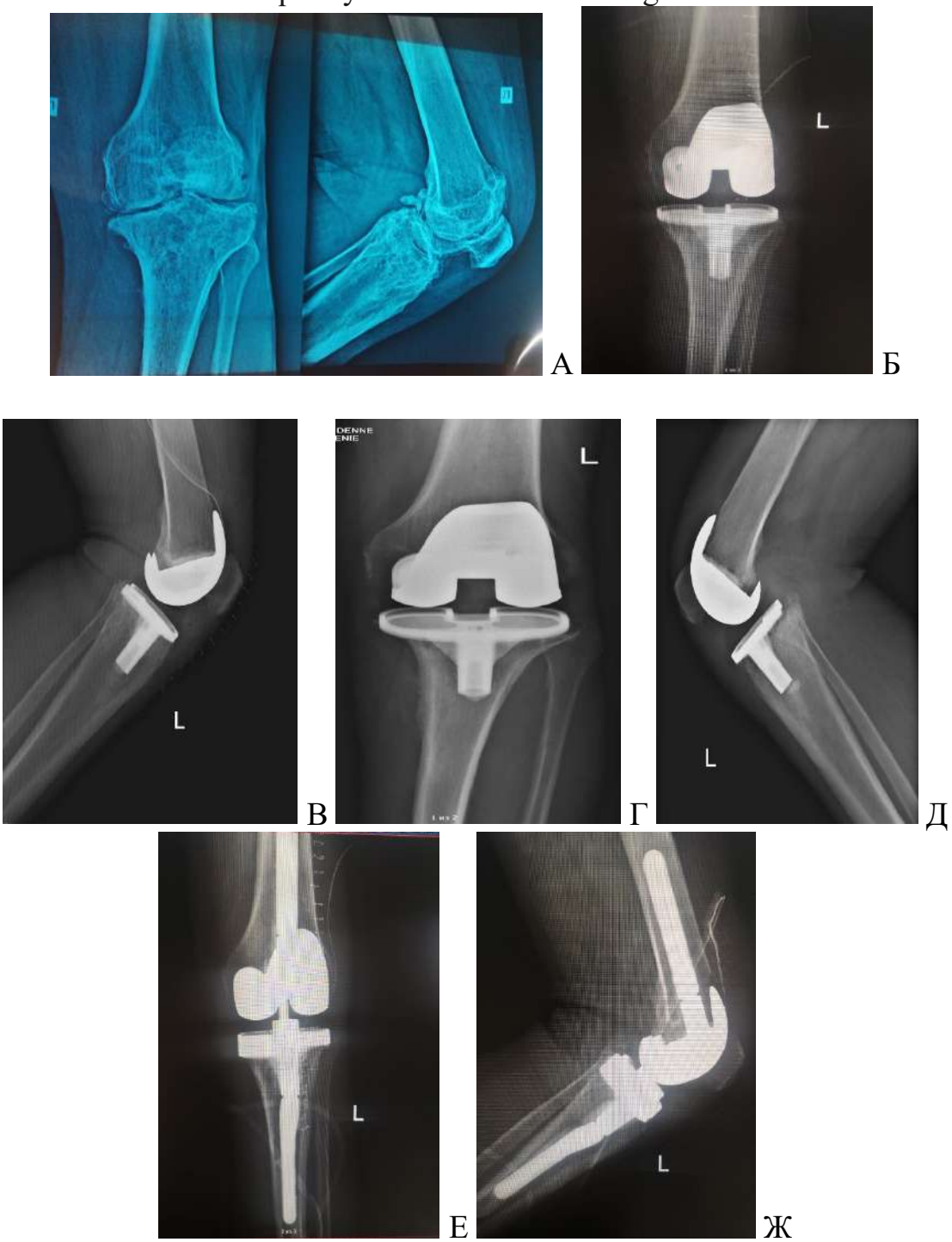

Figure 6.3. X-rays of patient B., 56 years old. A — osteoarthritis of the left knee joint of the III st. B, C — X-rays after knee replacement. D, D — X–rays after 6 months - aseptic instability of the arthroplasty. F, F — removal of implant components, installation of a revision arthroplasty LSSC

Patient C., Female, 59 Years Old. Presented in May 2017. Diagnosed with Stage III OA of the right knee (see Fig. 6.4 A, B). Comorbidities: Chronic viral hepatitis C, chronic gastritis in remission. Outpatient treatment was ineffective. The patient began to experience night pain.

Admitted in October 2017. The patient was examined. No absolute contraindications for surgical treatment were found. Anesthesia risk according to ASA – 1. Planned anesthesia was spinal. Total cemented arthroplasty was performed without complications (see Fig. 6.4 C). Duration of the surgery was 1 hour and 35 minutes. Blood loss was 250 ml. Stitches were removed on the 13th day.

The rehabilitation period was satisfactory. After 8 months, a fistula developed with purulent discharge from the wound. Microorganisms were isolated from the discharge. The patient was referred to the purulent osteology department for continued treatment, where the implant components were removed, and the purulent focus was sanitized. An articulating antimicrobial spacer was installed (see Fig. 6.4 D, E, F, G). The patient was discharged for outpatient treatment at her residence.

А

Б

В


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Figure 6.4. X-rays of patient B., 59 years old. A, B — pre- operative X-rays. Osteoarthritis of the right knee joint of the III st. B — X-rays after TKA. D, D — X–rays after 1 year - after removal of the arthroplasty and installation of an antimicrobial spacer. E, F, Z — MRI of the knee joint after removal of the arthroplasty and installation of an antimicrobial spacer. And, K, L, M — X-rays

after removal of antimicrobial spacer and extracellular transosseous osteosynthesis. N, O — control X-rays after 1 year. Successful arthrodesis of the right knee joint

After 3 months, the fistulous tract reopened, and the patient was hospitalized again in the purulent osteology department. Exacerbation of chronic osteomyelitis of the tibia and femur and osteonecrosis of the proximal tibia were identified. One week after hospitalization, removal of the spacer, radical surgical treatment of the inflammatory focus, and extracorporeal osteosynthesis for knee arthrodesis were performed (see Fig. 6.4 I, J, K, L). The infectious-inflammatory process was resolved. The patient was discharged for outpatient treatment in satisfactory condition.

One year after the operation, she was examined. Signs of infection were resolved, and arthrodesis was successful (see Fig. 6.4 M, N). Joint function was lost, and quality of life was rated as unsatisfactory.

All these clinical cases share a common circumstance: none of the patients received inpatient non-operative treatment for knee osteoarthritis. In no clinical observation were there courses of SYSADOA or PRP therapy. Before arthroplasty, all these patients were mobile and led relatively active lives. The examples demonstrate that had these patients received modern non-operative treatment aimed at reducing pain intensity and improving static-dynamic function, their quality of life and functional outcomes would likely have been better than those observed after knee arthroplasty.

The retrospective testing of the algorithm was carried out as follows. Long-term 5-year results are available in 131 (34.8%) patients out of 376. Excellent and good treatment results were found in 101 (77.1%), and satisfactory and unsatisfactory – in 30 (22.9%) patients (see Table 3.7). Among these 131 patients, only 40 (30.5%) had inpatient treatment using non-surgical methods before being admitted to the hospital for knee replacement.

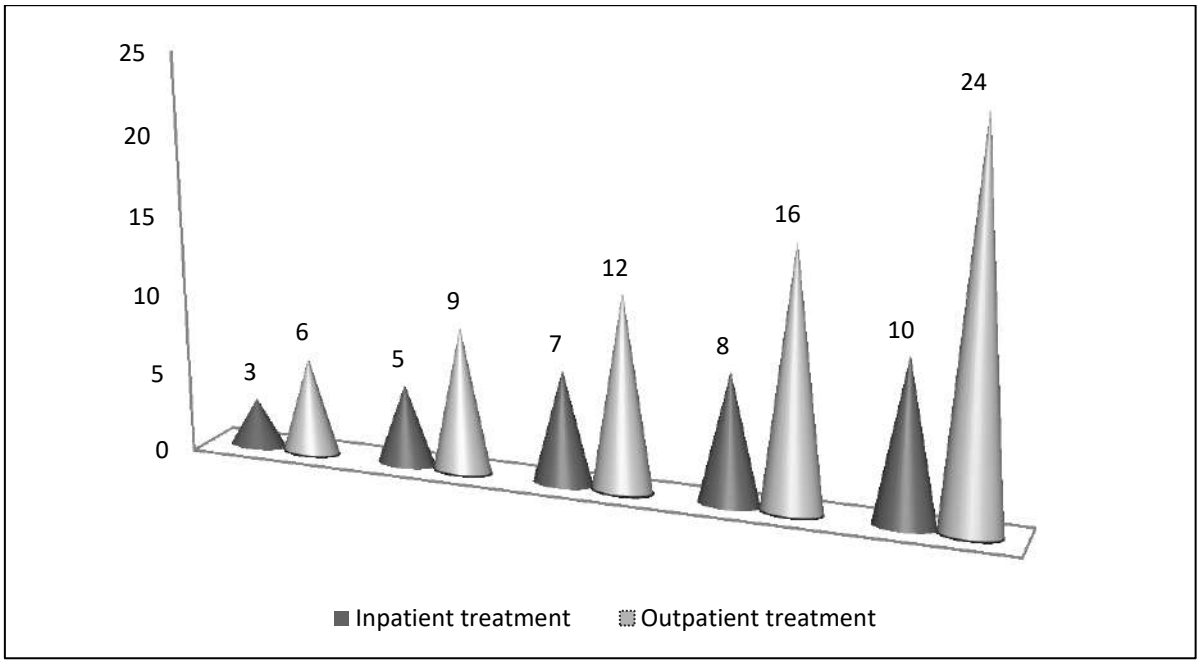

Figure 6.5. The number of satisfactory and unsatisfactory functional results (according to the WOMAC scale) after knee replacement in cases of presence and absence of previous courses of inpatient non-surgical treatment of idiopathic osteoarthritis of the knee joint

As indicated by the data presented in Figure 6.5, five years after arthroplasty, satisfactory and unsatisfactory functional results were verified in 4 (10%) cases among patients who had previously undergone stationary non-surgical treatment. In 91 (69.5%) patients, there was no record of stationary treatment for knee osteoarthritis. Satisfactory and unsatisfactory functional results were noted in 22 (24%) cases.

Thus, the developed algorithm for the comprehensive treatment of knee osteoarthritis allows for more than a twofold reduction (from 24% to 10%) in the number of satisfactory and unsatisfactory five-year treatment results for knee osteoarthritis. Despite such differences, from the standpoint of evidence-based medicine, these results cannot be considered statistically significant ($p > 0.05$). In this case, we are talking about a stable trend. Subsequent study and analysis of the long-term results of knee joint prosthesis in these patient groups can be regarded as promising for further development of the topic.

The dissertation research has shown that the application of a multidisciplinary approach algorithm to the treatment of patients with knee osteoarthritis in everyday clinical practice is promising. An individualized approach to the treatment of patients with idiopathic gonarthrosis improves functional outcomes and quality of life for patients, allowing for knee arthroplasty to be postponed to a later time.

In the Russian Federation, as in Europe, North America, and Southeast Asia, there are reports about the limited use of conservative treatment and the unjustified or premature performance of knee arthroplasty in osteoarthritis cases. The lifespan of the arthroplasty is limited. Total knee arthroplasty (TKA) is not an organ-preserving operation, as it involves the removal of the knee joint and the resection of the tibial and femoral bones. Furthermore, in recent years, there has been no consistent trend towards a reduction in negative outcomes and complications following TKA.

Currently, the indications for joint replacement with an implant cannot be deemed perfect. They are constantly being refined, typically towards their restriction. A promising direction for the research topic could be the development of a strategy for multidisciplinary treatment of knee osteoarthritis that considers non-surgical treatment methods, organ-preserving surgical approaches, and arthroplasty, as well as the clarification of indications for joint replacement with an implant.

Resume

Joint replacement with an implant is considered the surgery of choice for severe knee osteoarthritis and is widely practiced worldwide. However, TKA does not always yield good results, and the lifespan of the implant is limited to 10-20 years. In this situation, there is increasing attention to the existing indications for the surgery. In recent years, there have been more publications addressing the premature performance of this surgery and the limitations on indications for arthroplasty in knee osteoarthritis cases.

The results of knee arthroplasty are directly influenced by the stage of the pathological process, the age and gender of the patient, body mass index, comorbidity, and many other parameters. The complications of TKA, according to various researchers, range from 1.5% to 25%. Among these complications are deep infections, aseptic instability of the implant, periprosthetic fractures, and others. The number of patients dissatisfied with both the immediate and long-term results of TKA is increasing due to the natural wear of the prosthesis or inflated expectations regarding the effects of the surgery.

The results of the study of this issue indicate that, in some cases, the replacement of the knee joint with an implant was performed without justification or prematurely. Today, the possibilities of non-surgical treatment methods for knee osteoarthritis have significantly expanded. The use of SYSADOA medications, structure-modifying drugs, PRP therapy, autologous chondrocyte transplantation, local therapy, and physiotherapeutic treatments provide patients with a chance to maintain the functional activity of their own joint and potentially avoid or significantly postpone arthroplasty in the future. There are an increasing number of publications dedicated to organ-preserving surgical treatment methods: tunneling, bone plastic surgeries, arthroscopic interventions, and others. However, currently, non-surgical and organ-preserving surgical methods are not being utilized to their full potential. Overall, there is a limited number of works in the available literature addressing the role of total knee arthroplasty (TKA) in the comprehensive treatment of patients with knee osteoarthritis.

During the course of the work, data on several groups of patients were analyzed. Firstly, this includes information on 376 patients with knee osteoarthritis who underwent knee arthroplasty at the State Budgetary Healthcare Institution of the Republic of Karelia “Republican Hospital named after V.A. Baranov” (Petrozavodsk) from 2016 to 2019 (inclusive). The long-term treatment results were evaluated from 2 to 6 years after surgery. During the same period (2016 to 2019), 174 patients with the diagnosis of “knee osteoarthritis” were under conservative treatment at the same hospital. The groups were comparable in terms of age and sex.

Data from morphological studies of the synovial membrane and its immunohistochemical analysis for infiltrative changes during knee arthroplasty were studied separately. This was conducted on 30 patients with knee osteoarthritis who underwent arthroplasty in 2022 (selected by a continuous sampling method).

Among the 376 patients who underwent primary total TKA due to knee osteoarthritis, the majority were women—301 patients (80.1%). The largest group consisted of women aged 65 years and older—almost half of all observations (184 patients—48.9%). Among elderly patients, the ratio of men to women was 1:5 (9.8% and 48.9%, respectively).

Before undergoing knee arthroplasty, the majority of patients with knee osteoarthritis—269 (71.5%)—received outpatient treatment under specialist supervision or self-managed at home, typically taking non-steroidal anti-inflammatory drugs during exacerbations of osteoarthritis. In one out of five cases (74 observations—19.7%), the patient was referred for treatment and hospitalized for TKA after their first visit to a clinic due to osteoarthritis. Stationary conservative treatment for knee osteoarthritis (in the medical history) was performed in only 107 (28.5%) patients.

In most cases, the results of TKA were assessed as excellent or good. At the same time, intraoperatively and in the early postoperative period after TKA, complications related to the surgical wound and general complications were verified in 45 (12%) patients.

Intraoperative complications related to the cardiovascular system were noted in 6 (1.6%) patients; damage to the posterior cruciate ligament was observed in 5 patients (1.3%). Postoperatively, deep infections developed in 18 (4.8%) patients, and hematomas occurred in 17 (4.5%) cases.

Comorbidity of varying degrees of severity was identified in the majority of patients (351 patients—93.4%) hospitalized at V.A. Baranov Hospital for TKA. In these cases, there were between 1 to 5 comorbid conditions. Patients with a high degree of comorbidity prevailed—254 (67.6%) individuals. Among the comorbidities, cardiovascular diseases were most frequently noted (in descending order)—246 (65.4%) cases; nervous system diseases—232 (62.6%); obesity (increased BMI)—216 (57.4%); respiratory diseases—105 (28.3%).

In the early postoperative period following knee arthroplasty, some patients experienced local complications: hematomas, lymphorrhea, deep infections (both superficial and deep), bleeding, and damage to the knee ligament apparatus, among others. The most frequent complication was deep infection, which was noted in 21 (5.6%) observations.

By the end of the fifth year of observation, excellent and good quality of life was reported in 77% of patients. Satisfactory and unsatisfactory outcomes were observed in 23% of patients.

When analyzing the five-year results based on physical status across 4 groups of patients (4 levels of comorbidity: ASA I—“low,” ASA II—“below average,” ASA III—“above average,” and ASA IV—“high”), statistically significant differences were found only in patients with an ASA IV anesthetic risk, as indicated by the log-rank test ($\chi 2 = 0.93551$, significance level p-value = 0.0283); however, the number of patients with ASA IV was small—only 7 (1.9%) cases out of 376.

Functional results of TKA in the long term after the surgery (assessed using the WOMAC scale) did not significantly differ between patients with different comorbidity levels. Excellent and good functional results at the fifth year of

observation were noted in 78% of patients with low comorbidity, while in patients with high comorbidity, this figure was 74% ($p = 0.28$).

The aim of the phase of the work related to morphological studies was to determine the intensity of inflammatory changes in the synovial membrane and identify the risk of local complications after TKA based on the degree of inflammatory changes in the synovium.

Among the 187 patients who underwent total knee arthroplasty (TKA) at the clinic in 2022, the excised synovial membrane of the knee joint was studied in 30 cases. Morphological examination revealed varying stages of inflammatory changes, ranging from initial manifestations to pronounced intense infiltration. Among the 30 histological studies conducted, a mild degree of infiltrative changes was identified in 7 (23.3%) cases; a more pronounced degree of infiltration was verified in 12 (40%) patients, while intense infiltration was observed in 11 (36.7%) cases.

Analysis of the postoperative period showed that hematomas were identified in 2 out of 30 patients, and 5 patients experienced abundant drainage of serous fluid within 5–10 days post-arthroplasty, which was regarded as lymphorrhea. Notably, no such complications were observed in the group with mild infiltration of the synovial membrane. Among the 12 patients with morphologically confirmed intense infiltration of the synovium, 4 cases of lymphorrhea and 1 case of hematoma in the surgical site were noted.

The presence of pronounced inflammatory changes in the synovial membrane can be regarded as a prognostically unfavorable factor for the development of complications at the surgical site, which, according to various authors, may lead to different complications, including periprosthetic infections.

It is undeniable that orthopedic traumatologists, when deciding on the performance of knee arthroplasty, considered the peculiarities of the clinical picture, the results of investigations regarding the status of the ligamentous apparatus, and the stability of the knee joint. The stage of the pathological process was confirmed through X-ray images. However, it is noteworthy that in all

examined cases, physicians did not take into account the presence of synovitis of varying degrees of severity. At the same time, histological examination of the synovial membrane can be conducted following organ-preserving interventions, such as diagnostic and therapeutic arthroscopy, which is often performed in cases of knee osteoarthritis and precedes arthroplasty.

Based on the data from the morphological study, it can be assumed that in 12 (40%) patients with intensely infiltrated synovial membranes and inflammatory changes in the joint, knee arthroplasty was currently not indicated and was performed prematurely. To address the inflammatory changes, it would be advisable to conduct a course of conservative treatment for knee osteoarthritis aimed at preventing postoperative complications.

From 2016 to 2019, 174 patients with knee osteoarthritis aged 44 to 87 years received conservative therapy at the State Budgetary Healthcare Institution of the Republic of Karelia “Republican Hospital named after V.A. Baranov.”

Non-pharmacological methods of treating knee osteoarthritis were applied to all these patients. Among the physiotherapeutic procedures used were electromagnetic fields of ultra-high and high frequencies, ultrasound therapy (including phonophoresis of anti-inflammatory drugs), electrophoresis of anti-inflammatory medications (hydrocortisone), laser therapy, applications of heat carriers (paraffin, ozokerite, peat mud), and hydrotherapy. In 23 (13.2%) cases, the use of physiotherapy was contraindicated. For this group of patients, courses of radiotherapy were administered.

PRP (Platelet Rich Plasma) therapy, which involved intra-articular injection of platelet-enriched plasma, was applied to 22 (12.6%) patients. Basic chondroprotective therapy with SYSADOA (Symptomatic Slow-Acting Drug in Osteoarthritis) combined with therapeutic physical exercises was prescribed for 31 (17.8%) patients.

Functional results were assessed using the WOMAC scale at periods ranging from 3 to 6 years. The frequency of excellent and good outcomes following conservative treatment of knee osteoarthritis decreased by the fifth year of

observation from 66% to 60%, which was statistically insignificant ($p>0.05$). Assessment of WOMAC results post-knee arthroplasty shows a more pronounced decrease from 95% excellent and good results in the first year of observation to 77% by the fifth year. The probability of excellent and good functional outcomes (according to WOMAC) at the fifth year of observation for patients with low comorbidity was 0.78 (0.67; 0.88), while for those with pronounced comorbid conditions it was 0.74 (0.65; 0.81). No statistically significant differences were observed for either conservative treatment or after TKA. However, the trend of decreasing excellent and good results was more pronounced among patients who underwent TKA. It is likely that after 3–5 years, the functional results of arthroplasty and conservative treatment of knee osteoarthritis will converge. This prediction requires further study of the long-term results of conservative and surgical treatments for osteoarthritis over 10 and 15 years.

The study of five-year outcomes from conservative inpatient treatment of knee osteoarthritis suggests that positive (excellent and good) functional results can be expected in 60% of patients. In 40% of patients, functional outcomes by the end of the fifth year of observation were considered negative (satisfactory or unsatisfactory). The conducted research indicates that the negative dynamics of functional results are less pronounced in patients receiving conservative treatment than in those with knee osteoarthritis who underwent arthroplasty.

Several aspects were taken into account when creating an algorithm for the comprehensive treatment of patients with knee osteoarthritis.

Firstly, before undergoing TKA, 107 (28.5%) patients with knee osteoarthritis received conservative inpatient treatment. Outpatient and unsystematic treatment was administered to 269 (71.5%) patients. In 74 (19.7%) cases, knee arthroplasty was performed after the first visit to a clinic regarding knee osteoarthritis.

Secondly, in 36.7% of observations (approximately one in three patients), intense infiltration of the synovial membrane of the knee joint was noted. The presence of pronounced inflammatory changes in the synovial membrane can be

regarded as a prognostically unfavorable criterion for the development of complications at the surgical site, which, according to many researchers, may lead to deep infections in the area of the surgical intervention.

In the scientific medical literature, both in Russian sources and from authors in Europe, the USA, and Southeast Asia, there are numerous publications dedicated to the unjustified and premature performance of total knee arthroplasty (TKA). There is also an increasing number of articles on new modern minimally invasive surgical and conservative methods for treating knee osteoarthritis. However, there is currently no unified and widely accepted treatment scheme for patients with osteoarthritis that includes a multidisciplinary approach involving specialists of various profiles at all stages of examination and treatment.

The essence of the developed algorithm is that knee arthroplasty is considered the final stage of treatment for knee osteoarthritis. Total knee arthroplasty should be performed only after the use of conservative and minimally invasive surgical methods. Exceptions may include cases of joint instability in stage III osteoarthritis with pronounced pain syndrome. The created algorithm can serve as the basis for a developing treatment strategy for patients with knee osteoarthritis, which implies outpatient and inpatient examination and treatment using non-operative methods, organ-preserving surgical techniques, and TKA as a concluding stage of treatment with rehabilitation at any of the stages.

To form the concept of a treatment strategy for patients with knee osteoarthritis in the future, it is advisable to develop an algorithm that ensures sustainable interaction among specialists, including orthopedic surgeons, rehabilitation medicine and physical therapy specialists, therapists, rheumatologists, and rehabilitation specialists in both outpatient and inpatient and sanatorium-resort settings.

The algorithm has been tested on a retrospective group of patients based on the principle of "what if...". The long-term 5-year results were obtained for 131 (34.8%) patients out of 376. Excellent and good treatment outcomes were noted in 101 (77.1%) patients, while satisfactory and unsatisfactory outcomes were

observed in 30 (22.9%) patients. Among these 131 patients, only 40 (30.5%) had undergone inpatient treatment for knee osteoarthritis using non-operative methods prior to hospitalization for knee arthroplasty.

Five years after arthroplasty, satisfactory and unsatisfactory functional results were verified in 4 (10%) patients who had previously received inpatient non-operative treatment. Among 91 (69.5%) patients, there was no record of inpatient treatment for knee osteoarthritis. Satisfactory and unsatisfactory functional results were noted in 24 (22%) cases.

Thus, the developed algorithm for the comprehensive treatment of knee osteoarthritis allows for more than a twofold reduction (from 24% to 10%) in the number of satisfactory and unsatisfactory 5-year treatment outcomes for knee osteoarthritis.

Currently, there is a need for a multifaceted multidisciplinary study that will clarify the indications and contraindications for knee arthroplasty. It is advisable to regulate the therapeutic and diagnostic process, taking into account the potential for conservative treatment, rehabilitation activities, and organ-preserving surgical techniques.

CONCLUSIONS

1. Following primary total knee arthroplasty due to idiopathic osteoarthritis, intraoperative and postoperative complications were noted in 45 (12%) patients. Among the complications in the postoperative period, the predominant issues were infections at the surgical site (18 patients – 4.8%), hematomas (17 cases – 4.5%), and lymphorrhea (14 observations – 3.7%). The number of patients with excellent and good functional outcomes and quality of life after knee arthroplasty decreases by 23% by the end of the fifth year compared to the first year results.

2. According to morphological studies, weak degrees of infiltrative changes in the synovial membrane during arthroplasty were verified in 23.3% of cases; moderate degrees were found in 40%, and in 36.7% of cases, changes in the synovium were interpreted as intense infiltration. In most cases (71.4%), complications at the surgical site after TKA occurred in patients with pronounced inflammatory changes in the synovial membrane, which can be regarded as a prognostically unfavorable criterion for the development of complications at the surgical site.

3. Excellent and good functional outcomes five years after knee arthroplasty were observed in 78% of patients with low comorbidity and in 74% of clinical observations with pronounced comorbidities, which does not represent a statistically significant difference ($p>0.05$) and requires further monitoring and study of these patient groups.

4. The application of a multidisciplinary treatment algorithm for knee osteoarthritis allows for a reduction in the number of satisfactory and unsatisfactory functional outcomes from 24% to 10% over five years. The fundamental component ensuring improved treatment outcomes for patients with knee osteoarthritis is the organizational aspect, which includes the use of both non-operative and surgical intervention strategies in providing medical care to patients with osteoarthritis.

PRACTICAL RECOMMENDATIONS

1. When developing a treatment strategy for patients with knee osteoarthritis, it is recommended to apply a treatment algorithm that incorporates the use of conservative methods and arthroplasty.

2. The decision to perform knee arthroplasty should be made after utilizing the full range of conservative and organ-preserving surgical methods for treating knee osteoarthritis.

3. Based on morphological studies of the synovial membrane during arthroscopic treatment of knee osteoarthritis, pronounced inflammatory changes should be considered a prognostically unfavorable factor for the development of local postoperative complications following planned knee arthroplasty.

4. Knee arthroplasty should be viewed as a last resort for treating osteoarthritis, after which all other methods may prove ineffective, given that the lifespan of the implant is not unlimited. The treatment algorithm for patients with knee osteoarthritis, considering conservative methods and arthroplasty, allows for either avoiding arthroplasty or postponing it to a later date.

PROSPECTS FOR FURTHER RESEARCH

In the Russian Federation and in all developed countries, there is an increasing number of scientific publications indicating that knee arthroplasty for osteoarthritis is often performed unnecessarily and prematurely, while the potential of modern non-operative and organ-preserving surgical techniques is not always fully utilized. The results of this work serve as a motivation for conducting specialized scientific studies focused on identifying the role of arthroscopic and other organ-preserving techniques within the multidisciplinary treatment structure for knee osteoarthritis.

Another promising area of research involves developing a comprehensive treatment organization for patients with degenerative-dystrophic joint diseases, which includes outpatient assessment and treatment, inpatient care, sanatorium-resort treatment, and rehabilitative assistance. A third promising direction is experimental research. Investigations into the mechanisms of osteoarthritis development, especially in its early stages; the development of fundamentally new methods for organ-preserving surgical interventions; and questions concerning chondroplasty are all warranted.

Such research will enable the formulation of a comprehensive treatment strategy for patients with knee osteoarthritis, as well as refine and specify the indications for arthroplasty in one of the most prevalent diseases—knee osteoarthritis.

LIST OF ABBREVIATIONS

AD – arterial pressure

ALT – alanine aminotransferase

ArtKnee – arthroplasty knee

ASA – American Society of Anesthesiologists

AST – aspartate aminotransferase

BMI – body mass index

ECG – electrocardiography

ETN – endotracheal anesthesia

GB – hypertensive disease

HC – high degree of comorbidity

IOH – surgical site infection

KJA – knee joint arthroplasty

KOA – knee osteoarthritis

LK – low degree of comorbidity

MRI – magnetic resonance imaging

OA – osteoarthritis of the knee

PE – pulmonary embolism

PRP – platelet rich plasma

RF – Russian Federation

SMA – spinal anesthesia

SYSADOA – Symptomatic Slow-Acting Drug in

SZGMU – Northwest State Medical University

TKA – total knee arthroplasty

US – ultrasound examination

VPH – military field surgery

WHO – World Health Organization

WOMAC – Western Ontario and McMaster University Osteoarthritis Index

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APPENDIX

A CARD FOR REGISTRATION OF THE MEDICAL HISTORY OF A PATIENT
WHO UNDERWENT TOTAL KNEE REPLACEMENT
JOINTS DUE TO OSTEOARTHRITIS

1. Card number _____
2. Archive number of the medical history _____
3. Last name, first name, patronymic _____
4. Address _____
5. Phone number_____
6. Gender 1 – M; 0 – F.
7. Year of birth 1…
8. Month of birth 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – 11 – 12
9. Age _____ (full years) upon admission to the clinic for knee artroplastic.
10. Profession upon admission to the clinic for knee artroplastic:
    1 – physical labor
    2 – intellectual work
    3 – the mixed nature of work
    4 – retiree
11. Disability upon admission to the clinic due to:

0 – no; 1, 2, 3 groups (specify the reason)

12. Concomitant diseases during the examination of patients admitted to the knee artroplastic:
    0 – there was no

1. The cardiovascular system
- 1.1. coronary heart disease, angina pectoris of tension, 1 functional class
- 1.2. coronary heart disease, angina pectoris of tension, 2 functional class
- 1.3. coronary heart disease, angina pectoris of tension, 3 functional class
- 1.4. postinfarction cardiosclerosis
- 1.5. obliterating atherosclerosis
- 1.6. obliterating endarteritis
- 1.7. thrombophlebitis
- 1.8. hypertension (I, II, III ст.)
- 1.9. heart and vascular surgery (point out)
- 1.10. circulatory insufficiency (I, IIa, IIb, III stages)
- 1.11. rheumatism
- 1.12. other

2. Respiratory system
- 2.1. chronic bronchitis
- 2.2. silicosis
- 2.3. chronic pneumonia
- 2.4. bronchial asthma
- 2.5. pneumofibrosis
- 2.6. lung surgery (point out)
- 2.7. other

3. The digestive system
- 3.1. chronic gastritis
- 3.2. stomach or duodenal ulcer
- 3.3. chronic esophagitis
- 3.4. chronic enteritis
- 3.5. chronic colitis

3.6. nonspecific ulcerative colitis
3.7. Crohn's disease
3.8. chronic pancreatitis
3.9. chronic hepatitis
3.10. chronic cholecystitis
3.11. operations on the organs of the digestive system (point out)
3.12. other

4. Excretory system
4.1. urolithiasis
4.2. chronic pyelonephritis
4.3. chronic cystitis
4.4. operations on the excretory system (point out)
4.5. prostate adenoma
4.6. other

5. The endocrine system
5.1. diabetes mellitus
5.2. thyrotoxicosis
5.3. surgical diseases of the adrenal glands
5.4. operations on endocrine organs (point out)
5.5. other

6. Diseases of the nervous system and sensory organs
6.1. brain injuries
6.2. spinal cord injuries
6.3. operations on the sensory organs and nervous system (point out)
6.4. other

7. Infectious diseases
7.1. syphilis
7.2. tuberculosis
7.3. Botkin's disease
7.4. other

8. Gynecological diseases
8.1. uterine fibromyoma
8.2. other (point out)

9. Osteoporosis
9.1. there is
9.2. no

10. Other *(*point out*)*

13. Allergic status:
0 – without features
1 – allergy to medicines
2 – food allergies
3 – other types of allergies

14. Is the patient a smoker: 0 – no; 1 – yes
15. Year of operation: …
16. Month of operation: 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8 – 9 – 10 – 11 – 12.
17. Height …… centimetres.
18. Body weight ... kilograms.
19. Body Mass Index ...
20. Diagnosis upon admission:
1 – OAKnee I ст.
2 – OAKnee II ст.
3 – OAKnee III ст.

21. Duration of the disease (years) ____
22. Hospitalization:
    1 – planned
    2 – emergency
23. Features of the general objective status
    0 – there was no
    1 – were (specify)
24. Blood pressure during examination before surgery:
    1 – systolic …
    2 – diastolic …
25. Pulse during examination before surgery ... beats per minute
26. Electrocardiogram data before surgery:
    0 – without features
    1 – there were features (specify)
26. Data from X-ray examinations of the lungs before surgery:
    0 – without features
    1 – there were features (specify)
27. Data from endoscopic examinations before surgery:
    1 – were not executed
    2 – performed
        2.1 – without features
        2.2 – there were features (specify)
28. Tomographic examination data before surgery:
    1 – were not executed
    2 – performed
        2.1 – without features
        2.2 – there were features (specify)
29. Blood type (1); (2); (3); (4); (0) – no data available
30. Rh factor («+») 1; («–») 2; (0) – no data available
31. General blood test before surgery:
    1 – hemoglobin
    2 – red blood cells
    3 – hematocrit
    4 – white blood cells
    5 – Erythrocyte Sedimentation Rate
    6 – neutrophils
    7 – Segmentonuclear
    8 – stick- core
    9 – eosinophils
    10 – basophils
    11 – lymphocytes
    12 – monocytes
32. Biochemical blood test before surgery:
    1 – total protein
    2 – total bilirubin
    3 – residual nitrogen
    4 – creatinine
    5 – urea
    6 – SGPT
    7 – SGOT
    8 – alkaline phosphatase
    9 – sodium

10 – potassium
11 – glucose
12 – C-reactive protein
33. Coagulogram before surgery
1 – plasma recalcification time
2 – the prothrombin index
3 – fibrinogen
34. Operation
1 – planned
2 – emergency
35. Preoperative preparation before surgery:
0 – it was not carried out
1 – infusion therapy correction of the water-electrolyte balance
2 – antibacterial therapy
3 – correction of anemia
4 – other (specify)
36. The period of preoperative preparation is ... days
37. The risk of anesthesia by ASA
38. Type of anesthesia during surgery
1 – combined endotracheal anesthesia with artificial lung ventilation
2 – combined endotracheal anesthesia with portable breathing apparatus
3 – portable breathing apparatus
4 – spinal anesthesia
39. Intraoperative blood loss:
1 – up to 500 ml
2 – up to 1000 ml
3 – up to 1500 ml
4 – more than 1500 ml
40. Access:
1 – the front one
2 – mini
3 – other (specify)
41. Blood transfusion during surgery:
0 – there was no
1 – was, ... ml
42. Volume of intraoperative infusion:
1 – crystalloids
2 – plasma substitutes
43. Antibiotic therapy:
1 – cephalosporins: a) I generations, б) II generations, в) III generations
2 – fluoroquinolones
3 – metrogil
4 – other
44. The duration of the operation is ... minutes
45. The volume of surgical intervention:
2 – total knee arthroplasty
2.1 – total knee arthroplasty with cement fixation
2.2 – total knee arthroplasty with other types of fixation (Hinch)
2.3 – hemiarthroplasty
46. Types of endoprostheses:
1 – Zimmer
2 – Ceraver

3 – De Pui
4 – other

47. Intraoperative complications:
0 – there was no
1 – in the area of the intervention
1.1 – bleeding or damage to large vessels
1.2 – damage to large nerve trunks
1.3 – fracture of the femur
1.4 – fracture of the tibia
1.5 – damage to the ligamentous apparatus
1.6 – other
2 – complications outside the intervention area
2.1 – acute respiratory and cardiovascular insufficiency
2.2 – acute respiratory and cardiovascular insufficiency
2.3 – other

48. A complication occurred in the early postoperative period:
0 – There were no complications
1, 2, 3, 4, 5, 6, 7 a day later, a complication occurred in the early postoperative period

49. The nature of the discharge through drains:
1 – hemorrhagic
2 – serous
3 – purulent
4 – other (specify)

50. The amount of discharge through drains:
0 – no information available
1 – on the 1st day ... ml
2 – on the 2nd day ... ml
3 – on the 3rd day ... ml
4 – on the 4th day ... ml

51. Postoperative anesthesia:
1 – narcotic analgesics
2 – peridural analgesia
3 – nonsteroidal anti-inflammatory drugs
4 – other types

52. Encephalopathy:
0 – there was no
manifested on the 1st, 2nd, 3rd, 4th, 5th day

53. Blood pressure in the first day after surgery:
1 – systolic
2 – diastolic

54. Pulse in the first day after surgery ... beats per minute

55. Hemodynamic parameters
1 – stable
2 – unstable

56. Electrocardiography data on the first day after surgery:
0 – without features
1 – there were features (specify)

57. Clinical blood test on the first day after surgery:
1 – hemoglobin
2 – red blood cells
3 – hematocrit
4 – white blood cells

5 – Erythrocyte Sedimentation Rate
6 – neutrophils
7 – Segmentonuclear
8 – stick- core
9 – eosinophils
10 – basophils
11 – lymphocytes
12 – monocytes

58. Biochemical blood test on the first day after surgery:
1 – total protein
2 – total bilirubin
3 – residual nitrogen
4 – creatinine
5 – SGPT
6 – SGOT
7 – alkaline phosphatase
8 – sodium
9 – potassium
10 – glucose
11 – C-reactive protein

59. Coagulogram on the first day after surgery:
1 – plasma recalcification time
2 – the prothrombin index
3 – fibrinogen

60. Hyperthermia in the postoperative period:
0 – there was no increase in temperature during 1, 2, 3, 4, 5, 6, 7 days

61. Surgical treatment of complications in the early postoperative period:
0 – it was not carried out
1 – revision of the postoperative wound and its treatment
2 – revision endoprosthesis (resetting of endoprosthesis components)
3 – other

62. The day of the postoperative period for which the postoperative wound was audited:
0 – there was no revision
1, 2, 3, 4, 5, 6, 7 day

63. The course of the postoperative period after the revision of the postoperative wound:
0 – uncomplicated
1 – complicated (specify the complication)

64. The course of the postoperative period after revision arthroplasty:
0 – uncomplicated
1 – complicated (specify the complication)

65. Antibiotic therapy in the early postoperative period:
1 – cephalosporins
2 – fluoroquinolones
3 – Gentamicin
4 – other

66. Blood pressure on the fifth day after surgery
1 – It has returned to normal
2 – It has not reached a normal level

67. Blood pressure on the fifth day after surgery
1 – systolic
2 – diastolic

68. Пульс на пятые сутки после операции … ударов в минуту

69. Pulse on the fifth day after surgery in relation to preoperative
    1 – It has returned to normal
    2 – did not come to a normal level (to clarify)
70. Electrocardiography data on the fifth day after surgery:
    0 – without features
    1 – there were features (specify)
71. Clinical blood test on the fifth day after surgery:
    1 – hemoglobin
    2 – red blood cells
    3 – hematocrit
    4 – white blood cells
    5 – Erythrocyte Sedimentation Rate
    6 – neutrophils
    7 – Segmentonuclear
    8 – stick- core
    9 – eosinophils
    10 – basophils
    11 – lymphocytes
    12 – monocytes
72. Biochemical blood test on the fifth day after surgery:
    1 – total protein
    2 – total bilirubin
    3 – residual nitrogen
    4 – creatinine
    5 – SGPT
    6 – SGOT
    7 – alkaline phosphatase
    8 – sodium
    9 – potassium
    10 – glucose
    11 – C-reactive protein
73. Morphological examination of the inner condyle of the femur:
    1 – Stage 1 osteoarthritis
    2 – Stage 1-2 osteoarthritis
    3 – Stage 2 osteoarthritis
    4 – Stage 2-3 osteoarthritis
    5 – Stage 3 osteoarthritis
74. The total length of stay in the hospital ... (in days)
75. The length of stay in the hospital before surgery ... (in days)
76. Duration of stay in the intensive care unit .... (in days)
77. The length of stay in the hospital after surgery until discharge ... (in days)
78. Outcomes:
    1 – improvement after surgery
    2 – No change
    3 – deterioration after surgery
    4 – died
79. The course of the long-term postoperative period:
    0 – uncomplicated
    1 – complicated
    1.1 – surface infection
    1.2 – deep infection
    1.3 – debris syndrome

1.4 – dislocation of the endoprosthesis head
1.5 – instability of the endoprosthesis components
1.6 – periprosthetic fracture
1.7 – combination
1.8 – other

80. Year of observation (1, 2, 3, 4, 5, 6, 7, 8, 9, 10) _____
81. Functional results:
1 – good
2 – satisfactory
3 – unsatisfactory
82. Quality of life:
1 – good
2 – satisfactory
3 – unsatisfactory
83. Causes of death:
1 – pneumonia
2 – acute myocardial infarction
3 – pulmonary embolism
4 – multiple organ failure
5 – sepsis
6 – other
84. Death has occurred:
1 – up to 48 hours after surgery
2 – for ... a day