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Original article

## Analysis of the treatment of total knee arthroplasty

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### Abstract

Osteoarthritis of the knee joint of stages III-IV (according to the classification of Kellgren and Lawrence) is characterized by severe pain syndrome, impaired function of support and movement, as well as a significant decrease in quality of life.

The aim: to analyze the results of TKA operations performed in the Multidisciplinary City Hospital №2 of the Akimat of Astana over a five-year period.

Methods. In the period from 2020 to 2024, a retrospective study was conducted aimed at evaluating the clinical effectiveness of the treatment of patients after total knee arthroplasty. The study included 495 patients, including 346 (70%) women and 149 (30%) men, with an average age of 56 years (from 42 to 73).

Results. The diagnoses were distributed as follows: degenerative-dystrophic gonarthrosis was detected in 470 (94.9%) cases and accounted for the majority of operations, post-traumatic gonarthrosis in 9 (1.8%) cases, and 16 (3.2%) operations were performed as part of revision arthroplasty. A significant improvement in the functional status was recorded 3 months after the operation, when the index reached 82.7±35.8 points, and one year after the intervention, when it was 84.2±4.5 points. A similar dynamic was observed in patients' subjective assessment of quality of life on the SF-36 scale before and after surgery.

Conclusion. The main solution of TKA is to eliminate the pain factor and restore full joint mobility, thereby improving the quality of life of patients with disability. However, it is characterized with significant postoperative pain, which can hinder rehabilitation and cause complications.

Keywords: analysis, total arthroplasty, knee joint, degenerative-dystrophic arthrosis, treatment.

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## Introduction

Total knee arthroplasty (TKA) is one of the most common and expensive elective surgeries in the world, performed more than 600,000 times per year, according to the Department of Epidemiology and Biostatistics at the University of California, San Francisco, USA. Primary TKA is typically performed electively, with hospitalization costs averaging \$30,000. About 80% of patients are satisfied with the postoperative results, which justifies the frequency of this procedure and its high cost. However, about 5% of surgeries require revision surgery, which costs up to \$75,000 per procedure. In 2005, about 500,000 TKA surgeries were performed in the United States, with a total cost exceeding \$11 billion. By 2013, osteoarthritis was among the top five most expensive diseases in terms of hospital costs, and these five diseases account for about 20% of all hospital costs. The number of such surgeries is projected to increase as the US population ages [1].

To date, the TKA registry of the Vreden Russian Research Institute of Traumatology and Orthopedics (Russia) contains data on more than 39,000 operations, which allows tracking the dynamics of the development of this area of surgery in the Russian Federation. From 2011 to 2022, the center performed 36,350 primary endoprosthetics operations, which is 92.3% of all interventions. The number of primary operations increased from 1,678 in 2011 to 3,924 in 2022. Similar trends are observed in Australia and Sweden, where the number of such operations increased by 8.2% and 8%, respectively, in 2021 compared to 2020. In Australia, the proportion of primary interventions increased from 41% in 2005 to 76.1% in 2021, and in Switzerland from 24.4% in 2015 to 31.9% in 2020 [2].

## Materials and methods

A retrospective study was conducted from 2020 to 2024 to evaluate the clinical efficacy of treatment in patients after TKR. The study included 495 patients, including 346 (70%) women and 149 (30%) men, with an average age of 56 years (42 to 73). Indications for primary TKA in 470 patients were degenerative-dystrophic arthrosis of stage III-IV, in 9 patients - post-traumatic arthrosis, and in 16 cases, revision endoprosthetics was performed.

All patients were examined according to the standard algorithm. Before hospitalization, they were recommended to undergo X-rays, computed tomography (CT), general and biochemical blood tests, C-reactive protein testing, fibrogastroduodenoscopy (FGDS), ultrasound Dopplerography (USDG), echocardiography (EchoCG) and a dental examination with mandatory oral sanitation. Upon hospitalization, the assessment began with an analysis of the anamnesis, including extracts, X-ray results and laboratory data, as well as the chronology of the onset of pain syndrome. The nature of the pain, the level of physical activity before the operation, the presence of risk factors for infectious diseases, previous invasive interventions and the amount of conservative treatment were taken into account.

Before the operation, patients were injected intramuscularly with 2.0 ml of sibazon (5 mg/ml) for premedication. For 30 minutes before the protocol operation, 1.0 g of cefazolin or 1.5 g of cefuroxime was injected intravenously to prevent infectious complications. The surgical procedure was performed via a standard anterior median approach. Resection of the tibial condyles was performed using an extramedullary guide, and resection of the femur was performed using an intramedullary technique. Patellar replacement was not performed in any case. Non-antibiotic cement was used. The intraoperative

According to World Health Organization forecasts, by 2025 the number of people over 60 years old in the world will reach 1 billion, while the proportion of diseases and injuries of large joints among all diseases of the musculoskeletal system will increase by 80%. About 1.5 million endoprosthetic surgeries are performed annually worldwide [1].

According to the reporting data, in Kazakhstan about 1,700 people out of every 10,000 population need joint endoprosthetics (which corresponds to about 17,000 operations per year). However, the actual number of operations performed in the country is significantly lower [3].

Osteoarthritis of the knee joint stage III-IV (according to the classification of Kellgren and Lawrence) is characterized by severe pain syndrome, impaired support and movement function, as well as a significant decrease in the quality of life. One of the most effective treatment methods that allows you to restore the range of motion, stability in the joint and eliminate pain is total endoprosthetics [4,5].

Over the past decades, this operation has become one of the most common reconstructive procedures in orthopedics. However, despite the improvement of technologies and implants, up to 20% of patients remain dissatisfied with the outcome of the intervention [3,6].

*The aim of the study:* to analyze the results of TKA operations performed in the Multidisciplinary City Hospital № 2 of the Akimat of Astana over a five-year period.

infusion volume was 1500-2000 ml of crystalloid and colloid solutions.

Postoperatively, for the prevention of venous thromboembolism, patients were prescribed 0.4 ml of enoxaparin sodium solution subcutaneously in the evening, and after discharge - dabigatran etexilate 110 mg, 1 pill twice a day or rivaroxaban 10 mg once in the evening for three weeks. For non-drug thromboprophylaxis, elastic bandaging or special stockings were used, starting from the operating room, as well as ultrasound Doppler imaging of the lower limb vessels. Early mobilization began the day after surgery. Rehabilitation included a set of exercises supervised by exercise therapy doctors and physiotherapists using passive movements and myostimulation. Patients were recommended to limit the load when walking with crutches for three months.

A follow-up examination was conducted before discharge and after 3 months, then one year after surgery. The presence of pain syndrome was assessed and X-ray examinations were performed for signs of endoprosthesis loosening. Functional assessment was performed using the American Knee Society Score (KSS) knee joint assessment system [7], and subjective assessment of quality of life was carried out using the SF-36 questionnaire (physical and psychological components were summed up) [8]. Data was processed using the Stat Soft Statistica 6.0 program.

## Results

At the time of hospitalization, patients had severe limitations of movement in the knee joint, no extension and flexion, severe pain, decreased daily physical activity and deterioration in quality of life. According to the study

results, the average age of patients was 56.2 years (min 39, max 78). Of the 495 patients, 346 (69.8%) were women (Table 1).

Table 1 - Average rates of patients examined

Nº	Years	Female	Male	Average age	Average duration of surgery	Average bed-days
1	2024	65(67,7%)	31(32,3%)	54,2 (min 40 max 71)	78,0±12,0min.	9,0
2	2023	72(70,5%)	30(29,5%)	56,4 (min 41 max 75)	80,0±15,0min.	10,2
3	2022	75(70,7%)	31(29,3%)	55,3 (min 39 max 76)	82,0±10,0min.	11,3
4	2021	72(69,9%)	31(30,1%)	56,4 (min 40 max 71)	90,0±15,0min.	13,5
5	2020	62(70,4%)	26(29,6%)	58,5 (min 42 max 78)	92,0±10,0min.	13,5
	Sum	346 (69,8%)	149 (30,2%)	56,2 (min 39 max 78)	84,4±12,4min.	11,5

In our clinic (Multidisciplinary City Hospital №2 of the Akimat of Astana, Traumatology and Orthopedics Department), 495 TKA surgeries were performed from 2020 to 2024 (Table 2). Stryker Triathlon and Zimmer Biomet implants were used in all cases. The diagnoses were

distributed as follows: degenerative-dystrophic gonarthrosis was detected in 470 (94.9%) cases and accounted for the majority of operations, post-traumatic gonarthrosis - in 9 (1.8%) cases, and 16 (3.2%) operations were performed as part of revision endoprosthesis.

Table 2 - Number of operations and names of pathologies

Nº	Years	Number of operations	Diagnosis		
			Degenerative-dystrophic gonarthrosis III-IVstg	Post-traumatic gonarthrosis	Revision
1	2024	96	90 (93,8%)	1 (1,0%)	5 (5,2%)
2	2023	102	100 (98,2%)	1 (0,9%)	1 (0,9%)
3	2022	106	101 (95,3%)	2 (1,9%)	3 (2,8%)
4	2021	103	96 (93,2%)	4 (3,9%)	3 (2,9%)
5	2020	88	83 (94,4%)	1 (1,1%)	4 (4,5%)
	Sum	495	470 (94,9%)	9 (1,8%)	16 (3,2%)

The results of the assessment according to the KSS scale before and after the operation are presented in Table 3. The average assessment of the functional state of patients before the operation was 42.7±4.2 points. A significant

improvement in the functional status was recorded 3 months after the operation, when the indicator reached 82.7±35.8 points, and one year after the intervention, when it was 84.2±4.5 points.

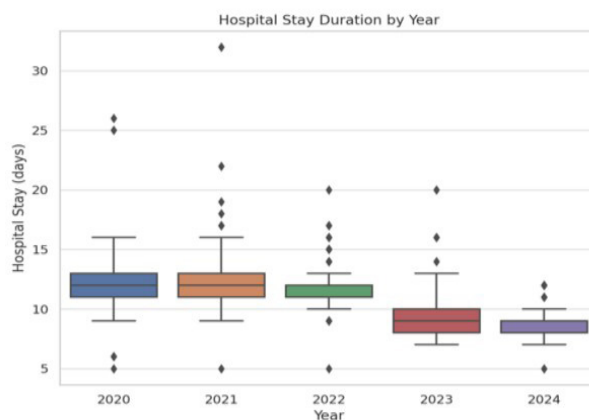


Figure 1 - Boxplot: Hospital Stay Duration by Year

The boxplot analysis demonstrates a significant reduction in hospital stay duration from 2020 to 2024, with median values decreasing from 12-13 days in 2020-2021 to 8-9 days in 2023-2024. Tukey's HSD test confirmed that

hospital stays in 2023 and 2024 were significantly shorter than in previous years (p<0.05), reflecting advancements in surgical efficiency, rehabilitation protocols, and perioperative management. However, the difference

between 2023 and 2024 was not statistically significant ( $p > 0.05$ ), suggesting that these improvements have stabilized.

Additionally, the reduction in outliers over time indicates more standardized post-surgical recovery protocols.

Table 3 - Assessment of knee joint function in patients of both groups according to the KSS scale

Observation period	Results
Before surgery	42,7±4,2
After 3 months	82,5±3,8
After a year	84,2±4,5

Similar dynamics were observed in the subjective assessment of quality of life by patients on the SF-36 scale

before and after surgery. The results of these assessments are presented in Table 4.

Table 4 - Assessment of quality of life on the SF-36 questionnaire

Observation period	Results
Before surgery	75,6±8,4
After 3 months	142,8±7,6
After a year	164,2±3,5

During the first 6 weeks after surgery, 7 (1.4%) patients required closed manual knee joint redressing under general anesthesia to eliminate range of motion

limitations. The condition was considered unsatisfactory if the joint flexion angle was less than 90°.

### Discussion

Postoperative pain is a major obstacle to restoring mobility and returning to active life after TKA. Effective pain management plays a key role in enhanced recovery protocols after TKA. Pain after TKA is complex, occurring both locally in the knee and along nerve pathways, which can lead to prolonged and delayed recovery, sometimes lasting several months. In some cases, pain can be a determining factor, significantly affecting the patient's quality of life. To combat pain after TKA, a comprehensive approach with analgesics is necessary, enhanced by the use of potentiating drugs. Some of them can be administered systemically, sometimes even before surgery, while others are applied locally, directly to the surgical site. Local administration can be carried out by injections at the surgical site or near nerve endings to reduce pain stimuli [9,10]. Local infiltration analgesia (LIA) effectively reduces postoperative pain in the early postoperative period and also reduces the need for narcotic analgesics. However, the problem of postoperative pain relief in patients unresponsive to LIA requires further research [5].

American researchers noted that transcutaneous peripheral nerve stimulation (TPNS) is a promising non-opioid method for treating chronic postoperative pain, in particular after TKA. Thin wire electrodes are inserted under ultrasound guidance and precisely directed to the femoral and sciatic nerves of the leg. The effectiveness of TPNS in reducing chronic postoperative pain has been clinically proven. This method improves the functional recovery of patients and accelerates their return to active life after TKA [11].

The complex innervation of the knee joint does not allow recommending any one type of blockade as the only method of postoperative pain relief. Increasingly, we are talking about combined blockade of two, and sometimes three nerves, which often requires the use of special equipment. The negative aspects of peripheral nerve blocks include muscle weakness and the associated risk of falling, as well as hypoesthesia (decreased sensitivity) of the lower limb.

Dissatisfaction with the results of postoperative

pain relief in patients with TKA remains one of the pressing problems of modern medicine and requires the development of new approaches to its solution. One of such solutions is the method of high-volume local infiltration anesthesia (HVLIA), which demonstrated its effectiveness in the works of D. Kerr, L. Kohan in 2008 [12]. Publications on the use of postoperative wound infiltration appeared earlier, but it was these authors who were able to demonstrate the effectiveness and safety of this method on a sufficiently large number of patients [13].

The significant severity of postoperative pain syndrome in TKA requires the development of new treatment protocols, since the use of only multicomponent systemic analgesia is ineffective. Epidural anesthesia (EDA) provides the best control over surgical pain, but it requires careful monitoring by the staff due to a fairly high incidence of adverse reactions, primarily the development of hypotension and postoperative nausea and vomiting. Despite certain technical and organizational difficulties in using EDA for postoperative pain relief in patients after TKA, the results obtained convincingly proved its effectiveness.

When using HVLIA, a level of analgesia comparable to EDA can be achieved. Therefore, HVLIA is not inferior in the effectiveness of postoperative pain relief to EDA, does not require strict monitoring and is accompanied by a lower incidence of adverse reactions and complications, and the simplicity, safety and effectiveness of the technique in the future can make it the "procedure of choice" in the scheme of multimodal analgesia during TKA [14].

Robotic knee replacement procedures are becoming a new trend that attracts the attention of orthopedic surgeons around the world. There is a hypothesis that the use of robotics improves the accuracy of prosthesis positioning and restoration of its centering. Studies have shown that robotic TKA provides superior postoperative anatomical and mechanical alignment compared to traditional TKA. However, clinical and functional outcomes, as well as the incidence of complications, remain the same [15].

The usage of 3D technologies to create individual



surgical templates and physical models of bones (tibia and femur) in TKA demonstrates good and excellent results. This method is especially useful in complex cases when standard instruments or computer navigation do not provide the required accuracy [4].

Studies show that small residual varus deformities (mean  $3.9^\circ \pm 0.74^\circ$ , from  $3.1^\circ$  to  $5.6^\circ$ ) after TKA in patients with varus gonarthrosis do not have a significant impact on the clinical, radiographic, functional and dynamometric results of treatment [16].

The range of motion in the knee joint before TKA plays a key role in determining the functional results after it. Limitation of mobility, especially associated with tension of the extensor muscles, before surgery increases the risk of limitation of flexion in the postoperative period. Increasing range of motion before TKA is therefore an important goal to create optimal conditions for the flexor muscles to work after surgery.

Knee flexion after TKA depends on many factors, but range of motion before surgery is one of the most significant [13,17,18,19].

The group of UK researchers identified the feasibility of a randomized controlled trial to evaluate a pre-habilitation program for frail patients undergoing TKA. Participants were instructed to perform daily home exercises for 12 weeks before surgery and were given a daily protein supplement. Qualitative interviews with participants and non-participants were conducted and analyzed using thematic analysis [17,19].

## Conclusion

Active treatment of degenerative-dystrophic diseases of the knee joints, in particular TKA, is becoming an increasingly common, frequently used method of treatment. The main solution to TKA is to eliminate the pain factor and restore full mobility of the joints, thereby improving the quality of life of patients with restoration of working capacity. However, this is characterized by significant postoperative pain, which can hinder rehabilitation and cause complications. It is also necessary to actively implement protocols for early postoperative rehabilitation of patients, aimed at early activation of patients after surgery and reducing the duration of their inpatient treatment.

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Rehabilitation interventions, including specific exercises and psychological support, play an important role in the recovery of knee function after TKA. Early rehabilitation, including Morita therapy, has proven effective in reducing the risk of deep vein thrombosis, as well as in reducing the time to restore lower limb motor function, including straight leg raise, walking time, and knee flexion range. This treatment program demonstrates significant potential in improving joint function, reducing pain, improving patients' quality of life, and increasing range of motion [20].

The technology of accelerated rehabilitation after large joint replacement, known as "fast-track", has demonstrated its safety and effectiveness. Its usage in the USA and European countries has significantly reduced the length of hospital stay for patients without increasing the number of complications. Further development of the "fast-track" technique should be aimed at improving pain relief, especially in the postoperative period, after the patient is discharged from the hospital [21,22,23].

The patient's age and the extent of surgical intervention are not contraindications for the use of the "fast-track" protocol. The key factors for success are informing the patient about the method and his active participation in the recovery process. The implementation of the protocol for accelerated recovery after endoprosthesis surgery in our country is at an insufficient level. Overcoming organizational difficulties along the way is an important task.

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**Authors' contributions.**

Conceptualization – M.A.; E.A.; A.M.; B.M.; methodology – M.A.; T.A.; A.K.; E.A.; verification – M.A.; M.K.; E.A.; A.M.; formal analysis – T.A., A.S.; M.K.; A.M.; writing (original draft) – M.A.; A.K.; M.K.; A.S.; writing (review and editing) – M.A.; M.K.; A.K.; B.M.; T.A.

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### Тізе буынын толық эндопротездеу емін талдау

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### Түйіндеме

III-IV сатыдағы тізе остеоартриті (Kellgren және Lawrence классификациясы бойынша) айқын ауырсыну синдромымен, тірек пен қозғалыс функциясының бұзылуымен, сондай-ақ өмір сапасының айтарлықтай төмендеуімен сипатталады.

Зерттеудің мақсаты: Астана қаласы әкімдігінің №2 көпсалалы қалалық ауруханасында бес жылдық кезеңде жүргізілген тізе буынын толық эндопротездеу бойынша операциялардың нәтижелерін талдау.

Әдістері. 2020-2024 жылдар аралығында тізе буынын толық эндопротездеуден кейін пациенттерді емдеудің клиникалық тиімділігін бағалауға бағытталған ретроспективті зерттеу жүргізілді. Зерттеуге 495 пациент кірді, олардың ішінде 346 (70%) әйелдер және 149 (30%) ерлер, орташа жасы - 56 жас (42-ден 73-ке дейін).

Нәтижесі. Диагностар келесідей бөлінді: дегенеративті-дистрофиялық гонартроз 470 (94,9%) жағдайда анықталды және операциялардың негізгі бөлігін құрады, жарақаттан кейінгі гонартроз 9 (1,8%) жағдайда және 16 (3,2%) операция ревизиялық эндопротездеу шеңберінде орындалды. Функционалдық мәртебенің айтарлықтай жақсаруы операциядан кейін 3 айдан кейін, көрсеткіш 82,7±35,8 балға жеткенде және араласудан бір жыл өткен соң, ол 84,2±4,5 балға жеткенде тіркелді. Ұқсас нәтиже пациенттердің операцияға дейін және одан кейінгі SF-36 шкаласы бойынша өмір сүру сапасын субъективті бағалауында да байқалды.

Қорытынды. Тізе буынын толық эндопротездеудің негізгі шешімі - ауырсыну факторын жою және буындардың толық қозғалғыштығын қалпына келтіру, осылайша еңбекке қабілеттілігін асырып, науқастардың өмір сүру сапасын жақсарту. Алайда, бұл операциядан кейінгі айтарлықтай ауырсынумен сипатталады, ол оңалтуға кедергі келтіріп және асқынулар тудыруы мүмкін.

Түйін сөздер: талдау, толық эндопротездеу, тізе буыны, дегенеративті-дистрофиялық артроз, емдеу.

### Анализ лечения тотального эндопротезирования коленного сустава

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## Резюме

Остеоартроз коленного сустава III-IV стадии (по классификации Kellgren и Lawrence) характеризуется выраженным болевым синдромом, нарушением функции опоры и передвижения, а также значительным снижением качества жизни.

Цель исследования: проанализировать результаты операций по тотальному эндопротезированию коленного сустава (ТЭКС), проведенных в Многопрофильной городской больнице №2 Акимата г. Астана за пятилетний период.

Методы. В период с 2020 по 2024 годы было проведено ретроспективное исследование, направленное на оценку клинической эффективности лечения пациентов после ТЭКС. В исследование включено 495 пациентов, среди которых 346(70%) женщин и 149(30%) мужчин, со средним возрастом 56 лет (от 42 до 73).

Результаты. Диагнозы распределились следующим образом: дегенеративно-дистрофический гонартроз был выявлен в 470(94,9%) случаях и составил основную часть операций, посттравматический гонартроз - в 9(1,8%) случаях, а 16(3,2%) операций было выполнено в рамках ревизионного эндопротезирования. Значительное улучшение функционального статуса было зафиксировано через 3 месяца после операции, когда показатель достиг  $82,7 \pm 35,8$  балла, и через год после вмешательства, когда он составил  $84,2 \pm 4,5$  балла. Аналогичная динамика наблюдалась и при субъективной оценке пациентами качества жизни по шкале SF-36 до и после операции.

Выводы. Основным решением ТЭКС является устранение болевого фактора и восстановление полной подвижности суставов, тем самым улучшая качество жизни пациентов с восстановлением трудоспособности. Однако это характеризуется со значительной послеоперационной болью, которая может препятствовать реабилитации и вызывать осложнения.

Ключевые слова: анализ, тотальное эндопротезирование, коленный сустав, дегенеративно-дистрофический артроз, лечение.