

Validity of Knee Arthroplasty in Osteoarthritis

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Abstract

Introduction and Materials and Methods: In the clinic of orthopedics and trauma North-western State Medical University named after I.I. Mechnikov from 01.01.2022 to 15.12.2022, a total of 187 total knee replacement (TKR) were done in patients with osteoarthritis. A random sample taken for histological studies from 30 patients aged 40 to 76 years (19 F, 11 M). Samples were prepared according to the standard protocol for bone tissue, the bone fragments tested were decalcified in electrolyte decalcification solution (Biovitrum, Russia). Histological processing, pouring, and microtomy with a section thickness of 5 µm were performed as per standard protocol. The preparations were stained with dyes (hematoxylin and eosin) and safranin O.

Results: Only 48 (25.7%) patients before TKR were at least once had inpatient conservative or minimally invasive surgical treatment for osteoarthritis of the knee joint. 18 (9.6%) patients had intraoperative and postoperative complications. Among the 30 morphological studies performed, 3 (10%) patients grade I, 8 (26.7%) subjects grade II, and in 19 (63.3%) - grade III osteoarthritis of the knee joint was diagnosed.

Conclusions: Among patients who underwent TKR, only one in four (48 people - 25.7%) was at least once had inpatient conservative or minimally invasive surgical treatment for OA. According to the morphological study, 11 (36.7%) clinical observations undergoing arthroplasty were verified as grade I-II OA. To form a strategy for the treatment of patients with osteoarthritis of knee joint, it is vital to develop an algorithm for teamwork between therapist, orthopedic surgeon, rheumatologist, rehabilitation medicine specialist, specialists in restorative medicine and healthcare organizers in the process.

Keywords: knee osteoarthritis, knee replacement, complications, morphological examination, indications and contraindications to surgery

Introduction

Osteoarthritis (OA) is the most common disease affecting more than 300 million people worldwide [1-3]. In the Russian Federation, OA is diagnosed in about 4% of the adult population, most often – in subjects over 60 years of age, and in recent years there has been a trend towards an increase in incidence of disease among the adult population [4-6]. One of the most common location of the disease is the knee joint.

The treatment of osteoarthritis of the knee joint is carried out by specialists of various profiles: therapist, orthopedic and trauma surgeon, rheumatologist etc. TKR today is the gold standard in the treatment of advanced stages of osteoarthritis. At the same time, the results of TKR cannot always be considered positive.

Such results are given by russian scientists. In 2019, A.V. Ly-chagin, et al. studied the validity of TKR in elderly patients. The

authors revealed that in 40% of patients, surgical tactics were overly active, and the intervention can be considered unnecessary [7]. Similar information is provided by foreign researchers. In the USA, the number of unjustifiably performed arthroplasty of knee joint reaches a third of operated patients [8]. Other authors noted that TKR is carried out without strong indications in 7-34% of cases [9,10]. In addition, some experts report that 82% of patients who have undergone arthroplasty of the knee and hip joints did not recover physical activity, and they are forced, as before the operation, to lead a “sedentary” lifestyle [11].

When choosing TKR as a treatment method, the clinical and radiological stage of the disease, the clinical picture, the nature and severity of the concomitant pathology, the patient’s desire and a number of other criteria were taken into account. Morphological analysis is carried out after the joint is replaced with an implant.

Purpose

A histopathological study of the specimen taken from the knee joint and a retrospective study of the validity of the TKR with the identification of clinical-morphological correlations.

Materials and Methods

In the clinic of traumatology and orthopedics of the Northwestern State Medical University named after I.I. Mechnikov from 01.01.2022 to 15.12.2022, 187 knee replacement operations were performed in patients with osteoarthritis.

All patients received information consent to conduct the study. The ethical standards set out in the Declaration of Helsinki have been fully complied with.

A random sample taken for histological studies from 30 patients aged 40 to 76 years (19 F, 11 M).

After the operation, tibial condyle fragments were fixed in 10% formalin solution for 24 hours. Then, for further histological examination, bone material was cut into slices.

Histological specimens were prepared according to the standard method for bone tissue, including the decalcination step [12], which was carried out according to the scheme: the bone fragments were decalcified in an electrolyte decalcification solution (Biovitrum, Russia) with a volume-to-volume ratio of decalcification fluid of 1:50. within 8 hours, simultaneously checking the degree of decalcination with a needle. After decalcination was completed, the samples were washed with tap water for 60 minutes. Histological processing, pouring, and microtomy at a section thickness of 5 µm were carried out as standard procedure. The preparations were stained with dyes (hematoxylin and eosin) and safranin O.

Grade (key feature)	Subgrade (optional)	Associated criteria (tissue reaction)
Grade 0: surface intact, cartilage intact	No subgrade	Intact, uninvolved cartilage
Grade 1: surface intact	1.0 Cells intact	Matrix: superficial zone intact, edema and/or fibrillation
	1.5 Cells intact	Cells: proliferation (clusters), hypertrophy Reaction must be more than superficial fibrillation only
Grade 2: surface discontinuity	2.0 Fibrillation through superficial zone	As above
	2.5 Surface abrasion with matrix loss within superficial zone	+Discontinuity at superficial zone
		± Cationic stain matrix depletion (Safranin O or Toluidine Blue) upper 1/3 of cartilage (mid zone) ± Disorientation of chondron columns
Grade 3: vertical fissures	3.0 Simple fissures	As above
	3.5 Branched/complex fissures	± Cationic stain depletion (Safranin O or Toluidine Blue) into lower 2/3 of cartilage (deep zone) ± New collagen formation (polarized light microscopy, Picro Sirius Red stain)
Grade 4: erosion	4.0 Superficial zone delamination	Cartilage matrix loss, cyst formation within cartilage matrix
	4.5 Mid zone excavation	
Grade 5: denudation	5.0 Bone surface intact	Surface is sclerotic bone or reparative tissue including fibrocartilage
	5.5 Reparative tissue surface present	
Grade 6: deformation	6.0 Joint margin osteophytes	Bone remodelling. Deformation of articular surface contour (more than osteophyte formation only)
	6.5 Joint margin and central osteophytes	Includes: microfracture and repair

Table 1: Cartilage Histopathology Assessment System (OOCHAS).

Condition of cartilaginous tissue, subchondral bone and inter-trabecular space tissue has been evaluated by microcopy.

The Cartilage Histopathology Assessment System (OOCHAS) was used to assess damage to the articular surface and subchondral bone (Table 1) [13].

Results

The data related to 187 patients who underwent the primary total knee replacement in 2022 due to osteoarthritis In the clinic of trauma and orthopedics North-western State Medical University was analyzed. The average age was 59.3±6.7 years (from 40 to 76 years).

Age and gender of 187 patients discharged from the clinic after TKR is presented in table 2.

Age	Number of Patients (%)					
Groups in	Male		Female		Total	
Years	№	%	№	%	№	%
18-44	8	4.3	15	8.0	23	12.3
45-64	32	17.1	57	30.5	89	47.6
65 and more	22	11.8	53	28.3	75	40.1
Total	62	33.2	125	66.8	187	100

Table 2: Distribution of patients undergoing primary total TKR based on their age and gender.

As follows from the data presented in table 2, among young patients, female patients dominated - 15 (8%) compared to men - 8 clinical observations (4.3%). In groups of middle-aged and older patients, women also dominated. At the same time, among young and elderly patients, the male-female ratio was 1:2, and in the middle age group (from 45 to 64 years) 1:3 (11.8% and 28.3%, respectively).

It has been revealed that only 48 (25.7%) patients before TKR were at least once admitted to inpatient for conservative or minimally invasive surgical treatment for osteoarthritis of knee joint. In most cases (139 observations - 74.3%), were only treated in outpatient clinic.

All 187 patients had a knee X-ray done before surgery. MRI was done in 84 (44.9%) cases. After a standard pre-arthroplasty examination, 123 patients (65.8%) were diagnosed with grade III osteoarthritis of the knee joint. In 64 observations (34.2%), stage II-III osteoarthritis of the knee joint was noted.

Local and general complications were noted during TKR and in the early postoperative period after knee arthroplasty. The majority of arthroplasty results were considered positive. At the same time, 18 (9.6%) patients had intraoperative and postoperative complications. Among the intraoperative complications, local ones were noted: damage to the ligaments of the knee joint - 4 (2.1%) cases (two injuries to the lateral ligaments and 2 - injury to the quadriceps of the thigh). When analyzing postoperative complica-

tions, 2 (1.1%) cases of superficial infection of the surgical area were noted. Cardiac disorders prevailed in the general complications (4 observations - 2.1%). There were no deaths during the operation and in the early postoperative period.

Of the 187 patients, 30 patients were randomly selected for postoperative histomorphological examination. The study involved tibial condyle and joint capsule of the knee joint.

While studying specimens, cases of both the early stages of osteoarthritis of the knee joint and osteoarthritis of the II and III stages were revealed.

Discussion

The presented histograms revealed different stages of osteoarthritis: from the initial manifestations of the pathological process to the stage III of the disease. It can be noted that among 30 morphological studies performed in 3 (10%) patients, stage I of osteoarthritis of knee joint was verified (Figure 1). Stage II OA was diagnosed in 8 (26.7%) cases (Figure 2), and stage III osteoarthritis according to N.S. Kosinskaya was diagnosed in 19 (63.3%) cases (Figure 3).

Without a doubt, orthopedic surgeons were guided not only by the data of X-ray or tomographic examination methods and the proposed stage of osteoarthritis when deciding on TKR. The features of the clinical picture (the intensity of pain syndrome, the effectiveness of conservative treatment, the history of the disease),

Figure 1: Articular cartilage (A) and subchondral bone (B) of the medial condyle of the femur of a patient who underwent total knee replacement. Osteoarthritis, OOCAS stage 2; stage I according to N.S. Kosinsky. A - hyaline cartilage tissue; B - subchondral lamellar bone tissue; C - intertrabecular spaces of the epiphysis filled with adipose bone marrow. Stain: Safranin-O.

Figure 2: Articular cartilage (A) and subchondral bone (B) of the medial condyle of the femur of a patient who underwent total knee replacement. Osteoarthritis, OOCAS stage 4. Stage II according to N.S. Kosinsky A - hyaline cartilaginous tissue with biochemically altered matrix; B - subchondral lamellar bone tissue with signs of osteosclerosis (thickening); C - intertrabecular spaces of the epiphysis filled with adipose bone marrow; * vertical, horizontal cracks and erosion (defect) of cartilage. Stain: Safranin-O.

Figure 3: Articular cartilage (A) and sclerotic subchondral bone (B) of the medial femoral condyle of a patient who underwent total knee replacement. Osteoarthritis, OOCAS stage 4-5. Stage III according to N.S. Kosinsky A - fibrous cartilaginous tissue; B - sclerotic subchondral lamellar bone and microcysts (*); The red line is the boundary between the remaining cartilage and the underlying bone tissue. Stain: hematoxylin and eosin. Magnification 100 X.

the results of the study of the stability of the knee joint and data on the state of integrity of the ligaments, etc. were also taken into account. However, it is noteworthy that in most cases (139 (74.3%) of observations among 187) total knee replacement was actually the reason for the primary inpatient treatment of the patient with knee osteoarthritis.

Replacing the knee joint with an implant is not an organ-preserving operation, because during the intervention, the segment of the limb (joint) is removed. I would like to mark that this stage of the operation - arthroectomy - is not taken out in the name of the intervention in the protocol in the medical history. The term "Arthroplasty" itself also does not reflect the essence of the operation, since the joint is not subjected to plastic surgery, but is removed. The term misleads patients about the substance of the intervention being performed. In addition, TKR, like any other operation, can be accompanied by intra- or postoperative complications up to death. Patients do not always comply with the doctor's recommendations regarding restriction of movement in the operated joint and a special regimen, which also leads to various kinds of complications. The life of the implant is not unlimited, and the results of revision knee replacement leave much to be desired. In addition, the indications for TKR are imperfect and are constantly subject to clarification towards their limitations. On the other hand, the healthcare structure of the Russian Federation does not provide clear guidelines for medical examination of patients with osteoarthritis; inpatient treatment of such patients within the framework of compulsory medical insurance has the cheapest tariffs, and the interaction of therapist, orthopedic surgeon, rheumatologist, rehabilitation medicine specialist and specialists in restorative medicine is not regulated by a strict algorithm. A similar situation is noted in the United States, in the countries of the European Union and Asia.

Based on the morphological data, it can be assumed that in 11 (36.7%) patients with stage I or II osteoarthritis (according to N.S. Kosinskaya) joint replacement was performed prematurely, without using the potential of conservative or minimally invasive surgical treatment of osteoarthritis of knee joint.

The presented results are an incentive to conduct a special scientific study devoted to the development of a strategy for the treatment of patients with osteoarthritis of the knee joint, including outpatient examination and treatment, inpatient conservative treatment, minimally invasive surgical techniques, TKR of the knee joint, as an extreme measure, and rehabilitation. The article is informational and descriptive. The results of the study will be considered baseline and can be used in statistical analysis as a control group after the development and implementation of the complex treatment algorithm for osteoarthritis of knee joint.

Conclusions

Both in Russia and around the world, the number of publications are increasing on the fact that knee replacement in osteoarthritis is often performed prematurely, while the potential of conservative and minimally invasive surgical methods are not used.

Among the patients hospitalized in the clinic for knee replacement, 48 (25.7%), i.e. only one in four, was at least once admitted inpatient conservative or minimally invasive surgical treatment for knee osteoarthritis.

According to the morphological study, stage III osteoarthritis was confirmed in 19 (63.3%) patients. In the remaining 11 (36.7%) patients who underwent arthroplasty, stage I-II osteoarthritis was verified.

To form a strategy for the treatment of patients with osteoarthritis of the knee joint, it is necessary to develop an algorithm for teamwork between specialist therapist, orthopedic surgeon, rheumatologist, rehabilitation medicine specialist, specialists in restorative medicine and healthcare organizers in the process.

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