



MORPHOLOGICAL FEATURES OF OSTEOARTHRITIS IN KNEE ARTHROPLASTY. A CLINICAL STUDY

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ABSTRACT

The regional clinic performed 187 knee replacement procedures on osteoarthritis (OA) patients. Materials were randomly selected for morphological analysis from 30 patients, 11 of whom were men and 19 of whom were women, ages 40 to 76. Of the thirty individuals that underwent morphological investigations, three (10%) had stage I OA; eight (26.7%) had stage II OA identified, and nineteen (63.3%) had stage III OA. Just one in four patients (48 individuals, or 25.7%) who received endoprosthetics had at least one round of inpatient conservative or minimally invasive surgical therapy for OA. The morphological research revealed that 11 (36.7%) of the patients who received arthroplasty had validated stage I–II OA. The conclusion is that in order to create a treatment plan for patients with osteoarthritis (OA), an algorithm for coordinating specialists' interactions must be developed. This algorithm should involve therapists, orthopedists, rheumatologists, rehabilitologists, specialists in restorative medicine, and health care coordinators.

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Introduction

With over 300 million cases globally, osteoarthritis (OA) is the most prevalent illness [1, 2]. The knee joint (KJ) is noteworthy as one of the disease's most frequent localizations [3, 4]. Treatment for knee osteoarthritis is provided by a variety of professionals, including rehabilitologists, rheumatologists, therapists, and orthopedic traumatologists. The procedure of choice for treating later stages of osteoarthritis nowadays is endoprosthetics of KJ (EKJ) [5]. But it's not always possible to view KJ arthroplasty outcomes favorably [6, 7].

The most recent research also offers these kinds of outcomes. For example, the validity of KJ endoprosthetics in older patients was investigated by Bork [8]. 40% of patients had excessively aggressive surgical techniques, making the surgery deemed unnecessary, according to the author. Weber *et al.* [9] have somewhat similar information. A third of people who have surgery nowadays have an unjustifiably executed KJ arthroplasty [10]. It has been observed by researchers that in 7–34% of instances, KJ arthroplasty is carried out without warrant [11]. Furthermore, according to some specialists, 82% of patients who have knee

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and hip arthroplasty do not resume physical activity and are compelled to continue living a "sedentary" lifestyle as they did prior to the procedure [12, 13].

The clinical and radiological stage of the illness, the clinical picture, the kind and severity of the concurrent pathology, the patient's desire, and a number of other factors were considered when deciding on EKJ as a therapeutic option [14-16]. After the joint is replaced with an implant, a morphological evaluation is often performed [17].

Consequently, the pathomorphological analysis of the excised knee joint components and the retrospective staging of the procedure with the detection of morphological and clinical correlations were the goals of this investigation.

Materials and Methods

Patients with osteoarthritis underwent 187 knee replacement procedures in the regional clinic in 2023. In order to perform the study, each patient was given informed consent. Fully upheld have been the moral guidelines outlined in the Helsinki Declaration [18]. For a lifetime pathoanatomical evaluation, materials from 30 patients, 19 women and 11 men, aged 40 to 76, were selected at random.

Following surgery, tibial condyle pieces were preserved throughout the day in a 10% buffered formalin solution. Then, bone material was sliced with a pair of saws for a later pathological investigation.

The normal protocol for bone tissue, including the decalcification stage, was followed in the creation of the histological preparations [19]. The examined bone tissue pieces were decalcified in an electrolyte decalcifying solution (Biovitrum, Russia) for eight hours at a volume ratio of 1:50 between the object's volume and the decalcifying liquid's volume, all the time using a needle to gauge the level of decalcification. The samples were washed with tap water for 60 minutes after the decalcification process was finished. Following the normal protocol, histological wiring, filling, and microtomy with a 5 µm slice thickness were carried out [20]. Safranin O, eosin, and hematoxylin were used to stain the preparations.

The state of subchondral bone, intertrabecular space tissue, and cartilage tissue was evaluated during microcopying. To evaluate injury to the articular surface and subchondral bone, the OCHAS pathomorphological categorization was employed (**Table 1**) [21].

Table 1. Pathomorphological classification of OCHAS

Stage	Substage	Related Criteria
Concomitant stage 0. Articular surface is intact, cartilage is intact criteria	–	Intact, uninjured cartilage
Stage 1. The articular surface is intact	1.0. Cellular elements are intact	Cartilage matrix: the surface area is intact, edema and/or fibrillation
	1.5. Cellular elements are damaged	Cellular elements: active proliferation, hypertrophy
	2.0. Fibrillation in the surface area	As stated above ± Roughness in the surface area
Stage 2. Surface tears/damages	2.5. Abrasion of the articular surface with loss of cartilage matrix	± Depletion of the cartilaginous matrix (stained with safranin O or toluidine blue) in the upper 1/3 of the cartilage (median zone) ± Disorientation of chondrocytic "columns"
	3.0. Simple cracks	As stated above
Stage 3. Vertical cracks	3.5. Branched cracks	± Depletion of the cartilaginous matrix (stained with safranin O or toluidine blue) in the lower 2/3 of the cartilage (deep zone) ± Formation of new collagen (microscopy in polarized light, picosirius red staining)
	4.0. Stratification of the surface area	Depletion of the cartilaginous matrix, formation of cysts
Stage 4. Erosion	4.5. Extensive damage to the middle zone	in the cartilaginous matrix
	5.0. The subchondral bone is intact	The articular surface is a sclerosed bone and/or the

subchondral bone	5.5. The presence of osteophyte rudiments	beginnings of osteophytes, fibrous fibrous cartilage.
Stage 6. Joint deformity	6.0. Osteophytes in the marginal zones of the joint	Remodeling of the subchondral bone. Deformation with an increase in the contour of the articular surface (due to the formation of osteophytes)
	6.5. Osteophytes in the marginal and central areas of the joint	Microfractures and remodeling sites

Results and Discussion

The information pertaining to 187 patients who had primary total knee arthroplasty at the regional clinic in 2023 due to osteoarthritis was examined. The patients ranged in age from 40 to 76 years old, with an average age of 59.3 ± 6.7 years. **Table 2** lists the age and gender of 187 patients who were released from the clinic following EKJ.

Table 2. Distribution of patients who underwent primary total EKJ due to osteoarthritis, taking into account their age and gender

Age, years	Number of patients (%)					
	Male		Female		Total	
	absolute	%	absolute	%	absolute	%
18–44	8	4.3	15	8.0	23	12.3
45–64	32	17.1	57	30.5	89	47.6
≥65	22	11.8	53	28.3	75	40.1
Total	62	33.2	125	66.8	187	100

From the data in **Table 2**, it can be shown that women outnumbered males among young patients: 15 (8%) against 8 (4.3%) clinical observations. Women also dominated the groupings of elderly and middle-aged patients. In the meantime, the male-to-female ratio was 1:2 among the young and old patients, and it was 1:3 (11.8% and 28.3%, respectively) in the middle-aged group of patients (45 to 64 years old). It was discovered from the anamnesis that only 48 (25.7%) of the patients had received at least one session of conservative or minimally invasive surgical therapy for KJ osteoarthritis prior to the endoprosthesis. In most cases (139 cases – 74.3%), only outpatient treatment took place. All 187 patients underwent an X-ray examination of the knee joint before surgery. In 84 (44.9%) patients, magnetic resonance imaging was carried out. Following a routine examination prior to arthroplasty, 123 patients, or 65.8%, were diagnosed with "osteoarthritis of the knee joint of the III St." 64 observations (34.2%) revealed the presence of OA in the KJ of the II–III stage.

During the EKJ and in the initial postoperative phase following knee arthroplasty, local and general problems were confirmed. Most people thought that the outcomes of the arthroplasty were good. Simultaneously, problems during and after surgery were experienced by 18 patients (9.6%). Local postoperative sequelae included injuries to the KJ's ligamentous apparatus in 4 (2.1%) patients, including 2 cases of lateral ligament injury and 2 cases of quadriceps femoris injuries. Two (1.1%) incidences of superficial surgical site infections were identified during the postoperative complications study. The structure of general complications was dominated by cardiac diseases (4 instances, 2.1%). Remarkably, no fatalities were reported during the procedure or in the initial postoperative phase.

Thirty individuals were chosen at random from a total of 187 patients to undergo postoperative pathomorphological evaluation. We looked at the KJ's articular capsule and tibial condyle. Cases of osteoarthritis of the KJ and II and III stages as well as the early phases of the disease were found in the micropreparations investigation (**Figure 1a**).

The many stages of OA are depicted by the histograms that are shown, ranging from the disease's early symptoms to its stage III. It should be mentioned that 3 patients (10%) out of the 30 morphological examinations performed exhibited I-stage OA of KJ (**Figure 1b**). In 8 (26.7%) cases, II stage OA was diagnosed (**Figure 1c**), and in 19 (63.3%) osteoarthritis of III stage OA was diagnosed (**Figure 1d**).

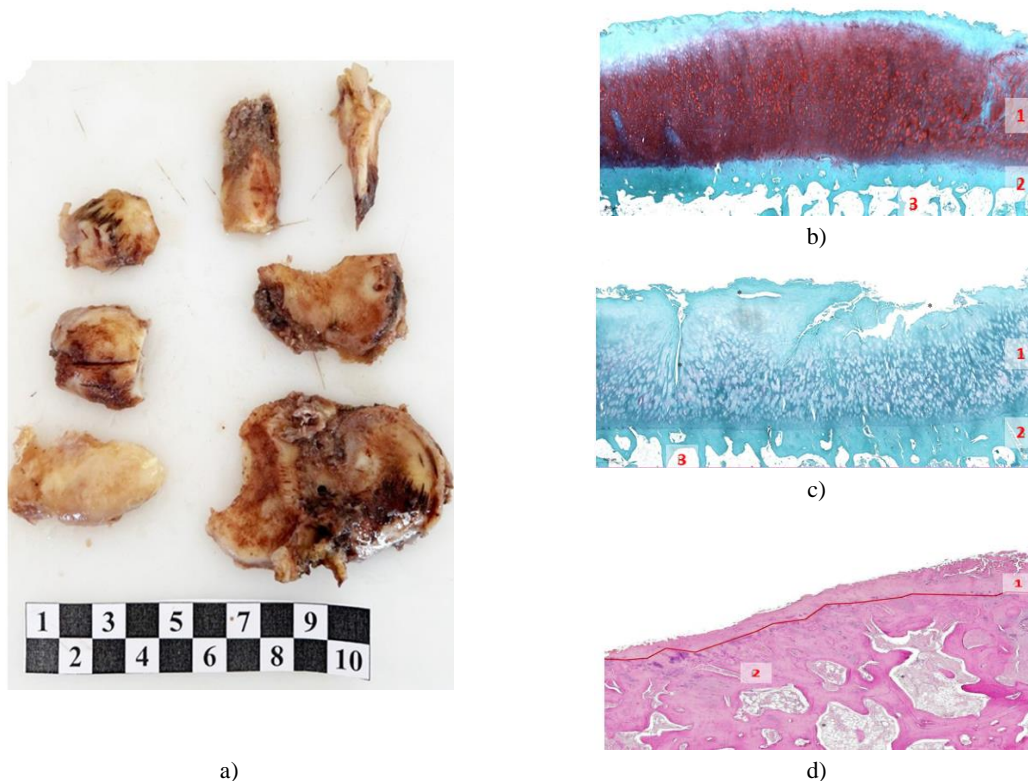


Figure 1. Postoperative pathomorphological examination of 30 patients. a) The appearance of the tissue material obtained by the pathology department after total knee replacement surgery. b) I stage OA of KJ (1 – hyaline cartilage tissue; 2 – subchondral lamellar bone tissue; 3 – intertrabecular spaces of the epiphysis filled with fatty bone marrow). Staining with safranin O, magnification $\times 100$. c) Articular cartilage and subchondral bone of the medial condyle of the femur of a patient who underwent total knee replacement. II stages OA of KJ (1 – hyaline cartilage tissue with a biochemically altered matrix; 2 – subchondral lamellar bone tissue with signs of osteosclerosis (thickening); 3 – intertrabecular spaces of epiphysis filled with fatty bone marrow; * – vertical, horizontal cracks and erosion (defect) of cartilage). Staining with safranin O, magnification $\times 100$. d) Articular cartilage and sclerosed subchondral bone of the medial condyle of the femur of a patient who underwent total knee replacement. III stage OA of KJ (1 – fibrous cartilage tissue; 2 – sclerosed subchondral lamellar bone tissue and microcysts (*)). The red line is the boundary between the remaining cartilage and the underlying bone tissue. Staining with hematoxylin and eosin, magnification $\times 100$.

Certainly, osteoarthritis specialists consider more than only the results of computed tomography or X-ray research techniques and the predicted degree of osteoarthritis when making decisions about knee replacements [22, 23]. The characteristics of the clinical picture (the severity of the pain syndrome, the efficacy of conservative therapy, the length of the illness), the outcomes of an investigation into the KJ's stability, and information on the state of the ligamentous apparatus were also considered [24]. It should be noted, therefore, that the majority of the time (139/74.3%) of the observations made out of 187 patients, complete knee replacement was the cause of the patient's initial inpatient therapy for OA of the KJ [25].

A knee replacement with an implant is not an organ-preserving procedure; it should be mentioned [26]. Like any other procedure, EKJ may also result in intra- or postoperative problems, some of which may be fatal [27, 28]. In addition, patients frequently disregard their physician's advice to limit their range of motion in the operated joint and adhere to a certain regimen, which can result in a number of problems [29-31]. Of particular note are the limited lifespan of the implant and the unsatisfactory outcomes of endoprosthetics [32]. The indications for endoprosthetics are also not ideal and are always being modified toward their restriction [33, 34]. Yet, a mechanism for medical assessment of individuals with osteoarthritis is not offered by the existing healthcare system [35]. Under mandatory health insurance, inpatient care is the least expensive for these patients, and there is currently no rigorous protocol governing the relationships between therapists, orthopedists, rheumatologists, rehabilitologists, and experts in restorative medicine [36].

Assuming that 11 (36.7%) of the patients with I or II stage OA underwent joint replacement surgery too soon without taking advantage of the possibility of conservative or minimally invasive surgical therapy for KJ OA is based on the findings from the morphological research. The outcomes that have been presented provide motivation for carrying out a unique scientific investigation focused on creating a treatment plan for individuals suffering from osteoarthritis of the knee joint. This plan should include conservative inpatient care, minimally invasive surgical methods, rehabilitation, and outpatient examination and treatment. After the creation and execution of an algorithm for the complicated treatment of OA of KJ, the study's findings will be taken into consideration and utilized as a control group in statistical analysis.

Conclusion

There is currently a growing body of research focused on the issue of knee replacements performed too soon in patients with osteoarthritis, despite the possibility of using conservative and less invasive surgical procedures. 48 patients, or one in four, who were admitted to the regional clinic for knee replacements received at least one session of inpatient conservative or minimally invasive surgical therapy for knee osteoarthritis. This is a 25.7% patient rate. The morphological analysis revealed that 19 (63.3%) individuals had definite stage III osteoarthritis. Stage I–II osteoarthritis was confirmed in 11 (36.7%) of the remaining patients who had arthroplasty procedures.

In order to establish a treatment plan for individuals suffering from osteoarthritis of the knee, an algorithm including the collaboration of therapists, orthopedists, rheumatologists, rehabilitologists, specialists in restorative medicine, and health care coordinators must be developed.

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