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TOTAL HIP REPLACEMENT IN FEMORAL HEAD OSTEONECROSIS

Abstract. The experience of hip replacement in young patients with osteonecrosis of the femoral head was analyzed in the article. The results of operations in the osteonecrosis group and osteoarthritis group in 3 years and 7 months after operations were compared. In 97.5 % of cases, cementless fixation implants with a ceramic on ceramic friction pair (45 %) and ceramic on polyethylene friction pair (45 %) were used. Surgical approaches by Moore, Hardinge and AMIS technique were applied. The clinical results of operations in the studied groups were similar, but the survival rate of endoprostheses in the osteonecrosis group was 91.5 %, and in the osteoarthritis group 97.2 %. In the osteonecrosis group an increased frequency of complications (dislocation of the endoprosthesis head, periprosthetic fracture, periprosthetic infection) and revision operations were observed. Our results show the influence of risk factors, concomitant diseases, the level of activity of young patients on the long-term total hip arthroplasty result.

Keywords: total hip arthroplasty, femoral head necrosis, osteoarthritis

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ТОТАЛЬНОЕ ЭНДОПРОТЕЗИРОВАНИЕ ТАЗОБЕДРЕННОГО СУСТАВА ПРИ ОСТЕОНЕКРОЗЕ ГОЛОВКИ БЕДРА

Аннотация. В статье проанализирован опыт эндопротезирования тазобедренного сустава у молодых пациентов при остеонекрозе головки бедра. Проведено сравнение результатов операций в группах остеонекроза и остеоартрита через 3 года и 7 мес. В 97,5 % случаев использовали эндопротезы бесцементной фиксации с парой трения керамика–керамика (45 %) и керамика–полиэтилен (45 %). Применялись хирургические доступы Moore, Hardinge, методика AMIS.

Клинические результаты операций в изученных группах были схожи, однако «выживаемость» эндопротезов в группе остеонекроза составила 91,5 %, а в группе остеоартрита – 97,2 %. В группе остеонекроза наблюдалась повышенная частота осложнений (вывих головки эндопротеза, перипротезный перелом, перипротезная инфекция) и ревизионных операций. Это свидетельствует о влиянии факторов риска, сопутствующих заболеваний, уровня активности молодых пациентов на отдаленный результат эндопротезирования.

Ключевые слова: тотальное эндопротезирование тазобедренного сустава, некроз головки бедренной кости, остеоартрит

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Introduction. Total hip arthroplasty (THA) is the method of choice for the treatment of late stages of femoral head necrosis (FHN) [1]. Today there are about one million performed replacements per year in the world in total. In particular, there are more than 370 thousand in the USA in 2014 [2]. Among all nosologies in which arthroplasty is performed, FHN takes 5–18 % [3, 4], and sometimes 50–60 % [5]. However, using of THA in young patients is not always justified, as it is combined with an increased risk of negative consequences. This is due to the fact that patients with FHN have metabolic disorders in

bone structure of the femur due to an increase in the resorption rate, leading to osteolysis and increasing risk of instability of the endoprosthesis components [6]. High functional requirements, the presence of concomitant comorbid diseases, and frequent alcohol dependence in patients with cardiomyopathic hypertension increase the risk of postoperative complications and worsen the results of THA [7, 8]. There are dislocations of the endoprosthesis head, periprosthetic fractures, periprosthetic infection among the complications [9]. These all lead to an inevitable increase in the number of revision surgeries, which makes up 10–15 % of the number of initially THA annually, according to world statistics [10]. Unfortunately, in some cases the problem is solved only by removal of the implant.

THA for femoral head osteonecrosis has been used for more than 25 years, in the Republic of Belarus. However, studies on its long-term results in young patients have not been carried out. Existing world registries show varying survival rates for THA. In the 90s, the level of unsuccessful results of THA reached 37–53 % [1]. At that time, cemented fixation prostheses with old design were used. Over time, the quality of the implants has undoubtedly improved. New friction pairs, anatomical stems, endoprotheses with modern metal structure, and coating to enhance osseointegration have appeared [11, 12]. However, reports of existing failures and high risk of revision operations in patients with FHN are continuing to appear in modern literature [13]. Therefore, the use of our experience in endoprosthetics in young patients in preparing for the consideration of the causes of complications and long-term results is very important. A clear algorithm for selecting patients, determining contraindications, and choosing the types of implants is becoming relevant.

Materials and research methods. Due to the similarity of the diseases structure in which THA is carried out from year to year, we were analyzing cases during 2016. The total number of operations taking into account bilateral THA was 469. 307 (65.5 %) operations were performed for idiopathic coxarthrosis, 77 (16.4 %) for displaced femoral neck fracture, 44 (9.4 %) for non-traumatic FHN, 24 (5 %) for post-traumatic coxarthrosis, 14 (3 %) for the false joint of the femoral neck, 3 (0.7 %) for the tumor of the femur.

The measure for inclusion of patients in the main study group (40 patients) was the non-traumatic nature of osteonecrosis. Exclusion measures were secondary head necrosis on the background of coxarthrosis, post-traumatic osteonecrosis, hip dysplasia, surgery on the hip joint, rheumatoid diseases. The comparison group consisted of 40 patients with idiopathic coxarthrosis who also underwent THA. The main group and the comparison group were comparable by gender, age, and time of hospitalization.

Gender analysis showed that there were 37 (92.5 %) male patients and 3 (7.5 %) female patients among the operated patients, the average age of them was 43.7 [41.2; 46.2] years. People of working age 25–55 years old were prevailed among patients with FHN in the study group. The age peak was 25–44 years, which corresponds to a relatively young age. Bilateral osteonecrosis of the femoral heads occurred in 34 (85 %) patients, and only 6 (15 %) had one of the sides affected.

In 37 (92.5 %) patients before THA conservative treatment was the main method (Fig. 1); in 3 (7.5 %) cases, decompression of the necrosis focus with bone grafting was previously performed.

Clinical assessment of patients before and after surgery was carried out on the basis of the Harris Hip Score [14]. To analyze the radiological results of the treatment, X-ray of the hip joint was performed in the direct and lateral projections with the capture of the middle third of the thigh. The characteristics of the FHN stages in the study group are presented in Tab. 1. In our work we used the ARCO classification of femoral head necrosis, taking into account the magnitude of the femoral head lesion and degree of its impression [15].

Table 1. Stages of osteonecrosis at the time of THA

ARCO Stage	Number of THA	%
0	—	—
I	—	—
II	1	2.5
III	22	55
IV	17	42.5
Total	40	100

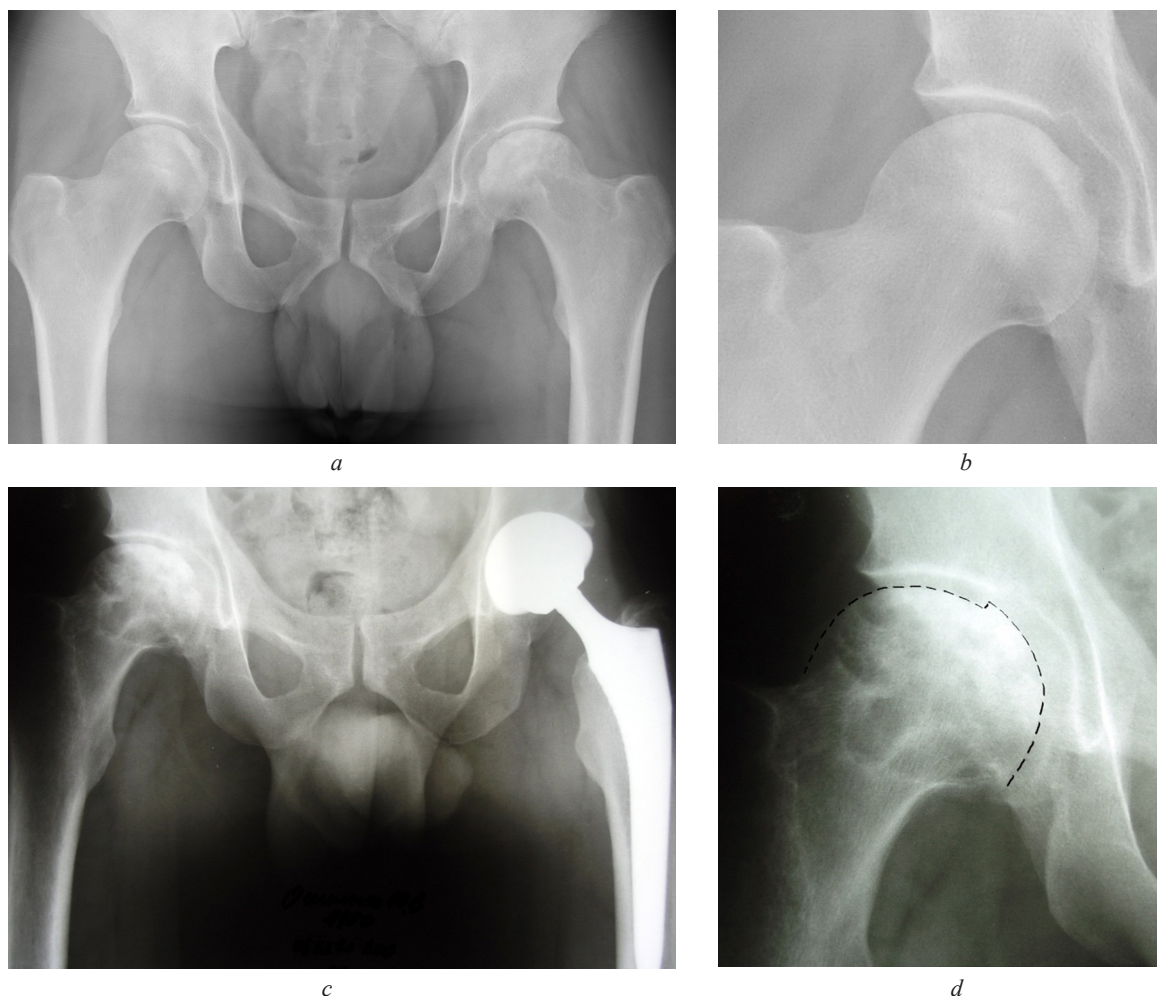


Fig. 1. Radiography of patient O., 38 years old, with FHN. Progression of osteonecrosis within 1 year after conservative treatment: *a* – both hips in 2018: stage ARCO II on the right, ARCO III on the left; *b* – right hip, stage ARCO II on the right, no collapse; *c* – both hips in 2019: left hip – THA, right hip – stage ARCO III, collapse 2 mm (*d*)

The analysis of the data revealed a late diagnosis. Osteonecrosis was diagnosed from 4 months to 1 year and 8 months from the onset of the first symptoms of the disease. In 57 % of cases, the diagnosis was established radiologically, i. e. already at a late stage, when the radiological manifestations of osteonecrosis were visually noticeable. In 33.3 % of cases, the diagnosis was confirmed using magnetic resonance imaging, and in 9.7 %, the diagnosis was established after computed tomography. On average, THA operations were performed after 2.5 years [1.5; 3.5] after diagnosis.

The disability group had 20 (50 %) operated patients, 1 (2.5 %) of which had the first disability group, 12 (30 %) – the second, 7 (17.5 %) – the third. 12 (30 %) patients did not work at the time of the surgery, 28 (70 %) had a permanent job.

Types of implants. The key to successful hip replacement is careful operation planning and selection of endoprosthesis components. The final decision is made by the surgeon intraoperatively and may even differ from the previously planned due to the discovery of the anatomical features of the operated joint and technical difficulties. The selection of the implant should take into account both the anatomical features of the hip joint, the structure and density of bone tissue, as well as the individual characteristics of the patient, his age, level of activity, the risk of complications associated with concomitant diseases. In addition to the relief of pain, endoprosthesis implies the elimination of the difference in the length of the limbs, lameness, restoration of range of motion. The restoration of the total femoral offset through the selection of components of the endoprosthesis for the correction of biomechanical disorders is the paramount importance [16]. The types of used implants are presented in Tab. 2.

Table 2. Types of implants

Components of the endoprosthesis	<i>n</i>	%
Acetabular component (type of fixation):		
screwed	—	
pressfit	40	100
cemented	—	
Femoral component: (type of fixation)		
pressfit	39	9.8
cemented	1	0.2
Insertion:		
standard	33	82.5
asymmetric	3	7.5
dual mobility	4	10
Friction pair:		
metal on polyethylene	4	10
ceramic on polyethylene	18	45
ceramic on ceramic	18	45

In 39 (97.5 %) patients with FHN we used cementless THA with a ceramic on ceramic (45 %) and ceramic on polyethylene (45 %) friction pair.

A cemented stem was used only in one case with severe osteoporosis of the femur. An asymmetric anti-dislocation plastic insertion was used in 3 (7.5 %) cases with overweight to prevent dislocations of the endoprosthesis head. A dual mobility system was used in 4 (10 %) cases.

The types of approaches that were applied are presented in Fig. 2.

Both the posterior Moore approach and the anterior transgluteal approach by Hardinge were used for implantation of standard cementless endoprosthesis in patients with body mass index less than 30 [17]. Moore approach was used in cases with body mass index more than 35, which allowed to manipulate more carefully with soft tissues without injuring the gluteal muscles (Fig. 3). The AMIS technique with special console to the operating table was used in some cases for implantation a dual mobility endoprosthesis [18]. In these cases, the minimized approach by Hueter modification was applied [19]. This technique made it possible to perform a gentle intermuscular approach to the hip joint, which is considered a less traumatic option for THA on condition of good skills [20].

THA were performed according to standard approaches; the volume of acetabulum and femur bone tissue resection depended on the type of implants and bone quality. In some cases with a good quality of the femur, we preferred to use anatomical stems with a minimum level of femoral neck resection, as well as legs with a hydroxyapatite coating for improving osseointegration. Particular attention was paid

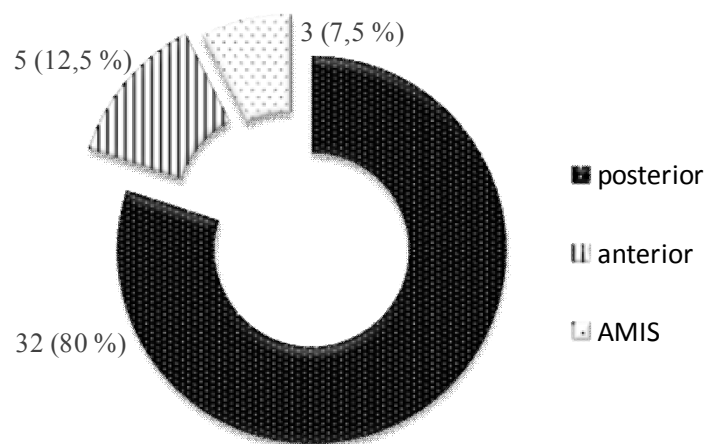


Fig. 2. Variants of surgical approaches

to observing the angle of cup inclination and the depth of its implantation in the acetabulum, the landing height and the correct antetorsion of the prosthesis stem relative to the femoral canal, the offset restoration, the strength of the primary fixation of the implant and the resistance of the endoprosthesis head to dislocation. In some cases, asymmetric anti-dislocation inserts were used to prevent head dislocation.

In 3 (7.5 %) cases, due to the presence of acetabulum osteoporosis, the pressfit cups were fitted with 6.5 mm spongy screws, which improved the primary fixation. Simultaneous bilateral THA was performed in 1 (2.5 %) case, due to bilateral lesion and severe pain. The average duration of the THA from the moment of anesthesia to the end of the operation was 1 h 43 min [1 h 37 min; 1 h 48 min].

During the first days after THA, the patients were in the intensive care unit. Using crutches and walking with a metered load on the operated limb was allowed after removing drainage from the wound on the 2nd day. Drug treatment, thromboprophylaxis, antibiotic prophylaxis, exercise therapy were carried out. 22 (55 %) patients were transferred to rehabilitation centers for further rehabilitation treatment. The average number of hospital days in the main group was 17.8 [16.3; 19.4].

Results and its discussion. We conducted a comparative assessment of the THA results in operated patients in osteonecrosis and osteoarthritis groups. The treatment results were studied in 35 patients in the osteonecrosis group and 36 patients in the osteoarthritis group (Tab. 3). The average follow-up was 3 years and 7 months.

Table 3. Comparative characteristics of clinical and demographic data in FHN and osteoarthritis groups

Indicator	FHN group	Osteoarthritis group	<i>p</i>
The number of patients (joints)	40	40	
Age, years	44 [41; 46]	46 [43; 49]	0.16
Male/female	37/3	36/4	1/0
Average follow-up, months	43 [42; 45]	43 [42; 45]	0.83
Harris hip score before surgery	54.5 [53.4; 55.6]	55.1 [53.6; 56.6]	0.73
Harris hip score after surgery	88.4 [84.7; 92.1]	88.6 [85.7; 91.4]	0.70
Complications			
Cup instability	–	1	
Stem instability	1	–	
Dislocation	2	1	
Infection	1	–	
Acetabular fracture	1	–	
Hip fracture	1	–	

Note. Comparison of independent samples by the Mann–Whitney criterion.

In the FHN group the average Harris hip score before THA was 54.5 [53.4; 55.6] out of the maximum possible 100, in the osteoarthritis group – 55.1 [53.6; 56.6]. After THA, the average Harris hip score in the main group was 88.4 [84.7; 92.1], and in the comparison group 88.6 [85.7; 91.4]. Evaluation of THA results in patients with osteonecrosis and osteoarthritis showed that in the main group the clinical results were slightly better than in the comparison group, but this was not statistically confirmed ($p > 0.05$) (Fig. 3).

In the postoperative period, 26 (74.3 %) patients from FHN group had a good and excellent clinical treatment outcome (the number of points from 80 to 100 by Harris scale). It consisted of decrease or absence in pain, an increase in the range of motion in the hip joint, and improvement of joint function.

An unsatisfactory result (<70 points) was obtained in 5 (14.3 %) cases of THA, in three of which, during the observation period, patients underwent revision surgery. In two cases there was pain and contracture. In 3 (9.4 %) cases out of 32, without revision surgery, lameness remained in patients at the time of examination.

Analysis of the THA results in both groups showed that the clinical condition of patients, assessed according to the Harris scale, was better in people in the age range from 24 to 40 years. The clinical results of THA among female patients were also better than among male patients.

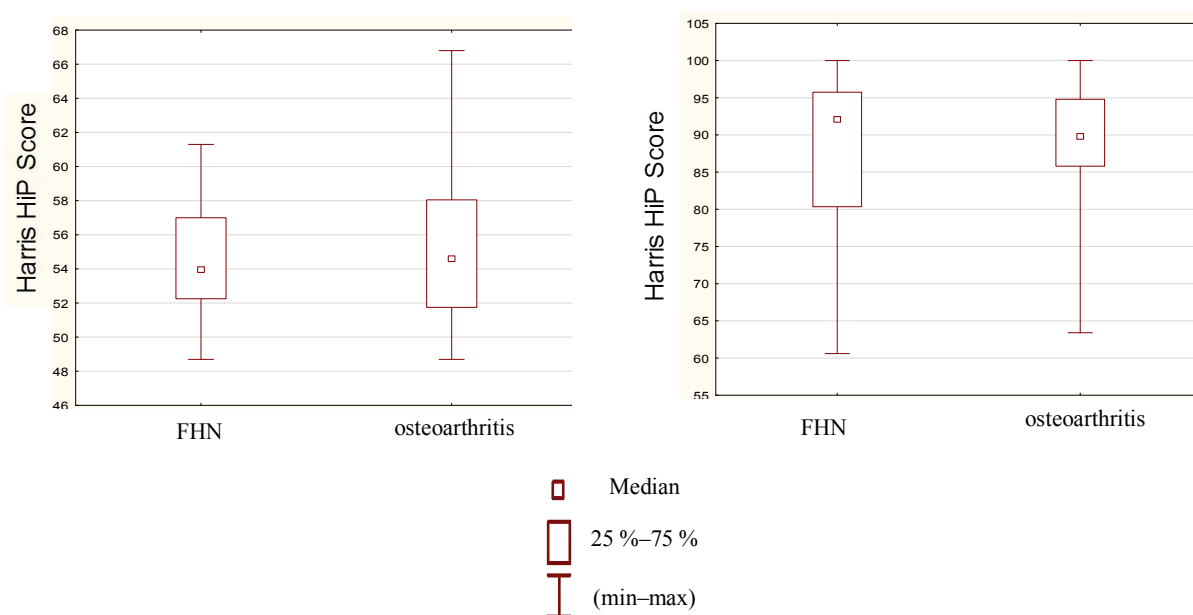


Fig. 3. Assessment of the patients clinical condition on a Harris scale before and after THA in the osteonecrosis and osteoarthritis groups

The *X-ray* assessment of the THA results was carried out on the basis of *X-ray* data of the hip joint in the direct and lateral projections. The initial sign of instability of the femoral component was the appearance of a “double line” around the stem, especially in zones 3–5 according to Gruen [21]. The “double line” arose due to the internal *X-ray* negative zone (bone resorption) adjacent directly to the implant, and the external *X-ray* positive (osteosclerosis). Obvious signs of instability were the prosthesis stem sagging down the femoral canal over 2 mm or its inclination relative to the initial position after primary implantation.

Signs of instability of the acetabular component were a “double line” around the cup, determined in the zones according to DeLee and Charnley [22], a change in the position of the cup (medialization, varus, valgus) relative to the initial setting. An additional confirmation of components instability was a displacement of the implants edges position revealed on the *X-ray* relative to the bone landmarks (apex of the greater or lesser trochanter, figure of a tear, iliac-ischial line).

In cases of polyethylene liner wear, an asymmetric arrangement of the prosthesis head relative to the edges of the cup, lysis of the bone tissue of the proximal femur and pelvic bone around the implants was noted. Among the complications in the osteonecrosis group, there were two (5 %) cases of prosthesis head dislocation, one case of deep periprosthetic infection, two cases of periprosthetic fractures that did not require osteosynthesis (fracture of the medial wall of the acetabulum and fracture of the greater trochanter of the femur).

Periprosthetic infection occurred in patient N., 41 years old. THA was carried out in 2015 regarding chlamydia-induced FHN. Antimicrobial treatment of chlamydial infection in this case was not carried out.

During the observation period, revision operations were performed in three cases for FHN patients: in one case an open reduction and replacement of the prosthesis head was performed with its stale dislocation; in the second – removal of prosthesis with deep periprosthetic infection; in the third case the cemented stem during aseptic instability was replaced with a modular revision leg.

Heterotopic hip joint ossification, degree I–II, according to the Brooker classification [23], was detected in 2 cases after anterior approach and in 5 cases after posterior approach.

Among the complications in the osteoarthritis group was one case of prosthesis head dislocation, treated with closed reduction. An audit operation was performed in one case for a patient with aseptic instability of a cementless endoprosthesis cup and wear of a polyethylene liner. A modular acetabular component based on a reconstructive ring has been installed.

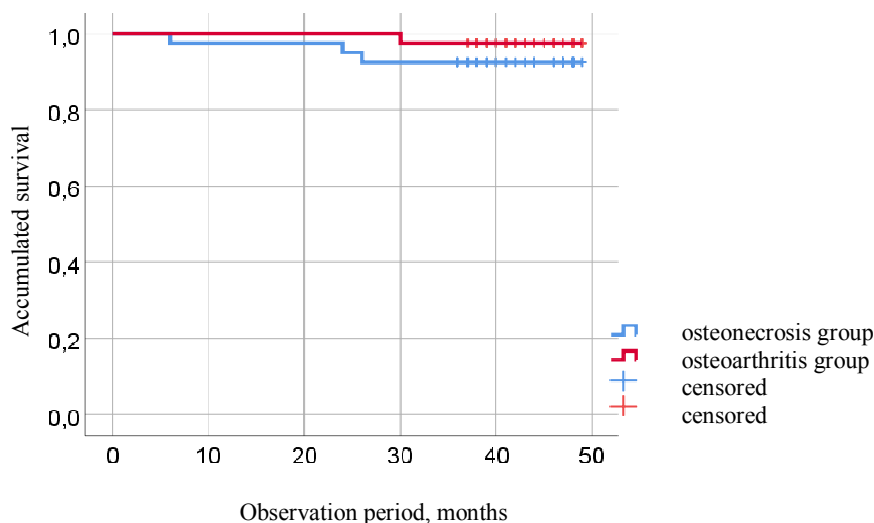


Fig. 4. Analysis of the survival rate of endoprostheses in groups of FHN and osteoarthritis

The revision of any component was the endpoint for determining the overall survival period of the endoprosthesis. Thus, the “survival” of endoprostheses in the osteonecrosis group during 43 months after surgery was 91.5 %, and in the osteoarthritis group 97.2 % (Fig. 4).

The results of THA operations were analyzed among all the evaluated cases in both groups depending on the installed friction pair (prosthesis head/insert). The clinical results obtained in patients with a ceramic on polyethylene friction pair and in patients with a ceramic on ceramic friction pair did not differ significantly ($p > 0.05$).

Conclusion. The analysis of the diseases structure in hip joint replacement showed that the share of non-traumatic femoral head osteonecrosis was 9.4 % among all nosologies. Young and able-bodied people age prevailed, the peak of which was 25–44 years old. For most of them, initially conservative treatment was the main one, which indicates a high probability of disease progression with this approach. In 57 % of cases, the diagnosis was established radiologically in the presence of obvious manifestations of osteonecrosis, which confirms the untimely diagnosis of the disease.

The clinical results of THA in young patients with femoral head osteonecrosis were similar to the results of THA for hip joint osteoarthritis. However, the endoprostheses survival rate in the osteonecrosis group during 43 months after surgery was 91.5 %, and in the osteoarthritis group 97.2 %.

The increased frequency of complications and revision operations in the osteonecrosis group indicates the influence of risk factors, concomitant diseases, the level of activity of young patients on the long-term THA results.

Conflict of interests. The authors declare no conflict of interests.

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