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Results of total hip arthroplasty in patients with reduced bone mineral density

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Total hip arthroplasty (THA) is one of the most common and clinically successful orthopedic surgeries aimed to eliminate pain and improve walking function in patients with osteoarthritis of the III–IV stages. Low mineral bone density (BMD) affects the survivorship of implants after THA and may cause long-recovery terms. Objective. Analyze the results THA in patients with normal and low BMD within a year after surgery. Methods. 49 patients (aged 30–75 years) were examined before and after uncemented primary THA. According to the results of two-photon X-ray absorptiometry before the surgery, they were divided into two groups: I, normal BMD — 27 (55.1 %) patients, T-criterion at the level of the proximal part of the unaffected femur -1 or more; II, reduced BMD — 22 (44.9 %), T-criterion is smaller for -1 . BMD, pain for VAS and function of the operated limb according to Harris score, it was assessed before THA and one week later; 2, 6, 12 months. Biomechanical examinations of the bearing capacity of the limb were performed before the surgery and 6 months after. Results. On all terms of postoperative follow-up, the indicator for VAS in patients of the II group was statistically worse, but pain syndrome decreased in parallel. Harris hip score was significantly lower in patients of the II group determined before surgery and after it up to 2 months of follow-up; after 6 months indicators became statistically similar. According to the results of statography regardless of BMD before the surgical treatment, the average support on the affected limb was (12.7 ± 9.2) % less than healthy ($p = 0.019$). By 6 months after THA, the difference in foot load was insignificant ($p = 0.675$). Conclusions. One year after THA, recovery of function according to the Harris hip score established in both groups. However, this process occurs in patients with low BMD and took place more slowly: only 6 months after surgery, the indicator leveled off with the normal group BMD, 6 months after surgery in patients of both groups, with the restoration of support on the operated limb during two-support standing was recorded.

Тотальне ендопротезування кульшового суглоба (ТЕКС) є одним із найпоширеніших і клінічно успішних хірургічних втручань для усунення болю та покращення функції ходьби у хворих на остеоартроз III–IV стадій. Низька мінеральна щільність кісткової тканини (МЩКТ) впливає на виживаність імплантатів після ТЕКС та є причиною подовшення термінів відновлення. Мета. Проаналізувати результати ТЕКС у пацієнтів із нормальною та зниженою МЩКТ протягом року після операції. Методи. Обстежено 49 пацієнтів (вік 30–75 років) до та після безцементного ТЕКС. За результатами двофотонної рентгенівської абсорбціометрії до операції їх розподілили на дві групи: I, нормальна МЩКТ — 27 (55,1 %) хворих, T-критерій на рівні проксимального відділу неураженої стегнової кістки -1 та більше; II, знижена МЩКТ — 22 (44,9 %), T-критерій менший за -1 . МЩКТ, біль за ВАШ і функцію оперованої кінцівки за шкалою Харріса оцінювали до ТЕКС та через тиждень; 2, 6, 12 міс. Біомеханічні обстеження опороспроможності кінцівки виконані до операції та через 6 міс. після неї. Результати. На всіх термінах спостереження показник за ВАШ у пацієнтів II групи виявився статистично значущо гіршим, проте больовий синдром паралельно знижувався. Суттєво менший бал за шкалою Харріса у хворих II групи визначено до операції та після неї до 2 міс. спостереження, через 6 міс. показники стали статистично близькими. За результатами статографії незалежно від МЩКТ до лікування опора на хвору кінцівку в середньому була на $(12,7 \pm 9,2)$ % меншою, ніж на здорову ($p = 0,019$). Через 6 міс. після ТЕКС різниця навантаження на стопи була несуттєвою ($p = 0,675$). Висновки. Через рік після ТЕКС відновлення функції за шкалою Харріса встановлено в обох групах. Проте цей процес у пацієнтів зі зниженою МЩКТ відбувався повільніше: лише через 6 міс. після хірургічного втручання показник вирівнявся з групою з нормальною МЩКТ. Через 6 міс. після хірургічного втручання в пацієнтів обох груп зафіксовано відновлення опори на прооперовану кінцівку під час двоножного стояння. Ключові слова. Остеоартроз, безцементне тотальне ендопротезування кульшового суглоба, відновлення функції, постуральний баланс, біль, мінеральна щільність кісткової тканини

Key words. Osteoarthritis, uncemented total hip arthroplasty, restoration of function, postural balance, pain, bone mineral density

Introduction

Most people who have undergone hip replacement are in the older age group, so they are often found to have signs of osteoporosis. A decrease in bone mineral density (BMD) in combination with a decrease in local blood circulation caused by additional trauma to bone structures and adjacent soft tissues during surgery leads to osteolysis, early instability of the endoprosthesis, and increases the risk of periprosthetic fractures. Total hip arthroplasty (THA) is one of the most common and clinically successful surgical interventions [1] to eliminate pain and improve walking function in patients with stage III–IV osteoarthritis.

Analysis of the physical functionality in patients with osteoarthritis of the hip joint before and after THA revealed a significant improvement in the quality of life associated with a decrease in pain intensity and an increase in the functionality of the lower extremities [2, 3]. Some long-term studies indicate preservation of violations and limitations after THA [4]. The opinions of researchers about static balance deficiency after the specified operation differ [2, 5–10].

Some studies on balance assessment have focused on the analysis of proprioception alone [11]. Zati A. et al. [12] showed that THA does not cause permanent changes in the perception of movements in the joints, because the updated mechanics of the hip joint allows to strengthen static and dynamic antigravity reactions.

Low BMD in the components of the hip joint was found to affect the survival of implants after THA [13], and is also the reason for prolonging the recovery period [14].

Purpose: to analyze the results of hip arthroplasty in patients with normal and reduced BMD within one year after surgery.

Material and methods

The materials of the study were discussed and approved at the meeting of the Bioethics Committee at the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine» (Protocol No. 182 of 09.07.2018).

The study involved examination of 49 patients aged from 30 to 75, with an average age of (54.0 ± 11.1) years. The patient underwent cementless THA operation. All patients underwent a densitometric BMD study of the lumbar spine and the proximal part of the femur from the side of the healthy joint before endoprosthetic repair. BMD was measured using an Explorer QDR 4500 bone densitometer (Ho-

logic, USA). According to the results of two-photon X-ray absorptiometry, the patients were divided into two groups according to the T-criterion of the proximal part of the femur, which did not differ significantly by age ($t = -0.031$; $p = 0.975$):

– I, normal BMD — 27 (55.1 %) persons with a T-criterion value of -1 or more: 17 (63.0 %) women and 10 (37.0 %) men, aged from 30 to 68 years, in on average — (54.0 ± 9.4) years; – II, reduced BMD — 22 (44.9 %) patients with a T-criterion level lower than -1 : 10 (45.5 %) women and 12 (54.5 %) men, aged 34 to 75 years, in on average (54.1 ± 12.8) years.

According to the diagnoses, the patients were distributed as follows: coxarthrosis — 38 (77.6 %), rheumatoid arthritis — 4 (8.2 %), false femoral neck joint — 4 (8.2 %), avascular necrosis of the head — 3 (6.1 %). In all persons, coxarthrosis was secondary in nature as a result of reactive arthritis. Among patients with coxarthrosis, it was right-sided in 21 (42.9 %), left-sided in 7 (19.7 %) and bilateral in 10 (20.4 %).

The functionality of the operated limb was evaluated according to the Harris Hip Scale before endoprosthetic repair and one week, 2, 6, and 12 months after it.

All patients underwent biomechanical tests of limb strength twice — before the operation and 6 months after. The examination was carried out on the basis of the laboratory of biomechanics of the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine» using the «Statograph» device [15].

The results were processed statistically: the mean (M) and its standard deviation (SD), minimum (min) and maximum (max) values of the sample were determined. T-test for independent samples was used for comparison between the groups. The analysis of the recovery time course of patients in two groups with different BMD was performed using the general linear model (GLM), and the null hypothesis on the absence of difference in the time course of change between the groups was tested by the Harris Hip Scale and the pain syndrome index on the visual analog scale (VAS). Comparison of two observation periods was performed using the T-test for repeated measurements (statography data). The analysis was performed in the IBM SPSS Statistics 20.0 package [16].

Results and their discussion

The recovery of patients with different BMD of the proximal femur after hip arthroplasty over a year was analyzed. The degree of pain syndrome

was determined before the operation and 2, 6, 12 months after it (Table 1). One week after the operation, the indicator was not evaluated, since some patients received anesthetics to reduce pain.

Assessment showed that before THA the patients had a rather strong pain syndrome: Group I — pain intensity (7.6 ± 0.6) points, which is statistically significant ($p < 0.001$) less than in Group II patients — (8.4 ± 0.6) points. Two months after surgical treatment, a noticeable decrease in pain syndrome was observed: Group I — (4.6 ± 0.6) points, Group II — (5.1 ± 0.7) points, the difference between the groups remained statistically significant ($p = 0.018$).

Six months after endoprosthetic repair, some patients did not have pain. In Group I, signs of feeling pain in ($1 \div 2$) points were recorded in 22 people out of 27, in group II — 21 out of 22, for this period the groups differed statistically significantly ($p = 0.048$). Twelve months after endoprosthetic repair in Group I, only 5 patients presented with a pain syndrome of 1 point, in Group II there were 13 such patients, and some assessed the pain at 2 points.

According to GLM data, the time course of pain syndrome in patients did not differ statistically significantly ($p = 0.097$). That is, despite the statistically significantly worse VAS score in Group II patients at all follow-up periods, in a year the VAS values coin-

cided. The time course of changes in the pain syndrome went parallel downward (Fig. 1, a).

The analysis of the recovery time course in patients with different BMD of the proximal femur after THA according to the Harris Hip Scale during the year is shown in Table 2.

Before treatment, patients with normal BMD on average had a statistically significant ($p = 0.001$) higher score on the Harris Hip Scale than individuals with reduced BMD. The same tendency was revealed a week after the operation, i.e. in Group I patients as compared to Group II, the score on the Harris Hip Scale remained significantly higher ($p = 0.003$). Two months after THA, the level of functionality of the hip joint increased significantly in both groups, but in Group I its value was significantly better ($p = 0.001$) than in patients with reduced BMD. Only 6 months after surgery, the level of functionality of the hip joint in both groups of patients was almost equalized ($p = 0.259$). The same time course remained a year later (Table 2).

According to the data of the general linear model (Fig. 1, b), the time course of changes in the Harris Hip Scale indicator in the groups were significantly ($p = 0.001$) different.

A significantly lower score on the Harris Hip Scale in Group II patients was determined before the operation and up to 2 months of observation after

Analysis of the time course of pain syndrome changes (according to VAS, points) in patients with different BMD after hip arthroplasty

Table 1

Group	Observation period				GLM
	before intervention	2 mths	6 mths	12 mths	
I (normal BMD) n = 27	7.6 ± 0.6 $7.0 \div 9.0$	4.6 ± 0.6 $4.0 \div 6.0$	1.3 ± 0.1 $1.0 \div 2.0$ (n = 22)	1.0 ± 0 (n = 5)	F = 2.592 p = 0.097
II (reduced BMD) n = 22	8.4 ± 0.6 $7.0 \div 9.0$	5.1 ± 0.7 $4.0 \div 6.0$	1.7 ± 0.5 $1.0 \div 2.0$ (n = 21)	1.1 ± 2.8 $1.0 \div 2.0$ (n = 13)	
Statistical significance between the groups	t = -4.658 p < 0.001	t = -2.450 p = 0.018	t = -2.036 p = 0.048	t = -0.609 p = 0.551	—

Analysis of the recovery time course in patients with different BMD after total hip arthroplasty according to the Harris Hip Scale

Table 2

Group	Observation period					GLM
	before intervention	week	2 mths	6 mths	12 mths	
I (normal BMD) n = 27	43 ± 5 $26 \div 49$	51 ± 7 $37 \div 66$	74 ± 6 $62 \div 86$	84 ± 6 $68 \div 93$	92 ± 5 $84 \div 99$	F = 677.5 p = 0.001
II (reduced BMD) n = 22	31 ± 3 $24 \div 36$	45 ± 8 $31 \div 60$	61 ± 8 $45 \div 74$	81 ± 10 $62 \div 95$	88 ± 6 $73 \div 98$	
Statistical significance between the groups	t = 9.592 p = 0.001	t = 3.127 p = 0.003	t = 5.704 p = 0.001	t = 1.147 p = 0.259	t = 1.872 p = 0.068	—

Table 3

Distribution of the share of weight on the feet during two-legged standing

Support on the limb	Statistical parameter	Observation period		Statistical significance of the difference M ± SD, t, p
		before treatment	6 months after treatment	
Operated limb	M ± SD min÷max	43.6 ± 4.6 40.2 ÷ 46.7	46.5 ± 5.1 43.1 ÷ 50.5	-2.9 ± 7.2 t = -0.984; p = 0.370
Contralateral limb	M ± SD min÷max	56.4 ± 4.6 53.3 ÷ 59.8	48.5 ± 10.4 40.6 ÷ 54.8	7.9 ± 10.7 t = 1.811; p = 0.130
Statistical significance of the difference	M ± SD, t, p	-12.7 ± 9.2 t = -3.404; p = 0.019	-2.0 ± 10.9 t = -0.444; p = 0.675	—

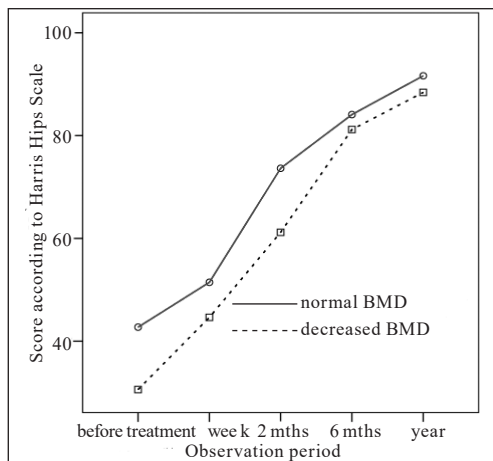
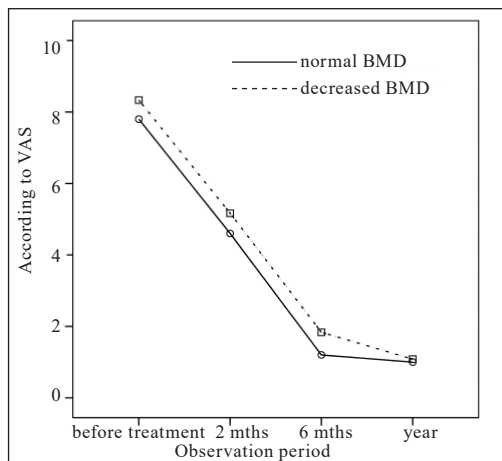


Fig. 1. Time course of change: a) pain syndrome according to VAS; b) assessment of hip joint functionality according to the Harris Hip Scale

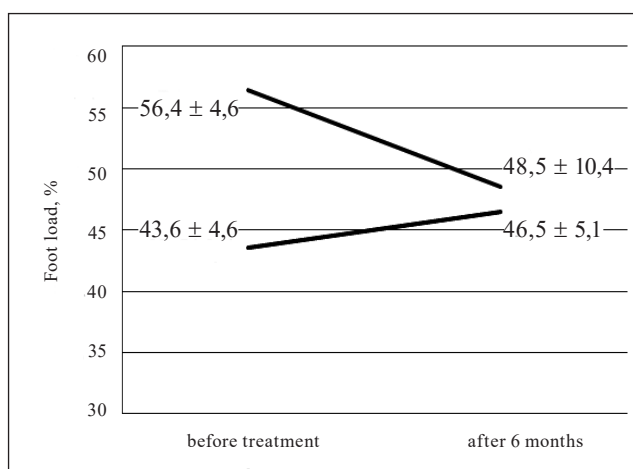


Fig. 2. Time course of changes in the load on the feet 6 months after THA

it, but 6 months after the operation indicators become statistically close.

As shown in the diagram, recovery of joint function in patients with reduced BMD compared to individuals with normal BMD occurred more slowly during follow-up. Only on the 6th month after the operation, the function of the hip joint restored to a good rating (80–90 points).

The patients also underwent a statistical examination. The indicator of load on the feet, namely the distribution of body weight, was chosen as the parameter

for assessing the recovery of bearing capacity (Table 3). In this part of the study, we did not evaluate the impact of BMD on foot load parameters due to the fact that the main factor in impaired endurance is the presence of pain syndrome, which is practically absent 6 months after surgery.

Before treatment, support on the diseased limb was on average (12.7 ± 9.2) % less than on the healthy one, the difference reached statistical significance (p = 0.019). Six months after THA, the difference in foot load decreased to (2.0 ± 10.9) % and did not differ statistically (p = 0.675). Endoprosthetic repair not only made it possible to increase the load on the operated limb, but also to relieve the contralateral limb. The diagram (Fig. 2) shows the time course of changes in the load on the feet before and 6 months after THA.

Discussion

The study showed that THA in all patients resulted in an improvement in the functional state. They noted a gradual decrease in the pain syndrome, which almost disappeared a year after the operation. In our opinion, its reduction affected the restoration of the functionality of the hip joint, that is, it made it possible to carry out full rehabilitation measures aimed at restoring muscle strength, symmetry of the load on the limbs during standing and walking.

Although complete recovery did not occur, improvement in hip function and general condition in both normal and reduced BMD patients was assessed by high scores on the Harris Hip Scale. The results of our research coincide with the data of other scientists: E. Sariali et al. [17] proved that the Harris Hip Score 2 years after THA did not correlate with the BMD level.

Many authors report an improvement in the quality of life of patients after THA, but some of them [18] note that pain may sometimes worsen after such an operation, mainly in women and patients of both sexes with osteoporosis.

A significant improvement in postural stability was found, as we did in our study, by A. C. Esbjornsson [19] and L. Labanca et al. [20]. They showed a significant reduction in lateral displacement (predominant support on one limb), although not to normal levels.

Conclusions

One year after total hip arthroplasty, recovery of functional status according to the Harris Hip Scale was established in both groups. However, joint function in patients with reduced BMD during follow-up was restored more slowly and only 6 months after surgery, the indicators were equal to the group with a normal BMD.

Six months after surgical intervention in patients of both groups, restoration of support on the operated limb during two-legged standing, i.e. symmetry of the load on the feet, was recorded. We attribute this to pain reduction.

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

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RESULTS OF TOTAL HIP ARTHROPLASTY IN PATIENTS WITH REDUCED BONE MINERAL DENSITY

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