

ALGORITHMS OF OSTEOPOROSIS DIAGNOSTICS, PREVENTION AND MANAGEMENT IN KNEE REPLACEMENT

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The aim of the investigation was to develop the algorithms of preoperative and postoperative diagnostics, prevention and management of osteoporosis in patients after knee replacement.

Materials and Methods. Based on densitometry and laboratory findings we analyzed bone mineral density in 204 patients, who had undergone knee replacement, among them women amounted 76.5%, men — 23.5%; mean age being 61.55 years. 87 patients (42.7%) in the study group were diagnosed osteopenia or osteoporosis, among them there were 84 (41.2%) female patients; 22 patients (10.8%) were found to have secondary osteoporosis; 65 (31.9%) — postmenopausal osteoporosis, the rest of the patients were found nothing.

Results. The suggested algorithm of preoperative osteoporosis diagnostics and management in endoprosthesis replacement provides early detection of gonarthrosis and reduced bone mineral density, and enables to provide differentiated therapy and perform a planned total knee replacement successfully. The tactics of postoperative control, prevention and management enables to prevent progressive bone mineral density reduction in patients after arthroplasty, and reduce the risks of early instability of an implant. The follow-up period was 9 years, no cases of aseptic instability were observed.

Key words: knee replacement; osteoporosis; densitometry; unstable prosthesis prevention.

Against the background of increasing the number of primary prosthetics in patients with gonarthrosis there increased the incidence of revision prosthetics for early and late instability of an implant. Provided prosthetics is performed correctly in terms of techniques, the achieved stability of the implant structure may become unsound in a short space of time because of the weakening of the bone structure. The response of the bone tissue to the implant as stress remodeling leads to increased bone resorption, thus reducing bone mass and creating prerequisites for fracture or instability of the prosthesis.

The aim of the investigation was to develop the algorithm of preoperative and postoperative diagnostics, prevention and management of osteoporosis in patients after knee replacement.

Materials and Methods. Based on densitometry and laboratory findings we analyzed bone mineral density (BMD) in 204 patients who underwent knee replacement from 2003 to 2012.

Among them, women amounted 76.5%, men — 23.52%. Age range was from 19 to 82 years, mean age was 61.55 years; the mean age of women was 61.83 years, men — 60.48 years. Elderly and old patients amounted to the majority of the patients (59.31%) that is 55.88% and 3.43% respectively.

The study was carried out in line with the Declaration of Helsinki (adopted in June 1964 (Helsinki, Finland)

and revised in October 2000 (Edinburgh, Scotland)) and approved by the Ethics Committee of the Rostov State Medical University (Russia). Informed consent was obtained from each patient.

All the patients underwent primary knee replacement, among them 40 patients (19.61%) underwent bilateral knee replacement, 87 patients (42.65%) — the right knee joint replacement, 74 patients (36.27%) — left knee joint replacement. Two patients had hip and knee joint replacement on one or opposite sides, three patients (1.47%) had three joint implants of the lower limbs.

Among the patients those with primary arthrosis — 152 (74.51%) cases and post-traumatic arthrosis at grades III–IV on Kellgren — 31 (15.2%) cases as well as patients with rheumatoid arthritis — 14 (6.86%) cases — prevailed, endoprosthesis for chronic osteomyelitis, benign and malignant tumors was rare — 7 (3.43%).

In the study group, 87 out of 204 individuals (42.65%) were diagnosed changes in BMD corresponding to osteopenia or osteoporosis, 84 among them being women (41.18%). 22 out of 204 individuals (10.78%), 19 among them being women (9.31%), were diagnosed secondary osteoporosis at the background of rheumatoid arthritis, hormonal therapy for bronchial asthma, hypo- or hyperthyroidism, diabetes, radiation therapy, after previous severe injuries of the knee joint, accompanied by prolonged immobilization. 65 women (31.86%) showed

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Table 1
Bone tissue status in women according to BMI and duration of menopause before surgery (n=65)

Indices	Duration of menopause, years		
	<15	15-20	≥20
Number of patients	8	26	31
Age, years	53.5	65.23	70.96
BMI	33.02	32.66	30.38
Age at menopause, years	42.88	48.08	47.0
The average duration of menopause, years	10.38	17.19	23.9
T-score max, RU:			
L _I -L _{IV}	-2.1	-2.9	-3.2
Proximal femur (total)	-1.68	-1.81	-2.6
Calcium total in serum, mol/L	2.34±0.1	2.34±0.12	2.36±0.08
Serum ionized calcium, mol/L	1.10±0.07	1.08±0.03	1.23±0.03
Inorganic phosphorus in serum, mol/L	1.08±0.17	1.11±0.18	1.20±0.24
Creatinine in urine, mol /L	14.71±0.09	13.90±0.13	10.84±0.26

post-menopausal osteoporosis, among them 21 patients (10.29%) had an early menopause of surgical or hormonal genesis.

When analyzing the correlation of body mass index (BMI), age, bone health, all the patients with postmenopausal osteoporosis and gonarthrosis were divided into three

groups: group 1 — patients with up to 15 years of menopause, group 2 — 15 to 20 years, group 3 — more than 20 years (Table 1).

Results and Discussion. In all the three groups of studied women the mean age of menopause was lower than in the population (in Russia the average age of menopause is 48–50 years [1, 2]). This is due to the fact that estrogen deficiency is a common factor predisposing to the development of menopause as well as osteoarthritis with osteoporosis. The longer the postmenopausal period, the lower the bone tissue density was. Together with the increase in the postmenopausal period we saw a decrease in the T-score of BMD and the average value of BMI. In 2004 V.V. Povoroznyuk et al. [2] in their study confirmed that patients with progressive gonarthrosis show worse indices of structural and functional bone tissue status. One of the causes for the progressive reduction BMD in patients with osteoarthritis may be that of the overproduction of inflammatory mediators that regulate bone remodeling [3, 4].

Based on the treatment experience we have developed an algorithm for preoperative diagnostics and management of osteoporosis to prevent early instability of an implant (Fig. 1). Preparation prior prosthetics is not required in case of normal value of BMD. Patients in premenopause are recommended to get a gynecologist’s advice on administration of hormone replacement therapy. On detecting osteopenia patients under 65 having a T-score of over –1.5 and patients over 65 having risk factors are administered ossein — hydroxyapatite complex

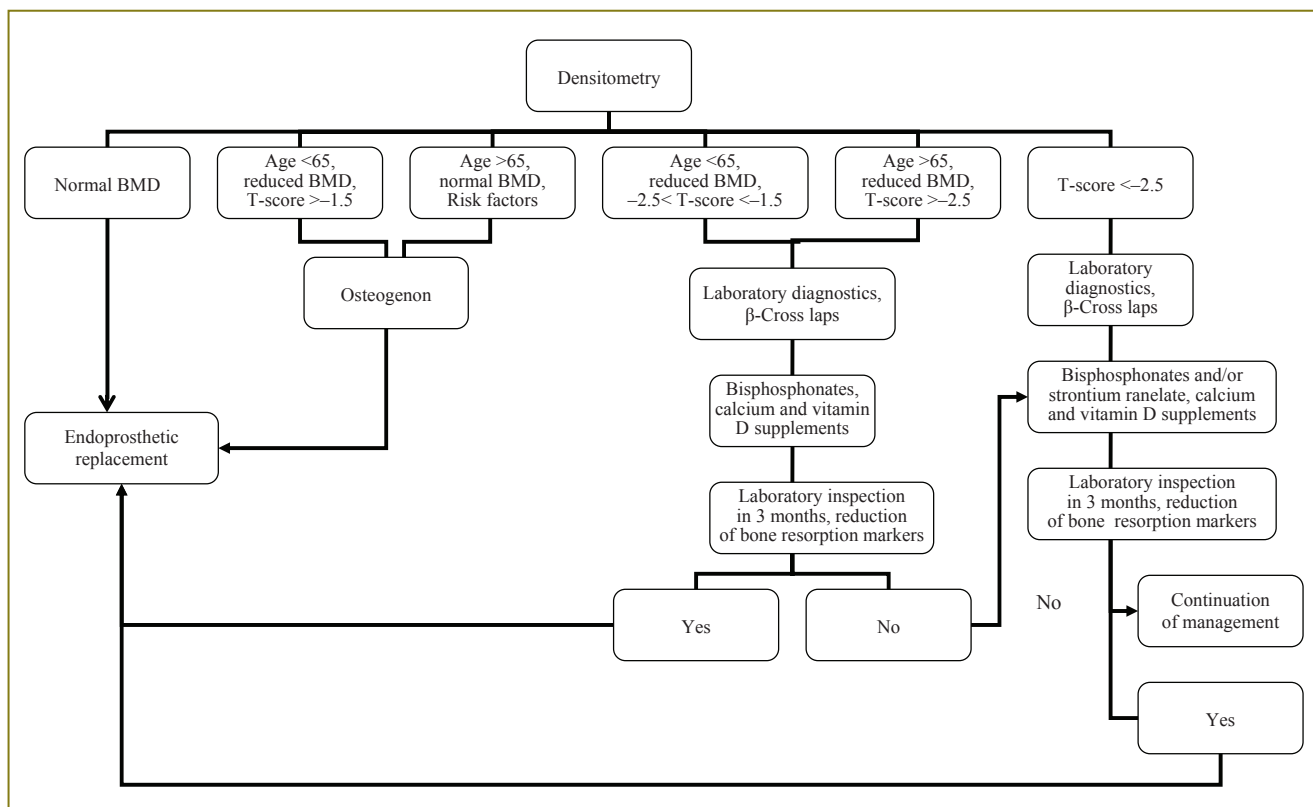


Fig. 1. The algorithm of preoperative diagnostics and osteoporosis management in knee replacement

(Osteogenon), 1 tablet 3 times a day for 1–3 months before surgery. According to several authors [5, 6], ossein — hydroxyapatite complex in postmenopausal women is more effective than therapy with calcium preparations and helps to maintain and, what is important, increase bone mineral density.

Patients with a T-score of under -2.5 , patients under 65 with a T-score of higher than -2.5 but lower than -1.5 , as well as patients over 65 with a T-score of 0 to -2.5 should additionally undergo laboratory diagnostics for β -Cross laps, osteocalcin.

Patients with higher levels of bone resorption markers are administered antiresorptive drugs of the first line. Preference should be given to nitrogen-containing bisphosphonates: Zoledronic acid in the first place and lbandronic acid more rarely. The realities of today show the problem of noncompliance to rank first. The survey and Q-data of patients with postmenopausal osteoporosis show that about 70% of women do not follow doctor's recommendations in whole or in part, which, undoubtedly, affects therapeutic efficacy [7]. Elderly and old people with cognitive disorders are less compliant. Easy therapeutic regimen with Zoledronic acid, requiring only a single injection of the drug a year, enables to eliminate the low efficacy of the treatment due to a patient's failure to follow medical advice. On reducing the level of osteocalcin patients receive strontium ranelate. At the same time the permanent intake of 500–1000 mg of calcium and 800 IU of vitamin D daily is administered.

Among the operated patients 34 (16.67%) of them had osteoporosis with a T-score of below -2.5 . Patients had been advised to complete dental procedures and not less than three months before the surgery, they had begun to receive antiresorptive therapy. The level of β -Cross laps and osteocalcin is a criterion for therapy efficacy. Performance

recovery by more than 30% of the initial level allows to prognose treatment efficacy and plan surgery. Therapy with calcitonin and bisphosphonates in two patients during a year and a half was not efficient. The combination of intravenous injection of Zoledronic acid in the standard dosage and strontium ranelate allows increasing bone density and perform knee replacement [8].

In the postoperative period all the patients were administered various pharmacological drugs to prevent bone loss. The main objective was to prevent the instability of the implant, the second objective was to reduce the risk of fracture. In 1982 P.J. Lesniewski [9] first described a case of cervical hip fracture in an 83-year-old patient 4 months after total knee replacement. In the same year, J.P. Mc Elwaine [10] reported 7 cases of stress fractures of the proximal femur 3–16 months after total knee replacement in the group of 500 operated patients. After that publications on stress fractures began to be regular [11]. According to these authors, stress fractures are polyethiologic. Local and systemic osteoporosis diagnosed in patients, steroid therapy, an increase in muscle activity and pressure on the femoral neck in patients, limiting mobility before the surgery due to acute pain were also of significance. Surgical techniques are also important, when installing a femoral component, impact forces are transmitted to the cervix and result in microfractures. The fractures become complete at expanding physical activity. In our group of patients we observed a 68-year-old patient, who had a fracture of the proximal femur 10 months after total knee replacement against the background of postmenopausal osteoporosis.

With the aim of optimizing the prevention and management of osteoporosis in the post-operative period we worked out an algorithm of pharmacological correction (Fig. 2).

Patients with normal BMD at the age of up to 50 should

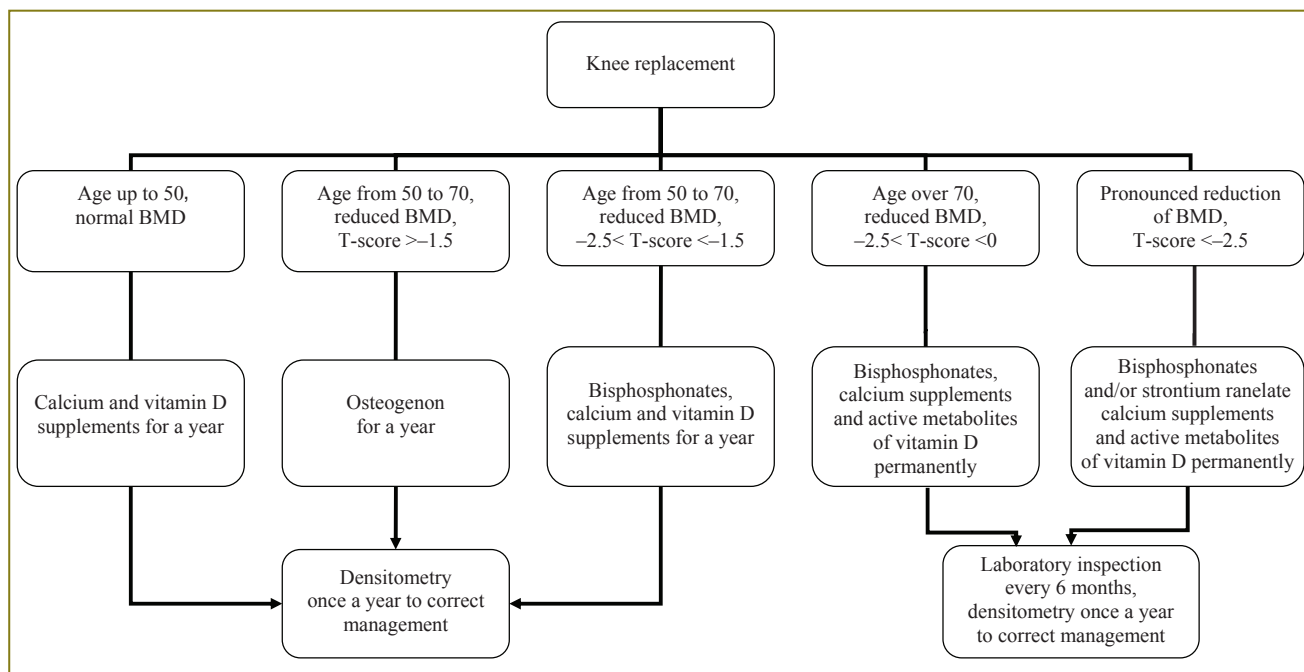


Fig. 2. The algorithm of postoperative prevention and management of osteoporosis in knee replacement

Table 2
Body mineral density before and after total knee replacement

Indices	Before surgery	After 6 months	After a year	After 2 years	After 3 years
Number of patients studied	204	186	123	106	98
Mean age, years	61.55±10.12	61.89±10.08	62.02±9.89	62.77±10.14	63.12±11.40
Number of patients with decreased BMD, abs. number/%	87/42.65	84/45.61	50/40.65	44/41.51	41/41.84
T-score max, RU:					
L _{II} -L _{IV}	-2.73±0.46	-3.11±0.51	-2.38±0.49	-2.29±0.51	-02.40±0.52
Proximal femur (total)	-2.03±0.41	-3.92±0.30	-2.52±0.32	-2.12±0.42	-2.36±0.38
Total calcium in serum mol/L	2.34±0.10	2.36±0.08	2.34±0.12	2.30±0.12	2.32±0.10
Ionized Calcium in Serum mol/L	1.10±0.07	1.23±0.05	1.08±0.04	1.10±0.06	1.10±0.07
Inorganic phosphorus in serum mol/L	1.08±0.17	1.20±0.24	1.11±0.18	1.10±0.18	1.09±0.16

be administered calcium and vitamin D3 supplements for a year. According to the most authors [12, 13], calcium citrate and calcium carbonate intake as a monotherapy and in combination with vitamin D reduces the rate of bone tissue loss, which, in our opinion, is sufficient with normal bone mineral density in order to prevent its loss.

Patients over 50 with normal reference bone density, but in premenopause, and patients with osteopenia (a T-score of higher -1.5) are administered ossein — hydroxyapatite complex, hormone replacement therapy on the gynecologist's advice. Patients at the age from 50 to 70 with a T-score of higher than -2.5 and lower than -1.5 are advised to continue bisphosphonate antiresorptive therapy for a year, but resume it not earlier than a month after joint replacement.

For the purpose of a differentiated approach to the management patients over 70 with a T-score of lower than -1.5 but higher than -2.5 should be selected into a particular group because it is the patients over 70 that may develop senile osteoporosis against the background of postmenopausal osteoporosis, and women develop it twice as often as men at that. An important role in the genesis of senile osteoporosis belongs to a negative calcium balance with the development of secondary hyperparathyroidism in combination with sex hormone deficiency and vitamin D deficiency. Intestinal calcium absorption decreases in the elderly, the renal function suffers, including the ability of calcidiol to hydroxylate into calcitriol, which is an active metabolite. Active metabolites of vitamin D (calcitriol and alfacalcidol in particular) should be added to the treatment regimen of these patients. However, the intake of these drugs increases the risk of hypercalcemia, which requires careful monitoring of calcium in the blood.

After surgery, all patients are advised to undergo densitometry 6 months after surgery, then once a year with the compulsory BMD study of the proximal femur on the side of the operation. Bone loss occurs most intensively in the first 6 months (the period of stress remodeling), followed by restoration to the 12th month after surgery [14].

With a significant reduction in bone mineral density (a T-score of lower -2.5), patients are administered bisphosphonates and/or strontium ranelate and calcium

supplements and active metabolites of vitamin D. Laboratory inspection is needed every 3–6 months to correct further management in addition to the annual densitometry.

98 patients (48%) were followed up for the results of bone densitometry for 3 years (Table 2). 6 months after surgery we observed an increase in the number of patients with reduced bone density and a T-score both at the L_{II}-L_{IV} level and in the proximal femur. A year after surgery and later on the number of patients with osteoporosis and osteopenia decreased, BMD indices reached the pre-operative ones, despite an increase in the average age of the group.

Conclusion. We have introduced the algorithm of preoperative diagnosis and management of osteoporosis at arthroplasty which allows an early detection of patients with gonarthrosis and reduced bone mineral density, differentiated management and successful performance of planned total knee replacement. The tactics of postoperative follow-up, prevention, and management enables to prevent progressive reduction of bone mineral density in patients after knee replacement and reduce the risks of early instability of an implant.

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