Turchin N. I. Optimization of complex therapy and rehabilitation of the musculoskeletal system in osteosarcopenia and vitamin D deficiency in postmenopausal women. Journal of Education, Health and Sport. 2020;10(1):310-319. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2020.10.01.034
https://apcz.umk.pl/czasopisma/index.php/JEHS/article/view/JEHS.2020.10.01.034
http://dx.doi.org/10.5281/zenodo.4468917

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.

Received: 20.12.2019. Revised: 25.12.2019. Accepted: 31.01.2020.

OPTIMIZATION OF COMPLEX THERAPY AND REHABILITATION OF THE MUSCULOSKELETAL SYSTEM IN OSTEOSARCOPENIA AND VITAMIN D DEFICIENCY IN POSTMENOPAUSAL WOMEN

Turchin N. I.

Odessa National Medical University, Ukraine

Abstract

Osteosarcopenia, i.e. combination of low muscle mass and reduced bone mineral density, is associated with aging and recognised as public health burden. The objective: to determine the possibility of treatment and rehabilitation to increase the functional capabilities of the musculoskeletal system in OSP and vitamin D deficiency in postmenopausal women. **Materials and methods.** 178 women aged 55.7 ± 0.6 years old, among them 148 OSP patients. Densitometry was performed, 25 (OH) D level in blood serum, C - terminal telopeptide, degradation product of type 1 collagen (CTx) were determined, functional tests were used. **Results and conclusions.** Complex use of physical rehabilitation (multifunctional trainer "HUBER") in combination with drug therapy (vitamin D, denosumab) promotes more effective increase of the functional capabilities of the musculoskeletal system: muscle strength, stability, coordination of movements, reduces functional limitations; promotes more effective treatment of structural and functional changes in bone tissue, increase BMD. Functional tests of the state of musculoskeletal tissue falls and are highly informative in terms of predicting the risk of fractures (impaired coordination and FraxAll, stability and FraxAl, risk of falls and FraxAll, dynamometry and FraxAll.

Key words: postmenopause; osteosarcopenia; vitamin D; therapy.

Osteosarcopenia (OSP) is a combination of low muscle mass and reduced bone mineral density (BMD) associated with aging and general pathogenesis [1-5].

The combination of sarcopenia (SP) and osteoporosis (OP) doubles the risk of fractures and premature death of patients [2]. A number of studies have shown that the muscle mass of the extremities are significantly lower in OP women than in the group with normal BMD [3, 4]. Vitamin D deficiency (VD) in postmenopausal women is a risk factor in the development of muscle weakness syndrome (decreased muscle strength, coordination of body movements in space, reaction time, functional mobility), the components of which increase the risk of falls and low-energy fractures. Low serum 25 (OH) D levels are also a risk factor for hip fracture [6]. Impaired balance and gait control, as well as impaired musculoskeletal function, are important falls risk factors [7]. Low-energy fractures occur in OP patients and are considered an important public health problem, as they lead to significant disability and premature death [8]. Currently, there is no specific treatment for muscle weakness, the primary one is prevention. Exercise, especially gradually increasing strength loads, stimulates muscle protein synthesis. Exercise for at least 20 minutes per week significantly increases muscle and bone mass, strength, reduces functional limitations, and prevents falls and fractures in the elderly [7]. Exercise has a positive effect on muscle mass and strength or physical performance in healthy individuals aged 60 and over [6, 7]. Adequate intake of vitamin D and intake of calcium and protein in conjunction with exercise improves muscle protein synthesis and has a positive effect on body composition by helping to reduce fat mass, increase or maintain muscle tissue, and preserve bone [10]. In accordance with international treatment guidelines and the prevention of VDD, correction of VDD in the adult population of Central European countries is carried out with the native preparation of vitamin D — Cholecalciferol [3]. The active metabolites of vitamin D include Alfacalcidol. Its action is associated with the formation of D-hormone in the liver, bypassing the renal hydroxylation circle.

This allows to administer the drug even with a reduced activity of 1α-hydroxylase in the kidneys in older persons [7].

OSP is often observed in PM women, reduces their physical capabilities, worsens the quality of life, contributes to an increase in the frequency of falls and, accordingly, the risk of OP fractures. Early diagnosis, timely treatment and rehabilitation of structural and functional changes in the musculoskeletal system in women working under unfavorable factors of the industrial environment are topical. **The objective:** To determine the possibility of treatment

and rehabilitation measures to increase the functional capabilities of the musculoskeletal system in OSP and vitamin D deficiency in postmenopausal women.

Materials and methods. Under our supervision there were 178 PM women aged 55.7 ± 0.6 years old, including 148 OSP patients, working at maritime sector. The control group consisted of 30 apparently healthy women. Densitometry was performed (osteodensitometer Hologic Discovery, USA) before the beginning of the treatment and in 12 months against the background of ongoing therapy. The level of 25 (OH) D in blood serum was determined by the enzyme immunoassay on a EUROIMMUN analyzer (Germany). A marker of bone tissue resorption, C-terminal telopeptide, degradation product of type 1 collagen (CTx), was determined in blood serum by the immunochemiluminescent method with Cobas - 6000 analyzer (Roche Diagnostics, Switzerland). Changes in CTx were observed at baseline after 3 and 6 months. Assessment of the functional state of skeletal tissue and falls risk were studied with the use of functional tests.

Thus,"tandem" test was used to assess the human's ability to maintain balance at rest, its test time is not less than 10 seconds; "get up and go" test (10 seconds); "sit-stand" test makes it possible to assess muscle strength and the risk of falls (no more than 10 seconds). Skeletal muscle strength was studied using a wrist dynamometer, (kg).

According to the methods of therapy, the patients were randomized into 2 groups: Group I - 83 women who received vitamin D metabolites and denosumab. Group II - 65 patients who received VD metabolites, denosumab, and the complex included training on a multifunctional HUBER simulator using stabilometry and stabilization training to correct balance and stability disorders. The results were statistically processed using Microsoft Office Excel and Statistica 10.0 software. Methods of primary descriptive statistics were used for mathematical processing: the mean value of the indicator, standard deviation, standard error, Student's t-test. When assessing the strength of the correlation coefficients, the Chaddock scale was used.

Results and discussion. BMD according to the T-criterion was reduced ($p < 0.05$) in both groups under study. It was (-2.33 ± 0.54 SD), ($p < 0.05$) in the Ist group and (-2, 29 ± 0.47SD), ($p < 0.05$) in the second group compared with the control group. Initially, BMD index did not differ in the groups under study and was (0.525 ± 0.039) g/cm^2, ($p < 0.05$) in the Ist group, and (0.524 ± 0.036) g/cm^2, ($p < 0.05$) in the IInd. . Initially, CTx was increased in both study groups: group I - (0.754 ± 0.015) mmol / l, ($p < 0.05$) and in group II - (0.775 ± 0.024) mmol / l, ($p < 0.05$), control - (0.364 ± 0.093) mmol / l. 25 (OH) D level corresponded to DVD: in group I it was (11.8 ± 1.57) ng / ml, ($p < 0.05$), in group II – (12.7 ± 1.35) ng / ml,

(p <0.05). The skeletal muscle strength, obtained with a wrist dynamometer, demonstrated a decrease in muscle strength: in group I it equaled to (10.9 ± 0.68) kg, (p <0.01), in group II - (11.3 ± 0.57) kg, (p <0.01), in the control group it was (45.35 ± 1, 24) kg. Functional tests results were as following. "Tandem test", "stand up and go", "stand up and sit down" showed reduced values in both groups in comparison with the control, respectively: in group I - (8.37 ± 0.42) s, (p <0.05), (13.2 ± 0.57) s, (p <0.05), (13.43 ± 0.54) s, (p <0.05); in group II - (8.34 ± 0.45) s, (p <0.05), (13.3 ± 0.42) s, (p <0.05), (13.5 ± 0.61) s, (p <0.05). After 12 months.of treatment, BMD in group I was (0.642 ± 0.039) g / cm^2, (p <0.05), in group II - (0.653 ± 0.043) g / cm^2, (p <0.05), which indicates a positive process of bone tissue formation (Fig. 1).

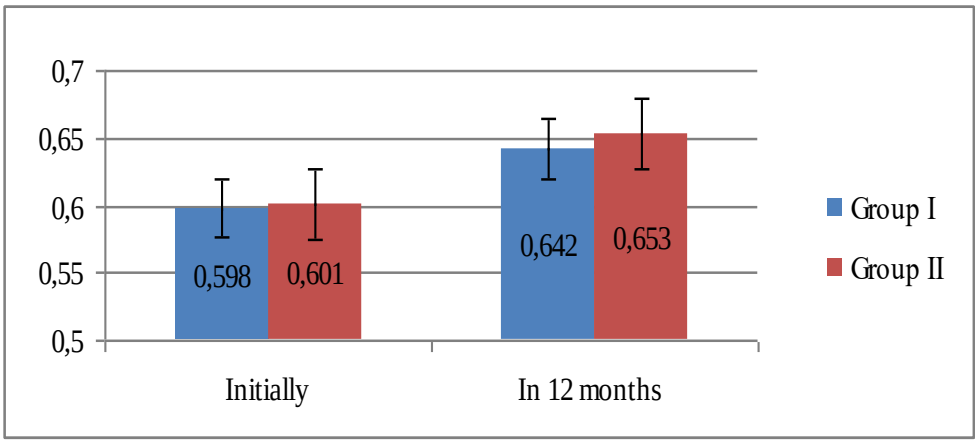

Fig. 1. Dynamics of BMD increase

As a result of the treatment, CTx index was reduced (p <0.05) in both groups after 3 months, which indicates the effectiveness of the therapy. However, in the second group against the background of therapy, the rate of decrease in CTx was significantly higher, CTx in group II - (0.564 ± 0.02) mmol / l, (p <0.01), in group 1 - (0.623 ± 0.01) mmol / l, (p <0.01) (Fig. 2).

At the background of ongoing therapy in the I st group women 25 (OH) D level after 3 months of treatment was (29.8 ± 1.1) ng / ml, (p <0.05), in group II it was (33.5 ± 1.3) ng / ml, (p <0.05); in 12 month 25 (OH) D level in group I was (35.5 ± 0.8) ng / ml, (p <0.05), in group II - (36.5 ± 0.5) ng / ml (p <0.05), (Fig. 3).

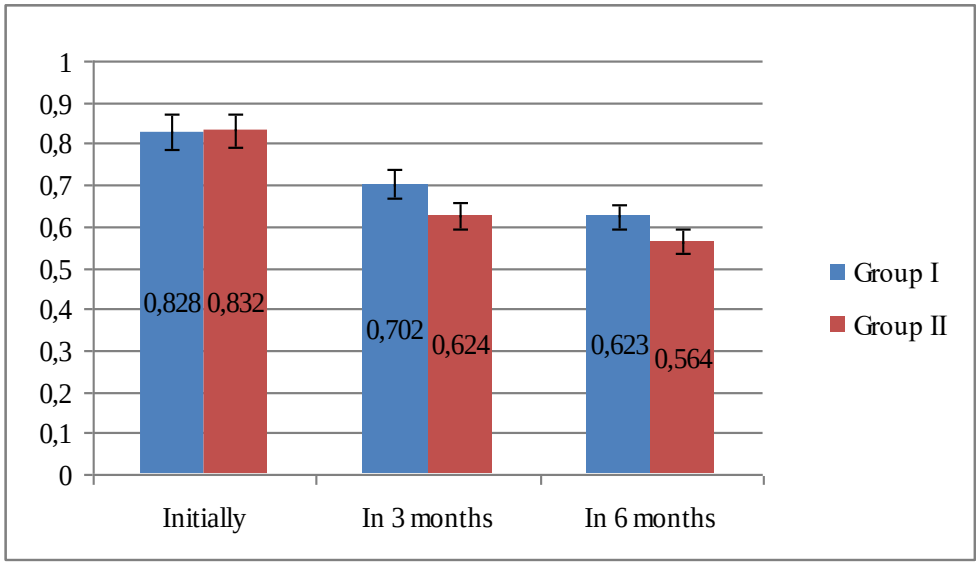

Fig. 2. Dynamics of CTx decrease during treatment.

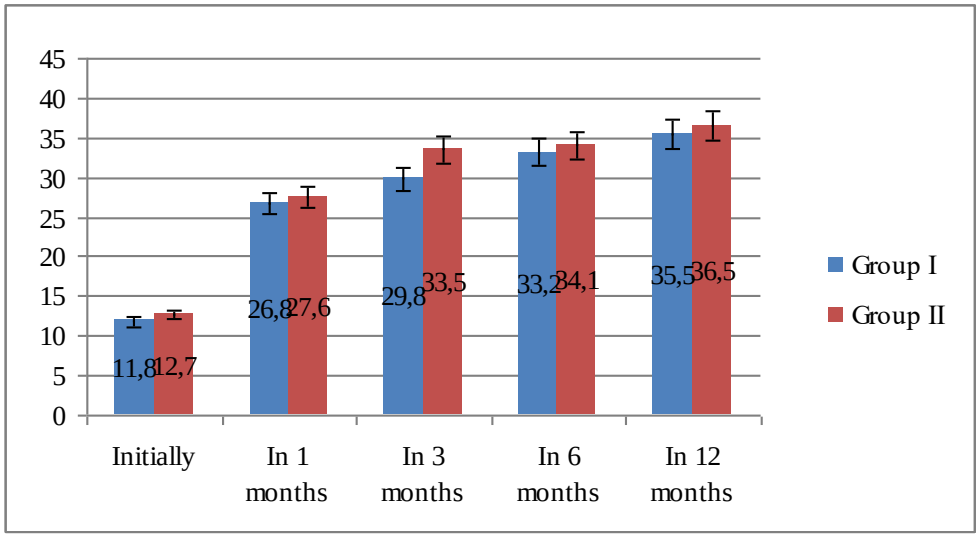

Fig. 3. Dynamics of 25 (OH) D in 1, 3, 6 and 12 months after treatment

"Tandem test" in the Ist group patients in 6 months of treatment was (9.38 ± 0.65) s, in 12 months - (12.2 ± 0.51) s, ($p < 0.05$); in the second group it was respectively (12.5 ± 0.51) s, ($p < 0.05$) and (14.2 ± 0 , 54) s, ($p < 0.05$), (Fig. 4). During treatment, a functional test “get up and drink” after 6 months, 12 months. in group I, it was (11.8 ± 0.34) s, (9.25 ± 0.38) s, ($p < 0.05$), respectively; in group II - (10.3 ± 0.38) s and (8.65 ± 0.37) s ($p < 0.05$) (Fig. 5). System-to-stand test after 6 months, 12 months. in group I was respectively (12.1 ± 0.53) s, (9.3 ± 0.56) s, ($p < 0.05$); in group II - (11.5 ± 0.51) s and (8.2 ± 0.62) s, ($p < 0.05$) (Fig. 6).

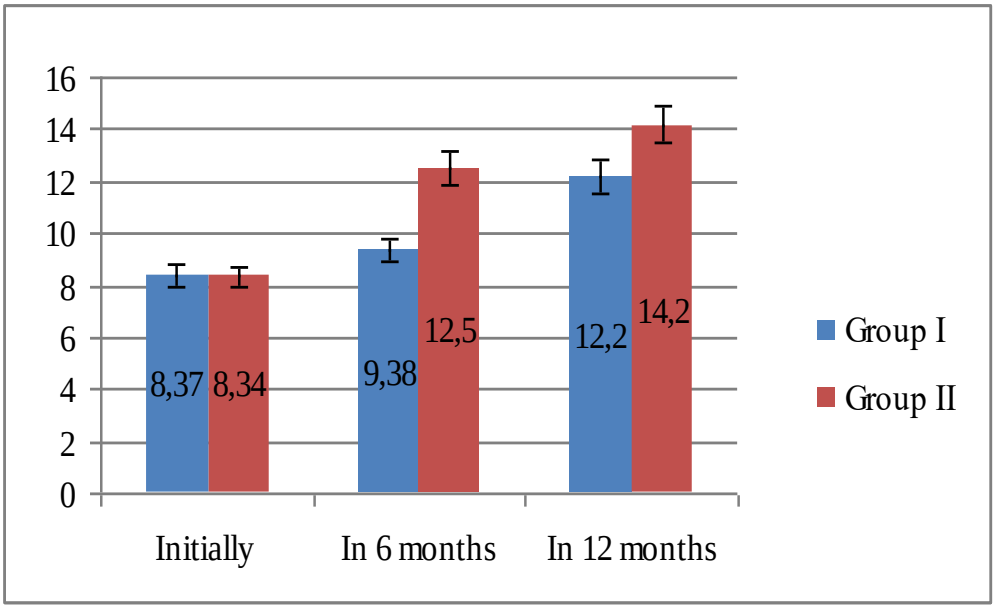

Fig. 4. The dynamics of the "tandem test" (s) in 6, 12 months of treatment

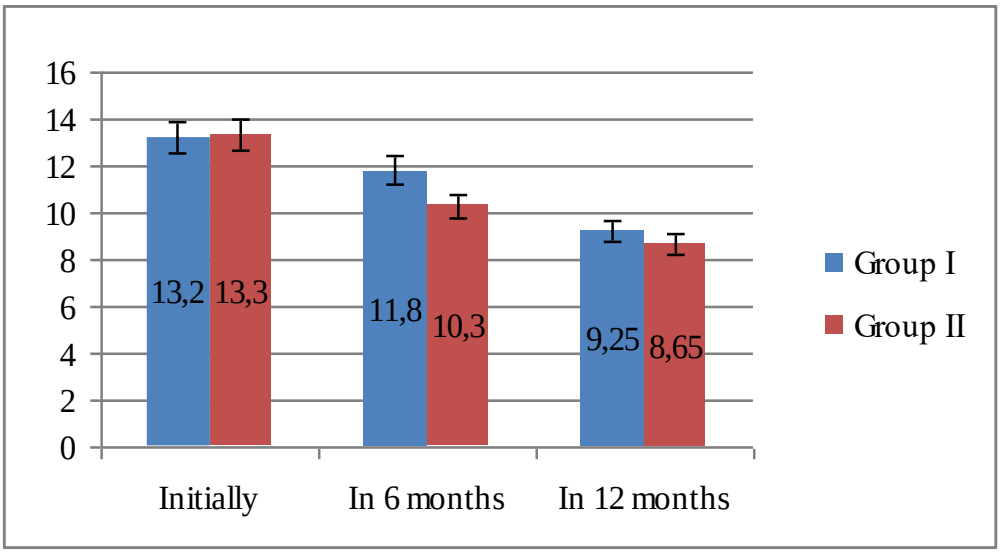

Fig. 5. The dynamics of the "get up and go" test (c) in 6, 12 months of treatment

The dynamometry test showed an increase in muscle strength after 6 and 12 months of treatment in both groups: in patients of the first group it was after 6 months. treatment (18.3 ± 0.7) kg, ($p < 0.05$), after 12 months. - (22.5 ± 0.68) kg, ($p < 0.05$), in the second group - respectively (23.5 ± 0.65) kg, ($p < 0.05$) and (28 ± 0.57) kg, ($p < 0.05$) (Fig. 7).

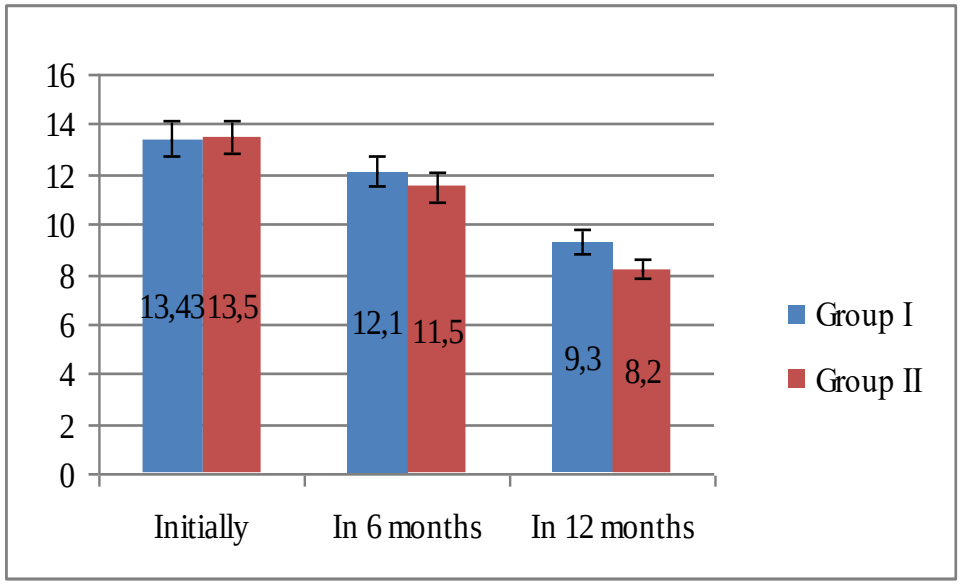

Fig. 6. The dynamics of the "sit down - stand up" test (c) after 6, 12 months of treatment.

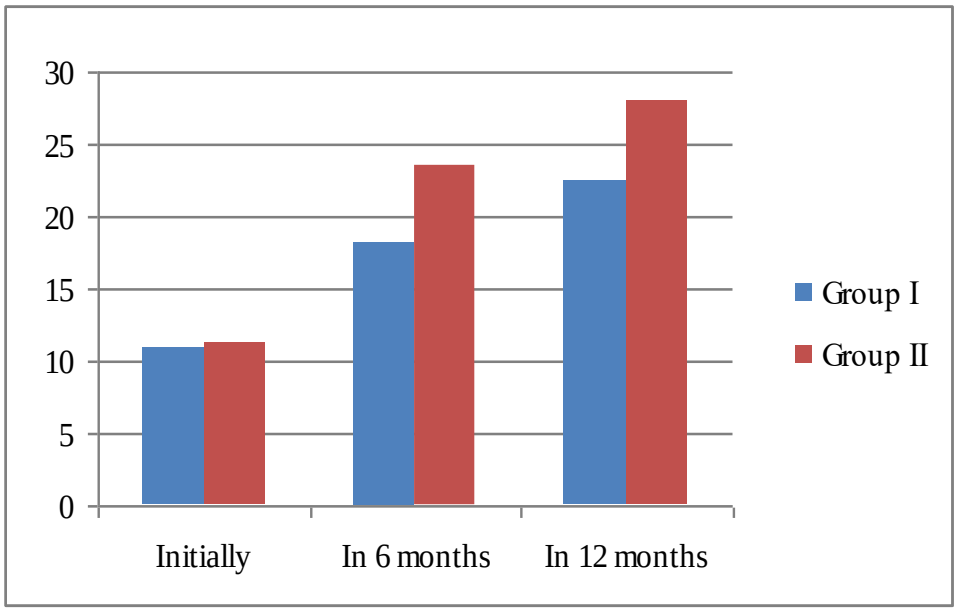

Fig.7. Dynamics of dynamometry (kg) at the background of the treatment in 6, 12 months

Correlation analysis showed a relationship between 25 (OH) D and CTx level ($r = -0671$; $p<0.01$), 25 (OH) D level and T-criterion ($r = 0.656$; $p<0.01$). According to Holick M. F. [11] vitamin D promotes bone health by maintaining the physiological level of parathyroid hormone and stimulating osteoblast activity, as well as stimulating bone mineralization,

thereby reducing the risk of falls and fractures. Bischoff-Ferrari H. A., Conzelmann M., Dick W. et al. [12] also believe that serum vitamin D levels <30 ng / ml (<75 nmol / L) are associated with disturbances connected with maintaining body balance, lower limb function, high rate of falls, low BMD, and muscle weakness. The treatment led to CTx ($p < 0.05$) decrease, increase ($p < 0.05$) 25 (OH) D in both groups, which indicates the effectiveness of the therapy. In 12 months of treatment comparative analysis of BMD changes two groups under study, it was noted that in the second group, BMD increase the lumbar spine was 3.6% higher ($p > 0.05$) compared with the the Ist group. During the treatment no new fractures were noted in the patients. Analysis of the functional tests results showed that the "tandem" test had a relationship with FraxAll ($r = - 0.67$; ($p = 0.05$)); “stand up and go” test correlates with FraxAll ($r = 0.64$; ($p = 0.05$)) and had connection with dynamometry ($r = - 0.63$; ($p = 0.05$)) as well as “sit down – stand up” test FraxAll ($r = 0.62$; ($p < 0.05$)), FraxAll ($r = - 0.77$; ($p = 0.05$)), Fraxhit ($r = - 0.70$; ($p < 0.05$)).

As a result of the treatment "tandem test", "get up and go", "stand up and sit down" showed a positive result ($p < 0.05$) in both groups. However, in the second group of patients, the effect of therapy was higher ($p < 0.05$) in comparison with initial data and the Ist group result. The latter was associated with training on the HUBER multifunctional simulator with the stabilometry and stabilization training to correct balance disorders and sustainability. The results obtained are consistent with literature data, which shows a positive relationship between serum 25 (OH) D levels and lower limb function, strength of the proximal muscle group, and the ability to perform physical actions. The studies that achieved an average serum VD level of > 30 ng / mL in participants showed significant reductions in falls and associated bone fractures. The decrease in the rate of fractures in the investigations performed is mainly connected with the decrease in the frequency of falls [11, 12].

Thus, against the background of the therapy, the patients of both groups noted an improvement in their well-being, besides BMD increase, functional indicators of muscle strength, stability, coordination of movements was noted, at the same time primary and repeated fractures were not recorded.

Conclusions. 1. Complex use of physical rehabilitation (multifunctional trainer "HUBER") in combination with drug therapy (vitamin D, denosumab) promotes more effective increase ($p < 0.05$) of the functional capabilities of the musculoskeletal system: muscle strength, stability, coordination of movements, reduces functional limitations; promotes more effective treatment of structural and functional changes in bone tissue, increase ($p > 0.05$) BMD.

2. Functional tests of the state of musculoskeletal tissue falls and are highly informative in terms of predicting the risk of fractures (impaired coordination and FraxAll (r = - 0.67; (p = 0.05), stability and FraxAll (r = 0.64; (p = 0.05)), the risk of falls and FraxAll (r = 0.62; (p = 0.05)), dynamometry and FraxAll (r = - 0.77; (p = 0.05)).

References

1. Clinical and biochemical phenotype of osteosarcopenia: World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases; 2017 March 23-26, Florence, Italy / A. Frisoli // Springer. - 2017. - P.106.

2.Crepaldi, G. Sarcopenia and osteoporosis: A hazardous duet / G. Crepaldi, S. Maggi // Journal of endocrinological investigation. - 2005. - Vol. 28, Issue 10. - P. 66–68.

3. Мурадянц А. А. Остеопороз и саркопения у больных ревматоидным артритом: как предотвратить костно – мышечные потери / А. А. Мурадянц, Н. А. Шостак, А. А. Кондрашов, В. Т. Тимофеев //Consilium Medicum. – 2016. - Vol. 18 (2). – С. 134–140 *[Muradyants A. A., Shostak N. A., Kondrashov A. A., Timofeev V. T. (2016). Osteoporoz I sarkopeniya u bolnyih revmatoidnyim artritom: kak predotvratit kostno – myishechnyie poteri [Osteoporosis and sarcopenia in patients with rheumatoid arthritis: the ways to prevent musculoskeletal loss]. ConsiliumMedicum, 18 (2), 134–140 [in Russian]*.

4.Walsh, M. C. Sarcopenia in premenopausal and postmenopausal women with osteopenia, osteoporosis and normal bone mineral density / M. C. Walsh, G. R. Hunter, M. B. Livingstone // Osteoporosis international : a journal established as result of cooperation between the European Foundation for Osteoporosis and the National Osteoporosis Foundation of the USA. - 2006. – Vol. 17, Issue1. - P. 61–67.

5. Kawao N. Interactions between muscle tissues and bone metabolism / N. Kawao, H. Kaji // Journal of cellular biochemistry. - 2015. - Vol. 116, Issue5. – P. 687–695.

6. Дефіцит та недостатність вітаміну D: епідеміологія, діагностика, профілактика та лікування : монографія / В. В. Поворознюк [та ін.] ; ред.: В. В. Поворознюк, П. Плудовські. - Донецьк : Видавець Заславський О.Ю., 2014. - 262 с. ***[P****ovoroznyukV. V., et al. (2014). DefItsit ta nedostatnIst viItamInu D: epIdemIologIya, dIagnostika, profIlaktika ta lIkuvannya: monografIya [Deficiency and insufficiency of vitamin D: epidemiology, diagnosis, prevention and treatment: monograph] Donetsk : Vidavets Zaslavskiy O. Yu. - Donetsk: Publisher Zaslavsky O. Yu., 262 s [in Ukrainian]*.

7. Vitamin D and muscle function: World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases; 2018 April 19-22, Krakow, Poland /O.Bruyère//Springer. - 2018. - P.124.

8. Kanis J, McCloskey E, Johansson H, Cooper C, Rizzoli R, Reginster J. European guidance for the diagnosis and management on osteoporosis on postmenopausal women. Osteoporosis International. 2013; 24(1):23-57. doi:10.1007/s00198-012-2074-y

9. Outcomes of the IOF-ESCEO sarcopenia working groups: World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases; 2018 April 19-22, Krakow, Poland / C. Beaudart// Springer. - 2018. - P.77-78.

10. Dairy products in the prevention and treatment of sarcopenia: outcomes of the ESCEO Working Groups: World Congress on Osteoporosis, Osteoarthritis and Musculoskeletal Diseases; 2018 April 19-22, Krakow, Poland / J.-Y. Reginster // Springer. – 2018. - P. 97

11. Holick M.F. (2007) Optimal vitamin D status for the prevention and treatment of osteoporosis. Drugs Aging., 24: 1017–1029.

12. Bischoff-Ferrari H.A., Conzelmann M., Dick W. et al. (2003) Effect of vitamin D on muscle strength and relevance in regard to osteoporosis prevention. Z. Rheumatol., 62(6): 518–521