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THE STATE OF THE BONE TISSUE IN MINERS WITH CHRONIC LUMBOSACRAL RADICULOPATHY

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Abstract. In the structure of occupational morbidity in Ukraine, the pathology of the locomotor system takes the second place after diseases of the broncho-pulmonary system, making its 5th part and reaching 601–604 cases per year (2015–2016). Chronic radiculopathy is the most common disease of the musculoskeletal system in the working population of Ukraine, which is mostly recorded in a cohort of miners. The risk of traumatism and development of occupational diseases in coal mining is 5–10 times higher than in other branches of industry. In view of this, the problem of timely diagnosis and prevention of development of chronic radiculopathy in mine workers in conditions of physical activity, forced work posture, unfavorable microclimate, is rather actual. The assessment of the state of the bone tissue is a very important diagnostic criterion for patients with chronic lumbosacral radiculopathy. Recently, the following methods are used to evaluate this indicator: definition of the index of mineral density of the bone tissue (DBT as a quantitative characteristics); determination of the TBS (trabecular bone score), which is its qualitative characteristics; definition of vitamin D level in blood serum; an indicator of a 10-year risk of osteoporotic fractures using a FRAX (fracture risk assessment tool), since these are directly degenerative-dystrophic changes in the spine that is one of the main etiological factors in development of chronic radiculopathy.

Purpose. To evaluate the state of the bone tissue in miners of main professions, suffering from lumbar sacchar spinal cord, by analyzing vitamin D level in patients' blood, the TBS index, T- and Z- indices and the FRAX tool.

Materials and methods. Investigations of the state of the bone tissue were conducted in a group of 60 miners of main professions with chronic lumbosacral radiculopathy (slaughterers, mining workers of the clearing face (MWCF), sinkers) in Donbas and Lviv-Volyn regions. There was used the two-photon X-ray absorbtionometry (Prodigy, GE Lunar, Madison, USA) and Prodigy (General Electric) with definition of the TBS index, T- and Z-score indices, FRAX, determination of the level of 25 (OH) of vitamin D in blood serum by electrochemiluminescent method on the Elecsys 2010 device.

Results. It was found that the average level of vitamin D in the blood of patients with chronic lumbosacral radiculopathy was within the normal range and made 37.59 ng/ml, with 6.6 % of patients with deficiency of vitamin, and 20 % – its insufficiency. The average index of TBS in the group was within the normative values (1,364), following the general tendency for men population of Ukraine; however, according to the T-score in 20 % of patients osteopenia was diagnosed (ranging from 1 to -2.5). The lowest level of FRAX was found in workers aged 30–39 and made 0.72, increasing with the age of patients.

Conclusion. The most informative indicator in assessing the state of the bone tissue in miners, suffering from chronic lumbosacral radiculopathy, was FRAX. It has been established that the level of vitamin D in miners depends on the experience of work in underground conditions and on the age in all groups of the examined patients.

Key words. Chronic lumbosacral radiculopathy, mineral density of the bone tissue, occupational pathology, locomotor apparatus

Introduction

Occupational morbidity, as an economic and social problem, has been widely discussed and debated for a long time from the point of view of evaluating health and methods of preventing morbidity in the working population. It is mainly in the coal industry of Ukraine that the highest rates of occupational diseases are recorded, because modern working conditions in coal mines are characterized by a large amount of non-mechanised work and labor-intensive processes, owing to which a part of intensive physical work is rather significant. In combination with other harmful factors of the work environment and the work processes, physical loads is a major factor in development of occupational pathology of the locomotor system (LMS), which accounts for 20 % of the total number of cases annually (757–1569) [1]. Among this group, chronic lumbosacral radiculopathy, in particular, takes a significant part, the risk factors of which are: intensive physical work, uncomfortable (forced or fixed) work posture, forced inclinations, unfavorable microclimate, osteoporosis.

Chronic radiculopathy is a multifactorial disease with many-sided etiological factors and complicated pathogenesis. One of the reasons for development of this pathology is disorders of the quantitative and qualitative characteristics of the bone tissue, which further results in osteoporosis. Osteoporosis is a common systemic skeletal disease affecting about 75 million people in Europe, the United States and Japan, and is characterized by a decrease in bone strength,

disorders in its microarchitecture and further increase risk of fractures. At present, the diagnostics of osteoporosis at the initial stages of the disease is still difficult, since in most cases the first clinical symptom of the disease is the so-called a «low-energy fracture» [2]. At the preclinical stage, osteoporosis can be detected only by instrumental or laboratory methods, and in recent years, new diagnostic methods are being actively developed and put into practice, which help to diagnose the bone marrow pathology at early stages and to identify risk groups [5].

The most informative indicator of the strength of the bone tissue and the risk of fractures is bone mineral density (BMD). The standard for determining the BMD is a two-photon X-ray absorptiometry – densitometry. However, the use of this technique in clinical practice has a number of limitations, in particular, a significant area of «overlap» between persons in which fractures occur and in which they do not occur. Densitometry is a method that makes it possible to obtain the data on the content of calcium in the bone tissue, which is the main structural element, and which, in its turn, helps to diagnose the development of osteoporosis. Most often densitometry is performed in the part of the lumbar spine, pelvic bones, sometimes in the forearm, and in some cases it is necessary to make examination of the entire skeleton [3].

One of the criteria for assessing the bone state is the TBS index, which is calculated by the structure of the DXA image and, according to the research data, is associated with bone microarchitecture and the risk of fractures. These data provide information about the BMD and are used in addition to the results obtained in the DXA analysis. This indicator, in combination with other clinical data is used to assess the risk of fractures and to monitor the treatment of patients. According to the research data, TBS (L1–L4) negatively correlates with age and decreases by 16.0 % in the age group 45–90. It is known that the presence and severity of degenerative-dystrophic changes in the spine exert an insignificant effect on the TBS index and a probable effect on the BMD in the part of the lumbar spine [4]. Osteoporosis rates progressively increase with age, resulting in an increase in disability and mortality rates in patients. According to domestic researchers, almost every third woman and every 5 men aged 65 years and older have at least one osteoporotic bone fracture. Therefore, a Ukrainian version of the 10-year bone fracture risk assessment tool (FRAX) [2, 4] was developed for correct assessment of disorders and proper interpretation of the densitometry data with definition of BMD and TBS - FRAX (fracture risk assessment tool) [2, 4].

Also, in scientific practice, a great attention of researchers is paid to the study of associated changes in muscle and bone tissues with age [6]. Numerous biological factors affecting simultaneously both muscle and bone tissue are established. Among them, the most important part is given to vitamin D and to the growth hormone [7]. Also, peculiarities of nutrition, physical activity, work activity, ethnicity, etc. are equally important for assessing the effect on the bone and muscle tissue [6, 8, 9].

Materials and methods

On the basis of the clinic of occupational diseases of the SI «Kundiiev Institute of Occupational Health of the NAMS of Ukraine» there were examined 60 miners of main occupations (mining workers of the clearing face, sinkers) with a diagnosis of chronic lumbosacral radiculopathy. The distribution of patients by experience and age is presented in Table 1.

All patients were screened by two-energy X-ray absorptiometry (DXA) on the device Ge Lunar (Lunar Prodigy) Hologic Discovery and Prodigy (General Electric) device with a radiation dose < 0.6 mr /year (6 μSv/year), which allows to get high quality images. Performing a clear reconstruction of the locking plates on the spine images, the apparatus shows intervertebral gaps. When conducting densitometry, the main measured indicators are T-score and Z-score. T-score means a comparison of the density of the bone tissue with the reference. According to the literature data, the indicator is normal from +2 to -0.9. If T-score is in the range from -1 to -2.5, a low mineral density of the bone tissue is stated, and in this

Table 1

Distribution of patients with chronic lumbosacral radiculopathy by experience and age

	Examined groups		
	group 1	group 2	group 3
	by age, years		
	30–39	40–49	50–59
Number of patients	10	26	24
	by experience, years		
	11–15	16–20	21–25
Number of patients	27	16	17

case it is osteopenia. With a T-score below -2.5, osteoporosis with high risk of fractures is diagnosed. Z-score is a comparison of the density of the studied bones with the average value of the indicator in a certain age group.

The Trabecular Bone Score (TBS) was evaluated using the TBS iNsight (Med-Imaps, Pessac, France) method, which provides an opportunity to analyze the trabecular structure according to various statistic properties of pixels in relation to the density, as a result of which an indicator is calculated which correlates with the 3D parameters of the projected trabecular bone.

The TBS index, obtained in the examination of miners with lumbosacral radiculopathy, was compared with the quality of the bone tissue in men of the Ukrainian population, depending on age (Table 2).

Using the Ukrainian FRAX model a risk of a probable 10-year fracture of bones of different locations (radial, shoulder, femoral bones and vertebral bodies) was calculated. The FRAX algorithm includes the data on age, body mass index and various clinical risk factors for fractures, taking into account the BMD index of the femoral neck and provides for a quantitative estimation of the total risk, based on a mathematical analysis of factors of osteoporosis development. The FRAX total was automatically calculated by the program at the device, which was used for densitometry (Ge Lunar, Prodigy), Prodigy (General Electric).

The level of vitamin D was determined by the electric chemiluminescent method in the blood serum of the subjects examined on the Elecsys 2010 device and compared with the norm according to the guidelines of the European Food Safety Authority, which in 2012 revised the maximum allowable intake and concentration of vitamin D (ULs) for all population groups, and determined it at the level < 20 ng / ml – deficiency, 20–30 ng/ml – insufficient vitamin D, 30–50 ng/ ml – optimal level, 50–100 ng/ml – high level of vitamin D.

The obtained results were processed by methods of parametric statistics using the standard programs «Microsoft Office Excel» and «Statistica». All indicators were statistically calculated by means of a one-factor disperse analysis by F-test or by Fisher's criterion (F-criterion, ϕ * –criterion), by comparing the value of statistics with the critical value of the corresponding Fisher distribution at a given level of significance. For greater convenience of the hypothesis the test was checked using a p-meaning (pF) – the probability that a random value with the given Fisher distribution will exceed the given statistic value. If for a two-way test -2p (F)) is less than the significance level of α, then the null hypothesis is rejected, otherwise it can be accepted.

Results

According to the results of the study, the average TBS at the level of L1–L4 made 1.364, which was not beyond the reference values defined in the male population of Ukraine. An analysis of changes of the age indicator shows that it gradually decreases with age in the examined patients. Also, an analysis of the TBS indicator was made, depending on the length of work of patients in conditions of significant physical activity, forced work posture and unfavorable microclimate. It was established that this indicator didn't have a clear dependence on the work experience of subjects working in hazardous conditions, since some patients aged 50 to 59 years had a period of experience ranging from 11 to 15 years (Figure 1). However, the variance analysis of the dependence of the TBS index on age and experience did not reveal any statistical significance in differences.

The next stage of the study was to determine the level of vitamin D in blood of patients with chronic lumbosacral radiculopathy. Its average concentration was 37.59 ng/ml at the norm of 30–50 ng/ml, indicating its normal level in the group of the subjects as a whole. In the analysis, a statistically significant decrease was recorded up to 33.85 ng/ml in the age group from 50 to 59 years in comparison with the reference values (Figure 2). The analysis of the level of vitamin D in blood, depending on the experience of miners with lumbosacral radiculopathy, showed its decrease with an increase in the work experience in harmful work conditions. At the same time it should be noted that in groups with the experience from 16 to

Table 2

Normative indices of the TBS index for men in the Ukrainian population

Index	Age, years					
	30–39	40–49	50–59	60–69	70–79	80–89
TBS L1-L4	1,263 ± 0,120	1,273 ± 0,120	1,217 ± 0,160	1,152 ± 0,180	1,161 ± 0,170	1,164 ± 0,180

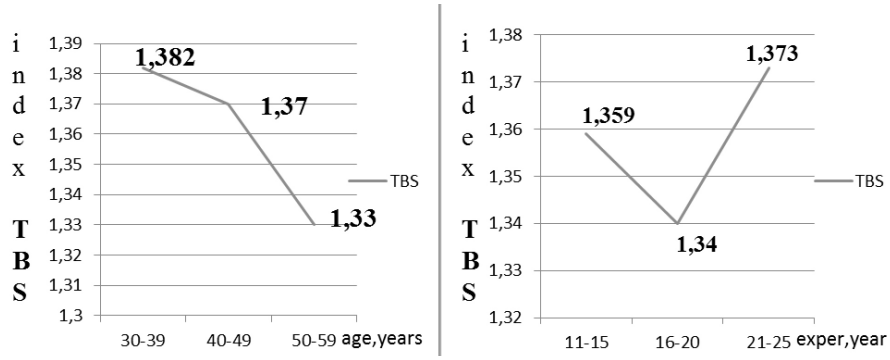

Figure 1. Dependence of TBS index on age and work experience of miners with lumbosacral radiculopathy

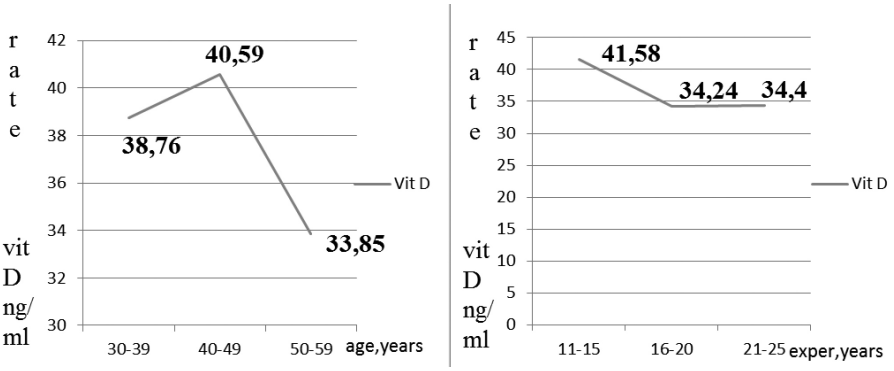

Figure 2. Dependence of the level of vitamin D (ng/ml) in blood on age and work experience of miners with lumbosacral radiculopathy

20 years and from 21 to 25 years, its rates were approximately the same (Figure 2). In this, in four (6.6 %) patients its deficiency (blood level < 20 ng/ml) was diagnosed, and in 12 patients (20 %) – insufficiency of Vitamin D (20–30 ng/ml), but according to the F-criterion the difference between the indicators in groups 1–2, 1–3, 2–3 was significant.

For the correct interpretation of the TBS index, T-score and Z-score indices were analyzed, depending on the age of the subjects being examined. The average values of the indicators in the group of miners were within the normal range and made (-0.1) for the T-score and 0.08 for the Z score, respectively. The highest values were recorded in the youngest age group (Figure 3). However, these indicators were the highest for the group of miners with duration of work experience in underground conditions from 21 to 25 years (Figure 4). And although the difference between the indices was not statistically significant, systemic osteopenia was diagnosed in 12 patients (20 %) according to the T-score, which ranged from -1 to -2.5.

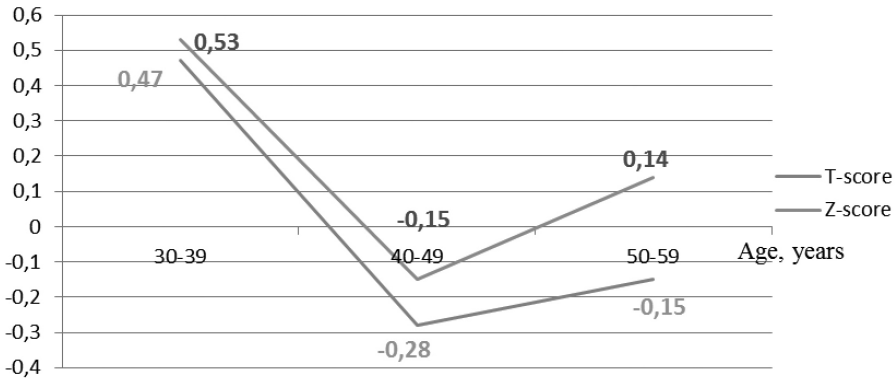

Figure 3. Dependence of indicators of T-score and Z-score on the age of miners with lumbosacral radiculopathy

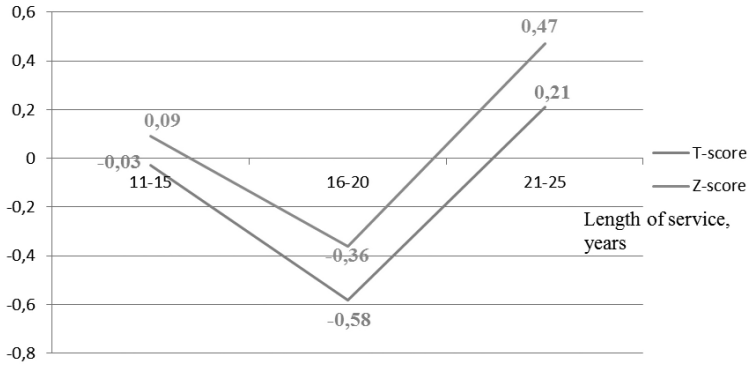

Figure 4. Depedence of indicators of T-score and Z-score on the work experience of miners with lumbosacral radiculopathy

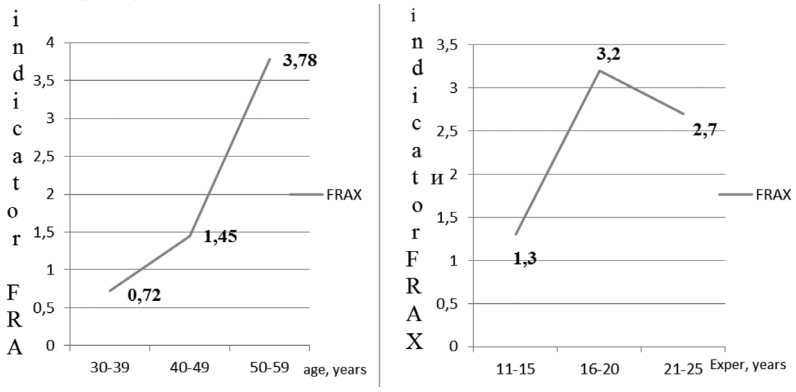

Figure 5. Dependence of the indicator FRAX total on age and work experience of miners with lumbosacral radiculopathy

Analyzing the FRAX indicator in the examined patients, depending on age, it was found that the mean score in the group was 2.44 with a tendency to increasing with the age of the subjects and reached the maximum value (3.78) in the age group 50–59 (Figure 5). It should be noted that the difference between indicators is characterized by a high degree of significance by the F-criterion. In the analysis of the FRAX indicator, based on the work experience, it is found that this indicator is lowest in the group of miners with experience from 11 to 15 years of work in harmful working conditions, which, as a rule, includes patients of the youngest age group (Figure 5), but for the F-criterion the significance of discrepancies is not confirmed.

Conclusion

1. The average values of the TBS index in miners with chronic lumbosacral radiculopathy were within the limits of the physiological norm and characterized by the tendency to decrease with age.
2. In assessing the main determinants of the quality of the bone tissue - T- and Z-scores, it is established that they repeat the general tendency of distribution of patients with the TBS index and have no clear dependence on work experience and age. It was determined that in 20 % of patients the systemic osteopenia was diagnosed according to the T-score, which was in the range from -1 to -2.5.
3. The investigation of vitamin D level in miners with chronic lumbosacral radiculopathy shows its normal content in the group in general (37.59 ng/ml), but in 6.6 % of the examined subjects its deficiency has been stated (blood level < 20 ng/ml), and in 20 % – its insufficiency (20–30 ng/ml). However, a significant decrease of its concentration in comparison with the reference values with the growth of age and work experience in harmful working conditions has been defined.
4. It was found that a 10-year fracture risk (FRAX) in the subjects increased with age and was higher in the group of 50–59 years old (index 3.78), and the difference between the indicators in group 1 (index 0.72), group 2 (index 1.45) and group 3 (index 3.78) by Fisher's criterion was highly significant.

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СТАН КІСТКОВОЇ ТКАНИНИ У ШАХТАРІВ З ХРОНІЧНОЮ ПОПЕРЕКОВО-КРИЖОВОЮ РАДИКУЛОПАТІЄЮ

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Вступ. У структурі професійної захворюваності України патологія опорно-рухового апарату займає друге місце, поступаючись лише хворобам бронхо-легеневої системи, і складає її 5 частку, сягаючи 601–604 випадків на рік (2015–2016 рр.). Найрозповсюдженішим захворюванням опорно-рухового апарату в працюючих України є хронічна радикулопатія, що здебільшого реєструється в когорті шахтарів. Ризик травмування та розвитку професійних захворювань у вуглевидобувній промисловості в 5–10 разів вищий, ніж у інших галузях промисловості. З огляду на це постає питання своєчасної діагностики та профілактики розвитку хронічної радикулопатії в працюючих в умовах фізичного навантаження, вимушеної робочої пози, несприятливого мікроклімату, у тому числі серед шахтарів. Оцінка стану кісткової тканини є надзвичайно важливим діагностичним критерієм у пацієнтів з хронічною попереково-крижовою радикулопатією. Останнім часом для оцінки цього показника набувають поширення наступні методики: визначення показника мінеральної щільності кісткової тканини (МЩКТ як її кількісна характеристика); визначення індексу TBS (trabecular bone score), що є її якісною характеристикою; визначення рівня вітаміну D у сироватці крові; показника 10-річного ризику остеопоротичних переломів за допомогою інструменту FRAX (fracture risk assessment tool), адже саме дегенеративно-дистрофічні зміни хребта є однією з основних етіологічних чинників розвитку хронічної радикулопатії.

Мета дослідження – оцінити стан кісткової тканини у шахтарів основних професій, що хворіють на попереково-крижову радикулопатію, шляхом аналізу показників рівня вітаміну D у крові пацієнтів, індексу TBS, T- та Z-показників, інструменту FRAX.

Матеріали та методи дослідження. Дослідження стану кісткової тканини було проведено в групі 60 шахтарів основних професій (забійник, гірничий робітник очисного вибою (ГРОВ), прохідник) вуглевидобувної промисловості Донбасу та Львівсько-Волинського басейнів, які хворіють на хронічну попереково-крижову радикулопатію. Використано метод двофотонної рентгенівської абсорбціометрії («Prodigy, GE Lunar», Мадісон, США) та Prodigy (General Electric) з визначенням індексу TBS, T- та Z- балів, показника FRAX, визначення рівня 25 (OH)vitamin D total (вітамін D загальний) у сироватці крові шляхом електрохемілюмінісцентного методу на апараті Elecsys 2010.

Результати. Встановлено, що середній рівень вітаміну D у крові хворих на хронічну попереково-крижову радикулопатію по групі був у межах норми та складав 37,59 нг/мл, при цьому в 6,6 % хворих визначено дефіцит вітаміну, а в 20 % – його недостатність. Середній показник індексу TBS по групі був у межах нормативних значень (1,364) і повторював загальну тенденцію в популяції чоловіків України, однак за показником T-бала в 20 % хворих діагностовано остеопенію (показник був у межах від -1 до -2,5). Найнижчий рівень FRAX виявлено в працюючих вікової групи 30–39 років і становив 0,72, який зростав з віком пацієнтів.

Висновки. Найбільш інформативним показником при оцінці стану кісткової тканини у шахтарів, що хворіють на хронічну попереково-крижову радикулопатію, визначений FRAX. Встановлено, що рівень вітаміну D у шахтарів залежить від стажу роботи в підземних умовах та віку в усіх групах обстежуваних пацієнтів.

Ключові слова: хронічна попереково-крижова радикулопатія, мінеральна щільність кісткової тканини, професійна патологія опорно-рухового апарату

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СОСТОЯНИЕ КОСТНОЙ ТКАНИ У ШАХТЕРОВ С ХРОНИЧЕСКОЙ ПОЯСНИЧНО-КРЕСТЦОВОЙ РАДИКУЛОПАТИЕЙ

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Вступление. В структуре профессиональной заболеваемости Украины патология опорно-двигательного аппарата занимает второе место, уступая лишь болезням бронхо-легочной системы, и составляет ее пятую часть, достигая 601–604 случаев в год (2015–2016 гг.). Наиболее распространенным заболеванием опорно-двигательного аппарата у работающих Украины является хроническая радикулопатия, которая в основном регистрируется у шахтеров. Риск травмирования и развития профессиональных заболеваний в углевыдобывающей промышленности в 5–10 раз выше, чем в других отраслях. В этом аспекте возникает вопрос своевременной диагностики и профилактики развития хронической радикулопатии у работающих в условиях физических нагрузок, вынужденной рабочей позе, неблагоприятного микроклимата, в том числе и у шахтеров. Оценка состояния костной ткани является чрезвычайно важным диагностическим критерием у пациентов с хронической поястнично-крестцовой радикулопатией. В последнее время для оценки этого показателя приобретают важность такие методы, как: определение показателя минеральной плотности ткани (МПКТ в качестве ее количественной характеристики); определение индекса TBS (trabecular bone score), который является ее качественной характеристикой; определение уровня витамина D в сыроватке крови; определение 10-годового риска остеопоротических переломов при помощи инструмента FRAX (fracture risk assessment tool), потому что именно дегенеративно-дистрофические изменения позвоночника являются одной из основных этиологических причин развития хронической радикулопатии.

Цель исследования – оценить состояние костной ткани у шахтеров основных профессий, которые болеют хронической пояснично-крестцовой радикулопатией, путем анализа показателей уровня витамина D в крови пациентов, индекса TBS, T-, Z-показателей, инструмента FRAX.

Материалы и методы исследования. Исследование состояния костной ткани было проведено в группе шахтеров основных профессий (забойщик, ГРОЗ, проходчик) углевыдобывающей промышленности Донбасса и Львовско-Волынского бассейна, которые болеют хронической пояснично-крестцовой радикулопатией. Использовался метод двохфотонной рентгеновской абсорбциометрии («Prodigy, GE Lunar», Мадісон, США) и Prodigy (General Electric) с определением индекса TBS, T-, Z-показателей, показателя FRAX; определение уровня витамина D (25(OH)vitamin D total) в сыроватке крови путем электрохемилюминисцентного метода на аппарате Elecsys 2010.

Результаты. Установлено, что средний уровень витамина D в крови больных на хроническую пояснично-крестцовую радикулопатию в группе был в пределах нормы и составлял 37,59 нг/мл, при этом у 6,6 % больных определено дефицит витамина, а у 20 % – его недостаточность. Средний показатель индекса TBS по группе был в рамках нормативных значений (1,364) и повторял общую тенденцию в популяции мужчин, однако по показателю Т-балла у 20 % пациентов диагностировано системную остеопению (показатель был в пределах от -1 до -2,5). Самый низкий уровень FRAX определился у работающих возрастной группы 30–39 лет и составлял 0,72, который увеличивался с возрастом пациентов.

Выводы. Наиболее информативным показателем при оценке состояния костной ткани у шахтеров, которые болеют хронической пояснично-крестцовой радикулопатией, определен FRAX. Установлено, что уровень витамина D в крови у шахтеров зависит от стажа работы в подземных условиях и возраста во всех группах обследуемых пациентов.

Ключевые слова: хроническая пояснично-крестцовая радикулопатия, минеральная плотность костной ткани, профессиональная патология опорно-двигательного аппарата

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