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THE INFLUENCE OF WORKING CONDITIONS ON BONE METABOLISM IN HOSPITAL SURGEONS

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Abstract

According to the scientific studies, there is an increase in morbidity with a temporary incapacity for work among surgeons due to diseases of the musculoskeletal system. Regular and continuous physical activity, uncomfortable working posture, being in a standing position during the entire operation, all these factors might contribute to the development of disorders of bone metabolism and the development of diseases of the musculoskeletal system. Purpose of the Study was to determine the characteristics of bone metabolism in surgeons of different age groups and experience, to study clinical and biochemical markers of bone remodeling disorders. The working conditions of a group of surgeons were studied and a hygienic assessment of the factors of the working environment and work process, which can lead to a decrease in bone mineral density and the development of osteopenic syndrome, was carried out. The hygienic assessment of the working environment and the working process showed that the working conditions belong to the 3rd class, 1st and 2nd degree. The adverse factor is the forced posture and constant static muscle tension during operations that take more than 80% of the working time. The article establishes dependence between the decreased bone mineral density and harmful and adverse factors of the work environment and the work process itself, as well as the age and work experience of surgeons.

Keywords: Bone metabolism in surgeons, osteopenic syndrome, occupational diseases, occupational hygiene, the severity of the surgeons

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1. Introduction

The quality of medical care to the population depends not only on the material and technical equipment of the hospital, but also on the medical personnel, the level of their qualification and state of health. Statistics indicates high rates of morbidity among healthcare professionals (Kosarev & Babanov, 2009). The number of studies examining the morbidity with a temporary incapacity for work among surgeons provides information on respiratory diseases, injuries, diseases of nervous system and sense organs, cardiovascular diseases, poisoning and allergies (Xusnutdinova et al., 2010). Male surgeons, depending on age, are more likely to lose their ability to work due to cardiovascular disease, allergic reactions, infectious diseases, injuries and poisoning (Bektasova et al., 2012; Xusnutdinova et al., 2010). According to scientific sources (Kosarev et al., 2007), there had been a recent increase in morbidity with temporary incapacity for work due to diseases of the skeletal system. Recent literature provides a sufficient amount of data on infectious diseases of medical personnel (Kosarev et al., 2007), a large number of articles is dedicated to the study of the cardiovascular diseases (Bektasova et al., 2012; Ermolina et al., 2012; Kosarev et al., 2007), latex allergy in surgeons (Ermolina et al., 2012; Govorin & Bodagova, 2013; Kosarev et al., 2007; Wilburn & Eijkemans, 2004), while there are rare indications of the state of the musculoskeletal system. Continuous physical activity, forced working posture throughout the entire surgical intervention (Govorin & Bodagova, 2013; Garipova, 2011; Sisi et al., 2008) contribute to bone metabolism disorders. As a result, the study of this chronic factor (static and dynamic physical load), which can lead to the development of osteopenic syndrome in surgeons, is an urgent problem (Yakupov & Karimov, 2010).

Bone remodeling is a lifelong process where mature bone tissue is removed from the skeleton and new bone tissue is formed (Anandarajian, 2012; Genant et al., 1988). Bone cells (osteoblasts and osteoclasts) and a number of biochemical and hormonal agents (cytokines, prostaglandins, growth factors, hormones, vitamin D) are actively involved in this process (Lesniak & Benevolenskaya, 2010). Great importance in the study of the process of bone remodeling is given to the role of cytokines (interleukin-6, interleukin-4), which stimulate osteosynthesis and prevent the resorption of bone tissue.

Many authors describe the problems of developing osteochondrosis and various forms of arthrosis in surgeons (Skripnikova et al., 2011), while the mechanisms of bone remodeling in this category of medical workers have not been studied enough. As a result, the study of bone metabolism is of particular relevance for occupational health in this professional group.

2. Problem Statement

Preserving the health of one of the leading professions in healthcare - surgeons is a priority. The specifics of working conditions and the intensity of the labor process constantly and adversely affect the main functions of organs and systems of surgical doctors. This led to the study of this issue, which is presented in the present study.

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3. Research Question

The study of bone tissue metabolism and the development of osteopenic syndrome under the influence of working conditions and the intensity of the labor process in surgeons.

4. Purpose of the Study

The Purpose of the Study is to identify and analyze the characteristics of bone remodeling in surgeons of different age groups and experience, to identify biochemical markers of bone destruction in terms of severity and intensity of the work process.

5. Research Methods

The study of the workplace ergonomics, the compliance of the working equipment with the requirements, the determination of the severity and intensity of the work process was conducted according to the method of ergonomic research, questionnaire survey and time tracking. The working conditions of doctors of the surgical departments in Saratov Regional Clinical Hospital and Engels City Clinical Hospital № 1 were evaluated in accordance with P 2.2.2006-05 "Guide on Hygienic Assessment of Factors of Work Environment and Work Load.

Criteria and Classification of Working Conditions", SanPiN 2.1.3.2630-10 "Sanitary-Epidemiological Requirements for Organizations Engaged in Medical Activities", SanPiN 2.2.4.3359-16 "Sanitary and epidemiological requirements for physical factors in the workplace", SanPiN 2.1.3.1375-03 " Hygienic Requirements for the Placement, Design, Equipment, and Operation of Hospitals, Maternity Hospitals, and other Medical Facilities". Biochemical and instrumental research methods to determine the processes of bone remodeling were conducted in the clinic of occupational pathology and hematology of Saratov State Medical University.

In total the study involved 67 surgeons (men) aged 32-53 years – group I. For the comparison group 42 volunteers (men, office employees) aged 33-54 years were selected – group II.

These groups (surgeons and volunteers) were further divided into 2 categories depending on age and total work experience.

i. Group IA – surgeons aged 32-40 years, 37 persons (with work experience up to 15 years).
ii. Group IB – surgeons aged 41-53 years, 30 persons (with work experience over 15 years).
iii. Group IIA – volunteers aged 31-41 years, 23 persons (with work experience up to 15 years).
iv. Group IIB – volunteers aged 42-52 years, 19 persons (with work experience up to 15 years).

Inclusion criteria: informed consent to participate, satisfactory physical and mental health. Exclusion criteria: refusal to participate, the presence of osteoporosis and other bone disease, the presence of pathologies that affect bone metabolism (hyperparathyroidism, thyrotoxicosis, syndrome, rheumatism, malabsorption syndrome), women, people taking glucocorticosteroids, anticonvulsant drugs, thyroid hormones.

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Before the inclusion participants were asked to read information about the objectives of the study and were guaranteed the confidentiality of the data obtained.

The main rates of bone metabolism (calcium, bone acid phosphatase (BAP), bone alkaline phosphatase (BALP) was studied by the calorimetric method on a Stat Fax photometer. Assessment of bone mineral density was conducted using ultrasonic densitometry "SunlighyOmnisense 7000". The result was estimated in standard deviations (SD) from peak bone mass. The normal range is the values of the T-criterion from 1 to -1 standard deviation, the decrease in bone mineral density (the presence of osteopenic syndrome) is from -1.1 to -2.5 standard deviation.

The processing of the data obtained. Statistical processing of the obtained results was performed using standard methods of variation statistics. Statistical processing was conducted on a personal computer with an Intel Atom Z3735F processor in a Windows 8 environment with the use of Microsoft Office Excel 2015 program, statistical package Statistica 13.0 developed by STATSOFT (license 2883).

6. Findings

Forced working posture, static muscle tension during the entire operation are the main adverse factors in the work process of a surgeon. The survey showed that 70% of surgeons complain of pain in small joints, 50% of surgeons complain of pain in large joints (knee and hip joints), 80% report pain in the cervical and lumbar spine. Therefore, the ergonomic characteristics of the working equipment (operating table, operating chair), which are not always adjustable to the necessary anthropometric parameters, forced working postures and muscle tension are adverse hygienic factors in the work process of surgeons. The working conditions of surgeons refer to the 3rd class of the 1st and 2nd degree in terms of severity of the work process. The results of osteodensitometry and the level of biochemical markers of bone metabolism (BAP, BALP, Ca ++) showed that bone remodeling processes remained within the normal range in groups IA and IIA (Table 1).

Table 1. Dynamics of indicators of ultrasound densitometry and biochemical markers of bone remodeling in surgeons and volunteers with work experience of up to 15 years (M ± m)

Subgroup / **Bone resorption markers**	**IA. Surgeons, men aged 32-40 years, with work experience up to 15 years inclusive, n=37**	**IIA. Male volunteers (office employees) aged 31-41 with work experience up to 15 years inclusive, n=23**
Ultrasonic densitometry (SD)[1]	0.9±0.059*	0.89±0.058*
Ca++ (mmol/L)	2.1±0.4	2.15±0.5
BAP2 (IU/L)	4.98±0.21	4.86±0.27
BALP2 (U/L)	89±1.62*	81±1.58

*– $p<0.05$

[1] – Ultrasonic densitometry (standard deviations)

[2] – Bone acid phosphatase

[3] – Bone alkaline phosphatase

The comparison of groups IB and IIB (Table 2) indicates that there were changes in the level of bone resorption and bone formation markers in the group IB.

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Table 2. Dynamics of indicators of ultrasound densitometry and biochemical markers of bone remodeling in surgeons and volunteers with work experience from 15 to 25 years (M ± m)

Subgroup / Bone resorption markers	IB. Surgeons, men aged 42-52 years, with work experience up to 15 years inclusive, n=30	IIB. Male volunteers (office employees) aged 42-52 years, with work experience up to 15 years inclusive, n=19
Ultrasonic densitometry (SD)[1]	-1.2±0.08*	-0.4±0.2
Ca++ (mmol/L)	2.5±0.3	2.1±0.5
BAP2 (IU/L)	5.9±0.3	5.8±0.2
BALP2 (U/L)	150.1±2.71*	99.08±1.81*

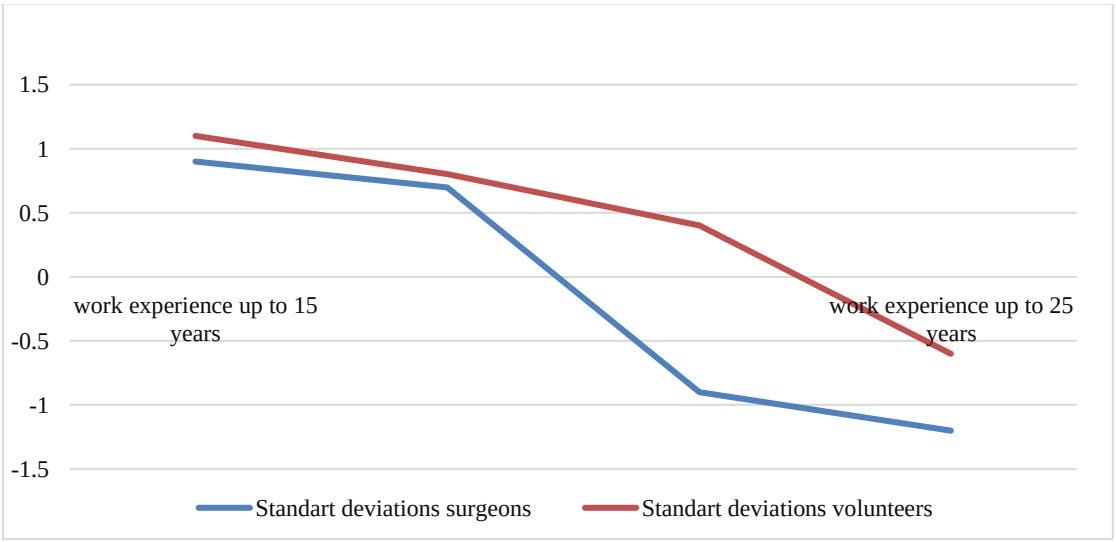
*– p<0.05

[1] – Ultrasonic densitometry (standard deviations)

[2] – Bone acid phosphatase

[3] – Bone alkaline phosphatase

There was an increase in the level of alkaline phosphatase bone isoenzyme to the upper limit of normal in group IB. This isoenzyme is produced by osteoblasts and its activity in blood plasma directly correlates with the formation of collagen, which indicates an increased activity of bone formation. An increase in the level of calcium in the blood plasma was revealed in the same group, which may indicate an increase in bone resorption. An important criterion for the activity of bone resorption and bone formation is the determination of the level of bone mineral density. A statistically significant decrease in bone mineral density by 0.2 SD was observed in group IB, which may also indicate the increase of osteoclast activity, bone destruction and the occurrence of osteopenia. In group IIB osteodensitometry parameters remained within the normal range (Figure 1).



Note: □ – volunteers; ○ – surgeons

Figure 1. Dynamics of the decrease in bone mineral density depending on age and experience of surgeons and volunteers

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7. Conclusion

The findings of the present study show that the influence of adverse hygienic factors of the work process of surgeons results in decreased bone mineral density and the development of osteopenia. Increased level of ionized calcium and alkaline phosphatase bone isoenzyme in blood plasma, a decrease in standard deviations (SD) during ultrasonic diagnosis indicates the development of this pathological process. The present studies allowed to establish a direct relationship between the age and experience factors and the intensity of bone resorption process.

The data obtained must be taken into account to ensure the professional safety and health of surgeons. Changes in the skeletal system, especially when symptoms of the disease appear, can cause loss of working capacity among highly qualified specialists in the absence of preventive measures. The absence of agreed recommendations on professional safety, addressing the specifics of the surgeon's work, can lead to the development of musculoskeletal disorders. In this regard, identifying of the pathogenetic influence of the workload of surgeons on the development of osteopenia involves the study of the main rates of bone formation and bone resorption, which may be important in substantiating the prevention system.

The analysis leads to the following conclusions:

- working conditions of surgeons refer to the 3rd class of the 1st and 2nd degree;
- one of the adverse factors affecting the labor hygiene of surgeons is continuous static muscle tension and working in forced body posture;
- increased bone resorption, the development of osteopenia may correlate with such factors as the work environment, the age and experience of the surgeon;
- the data obtained can be a rationale for optimizing working conditions aimed at preventing musculoskeletal disorders among surgeons.

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