INFLUENCE OF SILICON IN THE ATMOSPHERE ON OSTEOARTHRITIS CLINICAL COURSE

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ABSTRACT

Osteoarthrosis (OA) is the most common diseases of the musculoskeletal system which cause an enormous medical and social harm on the patients and the society. The risk factors of the OA development are high atmospheric concentrations of silicon compounds (Si). The purpose and the objectives of the study were the assessment of the role of silicon microelementosis in OA. The study included 105 patients with OA, with an average age of 44 and 81 years old, in the proportion of men and women as 1:5, with the duration of the disease 10 years. Using the method of atomic absorption spectrometry we determined Si content in blood and in hair, evaluated the level of the pollution with Si-containing compounds. It has been found out that silicon imbalance was typical in OA which is manifested by increasing of Si content in blood. Air pollution with silicon pollutants affects negatively the incidence of OA in regions which is accompanied by Si accumulation in patients' hair with a subsequent impact on the rate of articular syndrome progression, the development and the severity of subchondral sclerosis, ligamentosis of knee joints, reactive synovitis and cartilage bodies, and in relation to spondylopathy inhaled Si compounds have a certain protective action.

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Introduction. Osteoarthritis (OA) is the most frequent musculoskeletal system disease [1, 2]. Its prevalence among the whole population in some regions of the globe reaches 50 % and the number of such patients is constantly increasing, inflicting huge medical and social damage and exerting an unbearable economic burden on society [3].

OA risk factors including high concentrations of silicon compounds (Si) in the atmosphere and toxic effects on the body of inhaled quartz (Si dioxide) are considered as one of the negative pathogenetic factors of this disease [4, 5]. It should be noted that the prevalence of OA is higher in persons who associate with the working in manufacture of building materials that contain Si [6]. In special methods of investigation, quartz crystals are detected in the synovial fluid in 80 % of the patient number with OA [7], while Si in the joint of OA patients worsens the rheological properties of the synovial fluid [8-10].

It should be emphasized that the role of Si in the clinical and pathogenetic constructs of OA has not been adequately studied.

Purpose of the study. To assess the role of silicon microelementosis in OA, to study the effect of the atmospheric contamination by Si-containing pollutant level on the prevalence and nature of OA course.

Material and methods. 105 patients with OA were under observation. Among patients with OA, there were 16.2 % of men and 83.8 % of women aged 44 to 81 years (mean 57.7 ± 0.94 years). OA duration from the first signs of manifestation was 10.4 ± 0.58 years.

I, II and III radiological stage (RS) were detected in 26,7 %, 47,6 % and 25,7 % of the patient number respectively, clinical and sonographic reactive synovitis was diagnosed in 47.6 % of cases, the form of the disease with the Heberden and/or Bushar nodes presence in 38.1 %, polyarthrosis - in 85.6 %, spine osteochondrosis - in 90.5 %, spondylarthrosis - in 64,8 %, gonarthrosis - in 90,5 %, coxarthrosis - in 30,5 %.

All patients underwent peripheral joints, sacroiliac and vertebral articulations X-ray examination (Multix-Compact-Siemens apparatus, Germany), ultrasound investigation of joints (Envisor-Philips sonograph, The Netherlands), dual-energy x-ray osteodensitometry of the proximal femur («QDR-4500-Delphi-Hologic», USA). The progressive arthritis index (PAI) was calculated by the formula: PAI = $[(RS)^2 + S]$: D, where S is the sum of X-ray patterns of OA, D is the duration of clinical manifestation of the disease.

The levels of C-reactive protein (CRP) and fibrinogen (FG) were measured using an analyzer «Olympus-AU-640» (Japan). Blood and hair Si (Si^b, Si^h) content was determined using an atomic absorption spectrometer with an electrographic atomizer "SolAAr-Mk2-MOZe" (Great Britain), followed by counting the integral degree in the body of silicon microelement (BSM). As a control, 30 practically healthy people aged 18 to 62 years were examined, including 10 men and 20 women.

The hygienic assessment of the environment anthropogenic pollution was carried out by regional branches of the State Committee for Hydrometeorology, control of the natural environment and environmental safety based on the determination of xenobiotics in the atmospheric air. We estimated: 1) the distribution of the emission share into the atmosphere of 17 urban and 17 rural regions of the Donetsk region in the production of Si- containing building materials in relation to other industries; 2) the level of emissions into the atmosphere and the accumulation of industrial wastes in it in a year, based on the area and the individual; 3) degree of the atmosphere pollution by silica.

Statistical processing of the study results was carried out with computer variational, nonparametric, correlation, regression, one- (ANOVA) and multivariable (ANOVA / MANOVA) ("Microsoft Excel" and "Statistica-Stat-Soft", USA). The mean values (M), their standard errors (m) and standard deviations (SD), the Pearson parametric correlation coefficients (r) and the nonparametric Kendall (t), the Brown-Forsythe dispersion criteria (BF), Wilcoxon-Rao (WR), multiple regression (R), Student (t), and reliability of statistical indicators (p) were assessed. The critical level of significance in checking the statistical hypotheses in this study was equal to 0.05.

Results and discussion. In OA, the Si^b level was 217.0 ± 13.20 μg / l and Si^h - 23.6 ± 2.04 μg / g. The values of siliconemia were increased by 43 % (t = 2.65, p = 0.009). The silicon imbalance in patients with OA according to the BSM test was 3.2 ± 0.10 r.u., and there was no correlation between the parameters of Si^b and Si^h. Normal values of Si^b (M ± SD healthy) are established in 3.8 % of OA cases, increased (> M + SD) in 51.4 %, decreased (<M-SD) -44.8 %, and levels of Si^h in OA were 16.2 %, 23.8 % and 60.0 % respectively.

As shown by Brown-Forsythe dispersion analysis, the concentration of silicon in OA depended on the presence of manifest synovitis (BF = 3.01, p = 0.004) and the prevalence of articular syndrome (BF = 3.57, p = 0.001), the level of Si^h - on the number of painful joints (BF = 1.86, p = 0.013), LI (BF = 2.19, p = 0.002) and the severity of subchondral sclerosis (BF = 1.65, p = 0.035).

The average prevalence of OA in the regions of the examined patients residence was 253.4 ± 13.55 per 10 thousand population, the integral ecological index was 4.2 ± 0.31 r.u., the xenobiotic emissions to the atmosphere by the industry, transport and agriculture -1.5 ± 0.14 t / person / year, the accumulation of these wastes in the atmosphere is 916.7 ± 94.27 t^3 / km^2 / year. The structure of Si-containing building materials manufacture in the environmental contamination of the atmosphere in the patient's living areas was 20.2 ± 3.06 %, the level of pollutants in the inspired air of silica was 3.1 ± 0.11 points, the polluted atmosphere with silica by 100 thousand of the population was 3.4 ± 0.33 r.u.

According to the multivariate analysis of variance, environmental contamination of the atmosphere by silicon compounds affected the Si balance in the OA patients' body (WR = 5.04, p = 0.033). It should be noted that, in particular, there are direct correlation relationships of the Si^h parameters with the level of accumulation in the atmosphere of total industrial waste in general and silica (r = + 0.256, p = 0.008 and r = + 0.620, p <0.001) and BSM (r = + 0.233, p = 0.017 and r = + 0.394, p <0.001). The parameters of the Si-containing building materials share in the total industrial volume (BF = 271.31, p <0.001) and the degree of atmospheric pollution with silica (BF = 2.94, p = 0.005) affect the values of siliconemia in OA patients. The last ecological indicator contributed to the accumulation of Si in the OA patients' hair (BF = 1.89, p = 0.011).

The Si-containing building materials developmental capacity in the region of OA patients residence affect the development of spondylarthrosis (BF = 15.22, p <0.001), the prevalence of the

joint syndrome - (BF = 4.72, p = 0.032), LI (BF = 3.23, p <0.001), PAI (BF = 3.44, p = 0.020), subchondral sclerosis intensity (BF = 2, 08, p = 0.029) and the presence of ligamentosis in patients (BF = 4.85, p = 0.030) depended on the degree of silica atmospheric pollution, as demonstrated by the Brown-Forsythe dispersion analysis.

Kendall's analysis showed a feedback with the level of Si-containing xenobiotics in the atmosphere due to emissions from industrial factories of the building materials production and the development in OA patients of spinal osteochondrosis (t = -0.233, p <0.001) and spondyloarthrosis (t = -0.221, p = 0.001) (t = + 0.161, p = 0.015), the severity of the formation of subchondral sclerosis (t = +0.154, p = 0.020).

With the silica content in the inhaled air, there was a negative correlation of the spine osteochondrosis and spondyloarthrosis (t = -0.148, p = 0.026 and t = -0.178, p = 0.007, respectively), and the positive relationship of subchondral sclerosis (t = + 0.147, p = 0.027 (t = + 0.130, p = 0.0049), ligamentosis of the knee joints (t = + 0.217, p = 0.001), reactive synovitis (t = + 0.176, p = 0.008) and intra-articular chondromic bodies (t = +0.152, p = 0.022). The obtained data made it possible to speak about some protective effect of Si compounds in the atmosphere on spinal injuries in OA and negative influence on the course of peripheral articular syndrome.

Conclusions.

1. Violations of the silicon balance in osteoarthritis are closely related to the clinical. laboratory and X-ray-sonographic manifestations of the disease, participating in their pathogenetic constructs.

2. Pollution of the atmosphere by silicon pollutants adversely affects the prevalence of OA in these regions, which is accompanied by the accumulation of Si in the patients' hair with subsequent effects on the progression rate of the joint syndrome, the development and severity of subchondral sclerosis, the knee joints ligamentosis, reactive synovitis and chondromic bodies, and for spondylopathy, the inhaled compounds of Si have a certain protective effect.

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