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MODELING INDIVIDUAL PARAMETERS OF THE SUM IN SIZE OF THE INTERVERTEBRAL DISCS OF THE LUMBAR SPINE IN NORM IN GIRLS AND WOMEN

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Abstract

The individual parameters of the sum of intervertebral disc dimensions of the lumbar spine in norm in girls and women of first mature age were investigated on the basis of modeling. The simulations were performed by determining the relative proportional nonlinear somato-vertebral value (based on body length and body weight) and determining the total size of the sagittal and transverse dimensions of the intervertebral discs of the lumbar spine for each individual. Comparison of the sum of the measured indicators of vertical, sagittal and transverse dimensions of the intervertebral discs of the lumbar spine and the indicators obtained in mathematical modeling was performed with the obtained data.

Keywords: modeling, individual parameters, intervertebral disc, girls and women of the first mature age.

In medical practice, objective linear indicators of height, sagittal and transverse dimensions of intervertebral discs are practically not used as criteria for assessing their deviation from the norm. Existing normative parameters of linear dimensions of individual intervertebral discs are found only in single scientific papers and are not widely used in medical practice [1, 2]. Thus, the method of estimating the partial size of the intervertebral discs of the lumbar spine [3], involves calculating the average values of the size of the intervertebral discs without taking into account gender differences and individual anthropometric data. Determining relative indicators is the only way to take into account the individual characteristics of each human body, which makes it possible to more clearly judge the presence of the norm, or the beginning of the development of pathological changes [4, 5]. They provide an assessment of only the sagittal and transverse dimensions and do not take into account the height of the intervertebral disc, which is key in diagnosing the severity of pathological changes in the intervertebral disc [6, 7].

The simulations were performed by determining the relative proportional nonlinear somato-vertebral value (based on body length and body weight) and determining the total size of the sagittal and transverse dimensions of the intervertebral discs of the lumbar spine for each individual in girls and women of first mature age (16-26 years)). Comparison of the sum of the measured indicators of vertical, sagittal and transverse dimensions of the intervertebral discs of the lumbar spine and the indicators obtained in mathematical modeling was performed with the obtained data.

Drawing up an optimal regression polynomial in terms of predictability, number of variables and the possibility of logical verbal interpretation is the main task of the study. Dependent variables are the parameters of the intervertebral disc (sum of linear dimensions). When constructing the dependence of the sum of the linear dimensions of the intervertebral discs between L_1-L_2 lumbar segments on the mass-growth ratio with a 95% interval, it is possible to predict within 76 out of 80 cases within these limits of reliability. When constructing the dependence of the relative value of the mass-growth ratio to the unit of the total length of the three sizes of intervertebral discs L_2-L_3, L_3-L_4, L_4-L_5 lumbar segments from the mass-growth ratio with 99% interval it is possible to predict within these

probability 77 cases out of 80 .

When constructing the dependence of the relative value of the mass-growth ratio of the unit of total length of the three sizes of intervertebral discs D_2, D_3, D_4 from the mass-growth ratio to the unit of total length of the three sizes of intervertebral discs L_1-L_5 lumbar segments from the mass-growth ratio of 99% predict within these probabilities 76 cases out of 80.

The task is carried out by the method, which consists in determining the sum of three sizes of intervertebral discs L_1-L_5 segments of the lumbar spine in normon the basis of the value of mass-growth ratio, including preliminary construction of a regression model of relative proportional mass-growth ratio per unit length of three dimensions intervertebral D_1 disc between 1 and 2 lumbar vertebra, D_2 disc between 2 and 3 lumbar vertebra, D_3 disc between 3 and 4 lumbar vertebra, D_4 disc between 4 and 5 lumbar vertebra. The simulations were performed by determining the relative proportional nonlinear somato-intervertebral value based on the mass-growth ratio for each individual in the norm.

The coefficient of determination R2 above 80.4% predicts the expected dependent variable. The standard estimation error is a measure of the scattering of values, in this case 0.165. With this number of observations, the critical F is equal to 2.66. In our case, F is from 189.7 to 299.1, which is much more than the critical (calculated) value, on the basis of which the regression linear polynomial is significant (p <0.000001).

Verification of the adequacy of the regression model was determined by analyzing the difference between the prognostic and actual values of the relative parameter in each examined individual. The maximum relative deviations are generally not more than 10%.

Further algebraic transformation of the obtained equations of proportions to determine the value of the sum of three linear dimensions for each intervertebral disc in segments L_1-L_5 is normal from the values of mass and body length.

Thus, after converting the total sum of linear dimensions to the left part of the equation we obtain the following final results:

SD_1 =K/ (7,238+0,064*m-4,005*H) ± 10 %;SD_2 =K/ (7,096+0,058*m-3,854*H) ± 10 %;

SD_3 =K/(6,816+0,055*m-3,715*H) ± 10 %;SD_4 =K/ (6,361+0,055*m-3,559*H) ± 10 %, where:

SD_1 - the sum of the linear dimensions D_1 of the intervertebral disc in the norm (MRI measurement) in cm; SD_2 - the sum of the linear dimensions D_2 (cm); SD_3 - the sum of the linear dimensions D_3 (cm); SD4 - the sum of the linear dimensions of D_4 (cm); K - mass-growth ratio (kg / m); m - body weight (kg); H - growth (m).

The simulation is performed by determining the relative proportional somato-intervertebral values based on the mass-growth ratio and determining the total value of the three linear sizes of individual intervertebral discs L_1-L_5 segments in the norm for each individual. The standard error for these models is ± 5.0%. The developed mathematical models based on step-by-step regression analysis and algebraic transformations of proportions allow to determine the sum of standard MRI sizes D_1, D_2, D_3 and D_4 of intervertebral discs L_1-L_5 segments in the norm on the basis of anthropometric methods available in practical medicine - determination of body and length further obtaining a relative mass-growth rate.

Most of the predicted sums of the linear dimensions of the intervertebral discs between the lumbar vertebrae obtained by MRI examination do not differ by more than 10%. The general trend of the defined individual indicators is to reduce the range of linear parameters studied, it can be argued that the individual ranges of the norm are within ± 10%.

The use of the proposed approach makes it possible to conduct a direct prognostic assessment of the total value of standard linear MRI of the intervertebral disc between the lumbar vertebrae to diagnose early stages of intervertebral disc disease in MRI and CT examined.

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МОДЕЛЮВАННЯ ІНДИВІДУАЛЬНИХ ПАРАМЕТРІВ СУМИ РОЗМІРІВ МІЖХРЕБЦЕВИХ ДИСКІВ ПОПЕРЕКОВОГО ВІДДІЛУ ХРЕБТА В НОРМІ У ДІВЧАТ ТА ЖІНОК ПЕРШОГО ЗРІЛОГО ВІКУ

Анотація
На основі моделювання досліджено індивідуальні параметри суми розмірів міжхребцевих дисків поперекового відділу хребта в нормі у дівчат та жінок першого зрілого віку. Моделювання проводили через визначення відносної пропорційної нелінійної сомато-вертебральної величини (на основі довжини тіла та маси тіла) та визначення сумарної величини розмірів сагітального та поперечного розмірів міжхребцевих дисків поперекового відділу хребта для кожного конкретного індивідуума. Порівняння суми виміряних показників вертикального, сагітального та поперечного розмірів міжхребцевих дисків поперекового відділу хребта та показників отриманих при математичному моделюванні проводили з отриманими даними.

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