УДК 61:615.1(043.2)
ББК 5:52.82
А 43
ISBN 978-985-21-0632-0

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ОЦЕНКА ТРАБЕКУЛЯРНОГО КОСТНОГО ИНДЕКСА У ПАЦИЕНТОВ С САХАРНЫМ ДИАБЕТОМ 1-ГОТИПА

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ASSESSMENT OF THE TRABECULAR BONE SCORE IN PATIENTS WITH TYPE 1 DIABETES

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Резюме. В статье представлены результаты собственных исследований показателей трабекулярного костного индекса (ТКИ) у молодых пациентов с сахарным диабетом 1 типа и контрольной группы. 127 пациентов с диабетом и 98 лиц контроля были обследованы. Полученные данные свидетельствуют о снижении ТКИ в поясничном отделе позвоночника у пациентов с диабетом. Гендерные различияв показателях ТКИ не были обнаружены.

Ключевые слова: трабекулярный костный индекс, сахарный 1-го типа.

Resume. This article presents the results of own studies of trabecular bone score (TBS) in young patients with type 1 diabetes mellitus (T1DM) and control subjects. TBS is a non-invasive method for assessing the quality of bone tissue, available using standard osteo-densitometry protocol. 127 T1DM and 98 controls were examined. The obtained data indicate TBS decreasing in the lumbar spine, in patients with Type 1 diabetes. No gender differences were found in diabetic patients compared to the control group.

Key words: trabecular bone score, type 1 diabetes mellitus.

Relevance. In the world, Diabetes Mellitus (DM) is an escalating condition. Diabetic osteopathy being one of the chronic complications of Type 1 Diabetes Mellitus (T1DM) is associated with increased disability and mortality, even in younger patients.

Thus far, most studies that have been performed have focused on the Bone Mineral Density (BMD) in the lumbar spine or femur. However, the risk of osteoporotic fractures in patients with T1DM is also related to the quality of bone, which is normally difficult to evaluate non-invasively. It is well known that with T1DM there is a low rate of bone metabolism, a decrease in bone formation, a decrease in the differentiation of osteoclasts, henceforth, a deterioration in the quality of the organic matrix.

Goal: to observe the features of dual energy X–ray absorptiometry (DXA) data in T1DM patients. To study the quantitative and qualitative characteristics of the lumbar spine in T1DM patients. BMD was taken as a quantitative assessment and trabecular bone score (TBS) was used as qualitatively parameter.

Tasks: to assess the possibility of using trabecular bone index (TBS) and bone mineral density (BMD) to identify young T1DM patients and with osteoporotic vertebral body deformities (OVD).

Material and methods. We conducted a cross-sectional cross study on the basis of the State institution “Republican center for Medical rehabilitation and Balneotherapy” . Taking into account inclusion and exclusion criteria, the study involved 127 patients with T1DM and 98 individuals in the control group.

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Inclusion criteria: the presence of T1DM in the patient, the duration of the disease is more than 2 years, the patient's age is from 18 to 45 years.

A comprehensive clinical examination was conducted with the assessment of anthropometric data (height, weight, body mass index, waist circumference).

A study of the biochemical analysis of blood levels of HbA1c was carried out in the clinical diagnostic laboratory of the State Institution "Republican Center for Medical Rehabilitation and Balneotherapy." The state of the BMD and TBS of the lumbar spine was assessed on the basis of the DXA of the axial skeleton on a “PRODIGY LUNAR” densitometer (2004) from General Electric Medical Systems (USA). When interpreting the Z- score of BMD in young people, a decrease in this parameter from −2.0 or less is regarded as a low BMD. With the use of standard software (LVA - lateral vertebral assessment) provided by the manufacturer, the estimate of thoracic and lumbar spines in a lateral projection with the determination of osteoporotic deformities of the vertebral bodies (OVD) based on the semiquantitative classification of Jenant . The X-ray load was 0, 12 mSv.

Statistical processing of the results was carried out using the Statistica 10 .0 program with a preliminary check of the correspondence of the variables under consideration to the normal distribution by the Kolmogorov-Smirnov criterion. For quantitative values with a normal distribution, parametric comparison methods were used (Student's t-test). Non-parametric methods (Mann-Whitney U-test) were used for quantitative traits with a distribution other than normal. To compare the two groups, a four-field table of absolute frequencies was constructed using a qualitative binary feature and the exact Fisher test (F) or χ^2 Pearson was used.

Depending on the type of distribution, the results of the study are presented in the form of mean value (m) ± standard deviation (SD), 95% confidence interval (95% CI), median (Me) and interquartile range (LQ - UQ). The critical level of statistical significance was taken as the probability of an error-free prediction of 95% ($p < 0.05$).

Results and discussion.

Table 1. Clinical and laboratory parameters of the examined patients and persons of the control group

Parameters	Patient’s with Type 1 DM, n=157	Control group, n=98	Statistical significance of differences
Age, years	32,3 (25,5–41,6)	30,5 (24,7–36,0)	U=5063; p=0,175
Body weight, kg	68 (60–76)	68 (58–78)	U=5559; p=0,781
Height, cm	170 (164–174)	170 (166–176)	U=4989; p=0,130
BMI, kg/м^2	23,44 (21,55–25,70)	23,03 (21,20–25,76)	U=5402; p=0,536
Waist circumference, cm	71 (60–78)	74 (60–80)	U=2348; p=0,303
Gender, % (abs.) : Women Men	 36,8 (105) 63,2 (52)	 43,6 (67) 56,4 (31)	χ^2 =0,06; p=0,805
Duration Type 1 DM, years	13 (7–20)	–	–
Age of manifestation of Type 1 DM, years	17 (12–23)	–	–
НвА1с, %	8,2 (7,6–8,9)	4,9 (4,7–5,2)	U=32; p<0,001

The examined T1DM patients and the control group were comparable by sex, age, and anthropometric data. The average age of the examined patients (presented in table 1)

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allows them to be attributed to a group of young people. The average level of HBA1c in patients T1DM was 8,2 (7,6–8,9)%, which reflects the insufficient achievement of the target levels of glycemic compensation. In the group of patients T1DM, a history of low-energy fractures were significantly more likely.

BMD status. The results of the study showed a decrease in BMD of the lumbar spine in patients T1DM in comparison with the control group (table 2). Low BMD was detected in 14.6% (23 people) of type 1 diabetes and 4.1% (4 people) of control subjects (F = 0.03; p = 0.007)

Table 2. BMD indicators in patients T1DM and persons in the control group

Parameter	T1DM, n=157	Control group, n=98	p
BMD (L1-L4), g/см,	1,14 (1,04–1,22)	1,23 (1,13–1,34)	**U=3607; p<0,001**
Z-score (L1-L4)	–0,50 (–1,20–0,10)	0,40 (–0,40–0,80)	**U=1562; p<0,001**
BMD L1, g/см^2	1,02 (0,94–1,13)	1,12 (1,03–1,24)	**U=3352; p<0,001**
L1, Z-score	–0,80 (–1,80–(–0,20))	0,00 (–0,60–0,60)	**U=1448; p<0,001**
BMD L2, g/см^2	1,13 (1,04–1,23)	1,21 (1,14–1,33)	**U=3594; p<0,001**
L2, Z-score	–0,70 (–1,30–0,10)	0,20 (–0,50–0,90)	**U=1561; p<0,001**
BMD L3, g/см^2	1,21 (1,11–1,30)	1,30 (1,20–1,39)	**U=3787; p<0,001**
L3, Z-score	–0,10 (–0,90–0,70)	0,80 (0,10–1,00)	**U=1659; p<0,001**
BMD L4, g/см^2	1,14 (1,04–1,28)	1,25 (1,15–1,34)	**U=3922; p<0,001**
L4, Z-score	–0,60 (–1,50–0,50)	0,20 (–0,50–0,60)	**U=1821; p=0,002**

TBS parameters. According to the results of our study , low TBS values (L 1 - L 4) of the lumbar spine in patients T1DM (1,40 (1,33–1,46)) were established in comparison with the values of TBS in the control group (1,44 (1,39–1,48)) (table 3) .

Table 3. TBS indicators in patients with T1DM and control subjects

Parameter	T1DM, n=157	Control group, n=98	p
TBS (L1-L4)	1,40 (1,33–1,46)	1,44 (1,39–1,48)	**U=2775; p<0,001**
Z-score (L1-L4)	–0,30 (–0,80–0,40)	0,15 (–0,50–1,00)	U=618; p=0,092
T-score (L1-L4)	–0,30 (–0,90–0,30)	0,10 (0,00–0,50)	**U=249; p=0,018**
TBS L1	1,29 (1,22–1,39)	1,34 (1,29–1,42)	**U=2898; p=0,002**
TBS L2	1,40 (1,31–1,47)	1,46 (1,39–1,50)	**U=2834; p=0,001**
TBS L3	1,44 (1,36–1,51)	1,49 (1,44–1,53)	**U=2819; p=0,001**
TBS L4	1,44 (1,37–1,50)	1,50 (1,44–1,53)	**U=2972; p=0,004**

According to the data in Table 3, the largest decrease of TBS was detected in the first lumbar vertebrae (1.29 (1.22–1.39) vs 1.34 (1.29–1.42); U = 2898; p = 0.002).

In order to assess possible gender differences in bone quality, a comparison of TBS indicators in men and women in the control group and in patients T1DM were performed. Men and women in the control group did not reveal significant differences in the TBS values of lumbar spine (1.46 (1.43-1.53) vs 1.43 (1.39-1.47); U = 373; p = 0.166) . Similar results were obtained in patients with DM type 1: (1.42 (1.37-1.47) vs 1.39 (1.33-1.44); U=1385; B p = 0.257) in men and women respectively.

There was a significant association of TBS and BMD indices of the lumbar spine in patients T1DM (ρ=0.29, p=0.001). However, there were no significant differences in the

values of TBS in subgroups with normal and reduced BMD (1.41 (1.34-1.46) vs 1.36 (1.27-1.43); U = 725; p = 0.065) (table 4 and table 5).

Table 4. Correlation of TBS and BMD in patients T1DM

Parameter	ρ	p
TBS (L1-L4) vs BMD (L1-L4)	0,29	**p=0,001**
TBS Z-score (L1-L4) vs BMD Z-score (L1-L4)	0,40	**p=0,034**
TBS L1 vs BMD L1	0,43	**p<0,001**
TBS L2 vs BMD L2	0,38	**p<0,001**
TBS L3 vs BMD L3	0,39	**p<0,001**
TBS L4 vs BMD L4	0,35	**p=0,002**

Table 5. Correlation of TBS and BMD in control group.

Parameter	ρ	p
TBS (L1-L4) vs BMD (L1-L4)	0,26	**p=0,038**
TBS Z-score (L1-L4) vs BMD Z-score (L1-L4)	0,38	p=0,221
TBS L1 vs BMD L1	0,19	p=0,122
TBS L2 vs BMD L2	0,32	**p=0,009**
TBS L3 vs BMD L3	0,23	p=0,071
TBS L4 vs BMD L4	0,13	p=0,296

Assessment of the thoracic and lumbar spine in a lateral projection. According to the results of our study, osteoporotic vertebral deformities (OVD) occur statistically significantly more often in patients with diabetes compared with the control group

In eight patients (6.3%) T1DM, despite indicators consistent with the age norm of BMD, structural changes in vertebral bodies were established. This fact indicates that there are qualitative changes in bone tissue, leading to a decrease in its strength characteristics. 10 patients T1DM had several OVD's simultaneously.

Indicators of TBS and OVD . In order to assess the relationship between the values of TBS and the presence of OVD, patients T1DM were divided into two subgroups with their presence and absence.

In patients T1DM mellitus with the presence of a 1–3 degree OVD, low TBS values were reliably established in comparison with the subgroup without osteoporotic vertebral deformities. The results obtained indicate that bone microarchitectonics is better in patients with type 1 diabetes without OVD and is able to withstand a greater load.

Accuracy of identifying patients for Diabetic Osteopathy using TBS and Z – score: The accuracy of identifying patients T1DM with the presence of clinically significant OVD 2–3 degrees based on the established threshold TBS and Z - score is presented in table 6.

Table 6. Accuracy when using TBS and Z - score for the detection of OVD of 2–3 degrees

Parameter	Sensitivity (%)	Specificity (%)	Predictive value of a negative result (%)	Predictive value of a positive result (%)
TBS ≤1.279	90.9	77.6	98.9	27.8
Z – score ≤ – 1.0	90.9	66.4	98.7	20.4
TBS ≤1.279 or Z– score ≤ – 1.0	100	50.0	100	15.9

TBS ≤1.279 and Z – score ≤ – 1.0	81.8	93.9	98.2	56.3

In analyzing the data obtained it can be concluded that by using the isolation values TBS ≤1,279 and Z -test I ≤-1,0 marked low positive predictive value for diagnosis of patients with vertebral deformations.

However, with a combination of these parameters, both the specificity and prognostic value of a positive result increased. This combination had the best diagnostic efficiency (93.9%) for identifying patients T1DM with the presence of clinically significant OVDs of the 2nd to 3rd degree (χ 2 = 35.9, df = 2, p <0.001).

Conclusions:

1 In patients with type 1 diabetes mellitus, significantly lower TBS values of the lumbar spine (1,40 (1,33–1,46)) were established in comparison with the TBS in the control group (1,44 (1,39–1,48)); U= 2775; p<0,001) with the greatest decrease in the first lumbar vertebra (1.29 (1.22-1.39) vs 1.34 (1.29-1.42); U=2898; p = 0.002).

2 In men and women, comparable TBS were found in patients with type 1 diabetes (1.42 (1.37-1.47) vs 1.39 (1.33-1.44); U=1385; B p=0.257) and in the control group (1.46 (1.43-1.53) vs 1.43 (1.39-1.47); U = 373; p = 0.166).

3 There was a significant association of TBS and lumbar spine BMD in diabetic patients (ρ=0.29, p=0.001), however, there were no significant differences in the TBS in subgroups with normal and reduced BMD (1.41 (1.34-1.46) vs 1.36 (1.27-1.43); U = 725; p = 0.065).

4 There is a high risk of vertebral osteoporotic deformities for adults with type 1 diabetes (OS 11.2 (95% CI 2.7 - 46.2)) .

5 TBS is significantly lower in patients with diabetes mellitus type 1 with the presence of OVD 1–3 degrees than in the subset without OVD (U = 514; p <0.001).

6 Using of a combination of the obtained values of TBS ≤1.279 and Z – score ≤ – 1.0 has good sensitivity, specificity, prognostic value of positive and negative results for the identification of patients with type 1 diabetes with the presence of vertebral osteoporotic deformities (χ^2 = 35 9, p <0.001).

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