Original article

Trabecular bone score, bone mineral density and 10-year fracture probability in Ukrainian men of different ages

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Abstract

Objective. To evaluate the bone mineral density (BMD), trabecular bone score (TBS) and the 10-year probability of major osteoporotic fractures and hip fractures in the healthy men of different ages.

Materials and methods. We’ve examined 300 men aged 40–89 years (mean age – 60.9 ± 0.6 yrs; mean height – 1.74 ± 0.04 m; mean weight – 84.1 ± 0.9 kg), who were divided into groups depending on their age: 40–49 yrs (n = 52), 50–59 yrs (n = 86), 60–69 yrs (n = 89), 70–79 yrs (n = 59), 80–89 yrs (n = 14). The 10-year probability of hip fracture and the 10-year probability of major osteoporotic fracture risk were calculated by the Austrian, Polish and Russian FRAX® models. BMD of the whole body, PA lumbar spine and proximal femur were measured using the DXA method (Prodigy, GEHC Lunar, Madison, WI, USA) and PA spine TBS were assessed by the TBS iNsight® software package installed on the available DXA machine (Med-Imaps, Pessac, France).

Results. The age significantly influenced the BMD of lumbar spine (F = 2.84, p = 0.02) and femoral neck (F = 4.08, p = 0.003) in all the examined patients. A significantly decreased TBS (L1–L4) was determined in men according to their ages (40–49 yrs – 1.116 ± 0.02, 50–59 yrs – 1.111 ± 0.02; 60–69 yrs – 1.118 ± 0.02; 70–79 yrs – 1.062 ± 0.02; 80–89 yrs – 1.080 ± 0.05; F = 2.42, p = 0.048). We have observed a significant increase of a 10-year probability of major osteoporotic fractures in the men aged 80–89 yrs (p < 0.01) using the Russian FRAX® model, 60–89 yrs (p < 0.01) – Austrian FRAX® model, 70–89 yrs (p < 0.01) – Polish FRAX® model in comparison with the men aged 40–49 yrs. The 10-year probability of hip fractures significantly increased in the men aged 70–89 yrs in comparison with those aged 40–69 yrs (p < 0.01). TBS was significantly higher in men with normal BMD (1.121 ± 0.01), compared with the patients who have been diagnosed with an osteoporosis – 1.066 ± 0.03 (p = 0.04). The significant correlation was observed between TBS and BMD L1–L4 in the examined men (r = 0.12; p = 0.03). No correlation was found between TBS and BMD of femoral neck.

Conclusions. The TBS significantly decreased with ageing. Subjects with osteoporosis have significantly lower TBS data.
compared with the examined patients with a normal BMD. A significant correlation was found between the TBS and BMD of lumbar spine. The 10-year probability of a major osteoporotic fracture and hip fracture significantly increased in men with age. The trabecular bone score is an independent parameter for evaluation of the structural-functional bone state. We can use the TBS in combination with FRAX and BMD for the improved diagnosis of bone and joint diseases.

**Key words:**
trabecular bone score, bone mineral density, fractures

**Introduction**

There is a growing recognition of the fact that osteoporosis and fractures in older men are significant public health problems contributing towards disability and premature death. Osteoporosis is defined as a systemic bone disease characterized by a low bone mass and microarchitectural deterioration of bone tissue, with a subsequent increase of bone fragility and susceptibility to fracture. Osteoporosis affects women more frequently than men for several reasons. Men accumulate more bone mass during the peak growth years, making the adult male skeleton generally stronger. They also accumulate more muscle mass during puberty, which contributes to their skeletal strength. Male hormone production does not cease abruptly, testosterone level declines slowly throughout their life.

Men have osteoporotic fractures about 10 years later in life than women. A third of all fractures affecting men is femoral fractures [1], mortality caused by these fractures 37.5% higher than in women [2]. About 40% fractures of this localization occur at home, 20% of men with a fractured femur in anamnesis after some time might re-fracture. Almost half of femoral fractures are registered before 80 [3]. However, vertebral fractures equal the respective percentage of women’s.

At present, a special attention in the diagnosis of male osteoporosis is paid to the risk factors. A combination of several factors in one patient increases the risk of osteoporosis and fractures.

Diagnostic criteria of male osteoporosis are controversial. The gold standard to assess the Bone mineral density (BMD) is considered to be a dual X-ray absorptiometry (DXA), but this method does not assess microarchitecture alterations. According to the recommendations by the International Society for Clinical Densitometry (2013), BMD determination must be conducted in men over 70 years. The measurement of BMD for men aged 70 years and over is performed if they have risk factors for a reduced bone mass, such as low-energy fractures in their history, chronic diseases and drugs affecting the bone metabolism.

BMD evaluation BMD of men aged 50 years and over was conducted using the T-score; in the younger men using the Z-score. If the T-score is between −1.0 and −2.5 standard deviations (SD), we diagnose a low bone mineral density – osteopenia, less than −2.5 SD – osteoporosis. If the patients have low-energy fractures in their history, osteoporosis is diagnosed. Today there is no accurate data on the relationship of BMD and fracture risk, and whether men and women with the same values of BMD have the same risk factors [5].

BMD is a major but not unique predictor of the fracture risk. Some fractures occur in case of osteopenia or normal BMD. This indicates the need for other diagnostic criteria to identify the risk of fractures.

By the end of 2008, the experts of World Health Organization Metabolic Bone Disease Group developed their FRAX® algorithm. FRAX® (a Fracture Risk Assessment tool) has been developed for the prediction of a 10-year probability of hip fracture and 10-year probability of a major osteoporotic fracture (clinical spine, forearm, hip or shoulder fracture) based on clinical risk factors alone or the combination of clinical risk factors plus BMD. The FRAX algorithms are suitable for men and women aged 40 years and older who are not receiving treatment for osteoporosis. However, this method has been proposed recently, and there is a small number of studies that estimate the possibility of its use in men [10, 12].

Taking into consideration the urgency of osteoporosis for the global population and the constant search for improved diagnostic methods of structural-functional bone state, «Med-Imaps» company patented a new methodology – «TBS iNsight®» in 2006. TBS iNsight® software is an advanced application for DXA (GE Healthcare-Lunar or Hologic) evaluating the quality of bone microarchitecture known as Trabecular Bone Score (TBS). TBS is a texture analysis of bone X-ray images, embedded in the software and able in seconds to improve the osteoporosis diagnosis. It enables the doctor to identify the patients with a high fracture risk and also to select the appropriate treatment.

**The aim of the study** was to evaluate the BMD, TBS and the 10-year probability of major osteoporotic fractures and hip fractures in the healthy men of different ages.
Materials and methods

We’ve examined 300 men aged 40–89 years (mean age – 60.9 ± 0.6 yrs; mean height – 1.74 ± 0.04 m; mean weight – 84.1 ± 0.9 kg), who were divided into groups depending on their age: 40–49 yrs (n = 52), 50–59 yrs (n = 86), 60–69 yrs (n = 89), 70–79 yrs (n = 59), 80–89 yrs (n = 14). The 10-year probability of hip fracture and the 10-year probability of major osteoporotic fracture risk were calculated by the Austrian, Polish and Russian FRAX® models. BMD of the whole body, PA lumbar spine and proximal femur were measured using the DXA method (Prodigy, GE Lunar, Madison, WI, USA) and PA spine TBS were assessed by the TBS iNsight® software package installed on the available DXA machine (Med-Imaps, Pessac, France).

Results

The age significantly influenced the BMD of lumbar spine (F = 2.84, p = 0.02) and femoral neck (F = 4.08, p = 0.003) in all the examined patients (Figs. 1, 2).

A significantly decreased TBS (L1–L4) was determined in men according to their ages (40–49 yrs – 1.116 ± 0.02, 50–59 yrs – 1.111 ± 0.02; 60–69 yrs – 1.118 ± 0.02; 70–79 yrs – 1.062 ± 0.02, 80–89 yrs – 1.080 ± 0.05; F = 2.42, p = 0.048) (Fig. 3).

We have observed a significant increase of a 10-year probability of major osteoporotic fractures in the men aged 80–89 yrs (p < 0.01) using the Russian FRAX® model, 60–89 yrs (p < 0.01) – Austrian FRAX® model, 70–89 yrs (p < 0.01) – Polish FRAX® model in comparison with the men aged 40–49 yrs. The 10-year probability of hip
Table. Ten-year probability of osteoporotic fractures (%) according to the Austrian, Polish and Russian FRAX® models

<table>
<thead>
<tr>
<th>Age / Risk factors</th>
<th>A without BMD</th>
<th>with BMD</th>
<th>B without BMD</th>
<th>with BMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russia</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>40–49</td>
<td>5.18 ± 0.26</td>
<td>6.51 ± 0.45</td>
<td>0.24 ± 0.04</td>
<td>0.87 ± 0.23</td>
</tr>
<tr>
<td>50–59</td>
<td>5.18 ± 0.23</td>
<td>6.61 ± 0.38</td>
<td>0.39 ± 0.04</td>
<td>1.11 ± 0.22</td>
</tr>
<tr>
<td>60–69</td>
<td>5.22 ± 0.21</td>
<td>5.87 ± 0.29</td>
<td>0.66 ± 0.05</td>
<td>0.89 ± 0.11</td>
</tr>
<tr>
<td>70–79</td>
<td>6.04 ± 0.40</td>
<td>6.00 ± 0.63</td>
<td>2.00 ± 0.27</td>
<td>2.11 ± 0.54</td>
</tr>
<tr>
<td>80–89</td>
<td>8.74 ± 1.28</td>
<td>6.41 ± 1.08</td>
<td>4.73 ± 1.29</td>
<td>3.05 ± 1.02</td>
</tr>
<tr>
<td>Austria</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–49</td>
<td>3.38 ± 0.22</td>
<td>4.41 ± 0.38</td>
<td>0.26 ± 0.04</td>
<td>0.89 ± 0.22</td>
</tr>
<tr>
<td>50–59</td>
<td>4.32 ± 0.22</td>
<td>5.97 ± 0.46</td>
<td>0.61 ± 0.06</td>
<td>1.79 ± 0.36</td>
</tr>
<tr>
<td>60–69</td>
<td>5.38 ± 0.25</td>
<td>6.23 ± 0.39</td>
<td>1.33 ± 0.11</td>
<td>1.82 ± 0.25</td>
</tr>
<tr>
<td>70–79</td>
<td>8.87 ± 0.69</td>
<td>8.90 ± 1.13</td>
<td>4.48 ± 0.60</td>
<td>4.66 ± 1.07</td>
</tr>
<tr>
<td>80–89</td>
<td>16.09 ± 2.22</td>
<td>11.85 ± 1.96</td>
<td>10.24 ± 2.18</td>
<td>6.44 ± 1.88</td>
</tr>
<tr>
<td>Poland</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–49</td>
<td>1.98 ± 0.11</td>
<td>2.54 ± 0.21</td>
<td>0.17 ± 0.02</td>
<td>0.53 ± 0.13</td>
</tr>
<tr>
<td>50–59</td>
<td>2.28 ± 0.12</td>
<td>3.29 ± 0.27</td>
<td>0.36 ± 0.03</td>
<td>1.04 ± 0.20</td>
</tr>
<tr>
<td>60–69</td>
<td>2.57 ± 0.12</td>
<td>3.00 ± 0.19</td>
<td>0.64 ± 0.05</td>
<td>0.89 ± 0.12</td>
</tr>
<tr>
<td>70–79</td>
<td>3.93 ± 0.31</td>
<td>4.36 ± 0.65</td>
<td>1.80 ± 0.25</td>
<td>1.97 ± 0.50</td>
</tr>
<tr>
<td>80–89</td>
<td>8.41 ± 1.47</td>
<td>5.97 ± 1.20</td>
<td>5.54 ± 1.47</td>
<td>3.44 ± 1.16</td>
</tr>
</tbody>
</table>

Note: A – 10-year probability of a major osteoporotic fracture; B – 10-year probability of a hip fracture.
fractures significantly increased in the men aged 70–89 yrs in comparison with those aged 40–69 yrs (p < 0.01).

TBS was significantly higher in men with normal BMD (1.121 ± 0.01), compared with the patients who have been diagnosed with an osteoporosis – 1.066 ± 0.03 (p = 0.04) (Fig. 4).

The significant correlation was observed between TBS and BMD L1–L4 in the examined men (r = 0.12; p = 0.03). No correlation was found between TBS and BMD of femoral neck (Fig. 5).

**Conclusion**

The TBS significantly decreased with ageing. Subjects with osteoporosis have significantly lower TBS data compared with the examined patients with a normal BMD. A significant correlation was found between the TBS and BMD of lumbar spine. The 10-year probability of a major osteoporotic fracture and hip fracture significantly increased in men with age. The trabecular bone score is an independent parameter for evaluation of the structural-functional bone state. We can use the TBS in combination with FRAX and BMD for the improved diagnosis of bone and joint diseases.

**References**


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UKRAINOS SKIRTINGO AMŽIAUS VYRŲ TRABEKULINIO KAULO INDEKSAS, KAULŲ MINERALŲ TANKIS IR LŪŽIŲ TIKIMYBĖ PER 10 METŲ

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Santrauka

Tyrimo tikslas. Įvertinti skirtingo amžiaus sveikų vyrų kaulų mineralų tankį, trabekulinio kaulo indeksą ir pagrindinių osteoporozinių bei šlaunikaulio lūžių tikimybę 10 metų laikotarpyje.

Tyrimo metodai. Tyrimo metu buvo ištirta 300 vyrų, 40–89 metų amžiaus (amžiaus vidurkis – 60,9 ± 0,6 metai, ūgio vidurkis – 1,74 ± 0,04 m., kūno masės vidurkis – 84,1 ± 0,9 kg), tiriamieji buvo suskirstyti į grupes pagal amžių: 40–49 metų (n = 52), 50–59 metų (n = 86), 60–69 metų (n=89), 70–79 metų (n = 59), 80–89 metų (n = 14). Šlaunikaulio ir pagrindinių osteoporozinių lūžių tikimybės per 10 metų laikotarpį buvo apskaičiuotos pritaikius Austrijos, Lenkijos ir Rusijos FRAX modelius. Viso kūno, juosmeninės stuburo dalies ir šlaunikaulio proksimalinės dalies kaulų mineralų tankis buvo nustatytos dvisrautės radioabsorbcijométrijos tyrimu (Prodigy, GE Lunar, Madison, WI, USA), stuburo trabekulinio kaulo indeksas – iNsight® programiniu paketu, kuris įdiegtas į dvisrautės radioabsorbcijométrijos tyrimo įrenginį (Med-Imaps, Pessac, France).

Rezultatai. Visų tyrimo dalyvių juosmeninės stuburo dalies ir šlaunikaulio proksimalinės dalies kaulų mineralų tankis buvo nustatytos dvisrautės radioabsorbcijométrijos tyrimu (Prodigy, GE Lunar, Madison, WI, USA), stuburo trabekulinio kaulo indeksas – iNsight® programiniu paketu, kuris įdiegtas į dvisrautės radioabsorbcijométrijos tyrimo įrenginį (Med-Imaps, Pessac, France).

Reikšminiai žodžiai: trabekulinio kaulo indeksas, kaulų mineralų tankis, lūžiai