Original Article

A COMBINED USE OF BILATERAL INVESTIGATION WITH QUANTITATIVE ULTRASOUND AND A STRUCTURED QUESTIONNAIRE IN SCREENING FOR OSTEOPOROSIS

Dimitar M. Minkov, Ventzi B. Rossmanov, Tonislava P.Minkova[1], Nadya R.Veleva[2]

Clinic of Orthopedics and Traumatology, Medical University-Pleven
[1]Department of Psychology, St. Cyril and St. Methodius University of Veliko Turnovo
[2]Faculty of Public Health, Medical University-Pleven

Corresponding Author:
Dimitar M. Minkov
Clinic of Orthopedics and Traumatology,
89, Russe bul.
Pleven, 5800
Bulgaria
e-mail: minkov_d@mail.bg

Received: October 29, 2009
Revision received: November 30, 2009
Accepted: December 13,2009

Summary

Quantitative ultrasound (QUS) is a device method for non-invasive assessment of skeletal status to estimated bone mineral density (BMD). The absence of ionizing radiation, low investigation costs and availability of devices all make the QUS method preferable for conducting screening population research. Using structured questionnaires (Susan Brown's Osteoporosis Fracture Risk Questionnaire) in screening for osteoporosis is another approach: it is highly efficient and cost-effective to identify women with osteoporosis in the general population of a country. Osteoporosis screening through bilateral quantitative ultrasound osteometry was conducted in October 2007. We investigated 926 women who also filled in Susan Brown's Adult Osteoporosis Risk Assessment questionnaire right before the ultrasound investigation. T-score ≤ -1.0 was registered in 137 (17%) of the 243 (31%) investigated women from the age group over 45 years of age that were found to be at low risk of osteoporosis according to the questionnaire. The T-score was -0.1 to -2.5 in 192 (24%) women from a total of 432 (55%) at questionable osteoporosis risk, and a T-score ≤ -2.5 was found in 8 (1%) from a total of 112 (14%) patients with a likely osteoporosis risk.
Key words: quantitative ultrasound, T-score, structured questionnaire

Introduction

Osteoporosis is a systemic skeletal disease, characterized by low bone mass and microarchitectural deterioration of bone tissue, with a consequent increase in bone fragility and susceptibility to fracture [1].

The linear transformation of bone density is referred to as T-score. The T-score is estimated by first subtracting the value of the bone mineral density of young healthy population (BMD young) from the value of the measured bone mineral density (BMD) and then dividing it by standard deviation for young healthy population (SD): T-score = (BMD – BMD young)/ SD.

The World Health Organization uses the T-score as a basis for defining osteoporosis as a condition characterized by low bone density with a consequent

increase in bone fragility and susceptibility to fracture [2].

The World Health Organization (WHO) has established diagnostic criteria for osteoporosis based on the measurement of bone mineral density (BMD), expressed as T-score, which is the number of SD below the mean BMD of young adults at their peak bone mass:

1. normal BMD: T-score of -1 SD or above;
2. osteopenia: T-score of between -1 and -2.5 SD;
3. osteoporosis: T-score of -2.5 SD or below;
4. established (severe) osteoporosis: T-score of -2.5 SD or below, with one or more associated fractures.

The most widely used technique for diagnosing osteoporosis is the dual-energy X-ray absorptiometry (DXA) [3]. The World Health Organization recommends central DXA (an obligatory investigation of the femoral neck).

Quantitative ultrasound (QUS) is an alternative method for non-invasive assessment of the skeletal status that presents the estimated BMD and obviates qualities of bone tissue – elasticity, structure and geometry [4].

The absence of ionizing radiation, low investigation costs and availability of devices are some of the main reasons to identify QUS as a method of choice to conduct screening and population research.

Another approach to screening for osteoporosis involves using structured (dichotomous – YES/NO) questionnaires. One of the most popular questionnaires is the one-minute osteoporoses test of the World Health Organization. It consists of six questions, and is designed for self-assessment of osteoporosis risk.

Materias and Methods

To choose the questionnaire, we searched the Internet with Google as a tool and "osteoporosis questionnaire" as key words. We required a fully structured questionnaire with dichotomous questions with answers "YES" and "NO", so that we could process only simple answers when defining the results. All tests available were studied, and we chose Susan Brown's Adult Osteoporosis Risk Assessment (Osteoporosis Education Project, New York, USA). Dr. Brown gave us her kind permission to use her questionnaire for the purposes of our study. According to the "Rules for Test Adaptation" of the International Test Commission, the questionnaire was translated in Bulgarian and adapted in view of the linguistic and cultural differences between American and Bulgarian population. The questionnaires were given to the patients before the ultrasound investigation and the result were registered and announced to the participants during and after the ultrasound investigation.

Susan Brown's Adult Osteoporosis Risk Assessment questionnaire consists of 20 questions. In the case of four and under four positive answers, a low osteoporosis risk is determined. In the case of five to eight positive answers, it is assumed that the osteoporosis risk is questionable, and when the positive answers exceed nine, the osteoporosis risk is considered as likely.

The ultrasound device used for the peripheral ultrasound investigation was Sahara Clinical Bone Sonometer (Hologyc Inc), and the assessment was made according to the standard investigation protocol. The Sahara device conducts the measurement through transmission ultrasound technique, using an original coupling gel (Hologic Corp.). Quality control was performed twice a day by scanning of an original phantom from the producer.

Both calcanei of all of the subjects were investigated in the sequence left foot - right foot. Data recorded included estimated bone mineral density in g/cm^2 (eBMD), quantitative ultrasound index – QUI/Stiffness and T-score. To analyze the data, we used the average BMD value from the bilateral investigation [5].

The investigation included 926 women from different age groups as follows: up to 35 years of age – 26 women (2.8%), from 36 to 40 years of age – 45 (4.86%), from 41 to 45 years of age – 79 (8.53%), from 46 to 50 years of age – 161 (17.39%), from 51 to 55 years of age – 203 (21.92%), from 56 to 60 years of age – 177 women (19.11%), 125 from 61 to 65 years of age – 99 women (10.69%), from 66 to 70 years of age – 72 women (7.78%), from 71 to 75 years of age – 47 women (5.08%) and from 76 to 85 years of age – 17 women (1.84%). All of them were residents of the district of Pleven and had volunteered for ultrasound osteometry of the calcaneus. All investigations were carried out by one operator in October 2007.

For the skeletal status analysis by T-score, the data for the women over 50 years of age were used.

For children, men and premenopausal women the basic diagnostic characteristic is Z-score. It represents a comparison of a person's BMD with those of people of the same age.

Results

Data analysis of Susan Brown's questionnaire results placed 291 (31.43%) of the participants in the low osteoporosis risk group, 517 (55.83%) – in the questionable risk group, and 118 (12.74%) – in the likely risk group (Fig.1).

In the group with a T-score ≥ θ.1 were 289 of the investigated women over 50 years of age, and 184 women from the same age group were defined with low osteoporosis risk according to Susan Brown's test (Fig. 2).

In the group with a T-score from -0.1 to -2.5 were 301 of the investigated women over 50 years of age. In the same age group, 332 women were defined as low osteoporosis risk patients, according to Brown's test (Fig. 3).

In the group with a T-score ≥ 2.5 were 27 of the investigated women over 50 years of age. In the same age group, 79 women were defined as low osteoporosis risk patients according to Brown's test (Fig. 4).

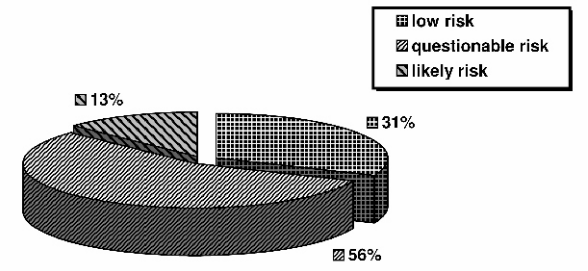

Figure 1. Distribution of females investigated according to Susan Brown's test results

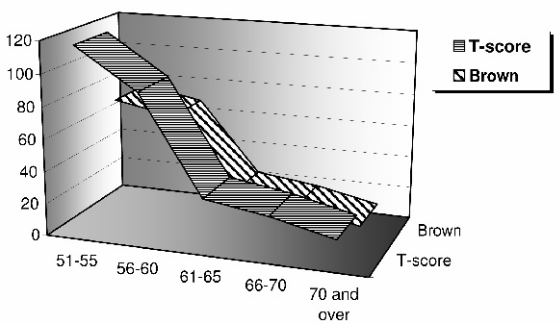

Figure 2. Distribution of females investigated and found with low osteoporosis risk according to Susan

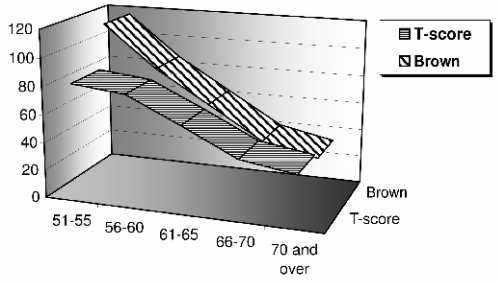

Figure 3. Distribution of females investigated and found with questionable osteoporosis risk according to Brown's test and with T-score from -0.1 to -2.5 from ultrasound osteometry

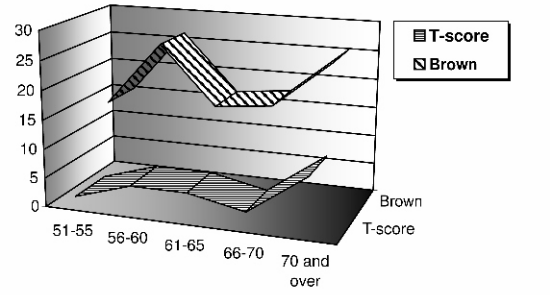

Figure 4. Distribution of females investigated and found with questionable osteoporosis risk according to Brown's test and with a T-score from ≤ 2.5from ultrasound osteometry

Table 1. Distribution of females investigated according to Brown's test and with a T-score from ultrasound osteometry

T-score/Brown	T-score≥ -1.0	-1,0>T-score> -2,5	T-score ≤ -2.5	Total
Yes ≤ 4	n=137 17.41%	n=100 12.71%	n=6 0.76%	n=243 30.88%
Yes ≤ 8	n=226 28.72%	n=192 24.40%	n=14 1.78%	n=432 54.89%
Yes ≤ 9	n=54 6.86%	n=50 6.35%	n=8 1.02%	n=112 14.23%
Total	n=417 52.99%	n=342 43.46%	n=28 3.56%	n=787 100%

Discussion

DXA of the femoral neck is a "gold standard" for diagnosis of osteoporosis. This method for accurate and precise diagnosis of osteoporosis, however, is associated with the use of ionizing radiation, is performed by a qualified radiologist. The large number of potential patients can be examined through structured questionnaires and/or by portable ultrasound devices.

Susan Brown's Osteoporosis Fracture Risk Questionnaire was used for the purpose of our study. The questionnaire includes questions about diet, physical activity, family history, bad habits and previous history of the persons investigated. Data obtained through the questionnaire could be used for osteoporosis prevention in general.

The results of the survey were analyzed on the basis of T-score. The categories from Susan Brown's questionnaire were matched to bone density charactetristics as follows: "low" as referring to normal bone density; "questionable" – to low bone density (osteopenia), and "likely osteoporosis risk" – to osteoporosis.

It should be noted that WHO allows the use of T-score as diagnostic criteria for DXA. With ultrasound devices, the reported T-score is associated with lower fracture risk as compared to the same T-score value given by DXA. Hologic reports a difference of 0.4 SD in the T-score, depending on the use of QUS or DXA [7]. Hologic suggests a diagnostic algorithm for ultrasound devices, according to which there is moderate fracture risk with T-score between 0 and - 1.0, and high fracture risk with T-score ≤ - 1.0.

In our study, an average T-score value of -0.8 was found in the investigated persons aged 50 to 59 years. The average T-score of age group 60-69 was – 1.3, whereas it was 1.6 in the group of subjects aged 70+. T-score was obtained after bilateral calcaneal measurement.

According to the results obtained using Brown's questionnaire, the age group over 45 years of age 243 (31%) persons fell in the low osteoporosis risk group but 137 (17%) of them were with normal bone density (T-score ≤ 1.0). Questionable osteoporosis risk was found for 432 (55%) persons but 192 (24%) of them has a T-score ranging from -0.1 to -2.5. The subjects at a likely osteoporosis risk were 112 (14%) while only 8 (1%) of these had a T-score of ≤ 2.5.

Conclusion

On the bases of our findings, we suggest the following approach: when patients are found questionable or at likely osteoporosis risk according to Susan Brown's questionnaire, and the T-score values are under – 1.6 SD, they should be referred for DXA. Such patients should be considered as exposed to high fracture risk.

References

1. National Institute of Health Osteoporosis prevention, diagnosis, and therapy. NIH Consensus Statement 2000;17:1-45.
2. The WH Study Group Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. 1994; World Health Organization, Geneva.
3. Schnitzler CM. Bone quality: a deter-minant for certain risk factors for bone fragility. Calcif Tisuue Int. 1993;53:S151-6.
4. Heaney RP, Kanis JA. The interpretation and utility of ultrasound measurements of bone. Bone. 1996;18:491-2.
5. Minkov DM, Rosmanov VB. Bilateral Quantitative Ultrasound Calcaneus Measurement or Two is More Than One. Orthopedics and Traumatology 2009;1:14-19
6. Boyanov M. X-ray osteodensitometry and quantitative bones ultrasound in clinician's practice. 2007; Central Medical Library – Sofia
7. Hologic.com. [Internet]. Hologic Review. The Sahara Clinical Bone Sonometer: clinical use of T- and Z-scores. c2005 [cited 2008 June 9]. Available at: www.hologic.com