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Comparison of three different osteoporosis risk assessment tools: ORAI (osteoporosis risk assessment instrument), SCORE (simple calculated osteoporosis risk estimation) and OST (osteoporosis self-assessment tool)

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Abstract

Background: SCORE, OST and ORAI risk assessment tools could reduce the cost burden of BMD tests by selecting the high risk patients to osteoporosis. In this study we compared the ability of these risk assessment measures to assess probability of the osteoporosis among post-menopausal women.

Methods: 211 post-menopausal women aged 45-88 years enrolled into the study. All of the patients underwent BMD test and divided into two groups according to T-Score level. 43 patients (20.4%) had T-Score ≤-2.5 (osteoporotic) (group-1) and 168 (70.6%) patients had T-Score of > -2.5 (non-osteoporotic). Among 168 non-osteoporotic cases, 88 had -2.5≤T-Score≤-2 in at least one bony area. These 88 cases in addition to the 43 cases with -2.5≤T-Score considered as high risk group to osteoporosis (group 2). Afterward, SCORE, OST and ORAI risk scores were calculated and sensitivity, specificity, likelihood ratio, accuracy index and area under the curve of each tool were determined in both groups and then compared with each other.

Results: SCORE had the highest sensitivity compared with others in both groups (95% and 88.2% respectively). Moreover, it had the highest diagnostic odds ratio and negative predictive value between the three methods. OST had the highest likelihood ratio and specificity in both groups (71.4% and 75.4%). There was significant difference between the sensitivity and specificity of the tests (p= 0.004 and 0.027).

Conclusion: OST with the highest specificity and positive LR had a special role in determining the osteoporotic patients and SCORE with the highest sensitivity and negative predictive value had an exceptional role in exclusion of the non- osteoporotic individuals. However, considering the area under the curve, there was no significant difference among these three methods in determining osteoporosis.

Keywords: Osteoporosis, Bone density, Risk assessment, Sensitivity, Specificity, Predictive value.

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Introduction

Osteoporosis is one of the most common metabolic bone disorders and the global major underlying diseases that predispose bones to fractures and increase morbidity and mortality along with therapeutic cost burden (1,2). It is almost asymptomatic and has a silent progression; however it could get symptomatic when fractures occur mainly in the spine and/or hip bones (2). It is usually characterized by bone tissue microarchitecture deterioration and a low den-

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sity bone mass which induces high fragility and susceptibility of bone fracture (3). WHO has defined osteoporosis as a low bone mineral density (BMD) of more than 2.5 standard deviations below the mean score for the young healthy adults (3, 4). Dual X-ray absorptiometry (DXA) is a gold standard measure to evaluate BMD and diagnosis of an osteoporosis using T and Z scores (5). Osteoporosis is more common in women especially in postmenopausal period and its prevalence is reported to be increased with age (1). There are several reports and evidences in this issue. A study done on more than 200,000 postmenopausal women aged older than 50 revealed that 7.2% of them suffered from osteoporosis and 11% of them had at least wrist, rib, hip and/or spine bone fractures (6). As Cass and colleagues reviewed in their study, US Preventive Service Task Force (UPSTE) recommended performing BMD in all of the women aged older than 65 years old with any race and gender and women aged between 60 and 64 years old with any risk factor for evaluation of an osteoporosis in 2002 (7). National Osteoporosis Foundation (NOF) showed later in 2003, that only 12% of women in this age group have been evaluating by DXA method (7). These clearly indicates the necessity of more feasible and inexpensive alternative diagnostic measures for BMD to assess or predict osteoporosis accurately. However, this question arises if BMD is neede in lower risk patinets or not. Several studies have been evaluated for osteoporosis risk factors and conclude that we can classify patients into two groups: high risk group and osteoporotic group (8). The aim of osteoporosis risk assessing and determining Risk Assessment Index (RAI) is not only to identify osteoporotic patients; it is implicated to identify the people who are at increased risk for osteoporosis and need more accurate evaluation by BMD. Screening by risk assessment measures can increase the efficacy of BMD with focusing on the high risk population (9). There are several accurate osteoporosis screening instruments such as OST (Osteoporosis Self-Assessment Tool) which is based on age and weight and is known as the simplest tool especially in outpatient clinic, ORAI (Osteoporosis Risk Assessment Instrument) and SCORE (Simple Calculated Osteoporosis Risk Estimation). Aim of this study is to determine and compare sensitivity and specificity of these three measures along with their predictive value to define high risk patients who may benefit from BMD.

Methods

Study Population

This was a retrospective cohort study that was conducted from March 2004 to March 2007. A total of 211 outpatient postmenopausal women were recruitex in the study with a mean age of 57.3±13.8 (45-88 years) who were referred to our BMD center for evaluation of bone density. Patients who met the following criteria were excluded from the study: history of anti-resorptive drugs use such as Bisphosphonates, Calcitonin, Raloxifene, history of estrogen replacement therapy during last five years, secondary osteoporosis due to the surgery or diseases such as diabetes, thyrotoxicosis, hyperparathyroidism, scleroderma, malabsorption syndromes and gastric surgery and drug induced osteoporosis due to immunosuppressive drugs, anticonvulsants drugs, Levothyroxin, Cyclosporine, Heparin or alcohol.

The study was approved by the hospital's ethics committee, and written informed consent was obtained from the patients.

Bone mineral densitometry and osteoporosis

DXA bone mineral densitometry was performed in all of the patients with LUNAR-DPXIQ device in L2-L4 lumbar vertebra and hip bones (total hip and neck).

Patient with a T-score of ≤ -2.5 in any bony area were considered as osteoporotic (43 of 211 cases). Individuals with -2.5 >T-score were considered non-osteoporotic (168 of 211 cases). However, according to the T-score ≤ -2 that is used as a threshold

Table 1. Patients classification

Osteoporotic (group 1)	T-Score ≤ -2.5	43 case	T-Score ≤ -2 High risk population (group 2)	131 cases
Non-osteoporotic	T-Score > -2.5	168 case	-2.5 ≤ T-Score ≤ -2	88
			T-Score >-2	80

to initiate treatment in our country, we considered another group of patients with T-score ≤ -2 in at least one bony area as a high risk population (131 patients including 88 of 168 non-osteoporotic cases (-2.5≤T-score≤-2) in addition to 43 osteoporotic ones) (Table 1).

Osteoporosis risk assessment tools

ORAI, SCORE and OST are defined in details in Table 2. The cut point score was 9, 6 and -3 for ORAI, SCORE and OST respectively.

Statistical Analysis

Data analysis was carried out using SPSS version 16.0 (SPSS Inc, Chicago, IL). Parametric data was reported as mean ± standard deviation. Categorical variables were presented as frequency and percentages. Sensitivity, specificity, likelihood ratio and predictive value tests were performed for OST, SCORE and ORAI risk assessment methods. The univariable analyses of the continuous and categorical variables were carried out using Student's t-test and Fischer exact test, appropriately. A p-value of less than 0.05 was statistically significant. All of these parameters were determined in CI=95%. A p-value of less than 0.05 was considered significant.

Results

This study included 211 female patients with a mean age of 57.3±13.8 years (aged 45 to 88 years old) and a mean weight of 68.19 (42-135). Of all 211 patients, 43 (20.4%) were osteoporotic (T-score ≤ -2.5) and 168 case (79.6%) were non-osteoporotic (T-score > -2.5). Among 168 non-osteoporotic cases, 88 (41.8%) had low bone mass (-2.5<T-score<-2) in at least one area. High risk group patients (T-score ≤ -2) were 131 cases including 88 of 168 non-osteoporotic cases (-2.5≤T-score≤-2) in addition to 43 osteoporotic ones (T-score≤ -2.5).

The sensitivity of OST to determine osteoporotic patients (T-score ≤ -2.5) and high risk group (T-score ≤ -2) were 73.8% and 71.4%, respectively. The sensitivity and specificity of OST to determine osteoporosis (T-score ≤ -2.5) were 73.8% and 71.4%, respectively. The negative predictive value of OST in assessing osteoporosis was 91.6% and the diagnostic odds ratio was 7 (Table 3 and 4).

The sensitivity and specificity of SCORE in patients with osteoporosis were 95.5% and 54.2%, respectively. The negative predictive value of SCORE in patients with T-score ≤ -2.5 was 97.8%. The sensitivity and specificity of ORAI in patients with T-score ≤-2.5 was 83.3%, 64.3%, respectively. The positive likelihood ratio (LR+) of OST was 2.63 vs. 2.22 for ORAI and 2.20 for SCORE tests. The area under the curve (AUC) for osteoporotic patients with OST, ORAI and SCORE methods were 81.5, 85.7 and 83.6, respectively (Table 3 and 4).

There was significant difference between sensivity and specificity of the tests (P-

Table 2. Definition of ORAI, SCORE and OST risk assessment tools

Variables	Score	Recommendations
ORAI		BMD is recommended for cases with ORAI >9 scores
-Age (years)		
75≤	15	
65-74	9	
55-64	5	
44-54	0	
-Weight (kg)		
<60	9	
60-69	3	
≥70	0	
-Recent use of Estrogens	2	
No	0	
Yes		
SCORE		BMD is recommended for cases with SCORE >6 scores
-Every gender other than black	5	
Rheumatoid arthritis-	4	
-Non traumatic fractures	4	
-12 scores for >45 years including wrist, rib and hip fracture	3	
-Every 10 years without taking estrogens	1	
OST		BMD is recommended for cases with moderate and high OST scores
-(Weight –Age) × 0.2		
OST>1	Low	
-3<OST <1	Moderate	

SCORE, simple calculated osteoporosis risk estimation; OST, osteoporosis self-assessment tool; ORAI, osteoporosis risk assessment instrument

value= 0.004 and 0.027) but the area under curve and accuracy for all three measures (Table 3 and 4).

Discussion

BMD by dual-energy x-ray absorptiometry (DXA) is still the gold standard of assessing osteoporosis of the bones in people without osteoporotic fractures (10). However, during the last decades several risk assessment tools have been identified to replace BMD in a first step to screen risk of osteoporosis in general population in order to reduce the cost burden of performing unnecessary measurement in individuals with the lower risk of the disease. Among the risk assessment tools, OST has been noticed and populated as it could be easily calculated just based on the two variables: age and weight (11). However, there are lots of controversies regarding the best alternative risk assessment measure for BMD due to different aspects and statistical analysis of the performed studies based on sensivity, specificity, AUC or odds ratio. Some studies have reported superiority of OST to SCORE and ORAI according to the higher sensitivity and simplicity of this test and some reported similarity of the tests according to AUC (7, 12-17).

In the present study, we compared these three accurate and common screening tools and reveled that SCORE had the highest sensitivity (both in osteoporosis and high risk group, 95.2% and 88.2%) and the highest negative predictive value (97.8) and subsequently diagnostic odds ratio and accuracy compared to the other methods. It shows a high power in detecting healthy and low risk people which is a very important factor to decrease the risk of missing real patients. I had the lowest specificity in both osteoporotic (54.2) and high risk patients (59.9) among other tests. It means

Table 3. Comparing results of OST, ORAI and SCORE tests in osteoporotic patients with T-score ≤ -2.5

Risk Assessment Tool	Odds ratio	Youden index	Accuracy	LR (-)	LR (+)	Negative Predictive Value	Positive Predictive Value	Specificity%	Sensitivity%
OST	7	45.2	55.5	0.37	2.5	91.6	39.2	71.4	73.8
ORAI	9	47.6	55.4	0.26	2.3	93.98	36.8	64.3	83.3
SCORE	23.6	49.4	58.4	0.09	2.08	97.8	34.2	54.2	95.2
P-value								0.004	0.027

OST, osteoporosis self-assessment tool; ORAI, osteoporosis risk assessment instrument; SCORE, simple calculated osteoporosis risk estimation; LR, likelihood ratio

Table 4. Comparing results of OST, ORAI and SCORE tests to assess osteoporosis in high risk patients with T-score ≤ -2

Risk Assessment Tool	Odds ratio	Youden index	Accuracy	LR (-)	LR (+)	Negative Predictive Value	Positive Predictive Value	Specificity %	Sensitivity %
OST	5.6	40.1	57.8	0.47	2.6	81.7	39.2	75.4	64.7
ORAI	5.4	39.7	57.4	0.41	2.2	83.5	8.36	67.6	72.1
SCORE	11.2	48.1	58.7	0.20	2.20	97.8	91.4	59.9	88.2
P-value								0.02	0.005

OST, osteoporosis self-assessment tool; ORAI, osteoporosis risk assessment instrument; SCORE, simple calculated osteoporosis risk estimation; LR, likelihood ratio

that SCORE will lead to more false positive results.

Regarding OST, it had the highest specificity (71.4%) and likelihood ratio (LR) (2.5) that means the test has lower false positive results and high power to detect the healthy individuals and could really decrease the cost burden of the BMD. With determination of AUC in each test, we could predict the diagnostic power of a test. However, in the present study there was no significant difference between AUC in 5% area of the tests (confidence interval 95%). It demonstrates that none of the tests has superiority over the others in this area.

It is in the line with asystematic review performed by Rud and colleagues in 2007 (14). They showed that the accuracy and diagnostic odds ratio of OST, SCORE and ORAI were similar in white women and OST did not have any superiority to the others. Gourlay et al (15) also demonstrated that there was no significant differences between these three tests according to the specificity, AUC and diagnostic odds ratio, but the sensitivity of OST in subjects aged 45- 64 years old was higher than SCORE and ORAI (89.2% vs. 88.5%). On the other hand, Geusens et al (12) demonstrated that sensitivity of OST in postmenopausal women was the lowest one comparing ORAI and SCORE (88% vs. 90% and 89% respectively). Cadarette et al (16) showed in their study that SCORE was better than ORAI to detect osteoporotic patients and predicting high risk group of people to osteoporosis according to higher sensitivity and specificity that is not in line with our result.

In another study, AUC was higher in OST rather than the other tests (82% vs. 80% and 76% for SORE and ORAI respectively) on postmenopausal Chinese women but the sensitivity and specificity of SCORE was higher than OST (17). Another study done by Cass and colleagues also showed the higher sensitivity and specificity for SCORE while comparing ORAI (7). Controversies among the aforementioned studies refer to the statistical analysis used by them and racial differences between their study groups. For example in earlier studies only sensitivity and specificity of these methods were compared to each other but

later the AUC and accuracy have been implicated by researchers.

Generally speaking, these clinical tools are supposed to exclude healthy subjects reliably and to select a smaller population for whom BMD measurement is of value. So the higher the sensitivity and negative predictive value, the more valuable is the test; however as long as the AUC and accuracy of the tests are similar, differences in sensitivity are not meaningful.

Conclusion

Our result shows the similarity of the tests. OST has no priority over the others; but as its simple, it could be more feasible in outpatient settings.

Consideringthe results of the present study, these three methods are similarly useful and none of them has priority overthe others.

Conflict of interest

The authors declare that they have no conflict of interest.

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