

Performance of Osteoporosis Risk Assessment Tools in Iranian Postmenopausal Women

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Risk indices have been developed to identify postmenopausal women at risk of low bone mineral density who need to undergo BMD testing. The aim of study was to compare performance of three decision rules for identifying women with primary osteoporosis in an Iranian postmenopausal population.

Materials and Methods: Three osteoporosis risk indices- the osteoporosis self assessment tool (OST), the osteoporosis risk assessment instrument (ORAI), and body weight criterion were calculated for 5573 out patients without risk factors for secondary osteoporosis or receiving active bone medication. BMD at spine and femoral neck were measured via dual x-ray absorptiometry. The sensitivity, specificity, positive predictive value, negative predicative value and area under receiver operating characteristic curve to identify those with osteoporosis were determined for each decision rule; these were then compared.

Results: The sensitivity of these risk indices ranged from 70% to 84.1% and specificity from 44.6 to 65.6%. The area under curve (ROC) in identifying patients with osteoporosis were significantly better for OST (0.75) and ORAI (0.74) compared with the body weight criteria (0.66). The negative predicative values ranged from 80 to 93%, while positive predication values ranged

from 33 to 45%.

Conclusion: Our data provide evidence for the application of OST, ORAI as useful clinical tools in making decision about which women need to be referred for BMD testing; more evidence however is needed to confirm validity of the body weight criterion. Of the three tools evaluated, the OST is the simplest and has the best potential for use in clinical practice.

Key Words: Osteoporosis, Postmenopausal women, Osteoporosis risk indices, Screening

Received: 08.05.2007- Accepted: 01.07.2007

Introduction

Osteoporosis is a systemic disorder characterized by decreasing bone density and micro-architectural deterioration of bone, which leads to fragile bone and susceptibility to fracture. It usually has no signs.¹ The method most commonly used to diagnose osteoporosis is measuring of bone mineral density (BMD) with "DXA" method in the pelvis region and lumbar vertebrae,²⁻⁴ however because of limitations in the availability of BMD technology and economical factors in developing countries, it has been suggested that this be done based on assessing the risk factors of patients.⁵⁻⁶ Various researches have identified risk factors for osteoporosis⁷⁻⁸ and

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on the basis of these the risk factors the "Risk Assessment Tools" have been defined.⁹⁻¹⁴

The Risk Assessment Tools cannot distinguish all subjects with osteoporosis, but do increase the capability of bone mineral density measurement to identify women with osteoporosis. It is necessary to assess the validity of these decision rules as suitable guidelines for the identification of patients that would most likely benefit from BMD testing in different communities.¹⁵ While these rules use a single cut point for deciding whether to test or not, it has suggested that two cut points be used in order to classify the likelihood of osteoporosis as low, moderate or high.¹⁶⁻¹⁸ The purpose of this research was to evaluate the efficacy of these methods in screening postmenopausal women in Iran. Our goals were to assess the validity and performance of the Osteoporosis Risk Assessment Instrument (ORAI), the Osteoporosis Self Assessment Tool (OST) and Body Weight Index to increase the efficiency of BMD measurement in identifying asymptomatic women who are at increased risk.

Materials and Methods

We used the medical database of women,

aged 45 years or over, referred between March 2001 to January 2006 by physicians to the Bone Mineral Density Measurement Center of the Shiraz Medical School in Iran. Women with major risk factors for secondary osteoporosis e.g. menopause before age 45, hyperthyroidism, hyperparathyroidism, long-term glucocorticoid use, rheumatological disorder and malabsorptive syndromes were excluded from the study. Moreover, those patients taking medications other than estrogen with direct effect on bone and with a prior fragility fracture were also excluded. BMD measurements using DXA (Dual x-ray absorptiometry) Technology (Lunar Corporation, Madison, WI), were obtained from the femoral neck and lumbar spine (L2-L4). According to WHO classification, subjects were categorized as normal (T score >-1), osteopenic (-1 < T score < -2.5), or osteoporotic (T score < -2.5).

The OST, ORAI indices were derived according to criteria established by their developer (Table 1); the following dichotomous cut offs for DXA referral were recommended: <2 for OST and >8 for ORAI. Also according to risk assessment, the patients were categorized as low, moderate or high risk.

Table 1. Decision rules for bone mineral density testing

| Decision rule | Calculation | BMD testing suggestion | Risk levels |
|------------------------|---|------------------------|---|
| ORAI | Points are given if: Age (years): >75 +15 Age (years): 65-74 +9 Age (years): 55-64 +5 Weight (kg) < 60 +9 Weight (kg): 60-70 +3 Add two points if estrogen is not currently taken | ORAI > 8 | Low: <9 Moderate: 9 to 17 High: >17 |
| Body weight index (kg) | | Weight < 70 | Low > 70 Moderate :57-70 High :<57 |
| OST | 0.2[weight(KG)-age(years)]; truncate to yield integer | OST < 2 | Low: >1 Moderate: 1 to -3 High: <-3 |

BMD measurement was also recommended if body weight was less than 70 kilograms.¹⁹ However, a value < 57.6, previously considered as an important risk factor,²⁰ was used as another cut point to classify subjects in to three groups based on body weight index. Table 1 shows these indices in detail. The specificity and sensitivity of each decision rule for selecting women with osteoporosis were identified. The receiver operating characteristic (ROC) curve of each decision rule was determined and compared. Positive and negative predictive values for identifying osteoporosis and helping the selection of patients for BMD testing were determined. We used SPSS (version 11.5) for statistic analyses.

Results

A total number of 5573 women were evaluated. The mean age of the women in our sample was 57.2±8.3 ranging from 45 to 88 years. The average weight, height and body mass index of the sample were 66.9±11.3 kg, 158±6.1 cm and 26.8±5.9 kg/m², respectively. Prevalence of osteoporosis was 30.8% at the lumbar spine and 20% at the femoral neck. The percentage of women with osteoporosis at either lumbar spine or femoral neck was 36.6%. Osteopenia was 39.7% at lumbar spine and 48.6% at femoral neck. The percentage of women with osteoporosis or osteopenia at either lumbar spine or femoral neck was 64.3%.

Prevalence rate of osteoporosis and osteopenia in different age group are shown in Table 2.

According to suggested cut points (OST score <2, ORAI score >8 and body weight <70 kg), OST recommended 47% women for BMD testing compared with ORAI (51%) and Body Weight index (60.5%). At the considered thresholds of OST, ORAI and Body Weight index, they selected 19.2%, 22% and 43.5% of the patients with normal BMD who were recommended for densitometry with DXA in which body weight criterion was selected significantly more.

Table 3 shows the sensitivity and specificity of each method for selecting women with osteoporosis in lumbar region and femoral neck separately. The sensitivity ranged from 70% to 74.9% for lumbar spine and 80.5% to 84% for femoral neck. Corresponding specificity values ranged from 45.9% to 62.6% for the lumbar spine and 44.6% to 60.6% for the femoral neck. It also summarized the sensitivity and specificity of these methods for women with osteoporosis at either lumbar spine or femoral neck, its sensitivity being between 70.7% and 74.2% and specificity between 47.4% and 65.6%. Negative predictive value was between 80% and 83% for lumbar vertebrae and ranged from 90% to 93% for the femoral neck; it was between 76% and 80% for osteoporosis at either lumbar spine or femoral neck.

Table 2. Prevalence of osteoporosis and osteopenia in different ages by BMD measurement site

| Age (yr) | Number | Osteoporosis at the lumbar spine (%) | Osteopenia at the lumbar spine (%) | Osteoporosis at the femoral neck (%) | Osteopenia at the femoral neck (%) | Osteoporosis at the lumbar spine or femoral neck (%) | Osteopenia at the lumbar spine or femoral neck (%) |
|----------|--------|--------------------------------------|------------------------------------|--------------------------------------|------------------------------------|--|--|
| 45-54 | 2521 | 16.4 | 40.6 | 7.5 | 45.5 | 19.1 | 62.9 |
| 55-64 | 1950 | 35.2 | 42.5 | 19.4 | 55.1 | 40.4 | 69.8 |
| 65-74 | 867 | 55.8 | 32.9 | 42.2 | 48 | 68.1 | 61 |
| >75 | 235 | 55.9 | 32.8 | 66.8 | 30.2 | 75.8 | 46 |
| Total | 5573 | 30.8 | 39.7 | 20 | 48.6 | 36.7 | 64.3 |

Table 3. Performance of decision rules for selecting women with osteoporosis

| | Lumbar spine | | | | Femoral neck | | | | Lumbar spine or Femoral neck | | | |
|--------------|--------------|-------------|------|------|--------------|-------------|-----|-----|------------------------------|-------------|-----|-----|
| | Sensitivity | Specificity | PPV* | NPV† | Sensitivity | Specificity | PPV | NPV | Sensitivity | Specificity | PPV | NPV |
| OST | 70‡ | 63 | 45 | 82 | 80 | 61 | 33 | 90 | 71 | 66 | 54 | 79 |
| ORAI | 73 | 59 | 44 | 83 | 84 | 57 | 33 | 93 | 74 | 62 | 53 | 80 |
| Weight index | 75 | 46 | 38 | 80 | 81 | 45 | 26 | 90 | 74 | 47 | 44 | 76 |

*: Positive predictive Value; †: Negative Predictive Value; ‡: All numbers are in percent

Table 4. Area under the ROC curves for three decision rules in different sites

| Decision rule | Lumbar spine (95% CI) | Femoral neck (95% CI) | Lumbar spine or Femoral neck (95% CI) |
|---------------|--------------------------|--------------------------|---|
| OST | 0.733 (0.718-0.747) | 0.798 (0.783-0.812) | 0.754 (0.741-0.768) |
| ORAI | 0.721 (0.706-0.735) | 0.788 (0.773-0.803) | 0.745 (0.732-0.759) |
| Weight index | 0.655 (0.650-0.681) | 0.709 (0.692-0.726) | 0.668 (0.653-0.683) |

These values indicate the efficiency of these indices for recommendation of BMD testing with DXA. Table 3 shows positive predictive value in different assessment methods.

When considering the area under the ROC curve for assessing capability of these methods for selecting women with osteoporosis for BMD testing, it seems that most of the area under the ROC curve for all considered parts is higher for OST and this area is meaningfully better and more suitable for OST and ORAI than the body weight index (Table 4).

The subjects were categorized into three groups based on risk indices. Increased

prevalence of osteoporosis with ascending risk category (low, moderate, high) was obvious for all three-risk tools. Of the women classified as high risk (3.6 %) based on OST risk levels, 90.5% had osteoporosis in the lumbar spine or femoral neck. Based on ORAI, in which 8.6 % of women were considered as high risk, 84.9% had osteoporosis in lumbar spine or femoral neck, but considering weight index, only 60.9% of high-risk women had osteoporosis.

Low risk postmenopausal women were 52.3%, 49% and 39.5% for the OST, ORAI and body weight index, respectively. Nearly 80% of women with low risk in OST and ORAI had no osteoporosis on BMD testing

with DXA. This was 77% for low risk women based on body weight index.

Discussion

Osteoporosis, a skeletal disease with significantly increasing morbidity and mortality worldwide, due to susceptibility to fracture, usually has no signs. With the fast increasing populations of Asian countries, it is predicted that 50% of hip fractures will occur in these countries by 2050.²¹ In the last decade, effective treatments for decreasing loss of bone density and cure of osteoporosis have been introduced.²² Moreover, DXA is recommended for measurement of bone mineral density and fracture risk assessment. Unfortunately, in most developing countries, these devices for BMD measuring are not available and BMD testing costs too much. Mass screening for osteoporosis is not recommended.³ Although most physicians are aware of osteoporosis, treatment significance and introduction of different ways to select high-risk subjects to measure BMD,^{2,20,23} osteoporosis is diagnosed and appropriately treated,²⁴⁻²⁵ only in a small proportion of patients, in which case using decision rules for identifying osteoporosis is helpful. In our study, the sensitivity for OST and ORAI to identify osteoporosis is between 70-80% with a negative predictive value between 80-90% and the under curve area is between 0.7-0.8, which showed the efficiency of these two tools for identifying subjects with osteoporosis. On the other hand, less than 30% of women without osteoporosis were introduced to BMD measurement center with these two tools. Although the sensitivity of the body weight index was close to previous methods, it indicated that 43.5% of women without osteoporosis for BMD testing. In addition, consistent with findings of other studies¹¹, the area under the ROC curve for body weight index was less than that for OST and ORAI, which demonstrates the lower validity of this index.

In one study of Asian countries, sensitivity, specificity and the area under the ROC

curve were 91%, 45% and 0.79 respectively for OST. The sensitivity was 90% and specificity 52% for the ORAI in identifying women with osteoporosis at the femoral neck which was similar to our study findings.¹⁶

In a study involving 644 postmenopausal women in Canada, the sensitivity ranged from 92% to 95% and the specificity from 35% to 64% to identify women with osteoporosis. Moreover, the area under the ROC curve was significantly better for OST and ORAI indices than for body weight index.²⁶ In another study conducted at the university of Liege in Belgium, the OST sensitivity ranged from 85% at the lumbar spine to 97% at the femoral neck and specificity was 34% at the femoral neck and lumbar spine to detect osteoporosis. In addition, negative predictive value was 89% at the lumbar spine and 95% at the femoral neck, values which were almost consistent with our findings in the current study, demonstrating the efficiency of OST in selecting women with osteoporosis. ORAI sensitivity was 79% at the lumbar spine and 82% at the femoral neck and specificity was 45% at the lumbar spine and femoral neck.²⁷

It seems that categorizing postmenopausal women to low, moderate and high-risk groups based on OST or ORAI is helpful for physicians, because 90.5% of high-risk women based on OST and 84.5% based on ORAI had osteoporosis whereas this value was 60.9% for body weight index.

As with most studies, our finding has some limitations, our data were collected from women attending clinics and may differ in some ways from the general Iranian postmenopausal population so the results may not be generalizable.

In conclusion, measuring BMD is the best method of identifying patients with osteoporosis but measuring BMD in all postmenopausal women is not feasible in most developing countries. It seems that OST and ORAI are effective screening tools for BMD testing in this study but further studies are needed to confirm the efficiency of body weight index.

The OST and ORAI tools were very effective in this Iranian population and the high negative predictive value allows for the safe ex-

clusion of healthy women, in order to allocate BMD test resources to those most likely to benefit.

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