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Section I: Fracture Risk Assessment

Validation of the Osteoporosis Self-Assessment Tool in US Male Veterans

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Abstract

The osteoporosis self-assessment tool (OST) is a screening instrument that uses age and weight as parameters to predict the risk of osteoporosis. This study was designed to evaluate OST in predicting osteoporosis in males. Male veterans aged 50 yr and older with no prior diagnosis of osteoporosis and no prior bone densitometry (dual-energy X-ray absorptiometry [DXA]) testing were eligible for the study. Sociodemographic information, medical history, and risk factors for osteoporosis were recorded. Anthropometric measurements were taken and DXA testing performed. The OST index for each subject was calculated and predictive values and receiver operating characteristic (ROC) curves were evaluated for OST and osteoporosis. Five hundred eighteen subjects underwent DXA, 92 (17.8%) had osteoporosis, 281 (54.2%) had low bone mass, and 145 (28.0%) had normal bone mineral density. The OST index ranged from −8 to 23 with a mean of 4 (standard deviation ± 4.3). An OST index of 6 or lower predicted osteoporosis with a sensitivity of 82.6%, specificity of 33.6%, and an area under the curve for the ROC curve of 0.67. OST index performed better in non-Hispanic whites and males >65 yr. OST predicts osteoporosis with moderate sensitivity and poor specificity in men.

Key Words: Dual-energy X-ray absorptiometry; men; osteoporosis self-assessment tool; screening.

Introduction

Osteoporosis is diagnosed frequently in males, but osteoporotic fracture-related mortality in males is twice that of females, emphasizing the importance for early diagnosis in men with increased fracture risk *(1)*. Secondary etiologies are responsible for 47% of osteoporosis in men but may not correlate with densitometric results *(2)*. The densitometric diagnosis of osteoporosis is based on calculations of fracture risk established in postmenopausal Caucasian women, therefore making the diagnosis in younger women, non-Caucasians, and men less precise *(3)*. The International Society of Clinical Densitometry has included recommendations for obtaining densitometry in men, where adherence is low even in the presence of recognized risk factors *(4)*.

Various tools are available to evaluate the risk of osteoporosis and initiate screening in groups. One such tool, the osteoporosis self-assessment tool (OST), is a simplified instrument that is derived by including only weight and age and was demonstrated to predict osteoporosis in postmenopausal Asian women at the greatest risk and where bone densitometry (dual-energy X-ray absorptiometry [DXA]) was not readily available *(5)*. OST was also found to be predictive of osteoporosis in both Caucasian women and men, but in small or retrospective studies *(6−8)*. We conducted this study to

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evaluate the predictive value of OST in a population of male veteran patients with a high prevalence of comorbidity.

Methods and Materials

Male patients older than 50 yr attending primary care clinics at 4 participating VA Medical Centers were invited to participate. Exclusion criteria included a prior diagnosis or treatment for osteoporosis, prior DXA, and metabolic bone diseases including osteomalacia, renal osteodystrophy, or osteogenesis imperfecta. Inability to undergo a DXA at 2 of 3 sites (lumbar spine, hip, or forearm) or excessive weight above the table limit for the instrument were additional exclusion criteria.

All participating subjects gave informed signed consent, approved by the local institutional review board. Data collected included sociodemographics, medical history, and a questionnaire of risk factors for osteoporosis (Appendix). A physical examination was performed for anthropometric measurements (height and weight). The OST index was calculated for each subject using the formula:

$$\text{OST index} = (\text{Weight [kg]} - \text{Age [yr]}) \times 0.2$$

The OST index is reported as an integer by rounding down its value to the nearest whole number *(5)*.

Subjects had bone mineral density (BMD) measured at the hip (femoral neck and total hip or greater trochanter), lumbar spine (anterior-posterior L1−L4 or L2−L4), or distal forearm. Trained technicians performed DXA on either the Hologic (Hologic Inc., Bedford, MA) or the Lunar (GE Healthcare, Madison, WI) scanner, specific to each participating center. To adjust for systematic differences in BMD by DXA, values were standardized to the Hologic BMD using published equations *(9)*. Site-specific T-scores were calculated. For the femoral neck and total hip, we used male- and race-specific reference data from the National Health and Nutrition Examination Survey III *(10)*. Osteoporosis was defined using the lowest site-specific T-score *(3,11)*. The threshold for establishing the diagnosis of osteoporosis was based on the World Health Organization (WHO) definition and consisted of a BMD value ≤ -2.5 standard deviation (SD) below the young adult mean (or a T-score ≤ -2.5). Low bone mass or osteopenia was defined as a BMD value at any site between < -1.0 and > -2.5.

Demographic data were reported as mean and SDs. The associations of demographic data and risk factors for osteoporosis with a diagnosis of osteoporosis (DXA T-score ≤ -2.5) were calculated by the nonparametric Wilcoxon test. Logistic regression analyses for osteoporosis were performed; variables with p-values < 0.1 were included in the model. The sensitivity, specificity, and predictive values of the OST index for osteoporosis were calculated and receiver operating characteristic (ROC) curves created. The ability of OST to predict osteoporosis in subgroups based on ethnicity (Caucasians vs African Americans) and age ($\leq$65 vs $>$65 yr) were analyzed. The 10-yr probability of a hip or other major fracture was calculated using the WHO Fracture Risk Assessment Tool (FRAX®), without BMD *(12)*. The FRAX® was developed to aid physicians with the decision to initiate antiosteoporosis therapy. The FRAX® was compared with the OST index. All analyses were performed using SAS version 9.1 (SAS Inc., Cary, NC). Significance was set at an alpha of 0.05.

Results

Five hundred twenty men were enrolled in the study from the 4 participating Veterans Affairs Medical Centers. The mean age of the cohort was 66 yr (SD $\pm$ 10.2) with a mean weight of 90.9 kg (SD $\pm$ 17.7), height of 173.2 cm (SD $\pm$ 7.6), and body mass index of 30.4 kg/m^2 (SD $\pm$ 7.6). The ethnic distribution of the cohort was 374 (72.2%) Caucasians, 130 (25.1%) African Americans, and the remaining 14 (2.7%) comprised Hispanics, Asians, and other ethnic groups. As is typical of cohorts of elderly male veterans, comorbid diseases were common (Table 1) Risk factors for osteoporotic fractures were common in this cohort; the most frequent were smoking (ever) 73.6%, alcohol ($>$4 ounces/d) 50.3%, a history of weight loss ($>$10% of body weight) 41.4%, history of fracture 39.9% (Table 1). Approximately 45% of the subjects were designated by the investigator to have other risk factors for osteoporosis, which included other inflammatory diseases. The differences in comorbid diseases and risk factors for osteoporosis between Caucasians and African Americans and between patients $\leq$ 65 yr and $>$65 yr are shown in Table 1.

Five hundred eighteen subjects underwent DXA and 92 (17.8%) had results that satisfied the diagnosis of osteoporosis; 281 (54.2%) had low bone mass (osteopenia) and 145 (28.0%) had normal BMD.

The OST index ranged from -8 to 23 with a mean value of 4 (SD $\pm$ 4.3). An OST index of 6 or lower predicted osteoporosis with a sensitivity of 82.6% and specificity of 33.6%. The predictive values for osteoporosis using varying OST indices are shown in Table 2.

Factors associated with a densitometric diagnosis of osteoporosis included other risk factors for osteoporosis ($p < 0.0112$), renal disease ($p < 0.0008$), weight ($p < 0.0001$), and OST index $\leq$6 ($p < 0.0023$); all 3 variables remained statistically relevant in multivariate analysis ($p = 0.0006$, $p = 0.0007$, and $p = 0.0019$, respectively). If OST was examined as a continuous variable in the multivariate analysis, a lower OST index had a p value of <0.0001.

The area under the curve for the ROC curve was 0.67 (Fig. 1). The predictability of OST was evaluated in different subgroups (Table 2). An OST index of $\leq$5 operated with the best combination of sensitivity (75.4%) and specificity (41.4%) for Caucasian men. An OST index of $\leq$6 in African American men predicted osteoporosis with a sensitivity of 70.0% and a specificity of 36.4%. In subjects aged $\leq$65 yr, an OST cutoff of $\leq$7 predicted osteoporosis with a sensitivity of 76.2% and a specificity of 39.5%, whereas in subjects $>$65 yr, an OST index $\leq$2 operated best, with a sensitivity of 80% and a specificity of 52.8%). Five hundred twelve