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RESEARCH ARTICLE

Predictive Accuracy of the Osteoporosis Self-Assessment Tool (OSTA) for Hip Fracture in Premenopausal women's

Shylaja S.[1*], Dr. Narasingh Malav[2]

Abstract

Perimenopausal women with type 2 diabetes mellitus (T2DM) face an elevated risk of osteoporotic hip fractures. The Osteoporosis Self-Assessment Tool for Asians (OSTA), which relies on age and body weight, is a simple screening method. However, its effectiveness in predicting fracture risk in this specific population remains unclear, particularly due to the complex relationship between T2DM and bone mineral density (BMD), as well as limited access to DXA scans. AIM - To assess the predictive ability of OSTA for hip fracture risk in perimenopausal women with T2DM. Methods: This retrospective study was conducted at Shri Mata Vaishno Devi Narayana Super Speciality Hospital between 2024 and 2025. The study included 182 women going through perimenopause. Of these, 62 had low-energy hip fractures, and 120 were controls, matched for age (within ±2 years), who had not had fractures. People with conditions affecting bone metabolism or significant spinal deformities were not included. OSTA scores were calculated using the standard formula [(weight in kg − age in years) × 0.2] and were classified as high risk (< −4), intermediate risk (−4 to −1), or low risk (> −1). Bone mineral density (BMD) was measured for all participants. The statistical methods included independent t-tests, analysis of covariance (ANCOVA), and receiver operating Characteristic (ROC) curve analysis. A p-value of less than 0.05 was used to determine statistical significance.

Results: Women in the fracture group were younger (67 ± 9.09 vs. 70.5 ± 8.02 years, $p = 0.0123$), taller (172 ± 8.09 vs. 168 ± 5.99 cm, $p = 0.0009$), and heavier (73 ± 9.75 vs. 44.15 ± 9.8 kg, $p < 0.001$) compared to the control group. Mean OSTA scores were higher in the fracture group (0.9 ± 2.75 vs. 0.29 ± 2.7), but the difference was not statistically significant ($p = 0.1591$). ROC curve analysis demonstrated poor predictive performance of OSTA for hip fracture risk (AUC = 0.534). The prevalence of osteoporosis was higher in the fracture group (66.7%) than in controls (41.4%).

Conclusion: The OSTA tool's predictive capacity for hip fracture risk in perimenopausal women with T2DM appears constrained, potentially due to the elevated body weight characteristic of this demographic. Although its straightforward design renders it appropriate for environments with limited resources, additional refinement is essential to enhance its precision within this particular cohort.

Keywords: Osteoporosis, Hip Fracture, OSTA, Perimenopause, T2DM, BMD.

Introduction

Background of the study

Osteoporosis, a weak and brittle bone condition, is distinguished by diminished bone strength and microarchitectural degradation of bone, thereby elevating the risk of fractures from minimal trauma. Throughout life, bone undergoes continuous remodelling, a process governed by a delicate equilibrium between osteoclast-mediated bone resorption and osteoblast-mediated bone formation. In contrast, people with osteoporosis experience a disruption of this balance. Specifically, the breakdown of bone happens faster than the creation of new bone. This results in a gradual loss of bone, a decrease in bone mineral density (BMD), and a decline in the overall quality of the bone. In clinical practice, osteoporosis is often described as a «Weak and brittle bone disease» because it usually does not show symptoms until a fragility fracture occurs. Recent studies have highlighted the perimenopausal period as a notably important and vulnerable time for the development and worsening of osteoporosisrelated fractures. The risk of fractures during this period can vary significantly, depending on where the fracture occurs and how much bone loss has occurred. Dual-energy X-ray absorptiometry (DXA) is

[1]Ph.D. Scholar, Desh Bhagat University, Punjab, India

[2]Professor, Desh Bhagat University, Punjab, India

***Corresponding Author:** Shylaja S., Ph.D. Scholar, Desh Bhagat University, Punjab, India, E-Mail: shylajas503@gmail.com

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currently regarded as the gold standard technique for the quantitative assessment of bone mineral density (BMD). BMD assessment is a vital diagnostic tool for osteoporosis, serving as a key independent predictor of subsequent fracture risk. Nevertheless, research has repeatedly revealed considerable variability in BMD measurements within perimenopausal women, with findings spanning from normal bone density to considerably diminished levels, and, in some instances, even elevated values. This variability is thought to arise from the intricate and multifaceted hormonal shifts, particularly the reduction in estrogen, alongside metabolic changes that characterize the menopausal transition. As a result, this variation has led to ongoing uncertainty and debate about the best and most effective ways to screen for osteoporosis in this specific group of people. To address the challenges posed by constrained healthcare resources and restricted availability of DXA scanning, the Osteoporosis Self-Assessment Tool for Asians (OSTA) was developed as a simple, rapid, and cost-effective screening instrument. This tool employs only two easily obtainable clinical parameters—age and body weight—to estimate a person's risk of osteoporosis.

Within Asian populations, OSTA has exhibited a reasonable degree of accuracy in pinpointing individuals who would benefit from formal BMD testing, thereby proving especially useful in resource-limited clinical environments where DXA facilities are not readily accessible. Moreover, accumulating evidence from various studies indicates that the OSTA may also possess the capacity to predict fracture risk, particularly in postmenopausal women. The OSTA score was initially formulated and validated using extensive, population-based data gathered from various Asian nations. It categorizes individuals into distinct risk groups based on easily obtainable anthropometric and demographic data, thus enabling early identification and prompt intervention for those at elevated risk. With the population getting older and more women entering perimenopause, healthcare providers are encountering this stage of life more frequently. This demographic faces a heightened risk of osteoporosis, a condition that can be exacerbated by other health problems, such as type 2 diabetes.

Hip fractures, a frequent consequence of osteoporosis, are particularly serious and can have the most detrimental impact. These fractures are linked to significant increases in illness, death, and overall healthcare costs. Although dual-energy Xray absorptiometry (DXA) is still the best method for measuring bone density and assessing fracture risk, its use is often limited by high costs, limited availability, and restricted access in many healthcare settings. Therefore, a simple, reliable, and cost-effective screening tool is urgently needed to accurately identify people at higher risk of hip fractures. This study was designed to evaluate how well the Osteoporosis SelfAssessment Tool for Asians (OSTA) predicts hip fracture risk in perimenopausal women.

Material and Methods

A retrospective study was conducted at the Shri Mata Vaishno Devi Narayana Superspeciality Hospital in Katra, Jammu & Kashmir, India. From 2024 to 2025, the study included perimenopausal women who had intertrochanteric or femoral neck fractures caused by low-energy trauma. Patients were eligible for inclusion if they had undergone bone mineral density (BMD) measurements of the hip and spine on the contralateral (non-fractured) side at the time of the fracture.

Age-matched control participants without any history of lowenergy fractures were selected from the hospital's patient database based on medical records and available BMD results. For each woman with a hip fracture, two controls in the perimenopausal phase, matched within ±2 years of age, were included. Participants were excluded if they met any of the following criteria: (1) a history of spinal surgery, (2) any medical condition or ongoing treatment known to significantly affect bone metabolism, or (3) severe scoliosis or advanced degenerative lumbar disease that could compromise the accurate assessment of bone mineral density. Osteoporosis was diagnosed in all cases using a combination of clinical questionnaires and a review of medical records. The body mass index (BMI) was calculated using the standard formula: weight in kilograms divided by height in meters squared (kg/m^2). The OSTA (Osteoporosis Self-assessment Tool for Asians) index is calculated using the formula: [body weight in kg − age in years] × 0.2, with any decimal values truncated or reduced. Based on the resulting OSTA score, participants are classified into three risk categories for osteoporosis: low risk (score > −1), intermediate risk (score between −4 and −1), and high risk (score < −4). This simple index was computed for each participant using their recorded age, height, weight, body mass index (BMI), fracture site (if any), and the derived OSTA score. Data Analysis Statistical analyses were conducted using SPSS (Version 25). Continuous variables were summarised using the mean and standard deviation (SD). Differences between groups were evaluated using either the independent Student's t-test or analysis of covariance (ANCOVA), depending on whether the data met the assumptions of normality and distribution. The comparisons were adjusted for possible confounding variables. A p-value below 0.05 was considered statistically significant. In addition, the diagnostic performance of different parameters was evaluated using receiver operating characteristic (ROC) curve analysis, and the results were reported as the area under the curve (AUC) along with its 95% confidence interval.

Observation and Results

The final study group consisted of 182 women, including 62 with hip fractures and 115 controls. Table 1 presents the descriptive data of the study population.

Table 1

Subjects with fracture(n = 62)	*Mean (range)*	*SD*	*Control subjects(n = 115)*	*SD*	*p-value*
Age (years)	67	9.09	71.5	8.02	0.0123
Height (cm)	172	8.09	168	5.99	0.0009
Weight (kg)	73	9.75	40.15	9.8	0.0
BMI	28.21	3.87	21.09	3.7	0.8419
OSTA score	0.9	2.75	0.29	2.7	0.1591

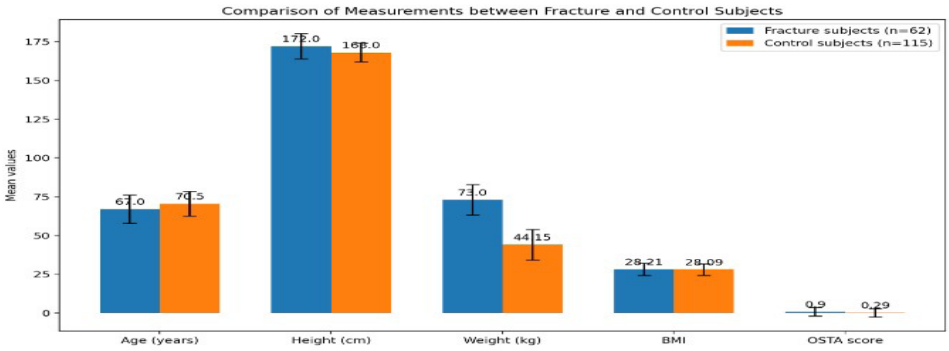

Figure 1

The study examined 62 individuals who had suffered fractures and compared them with 115 healthy control participants, assessing five key measurements in total. Those in the fracture group were slightly younger on average, at 67 years (SD 9.09), compared to 70.5 years (SD 8.02) in the control group. It shows that age plays a significant role ($p=0.012$) in increasing fracture risk in this population. Interestingly, the fracture patients were notably taller (172 cm ± 8.09 versus 168 cm ± 5.99, $p = 0.009$) and substantially heavier (73 kg ± 9.75 against 44.15 kg ± 9.8, $p < 0.001$). These findings highlight a clear link between greater height and body weight and a higher chance of experiencing fractures. In contrast, body mass index (BMI) showed almost no difference between the two groups (28.21 ± 3.87 in the fracture group versus 28.09 ± 3.7 in controls; $p = 0.8419$), suggesting that BMI may not be a useful indicator of fracture risk. Similarly, the fracture group had a somewhat higher OSTA score (0.9 ± 2.75) than the controls (0.29 ± 2.7), but this difference was not statistically significant ($p = 0.1591$), suggesting that the OSTA tool alone may not reliably predict fractures in these subjects. The specific measurements, such as age, height, and weight, can provide more valuable insights for fracture risk evaluation than BMI and OSTA.

Discussion

This study examined how well the Osteoporosis Selfassessment Tool for Asians (OSTA) could distinguish between women with type 2 diabetes who had experienced hip fractures and those who had not. The findings suggest that OSTA, when used alone, may still offer practical clinical value in this specific patient group. For a large number of women living with type 2 diabetes, any method used to assess fracture risk needs to be simple, quick, and inexpensive. OSTA meets all these requirements. It can be especially helpful in settings where dual-energy X-ray absorptiometry (DXA) scans are either too expensive or unavailable.

Bone mineral density (BMD) remains the most common way to estimate the likelihood of osteoporotic fractures in people with risk factors. However, earlier studies have produced mixed and sometimes conflicting results regarding BMD levels and the actual risk of osteoporosis among patients with type 2 diabetes mellitus (T2DM). In this particular study, women who had experienced hip fractures showed noticeably lower BMD values compared to the control group. Osteoporosis was also more common in the fracture group (66.7%) than in the control group (41.4%). The study's findings highlight a key observation: people with diabetes often have bones that are more likely to break, even though their bone mineral density (BMD) measurements are similar to those of people without diabetes. This heightened fragility is thought to stem from alterations in the bone's structural composition and its inherent material characteristics. Therefore, assessing the risk of fractures in people with type 2 diabetes presents unique challenges that go beyond what standard bone mineral density (BMD) tests can fully assess.

Though dual-energy X-ray absorptiometry (DXA) is widely regarded as the benchmark for assessing bone mineral density, its availability is often hampered by cost and resource constraints in many healthcare settings. Plain X-rays, by contrast, are only capable of revealing substantial

bone loss after a considerable portion—30 to 50 percent—of the bone mass has already been lost. To determine the most suitable OSTA cut-off values for predicting hip fractures in this population, researchers used the Youden index. This statistical approach helps find the threshold that best balances sensitivity and specificity. According to the analysis, OSTA scores of –2.5 and 2.5 were identified as indicators of increased fracture risk, and patients falling into these ranges may require closer monitoring and further evaluation.

However, when OSTA was tested in this group of diabetic women, its overall predictive performance turned out to be rather limited. There was no statistically significant difference in OSTA scores between the women who had hip fractures and those who did not. The receiver operating characteristic (ROC) analysis further confirmed only modest predictive ability, with an area under the curve (AUC) of 0.534, sensitivity of 44.8%, and specificity of 73.8%.

A key limitation appears to stem from the fact that OSTA relies solely on two factors — age and body weight. In patients with type 2 diabetes, obesity is very common, and this can interfere with the tool's accuracy. Excess body weight is known to help maintain bone mineral density through several mechanisms. These include hormonal changes, such as increased levels of leptin, estrogen, and insulin, as well as the mechanical stress that bones experience. Although this protective effect on BMD is beneficial, it can make it harder for OSTA to accurately identify people who are truly at high risk of fractures.

Conclusions - Unlike its limitations, OSTA can function as a quick and simple, expedient, and economical instrument for the initial evaluation of hip fracture risk in women with T2DM. Although it possesses little predictive value in this demographic, it is appropriate for extensive screening in the absence of DXA, enabling doctors to pinpoint patients who might require further assessment and management.

Abbreviations - Bone Mineral Density (BMD), Body Mass Index (BMI), and Osteoporosis Self-Assessment Tool for Asian (OSTA), and Dual-energy X-ray absorptiometry (DXA).

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