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Original Article

Trabecular Bone Score Is a Valuable Addition to Bone Mineral Density for Bone Quality Assessment in Older Mexican American Women With Type 2 Diabetes

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Abstract

Altered bone quality due to the underlying metabolic changes of type 2 diabetes (T2D) has been hypothesized to affect bone strength, leading to increased fracture risk in patients with T2D. Lumbar spine trabecular bone score (LS-TBS), an indirect measure of trabecular microarchitecture, provides information on bone quality and has been associated with T2D. However, trabecular bone score (TBS) is also affected by demographic patterns and body size, and is expected to be different in people from various ethnic or racial backgrounds. Therefore, it is important to understand associations between T2D and TBS for each ethnic or racial group separately. Although the relationship between TBS and age has been reported to be similar between non-Hispanic Caucasians and Mexican Americans (MAs), data on associations of LS-TBS with T2D in older MAs are lacking. Here, we report associations between TBS and T2D in 149 older MA men and women. Participants are part of a cohort known as the Cameron County Hispanic Cohort in Texas who have high prevalence of obesity and poor glycemic control. Bone mineral density was not altered for MA women with T2D, but was significantly higher in MA men with T2D compared with MA men without diabetes. Low LS-TBS was associated with T2D in women in our study. Although low TBS was associated with older age in men, TBS did not show any significant association with T2D for men. These results are similar to those found in other studies of non-Hispanic whites with diabetes. LS-TBS may add value in diagnosing poor bone quality in older MA women with T2D regardless of bone mineral density scoring.

Key Words: Bone mineral density; bone quality; Mexican Americans; trabecular bone score; type 2 diabetes.

Introduction

Dual-energy X-ray absorptiometry (DXA)-acquired bone mineral density (BMD) remains the gold standard for diagnosing osteoporosis and assessing risk of fragility fractures *(1)*. However, a paradoxical presence of fragility fractures with high or normal (nonosteoporotic) BMD in patients with type 2 diabetes (T2D) suggests that DXA may not be reliable for assessing fracture risk in subjects with T2D *(2)*. An altered state of bone quality—caused by underlying metabolic changes of T2D—has been hypothesized to cause reduced strength and bone turnover, leading to increased fracture risk in patients with T2D *(2,3)*. Trabecular bone score (TBS), an indirect measure of trabecular microarchitecture derived from lumbar spine DXA images, provides information on bone quality based on pixel

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gray-level variations in the DXA image *(4,5)*. Previous studies reported that lumbar spine TBS (LS-TBS) was decreased in patients with T2D compared with those without diabetes *(6,7)*. However, TBS was also reported to be affected by demographic patterns and body size, and thus may be different in people from various ethnic or racial backgrounds *(8)*. One study reported that LS-TBS may not be a better indicator of fracture in African Americans with T2D, as described for their Caucasian counterparts *(5)*. Thus, it is important to understanding associations between T2D and LS-TBS for each ethnic or racial group separately. Specifically, data are lacking in the literature concerning associations of TBS with T2D in older Mexican Americans (MAs). To evaluate the utility of LS-TBS for assessing fracture risk in MAs with T2D, it is important to first determine if lower LS-TBS is associated with T2D in older MA men and women.

The Cameron County Hispanic Cohort (CCHC) is a two-stage randomly selected "Framingham-like" cohort of MAs on the US Mexico border with severe health disparities. Prevalence of T2D in this cohort is much higher than the national average *(9,10)*. Here, we report associations between LS-TBS and T2D in the older MAs who are CCHC participants.

Materials and Methods

Study Participants

A bone health protocol (approved by UTHealth Committee for the Protection of Human Subjects) was developed in 2013 to understand epidemiology of skeletal health risk factors in relation to age-related bone loss and fracture risk in this population. Under this protocol, participants receive annual DXA-acquired BMD of the hip and spine regions by Hologic QDR 4500 (Hologic Inc., Marlborough, MA). A total of 171 men and women (72 with T2D and 99 without diabetes) from the CCHC who were 50 years or older were identified as having an LS-DXA scans performed between August 2014 and June 2017. After excluding men and women with body mass index (BMI) <15 and >37 kg/m^2 (based on working BMI ranges for LS-TBS *(5,8)*), a total of 153 LS-BMD scans were reanalyzed with the TBS software. Thus, 42 men and 59 women without diabetes and 14 men and 38 women with T2D were included in the final analysis.

Measurements

Areal BMD of the hip (femoral neck) and spine regions (L1–L4) were measured using Hologic Discovery W (Hologic Inc.). The lumbar spine anterior-posterior DXA images from these participants were used to calculate LS-TBS using TBS iNsight v2.1 (Medimpas, Merignac, France) in accordance with the manufacturer recommendations to generate the LS-TBS parameters of the lumbar spine (L1–L4). The percent coefficient of variation (CV%) for lumbar spine scans in the particular DXA machine used in our study is 0.97%.

Height in centimeters was measured using a stadiometer after participants removed their shoes, standing on the floor. Weight in kilograms was measured to the nearest 10th on a digital scale after participants removed their shoes and personal items from pockets. BMI was calculated as weight in kilograms divided by height squared in meters (kg/m^2). T2D status was based on self-reported physician diagnosed of diabetes or on the American Diabetes Association guidelines based on fasting plasma glucose and hemoglobin A1c (HbA1c) results.

Statistical Analysis

To account for known differences in BMD between men and women, data analysis for men and women was done separately in the current study. Data such as age, weight, height, and HbA1c were collected as part of the CCHC protocol.

For descriptive purposes, we also reported percent distribution of LS-TBS and LS-BMD in 3 different categories. We used the following ranges for categorizing the LS-TBS values *(4)*: LS-TBS ≤1.200 was categorized as degraded microarchitecture; LS-TBS between 1.200 and 1.350 was classed as partially degraded microarchitecture; and LS-TBS ≥1.350 was classed as normal microarchitecture. LS-BMD was categorized based on T-scores according to the World Health Organization criterion: osteoporotic (T-score ≤–2.5), osteopenia (T-score between –2.5 and –1.0), and or normal (T-score ≥–1.0).

Linear regression analysis determined if low LS-TBS was associated with T2D in older MA men and women. For the regression analysis, LS-TBS was the outcome (continuous form) variable for this study, and status of diabetes (a diagnosis of T2D or no diabetes) was the independent (categorical) variable for our analysis. The regression model was adjusted for age, BMI, HbA1c, and LS-BMD.

Results

Descriptive data for included subjects are shown in Table 1. Mean (±standard deviation) age for men and women were 64 (8) and 63 (8) yr. Mean (±standard deviation) BMI for men and women were 29 (4) and 30 (4) kg/m^2. Men with T2D had a statistically significant higher mean LS-BMD than men without diabetes, but there was no difference in LS-BMD for women. Although there were no differences in TBS between men with T2D and without diabetes, women without diabetes had a significantly higher mean TBS (Table 1).

Regardless of gender or diabetes status, the categorical breakdown was significantly different depending on whether LS-TBS or LS-BMD was used for classification (Fig. 1): more subjects were classified as having degraded architecture by LS-TBS than as osteoporotic by LS-BMD. However, when comparing subjects with T2D with subjects without diabetes, the results were dependent on gender. For MA men,