Journal of Clinical Densitometry: Assessment & Management of Musculoskeletal Health, vol. ■, no. ■, 1–5, 2016

1094-6950/■:1–5/$36.00
http://dx.doi.org/10.1016/j.jocd.2016.01.002

Original Article

The Effect of Changing Scan Mode on Trabecular Bone Score Using Lunar Prodigy

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Abstract

Trabecular bone score (TBS) is a measure of gray scale homogeneity that correlates with trabecular microarchitecture and is an independent predictor of fracture risk. TBS is being increasingly used in the assessment of patients at risk of osteoporosis and has recently been incorporated into FRAX®. GE Lunar machines acquire spine scans using 1 of 3 acquisition modes depending on abdominal tissue thickness (thin, standard, and thick). From a database review, 30 patients (mean body mass index: 30.8, range 26.2–34.1) were identified who had undergone lumbar spine DXA scans (GE Lunar Prodigy, software 14.10; Lunar Radiation Corporation, Madison, WI) in both standard mode and thick mode, on the same day with no repositioning. Lumbar spine bone mineral density (L1–L4) and TBS were derived from the 30 paired spine scans. There was no significant difference in lumbar spine bone mineral density between the 2 scanning modes. There were, however, significant higher TBS values from the spine scans acquired in thick mode compared to the TBS values derived from spine acquisitions in standard mode (mean TBS difference: 0.24 [20%], standard deviation ±0.10). In conclusion, these preliminary data suggest that TBS values acquired in the GE Lunar Prodigy are dependent on the scanning mode used. Further evaluation is required to confirm the cause and develop appropriate protocols.

Key Words: Osteoporosis; DXA; TBS.

Introduction

Trabecular bone score (TBS) is a measure of gray scale homogeneity that correlates with trabecular microarchitecture *(1,2)*. In large prospective studies, TBS has been shown to be a risk factor for fracture independently of bone mineral density (BMD) and other major risk factors including age and previous fracture *(3–5)*. TBS is being increasingly used in the assessment of patients at risk of osteoporosis and has recently been incorporated into the FRAX® algorithms *(6,7)*.

The precision of BMD and TBS is crucial for their reliable use as clinical tools in the assessment of osteoporosis. In the longitudinal assessment of patients, precision is particularly important as the rate of bone loss in most subjects is relatively slow (1%–2% pa). A complicating factor is that acquisition of dual-energy absorptiometry (DXA) spine scans can be obtained in different scanning modes. Changing scanning mode can potentially result in a small change of BMD *(8)*. However, in a situation where a patient has gained or lost a significant amount of weight between serial scans, the recommended scanning mode by the manufacturer may change from the mode used in earlier scans.

Bandirali et al *(9)* have previously reported from phantom *(10)* and in vivo studies *(11)* that there is no significant change in TBS between different scan modes using a Hologic QDR-Discovery A. There are no published data on precision of TBS between different scan modes using a GE Lunar Prodigy DXA scanner.

To maximize the ability to detect a real change in BMD, our departmental protocol is that, in patients returning for progress BMD evaluation who have experienced a significant change in weight, spine scans are acquired using the

Received 08/7/15; Revised 12/27/15; Accepted 01/6/16.
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recommended manufacturer scanning mode as well as in any different mode, which was recommended and used in the baseline scan. Our clinical experience with a GE Lunar Prodigy brought to light an unexpected difference in TBS when spine scans are acquired in different scanning modes. We report here our clinical experience in a group of 30 patients who underwent duplicate spine scans, with TBS assessment, as part of routine clinical care.

Materials and Methods

Subjects

From a review of our DXA database, we identified 30 patients returning for progress BMD evaluation who had experienced a significant change in weight and who had on their return visit subsequently been measured in 2 different spine scanning modes on the same day.

To determine the short-term precision of BMD and TBS using the same scanning mode, duplicate spine scans on the same day were obtained in 30 volunteers who had given informed consent.

DXA Scanning

Two experienced technologists acquired all scans using a GE Lunar Prodigy (Software14.10; Lunar Radiation Corporation, Madison, WI). GE Lunar recommends thin mode in subjects less than 13 cm, standard mode in subjects 13–25 cm and thick mode in subjects over 25 cm *(12)*. All subjects had spine scans acquired on standard and thick modes with no repositioning between the scans. Lumbar spine BMD (L1–L4) and the corresponding TBS were derived using standard analysis according to the guidelines of the International Society for Clinical Densitometry for both standard acquisition (BMDst and TBSst) and thick acquisition (BMDth and TBSth).

Statistical Analysis

In the 30 volunteers, precision of duplicate lumbar spine BMD and TBS, acquired on the same mode, was measured as the root mean square expressed as a percentage of the means.

In the 30 subjects with lumbar spine scans acquired in different scanning modes, precision of lumbar spine BMD and TBS was again expressed as the root mean square expressed as a percentage of the mean. The absolute BMD values (gram per square centimeter) and TBS values from the 2 scanning modes were compared using Student's paired *t*-test. The agreement between the 2 scanners in the measurements of TBS and BMD was tested using Bland–Altman analyses.

Least significant change (LSC) was calculated using the calculated precision and assuming a significance of $p \leq 0.05$.

Table 1
Characteristics of Patients

Variable	Mean	Standard deviation	Range
Age (yr)	66.5	9.8	41.5–81.8
Height (m)	1.63	0.10	1.47–1.82
Weight (kg)	79.8	8.8	61.0–94.0
BMI (kg/m^2)	30.1	2.6	25.0–34.1
Tissue thickness (cm)	25.2	1.1	23.0–27.7

Abbr: BMI, body mass index.

Results

Subjects

There were 30 subjects including 19 women (63%) and 11 men (37%) with lumbar spines acquired in both standard and thick scanning modes. The characteristics of the 30 subjects are shown in Table 1.

Within Scanning Mode Comparison

The precision obtained by the 2 technologists in duplicate scans of volunteers in the same scanning mode was equivalent. The precision of TBS acquired on the same mode was 1.3%. The LSC was 4%. Precision of lumbar spine BMD acquired on the same mode was 0.7% and the LSC was 2%.

Between Scanning Mode Comparison

There was no significant difference in lumbar spine BMD between standard and thick scanning modes (mean difference: 0.002 g/cm^2, standard deviation ±0.05, $p = 0.79$; Figs. 1 and 2).

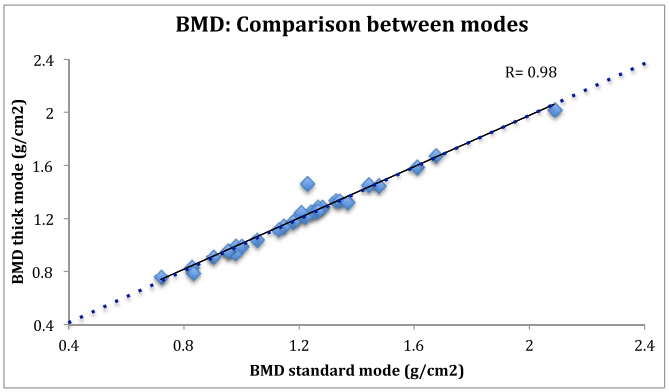

Fig. 1. Lumbar spine BMD (L1–L4) acquired on standard mode vs BMD acquired on thick mode. The regression line is shown (BMDth = 0.97, BMDst +0.04, $r = 0.98$, $p < 0.0001$). The line of identity is also shown. BMD, bone mineral density.