COMMENTARY

TBS and bone strength

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The recent study from Maquer et al.,¹ indicating that the initial slope of the variogram (ISV), foundation of the trabecular bone score (TBS), is not or poorly associated with vertebral strength has generated much interest and leads us to ask a number of questions.

Before focusing on conclusions of this paper and comment on it, a brief summary of where we are with TBS appears necessary.²⁻⁵

What is the TBS?

TBS is a texture parameter that evaluates pixel gray-level variations in anteroposterior dual energy X-ray absorptiometry (DXA) images of the lumbar spine. It was developed to reflect bone microarchitecture and is currently used in clinical studies for predicting fracture risk. The TBS analyzes local gray-scale variations in two-dimensional (2D) projection images. The method was initially described on three-dimensional (3D) micro-computed tomography (µCT) image and subsequently adapted for DXA images. The software for TBS computation (TBS iNsight, Geneva, Switzerland) can be installed on high-performance DXA machines. TBS and areal bone mineral density (aBMD) are computed in the same region of interest but separately and via different methods. A high TBS value is thought to reflect a microarchitecture associated with good mechanical strength. A low TBS value, in contrast, indicates poor-quality microarchitecture, TBS is thought to reflect the homogeneity of the trabecular microstructure, hence potentially a higher strength, although the respective contribution of trabecular vs cortical compartments to vertebral resistance to failure is not clear, being likely dependent on age. The TBS can currently and easily be obtained in everyday practice on DXA images of the lumbar spine. The reimbursement policy is not yet established in most countries, however. In clinical practice, the TBS may be used in a ‘qualitative’ manner, that is, for subjects with a normal BMD value and a low TBS value. From a quantitative point of view, the TBS may be used as a modulator of FRAX tool (see below).

What Evidence Do We Have Today That TBS Can Be Used for Predicting Fragility Fractures?

Several prospective studies have shown that TBS is an independent predictor of fracture. A meta-analysis including 17 809 persons (both men and women) has been recently published by McCloskey et al.⁶ The gradient of risk (GR) of TBS for major osteoporotic fracture was 1.44 (95% CI: 1.35–1.53) when adjusted for age and time since baseline and was similar in men and women. The gradient was quite similar for hip fracture: 1.44 (95% confidence interval (CI): 1.28–1.62). Also, the combination of both TBS and aBMD increases the prediction of fracture, as it was well demonstrated in the Manitoba cohort.⁷ These findings suggest that TBS and aBMD are two independent predictors of fracture. In the same manner, it has been shown that the correlation between TBS and lumbar spine aBMD is statistically significant but weak (r ≈ 0.3). When adjusted for FRAX 10-year probability of major osteoporotic fracture, TBS remained a significant, independent predictor for fracture (GR 1.32, 95% CI: 1.24–1.41).⁶ Also, the adjustment of FRAX probability for TBS resulted in no change in the GR (1.76, 95% CI: 1.65, 1.87 vs 1.70, 95% CI: 1.60–1.81), although some increase or decrease may be detected according to age.⁶ Owing to these findings, it is now possible to include in the FRAX the value of TBS for improving the calculation of the probability of both major and hip fractures.

What Evidence Do We Have Today That TBS Reflects Bone Microarchitecture?

Because of its measurement conditions (images obtained from DXA), the TBS cannot be considered as a true parameter measuring bone microarchitecture. Several ex vivo studies investigated the relationship between TBS and micro-architectural parameters. Winzenrieth et al.⁸ showed that TBS derived from 2D-projection µCT images of human cadaveric vertebrae correlated with several trabecular microarchitecture indices measured by µCT. The levels of correlation were as follows: Conn. D: r = 0.746 (P < 0.001), trabecular number (Tb.N): r = 0.637 (P < 0.001), and trabecular separation (Tb.Sp:
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