Dependence of Trabecular Bone Score with the Degree of Vertebral Body Compression

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Introduction

The evaluation of bone health and the prevention of fractures are important concerns in our aging populations. TBS represents the standard deviation of the areal bone mineral density (aBMD) distribution obtained by dual-energy x-ray absorptiometry (DXA) and is believed to characterize the mechanical integrity of the trabecular bone architecture. This belief was challenged in previous biomechanical studies and this work aims to understand the benefit of the Trabecular Bone Score (TBS) as an additional tool in clinical practice to evaluate the risk of subsequent vertebral fractures [1].

Materials and Methods

Twenty L1-L4 vertebral bodies were dissected from 5 fresh human donors (2M and 3F). A DXA scanning chamber was designed to measure TBS and aBMD of these vertebrae *ex situ*. Repeatability of both variables was quantified for various layers of attenuating water. Five successive uniaxial compression steps were then applied on each vertebra down to increasing strain levels from 2, 4, 8, 16 to 32%. The actual residual degree of compression was determined with a caliper after relaxation of the load. After each compression step, a DXA scan was performed to assess TBS and aBMD in the intact state and then after each compression step. Mixed linear regression models were fitted on TBS and aBMD with donor as a random effect, vertebral level as a fixed effect and the actual degree of compression as a continuous independent variable.

Results

Reproducibility of the DXA measurements were 1.256% and 1.377% and were comparable *in and ex situ*. The results of the model (see Fig. 1) show an overall positive correlation of aBMD with the degree of compression (r= 0.656, p< 0.01, rmse= 0.047) and a negative correlation of TBS with the degree of compression (r= -0.308, p= 0.005, rmse= 0.084).

Discussion

First, this *in vitro* study confirms the well-established notion that aBMD increases in fractured vertebrae. In a short period of time, during which no bone resorption has time to takes place, the bone mass is approximately constant for a decreasing area, leading to the increase of aBMD. This increase in aBMD may be wrongly interpreted as a positive effect on bone health and corrupts densitometric measures at the spine. Interestingly, the results demonstrate also that TBS decreases significantly with the degree of vertebral compression. In clinical practice, a reduction in TBS indicates a further risk of vertebral fracture. Accordingly, the present results suggest that TBS represents a coarse surrogate of a vertebral fracture assessment (VFA) and therefore predicts future vertebral fractures based on the well-known epidemiological relationship between existing and future vertebral fractures. This *in vitro* study has a few limitations. Particularly, only 5 donors were included in the study and *ex situ* DXA of a vertebral body does not account for the posterior elements and the soft tissues present *in vivo*.

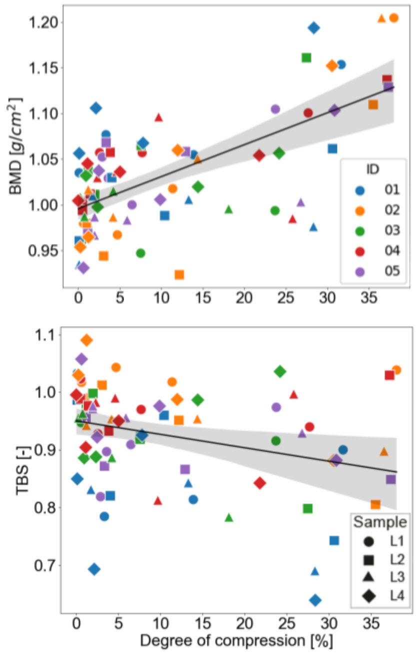

Fig. 1 The figure illustrates the positive correlation of aBMD on the top, and the negative correlation of TBS, on the bottom, with respect to the degree of vertebral compression. Each vertebra from L1 to L4 is indicated with a different marker and colors differentiate each donor.

References

[1] Mirzaali et al. (2018), PloS ONE 13(8):e0202210
[2] Maquer et al. (2016), J Bone Miner Res 31(2):341-346.

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