

DISTRIBUTION OF BONE MINERAL DENSITY IN THORACIC AND LUMBAR VERTEBRAE: AN *EX VIVO* STUDY USING DUAL ENERGY X-RAY ABSORPTIOMETRY (DXA).

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INTRODUCTION

Vertebral fractures are considered to be one of the hallmarks of osteoporosis. The aetiology of these fractures remains unclear, since individuals with comparable bone mineral density (BMD) measured with DXA demonstrate different prevalence rates for fracture. Previous research has demonstrated heterogeneity of bone properties within the vertebral centrum [1]. The distribution of BMD within the centrum may help to explain the aetiology of these fractures. The majority of vertebral fractures occur in the mid thoracic spine. However, DXA cannot be used to measure BMD in this area *in vivo*. The aims of the current study were to determine if regional differences exist in BMD in thoracic and lumbar vertebrae and to determine if the patterns of BMD distribution were similar between these levels.

METHODS

Six embalmed cadaver spines were used for this study (mean 81yrs). Antero-posterior and lateral DXA scans were performed on each specimen with an Hologic QDR4500 densitometer. The lateral scan was used to calculate areal BMD for the whole vertebral body and in 3 subregions orientated longitudinally (posterior, middle, anterior) and 3 subregions orientated transversely (superior, central, inferior) for T7, T8, L2 and L3. Vertebral areas were defined manually by the raters and were of equal size in each plane for each vertebral body. Differences in subregional BMD were examined using a one way repeated measures ANOVA with 4 levels set *a priori* (whole vertebral body with 3 subregions) to prevent *post hoc* comparisons of overlapping subregions.

RESULTS AND DISCUSSION

A significant difference in subregional BMD was found for T7, T8, L2 and L3 ($p < 0.05$). Post hoc tests revealed significantly lower BMD in the central zone of T7, T8, L2 and L3 ($p < 0.05$) (see Figure 1), and in the anterior zone of L2 and L3 ($p < 0.05$) (see Figure 2). Volumetric BMD, rather than areal BMD may be a better variable for longitudinal subregion comparisons due to differences in their 3D geometry. These results confirm the ability of a commonly used clinical tool, DXA, to detect differences in BMD within vertebral bodies. The results also demonstrate that interpretation of whole vertebral BMD in isolation can obscure potentially important regional density characteristics. The lower BMD observed in the central subregion of thoracic and lumbar vertebrae may help to explain the mechanisms underlying vertebral crush fracture. Compared to the other subregions, the central subregion contains minimal cortical bone and maximal trabecular bone. Therefore, this area may be of significant clinical importance given that trabecular bone is known to be

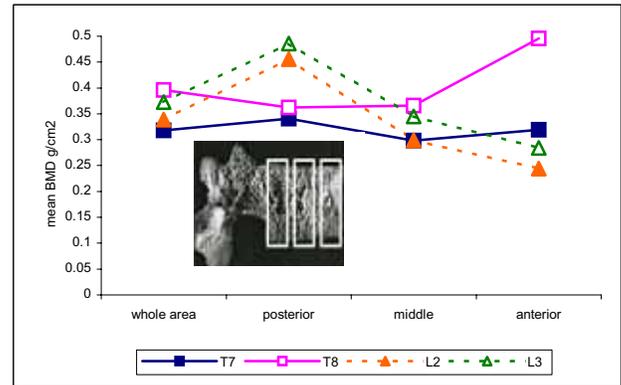


Figure 1: Mean BMD for whole vertebral area and posterior, middle and anterior (transverse) subregions at T7, T8, L2, L3

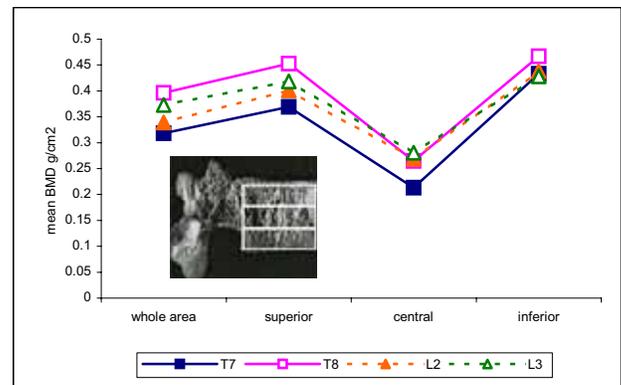


Figure 2: Mean BMD for whole vertebral area and superior, central and inferior (longitudinal) subregions at T7, T8, L2, L3

the dominant structural component in resisting compressive load [2]. Significantly lower BMD in the anterior zone of lumbar vertebrae may help to explain a mechanism for vertebral wedge deformity. Figure 2 illustrates a similar density distribution profile between thoracic and lumbar vertebrae. Given that thoracic BMD cannot be measured *in vivo* with DXA, it may be plausible to assume that measurement of lumbar subregional BMD could be used to predict thoracic BMD distributions.

CONCLUSIONS

DXA can be used to detect differences in BMD within vertebral bodies. These differences may explain, in part, mechanisms underlying vertebral fracture. Intra-vertebral density profiles show some similarities between thoracic and lumbar vertebrae.

REFERENCES

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2. Silva MJ, et al. *Spine* **22**, 140-150, 1997.