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Oral Abstract

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Contribution of trabecular rod spatial orientation to prediction of vertebral body bone strength

Parkinson IH[1], Badiei A[1], Stauber M[2], Müller R[2] and Fazzalari NL[1]
[1]*Division of Tissue Pathology, Institute of Medical and Veterinary Science and Hanson Institute, Adelaide, South Australia*
[2]*Institute for Biomechanics, ETH Zurich, Zurich, Switzerland*

Micro-CT imaging enables measurement of bone microarchitecture and subsequently mechanical strength of the same sample. It is possible using micro-CT data to perform morphometric analysis on individual rod and plate bone trabeculae using a volumetric spatial decomposition algorithm and hence determine their contribution to bone strength.

Twelve pairs of vertebral bodies were harvested from 12 human cadavers and bone cubes (10mmx10mmx10mm) were obtained. After micro-CT imaging, the volumetric spatial decomposition algorithm was applied. Trabecular rods were classified as horizontal or vertical and mean rod and plate thickness (<Ro_H.Th>, <Ro_V.Th>, <Pl.Th>) mean rod and plate length (<Ro_H.L>, <Ro_V.L>, <Pl.L>) and BV/TV were calculated for each sample. Bone strength was measured in compression, where one sample from each pair was tested supero-inferiorly (on-axis) and the paired sample was tested antero-posteriorly (off-axis).

BV/TV was the strongest predictor of on-axis (r^2=0.77, p<0.0001) and off-axis strength (r^2=0.54, p<0.0001), respectively. Prediction of on-axis strength was improved to r^2=0.87 with the addition of <Ro_V.Th>, <Ro_V.L> and <Pl.L>. Prediction of off-axis strength was improved to r^2=0.83 with the addition of <Ro_H.L>, <Pl.Th> and <Pl.L>.

Microarchitectural measures of individual trabeculae that contribute to bone strength have been identified. In addition to the contribution of BV/TV, measures of horizontal trabecular rods and trabecular plates contribute an additional 29% to prediction of off-axis strength, whereas measures of vertical trabecular rods and trabecular plates contribute an additional 10% to prediction of on-axis strength. Decomposing vertebral body bone architecture into its constituent elements enables identification of the critical components that determine bone strength.