2007 ANZBMS ASM
17th Annual Meeting of the Australian & New Zealand Bone & Mineral Society
9-12 September 2007, Queenstown, New Zealand
www.anzbms.org.au/asm/asm2007

2007 Best Clinical Abstract

Winner: Dr Ian Parkinson, *et al.*

Abstract:

Prediction of vertebral body bone strength: the contribution of individual trabecular elements

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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.

Forty eight 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. Mean rod and plate thickness (<Ro.Th>, <Pl.Th>) mean rod and plate length (<Ro.L>, <Pl.L>), mean rod and plate volume (<Ro.V>, <Pl.V>), BV/TV, total rod volume (Ro.BV/TV) and total plate volume (Pl.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 $r^2=0.90$ with the addition of <Ro.L>, <Pl.Th> and Pl.BV/TV. Prediction of off-axis strength was improved to $r^2=0.92$ with the addition of <Ro.V>, <Ro.L> and the ratio of <Ro.V> to <Pl.V>.

Microarchitectural measures of individual trabeculae that contribute to bone strength have been identified. In addition to the contribution of BV/TV, trabecular rod morphology contributes 38% to prediction of off-axis strength, whereas measures of trabecular plate and rod morphology contribute 13% 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.