Understanding the Relationship Between Loading History and Trabecular Architecture in the Sheep Calcaneus

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Cortical and cancellous bone are believed to adaptively remodel to the forces applied to them and it has been suggested that both types of bone reflect the accumulated affects of their loading history. These concepts are applied to sheep calcanei, shown to be loaded in habitual bending, in order to test the hypothesis that the trabecular architecture would reflect an adaptive response to the compression/tension loading history of the bone.

One calcaneus from each of eleven skeletally mature sheep were obtained and scanned in a Micro-CT at a 46-micron resolution. Using the MicroView program, the trabecular number, trabecular thickness, trabecular separation, connectivity, and bone volume fraction were measured in 3mm cubic regions of interest (ROIs). A total of eight ROIs were taken from the tension and compression regions at 20, 30, 40, and 50% of diaphyseal length. The data collected was then compiled and analyzed using T-test and ANOVA statistical analyses.

The data were inconsistent in their statistically significant differences and did not observably reflect an adaptive response to the loading history of the bone. While the hypothesis was not completely supported some trends in trabecular architecture were observed. First, the trabecular number, thickness, and connectivity all decrease in the region of compression and increase in the region of tension along the observed lengths. Also between the 20-50% lengths, the bone volume decreases for both regions. Finally, there may be support for trabecular adaptation to mixed loading at the 20-30% lengths versus pure bending at the 40-50% lengths.

Due to the statistical inconsistencies of the results, more research is needed to understand what correlation, if any, exists between trabecular architecture and loading history before any conclusions can be drawn. Future studies should take into consideration additional measures of trabecular architecture and the morphology of the surrounding cortex.