Affects of hormone and bisphosphonate treatment in osteoporosis

Beamline: U10B

Technique: Infrared microspectroscopy

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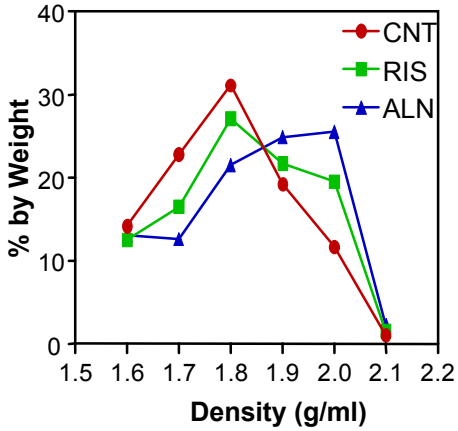
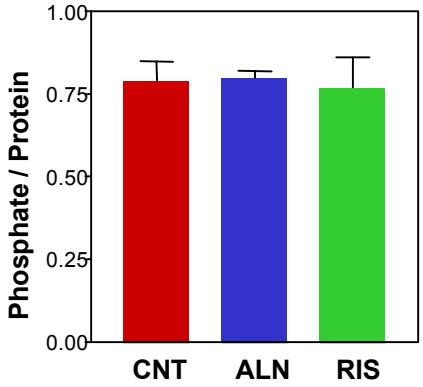
Motivation: Suppression of bone turnover using anti-resorptive agents such as bisphosphonates prevents bone loss but also may increase tissue mineralization. This may change the mechanical properties of bone, making them more prone to initiate microcracks. In a recent study, we examined whether suppression of remodeling, caused by treatment of 35 dogs for one year with five times the clinical dose of either alendronate or risedronate, was associated with increased bone mineralization, and whether it changed the nature of the mineral crystal.





(Left) Density centrifugation of control, ALN, and RIS treated bone, demonstrating a macroscopic increase in bone mineral density. (Right) FTIR imaging of the same treatment groups reveals no local over-mineralization.

Results: Density fractionation, infrared microspectroscopy, peripheral quantitative computerized tomography (pQCT), and quantitative backscattered electron microscopy (qBSE) were used to evaluate changes in mineral and matrix content and composition of bone tissue on a macroscopic and microscopic level. Following 12 months of treatment, density fractionation demonstrated a significant shift towards higher bone density in both alendronate ($p = 0.04$) and risedronate ($p = 0.002$) treated bone. However, the three microscopic imaging modalities (IR, pQCT and qBSE) did not detect any significant differences in mineralization. This suggests that there was *no local over-mineralization* of the tissue; the treatments simply increased the overall *quantity* of fully mineralized bone. In addition, no significant differences in the collagen structure, or in the maturity, length, or size of the mineral crystals were detected. There were also no differences in tissue elasticity or hardness. Thus, we concluded that bisphosphonate treatment at high doses allows bone to fully mineralize, increasing the propensity for microcracks to form. At the same time, bisphosphonates slow the damage-repair process, so these microcracks accumulate over time instead of being replaced by new, healthy bone.