

Examination of Bone Chemical Composition in Osteoporosis Using Fluorescence-Assisted Synchrotron Infrared Microspectroscopy

L. Miller, J. Tibrewala (NSLS, BNL) and C. Carlson (Dept. of Veterinary Medicine, U. of Minnesota)

Abstract No. Mill8087

Beamline(s): U10B

Although it is clear that osteoporosis is associated with a reduction in bone mass and a fragile skeleton, it is not understood whether the chemical composition of osteoporotic bone is different from normal bone. In this study, cynomolgus monkeys (*Macaca fascicularis*) were administered fluorochrome labels at one (calcein-label) and two (alizarin complexone-label) years after ovariectomy (Ovx) or Sham ovariectomy (Intact), that were taken up into newly remodeled bone. Using fluorescence-assisted synchrotron infrared microspectroscopy, the chemical composition of bone from Intact versus Ovx monkeys has been compared. Results from overall composition distributions (labeled + non-labeled bone) reveal similar carbonate / protein and phosphate / protein ratios, but increased acid phosphate content and different collagen structure in the Ovx animals. Analysis of the fluorochrome-labeled bone indicates similar degrees of mineralization in bone remodeled after one year, but decreased mineralization in Ovx bone remodeled two years after surgery. Thus, bone from monkeys with osteoporosis can be characterized as having abnormal collagen structure and reduced rates of mineralization. Coupled with factors such as trabecular architecture and bone shape and size, these ultrastructural factors may play a contributing role in the increased bone fragility in osteoporosis.

L.M. Miller, J. Tibrewala, C.S. Carlson (2000). Examination of bone chemical composition in osteoporosis using fluorescence-assisted synchrotron infrared microspectroscopy. *Cellular and Molecular Biology*, **46**:1035-44.

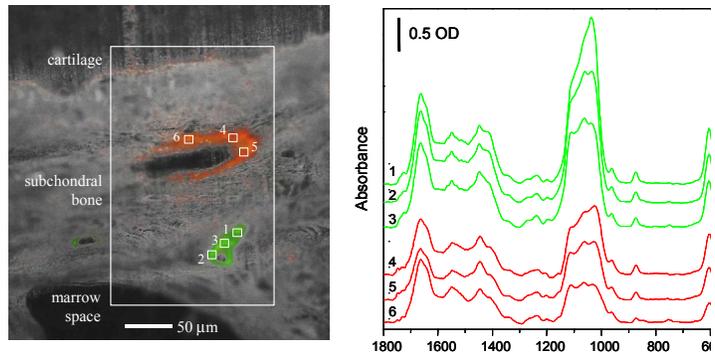


Figure 1. (Left) Region of subchondral bone from an Ovx monkey. (Right) Individual IR spectra were collected in the calcein-labeled region of bone (remodeled 1 year after surgery, spectra 1-3) and alizarin complexone-labeled region of bone (remodeled 2 years after surgery, spectra 4-6). For each of these spectra, 128 scans were collected at 4 cm^{-1} resolution using a $10 \times 10 \text{ }\mu\text{m}$ square aperture and a Cu-doped Ge detector

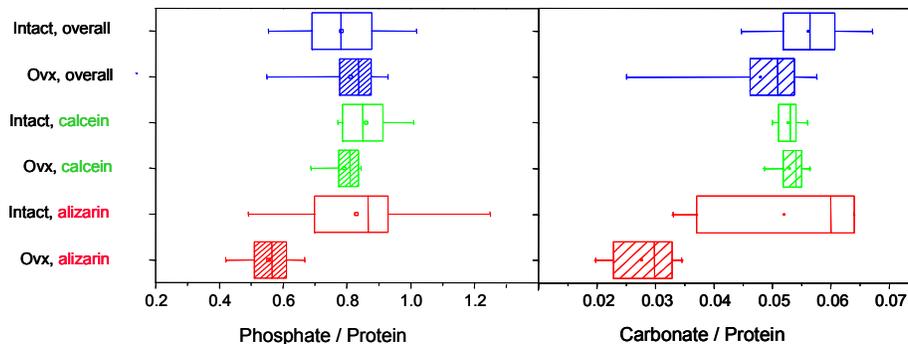


Figure 2. Box and whisker plots illustrating the overall, calcein-labeled, and alizarin-labeled chemical composition distributions for Intact versus Ovx monkeys: (left) phosphate / protein ratio; (right) carbonate / protein ratio. Box vertices represent 25, 50, and 75 percentiles of the data; whiskers represent 5 and 95 percentiles. Squares in the centers of the boxes represent the mean value for the distribution. In the Ovx animals, both phosphate/protein and carbonate/protein ratios are significantly decreased two years after ovariectomy (alizarin-labeled bone).