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AN ANALYSIS OF ZINC DISTRIBUTION IN THE CORTICAL BONE OF THE HUMAN FEMUR

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Abstract

The distribution of zinc in the cortical bone of human femora was undertaken in this study. Two mid-shaft femora from a collection of samples from the Malawi Sub-Saharan African Modern Human collection were used. The samples were collected with the cooperation of the University of Malawi Medical School and the New York University College of Dentistry. The samples were cut, processed, embedded, sectioned and elemental data was extracted via laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS). The fine spatial resolution and minimal sample destruction of this technique made it a prime candidate for understanding how zinc fluctuates across human cortical bone.

In this study, we analyzed the zinc content gradient from the periosteal to endosteal surface. Areas of organized, primary lamellar bone and secondary osteonal bone were sampled. An internal standard of calcium was used to form zinc/calcium ratios suitable for analysis. Hard tissue microscopy techniques were used to analyze bone growth rate. As zinc deficiency has been repeatedly linked to growth stunting in clinical literature and in cell biology as a promoter for osteoblast bone formation, it is hypothesized that bone growth rate should correlate with zinc content. Lamellar bone has been shown to be an incremental tissue corresponding with biological rhythms seen in teeth. Thus, in areas of wider lamellae (i.e. higher bone growth rate) we should see higher levels of zinc and in areas of smaller lamellae (i.e. lower bone growth rate) we should see lower levels of zinc.

Zinc was not seen to fluctuate with bone growth in areas of greater lamellar bone deposition (wider lamellae) nor with areas of thinner lamellae. The Zn/Ca ratios were seen to tightly correlate with the type of bone tissue sampled, however. The highest Zn/Ca ratios were observed in the periosteal and secondary remodeled bone, while the lowest being in the endosteal bone. Significant differences in Zn/Ca ratio were found between endosteal bone and periosteal/secondarily-remodeled bone. This study reemphasizes the importance of trace elements, such as zinc, as they relate to hard tissue growth and metabolism.