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Variation in juvenile long bone properties as a function of age: mechanical and compositional characterization

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Abstract-

Bone is a heterogeneous, hierarchical biocomposite material made of an organic matrix filled with a mineral component, which plays an important role in bone strength. Although the effect of the mineral/matrix ratio on the mechanical properties of bone during aging has been intensively investigated, the relationship between the mechanical properties and the chemical composition of bone with age requires additional research in juvenile individuals. In this study, bone coupons from bovine and ovine animal species were machined from cortical areas of long bones to quantify whether the variation in mechanical properties at different stages of development is related to the change in the composition of bone tissue. An energy-dispersive X-ray detector (EDX) attached to a scanning electron microscope (SEM) was used to perform a compositional analysis of the tissue. In addition, nanoindentation analyses were carried out to address how the elastic modulus changed with age. Nonparametric statistical analyses found significant differences (p < 0.05) in Ca content and elastic modulus between species, but no differences were found within each species with development. A multiple linear regression model found that the elastic modulus was significantly related to the decrease in P and C in the samples, to the animal species (larger in bovine), and development, although not linearly. This model also found an interaction between Ca and development that could explain the lack of significance of the relationship between the elastic modulus and development in the univariate models.

Index Terms- cortical bone; aging; elastic modulus; nanoindentation; composition

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