Cortical bone composition and orientation as a function of animal and tissue age in mice by Raman spectroscopy

Abstract

Important aspects of bone tissue quality include the physicochemical properties of its main constituents, the organic matrix and the mineral crystals. One of the most commonly reported measurements of Raman analysis of bone is the mineral to matrix ratio, obtained from the ratio of the integrated areas of any of the phosphate and amide peaks which depend on both tissue organization and composition. Cube-like samples of normal mouse cortical bone taken from the diaphysis and metaphysis of the femur were investigated within different age groups (2, 4, 8 and 12 weeks) by Raman microspectroscopy. Anatomically identical bone in both longitudinal and transverse directions was analyzed, enabling the discrimination between orientation and composition changes both as a function of animal age, and tissue age within the same animal. The results of the present study indicate that there is a parallel evolution of both orientation and chemical composition as a function of animal age, as well as tissue age within the same specimen. Our tissue age modified ratio of the carbonate to phosphate Raman peaks suggests that the bone mineral crystallite maturity remains relatively constant with animal age. Comparisons of polarized and depolarized experiments in the transversal plane of the diaphysis show a lack of orientation effects as a function of tissue age within the same animal, but exhibit differences as a function of animal age. In the metaphysis, the orientation effect is evident too, albeit less pronounced. This is most likely due to either the age difference between the two tissues within the same specimen in the long bone axis, as metaphyseal bone is generally younger than diaphyseal, or the more random orientation of the tissue collagen itself.