TISSUE MINERALIZATION OF HYDROXYAPATITE

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Apatite/hydroxyapatite, one of the most widely distributed minerals in the world, exists in both sedimentary and organic environments. Although the crystallographic structure and chemical information of apatite minerals is well documented, an understanding of the formation/transformation mechanism at the microscopic level remains unclear. This paper presents the (bio)mineralization of hydroxyapatite in both natural and laboratory environments using an electron microscopy approach with an emphasis on the mineral/substrate interface.

Previous examination of hydroxyapatite's role in the development of tesserae of shark skeletons have found morphologically and elementally distinctions in the mineralized and unmineralized phases of tesserate. Both SEM and TEM images of collagen fibers illustrated the formation of tesserae and mineralization of tissue. Cross-sectional EM study revealed that isolated mineralized phases were embedded in the unmineralized tissue and hydroxyapatite crystals have been observed "walking" out from the mineral border onto the variously mineralized fibers. Electron diffraction and HRTEM images indicate that prismatic cartilage was composed of nanocrystalline hydroxyapatite. Microchemal analysis using EDS also showed a dramatic increase of Ca and P at the mineralization front while S gradually decreased.

The formation of hydroxylapatite in synthetic tissue was examined in the laboratory for bone implant integration. SEM images show that the osteoblastic culture on the acidetched Ti disk had a fibrous network with small globular structures. The cross-sectional TEM study shows a layer of well-mineralized tissue developed on the Ti substrate. The mineralized tissue consists of fibrous and platy minerals composed of Ca and P, and has the diffraction characteristic typical of hydroxylapatite. Tissue cultured remotely from the Ti layer appeared amorphous. The numerous short-range ordered fringes observed in HRTEM, indicate the presence of poorly defined nanocrystallites, which in turn infers the onset of crystallization had occurred in the tissue. The mineralization behavior of hydroxyapatite in different parts of tissue demonstrate that Ti had a positive effect on the process of tissue mineralization.

Keywords: biomineralization, tissue mineralization, hydroxyapatite, electron microscopy