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Ultrasonic wave properties in the bone axis direction of bovine cortical bone

Kazufumi Yamamoto[a], Yuichiro Yaoi[b], Yu Yamato[a], Takahiro Yanagitani[c], Takaaki Koizumi[b], Mami Matsukawa[b], Kaoru Yamazaki[a] and Akira Nagano[a]
[a]Orthopaedic Surgery, Hamamatsu University School of Medicine, 1-20-1 Handayama Higasi-ku, 431-3192 Hamamatsu, Japan
[b]Doshisha University, 1-3, Tatara Miyakodani, 610-0321 Kyotanabe, Japan
[c]Graduate school of engineering, Tohoku University, 28 Kawauchi Aoba-ku, 980-8579 Sendai, Japan

Quantitative ultrasound (QUS) is a good method to measure elastic properties of bone (one indicator of bone quality) in vivo. Bovine cortical bone has two typical microstructures, plexiform and Haversian. In the nanoscopic level, bone consists of calcium phosphate, which forms incomplete hydroxyapatite (HAp) crystal. The preferred orientation of c-axis of HAp crystallites induces anisotropy and inhomogeneity of elastic properties in bone. In this study, relationship between speed of sound (SOS) and HAp crystallites orientation in the axial direction were investigated in two foreign age bovine cortical bones. The dependence of attenuation on the anatomical position was also investigated. Two ring shaped cortical bone samples were made from 36 and 24-month-old bovine femur. SOS was measured by a conventional ultrasonic pulse system, using self-made PVDF transducers. The integrated intensity of (0002) peak obtained using X-ray diffraction was estimated to evaluate the amount of preferred orientation. Regardless of age, a significant correlation between SOS and preferred orientation of HAp crystallite was observed in the parts of the plexiform structure, and gradient of the relation showed a similar tendency. Attenuation seemed to strongly depend on bone microstructure because of its porosity.