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Structural and Morphological Characterization of Inorganic Deposits in Spinal Ligaments

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Abstract : The mineralization is a curious problem of connective tissues. Factors which may play a decisive role in the regulation of the yellow ligaments (YL) mineralization are still open questions. The aim of the studies was a detailed description of the chemical composition and morphology of mineral deposits in the human yellow ligaments. Investigations of the structural features of deposits were used to explain the impact of various factors on mineralization process. The studies were carried out on 24 YL samples, surgically removed from patients suffer from spinal canal stenosis and the patients who sustained a trauma. The micro-computed tomography was used to describe the morphology of mineral deposits. The X-ray fluorescence method and Fourier transform infrared spectroscopy were applied to determine the chemical composition of the samples. In order to eliminate the effect of blur in microtomographic images, the correction method of partial volume effect was used. The mineral deposits appear in 60% of YL samples, both in patients with a stenosis and following injury. The mineral deposits have a heterogeneous structure and they are a mixture of the tissue and mineral grains. The volume of mineral grains amounts to (1.9 ± 3.4)*10-3 mm3 while the density distribution of grains occurs in two distinct ranges (1.75 - 2.15 and 2.15-2.5) g/cm3. Application of the partial volume effect correction allows accurate calculations by eliminating the averaging effect of gray levels in tomographic images. The B-type carbonate-containing hydroxyapatite constitutes the mineral phase of majority YLs. The main phase of two samples was calcium pyrophosphate dihydrate (CPPD). The elemental composition of minerals in all samples is almost identical. This pathology may be independent on the spine diseases and it does not evoke canal stenosis. The two ranges of grains density indicate two stages of grains growth and the degree of maturity. The presence of CPPD crystals may coexist with other pathologies.

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