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AGE-RELATED CHANGES IN BONE AND MUSCLE TISSUE IN FORENSIC MEDICINE

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Abstract: The literature review provides current data on the morphology and morphological equivalents of external influences on the bone, as well as the consequences of pathological processes. From the point of view of the cited authors, the strength, hardness, fragility and elasticity of bone are associated with the interactions of bone tissue nanostructures, and the nanomechanism of bone injury is given.

Keywords: Forensic medicine, method, treatment, trauma, bone tissue.

INTRODUCTION

Bone tissue has always been the object of close attention of forensic doctors, anthropologists, and orthopedic traumatologists. Views on the morphology and functions of bone tissue over the past 30 years have progressively changed from an isomorphic structure to an actively metabolizing tissue. Views on the morphological components of bone tissue changed similarly.

MATERIALS AND METHODS

Bone tissue is considered as a five-level medium [9, 13, 17, 20, 25] with a bipolar macromolecule of tropocollagen in complex with inorganic crystals - in the first level. The next three are structural gradations of collagen microfibrils, and the 5th structural level is the structural element of bone – osteon [2, 5]. According to the qualitative characteristics of bone tissue, dense matter consists of thin bone plates, the boundaries of which on transverse sections of bone appear very clearly, since the cavities of bone plates in dense bone matter are located, as a rule, between adjacent plates. In some places, the bone plates are in contact with each other, and in some places, intercalary plates are located between them [1, 3].

RESULTS AND DISCUSSION

Each plate consists of bone crystals that have a constant structure in the form of ordered hexagonal and even seven-sided prisms with arched shapes. With probe microscopy, bone crystals usually have a size of 20x5x1.5 nm. Undoubtedly, the sizes of crystallites and microstrains of the crystal lattice are important substructural characteristics of bioapatite, determining its physical and crystal chemical properties [2]. Separate determination of these parameters and the establishment of their quantitative relationship with age-related and pathological changes significantly expands modern ideas about the bone mineral, since the sizes of crystallites are associated with their surface features, and microdeformations of the lattice are associated with its defects and imperfections structures [4].

Bone tissue in the body is presented in two types: compact, or cortical, and spongy, or trabecular [3]. A distinctive feature of the structure of bone tissue is a large amount of intercellular substance with a relatively small number of bone cells. Inorganic compounds predominate in the intercellular substance. In compact bone, the so-called organic matrix makes up about 20%, inorganic substances – 70% and water – 10%. Organic components predominate in cancellous bone (>50%), inorganic components account for 35–40%.

The main component of the organic matrix of bone tissue (>95%) is fibrillar protein – collagen. Collagen is directly involved in mineralization processes, being an excellent stimulator of the nucleation of bioapatite crystals [2]. As a result of the interaction of collagen with mineral matter, a perfect biological structure is formed, characterized by enormous mechanical strength and high physiological activity [3]. Tropocollagen contains three polypeptide chains, which have a helical shape and are twisted into a triplet around a common axis, forming a second-order helix. The construction of higher order molecular structures – secondary and tertiary – in collagens, as well as in other proteins, is determined by the primary structure – the sequence of amino acid residues in polypeptide chains [5].

Probe microscopy of the bone tissue of the lower jaw shows that collagen molecules are not connected end-to-end, and there is a gap of 35–40 nm between them. It is assumed that in bone tissue these spaces act as mineralization centers where calcium phosphate crystals are deposited. With atomic force microscopy, fixed and contrasted collagen fibrils appear transversely striated with a period of 67 nm, which includes one dark and one light stripe, with an average diameter of 100 nm. It is believed that such a structure maximizes the resistance of the entire unit to tensile loads. The dynamics of deformation is influenced by many factors: this is the direction vector, the speed of impact, the mass of the traumatic object and its area, etc. The scale of destruction - the length and extent of the fracture with a constant magnitude of impact - is almost always different [1, 3], which many authors associate with the individual physical characteristics of the bone (hardness, fragility, structural features). This motivates the judgment about the mutual relativity of the degree of destruction and the magnitude of the external influence. All these factors can be clarified when applied to the study of dense tissues using atomic force microscopy.

The combination of fibrils with crystals constitutes the first structural level of bone tissue. The main structural element of bone tissue is formed due to the connection of fibrils into plates or cylindrical shells, which are collectively called lamellae [5].

CONCLUSION

The emergence and beginning introduction of atomic force microscopy into research practice would make it possible, without particularly complex preparation of objects, to use native bone to establish, first of all, the relationship between the organic and mineral matrix, to give quantitative and qualitative characteristics of both organic and mineral matrix.

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