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Changes of Surface Electric Potential of Bones Depending on their Age

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Summary

The aim of this research was to determine how surface electric potential of bones changes with their age and how it correlates with mechanical properties of bones. Surface electric potential was measured in 6 cross-sectional zones of the tibia. Changes of bones surface electric potential with age were determined and correlations between surface electric potential and mechanical properties were derived.

Introduction

Previously it was determined that adhesion of osteoblasts happens more rapidly when electric potential of hydroxyapatite (HAP) increases.[1] By knowing that concentration of HAP in bones is fairly high (~50 %) [2] and osteoblasts are cells that synthesize bone, it can be deduced that electric potential might play a role in bone remodeling process . By knowing how electric potential changes in bones with their age some other correlations may be derived, i.e. between electric potential and mechanical properties because mechanical properties of bones also change with age. The aim of this research was to determine how surface electric potential of bones changes with age and how it correlates with the mechanical properties of bones.

Methods

Electric potential measurements were made on bovine tibia bone using *Solver P-47 PRO* atomic force microscope with *Kelvin Probe Force Microscopy* function. Bovine bones of different ages were selected and divided into 3 age groups: *young* (0.5 – 1 y/o); *middling* (2 – 4 y/o); *old* (5 y/o and older). Measurements were made along the mid-axes of each of 6 bone cross-sectional zones (Fig. 1).

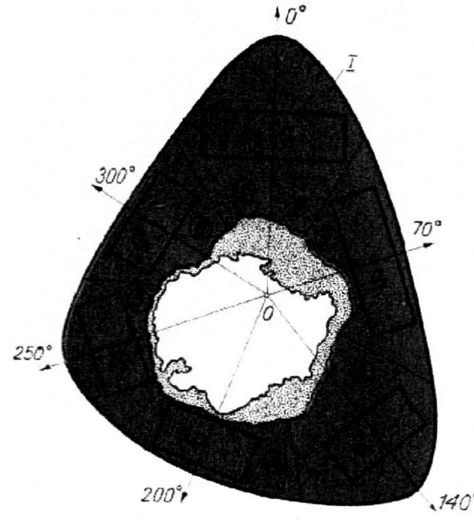

Fig. 1. Mid-axes of 6 bone cross-sectional zones that are determined by angle with the mid-axis of the first zone (0 °) [3]

Results

It was determined that electric potential of bones differ between the cross-sectional zones (Fig. 2). Maximal values of electric potentials can be found in the so called *corner zones* (zones number 1, 3 and 5) (Fig. 2).

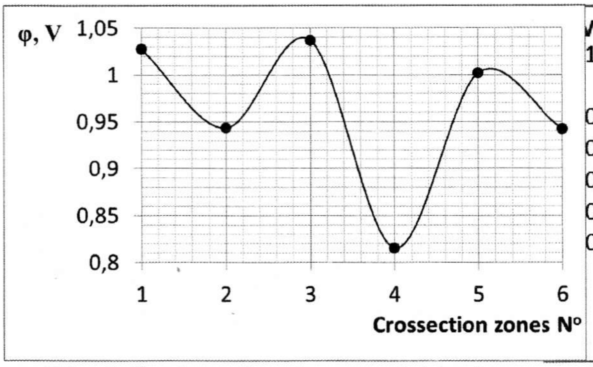

Fig. 2. Surface electric potential in 6 cross-sectional zones

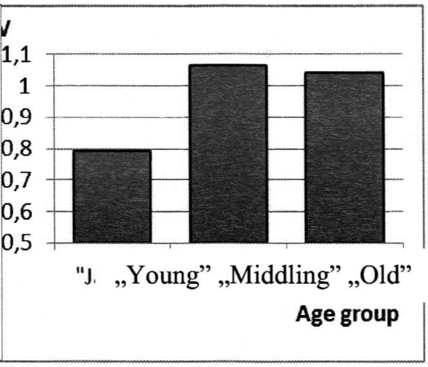

Fig. 3. Surface electric potential of bone in different age groups

Mechanical properties of these 6 cross-sectional zones are already known [3]; therefore, correlations between electric potential and mechanical properties can be derived. It was found out that there is a strong positive correlation between electric potential and mechanical properties when bone is deformed in radial direction such as elastic modulus, ultimate strain and Poisson coefficient. There were no correlations between electrical potential and these mechanical properties when deformation applied in different directions.

It was also determined that electric potential changes with age (Fig. 3). It can be seen that electric potential increases from *young* to *middling* bones and then decreases to old bones.

Conclusions

1. Surface electric potential in bones changes with their age;
2. Electric potential correlates with mechanical properties of bones, because it has an influence on bone remodeling process.

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