THE STRUCTURE OF LONG BONES’ DIAPHYSIS COMPACTA IN LEPORIDAE, OBSERVED IN POLARIZING MICROSCOPE

STRUCTURA COMPACTEI DIAFIZARE A OASELOR LUNGI LA LEPORIDAE, OBSERVATĂ LA MICROSCOPUL DE POLARIZARE

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The study of limb long bones of two Leporidae species was done on dried bone preparations, obtained by polishing and then examined in usual polarized microscopy and also in circular variant using a potassic mica filter of \(\frac{1}{4}\lambda\). In diaphysis and metaphysis compacta were identified three basic histoarchitectural types: osteonal type in diaphysis, interstitial type in proximate metaphysis and circumferential type, specific for distal metaphysis. The micrometric measurements effected to diaphysis level put into evidence more fragile bony structure in domestic rabbit as consequence of life in captivity, without excessive locomotory requirements, comparatively to more strong bony structure present in wild rabbit.

**Key words:** wild and domestic rabbit, long bones, histoarchitecture, micrometric measurements

Introduction

On skeleton bones of vertebrates, still during ontogeny and then entire life, there exert various action forces (compression, drive, torsion etc.). Their action, conjugated with induced reaction forces, creates in the bony tissue a “tension state”, which by mechanisms incomplete cleared up will determine not only the anatomic details of bones, but also their histoarchitecture, until to submicroscopic level and even to molecular one [2].

Because of genetic determination and also such ones, the skeleton bones are considered mechano-structures in which the materialized support of mechanical needs is developed mainly in direction of requirements [3]. As result, each bone became an “absolute minimal construction”, which gives maximal resistance with minimal bony tissue consumption [4]. Then, having the stamp of all actions, which exerted on them, it means that structural details of bones reflect precisely the measure of their actions.

These concepts were the motivation of present comparative study of limb long bones’ histoarchitecture in two species of *Leporidae*, in which the locomotory...
apparatus is solicited in different manner, depending on captivity and wilderness conditions.

**Material and Methods**

The researches were effected on limbs’ long bones (humerus, radius, ulna, femur and tibia) from five domestic rabbits (Spotted breed) and five wild rabbits (*Lepus europeus* sp.), all males and with relatively the same body weight.

After usual processing of bones (maceration, degreasing, drying etc.), were effected microscopic preparations by polishing, but not coloring. The samples have been transversal sections through diaphysis middle and through the two metaphysis, proximate and distal ones.

To observe more clearly the lamellar bone structure we must use the polarizing microscope, in usual variant and in circular one, with potassic mica filter of $\frac{1}{4}\lambda$, which inducing color effects permitted a better making evident of bony lamellae arrangement [7].

On same preparations were done some measurements by ocular micrometer proceeding, such as: diaphysis external diameter, medullar canal diameter and diaphysis compacta thickness. Also, was calculated the medullar index as ratio between medullar canal diameter and diaphysis compacta thickness [6].

**Results and Discussions**

The examination in polarized light of all microscopic preparations puts into evidence that, depending on predominant manner of lamellae arrangement in the diaphysis compact bony tissue, there are three types of histoarchitectures:

1. **The osteonal type** in which, between two circumferential lamellae (inner and outer), can be seen a great number of osteons (Havers systems) and few spaces among them are filled with interstitial lamellae (inter-haversian).

2. **The interstitial type** characterized by the fact that the space between outer and inner circumferential systems is occupied by reduced number of osteons and the predominant structures are the interstitial lamellae.

3. **The circumferential type** in which the extension limit of outer and inner circumferential systems is hard to be done, because the diaphysis compacta is made especially by concentric bony lamellae (perimedullar and subperiosteum), with rare small size osteons among them.

The existence of some structural specific features, personal to each studied bone, permits however the finding that in all cases, both in domestic rabbits and also in wild ones, the compacta histoarchitecture in diaphysis middle is of osteonal type, that one of proximate metaphysis is of interstitial type and that one of distal metaphysis is of circumferential type.

Besides some dimensional differences between the two *Leporidae* species, which will be analyzed further on, it must be mentioned that in wild rabbit species
the osteons have smaller diameter and were more numerous than in domestic rabbit species.

Some experimental researches lead to conclusion that the bony structure, which gives maximal mechanical resistance, is the osteonal one, especially when the osteons are smaller, dense and with tight collagen fiber winding in lamellae [11]. Tests effected on isolated osteons have demonstrated that maximal resistance to pressure is all greater as the lamellae contain more collagen fibers, this fact establishing an increased degree of bony matrix mineralization [1].

In order of mechanical resistance, after osteonal structural type is situated the interstitial type observed in proximate metaphysis compacta, and with more reduced resistance the circumferential type presents in distal metaphysis. In lever position of limb long bones, the mechanical requirement by bending is maximal to diaphysis level and proximate metaphysis requirement is superior to that of distal metaphysis one [10].

The results of micrometric measurements are presented as average values in table 1.

<table>
<thead>
<tr>
<th>Bone name</th>
<th>Diaphysis diameter (mm)</th>
<th>Medullar canal diameter (mm)</th>
<th>Diaphysis compacta thickness (mm)</th>
<th>Medullar index (MI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dr</td>
<td>Wr</td>
<td>Dr</td>
<td>Wr</td>
</tr>
<tr>
<td>Humerus</td>
<td>8.0</td>
<td>9.5</td>
<td>6.2</td>
<td>6.7</td>
</tr>
<tr>
<td>Radius</td>
<td>4.9</td>
<td>5.3</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Ulna</td>
<td>5.4</td>
<td>6.4</td>
<td>3.8</td>
<td>4.2</td>
</tr>
<tr>
<td>Femur</td>
<td>8.0</td>
<td>12.0</td>
<td>5.6</td>
<td>8.4</td>
</tr>
<tr>
<td>Tibia</td>
<td>8.5</td>
<td>9.8</td>
<td>5.7</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Dr –domestic rabbit; Wr –wild rabbit

As first observation, we note that in wild rabbits, comparatively to domestic ones, there are evident superior values of diaphysis diameter, relatively the same values for medullar canal diameter and less important differences for diaphysis compacta thickness and for medullar index. From these values also results the fact that do not exist a direct correlation between external diameter of limb long bones and diaphysis compacta thickness, but only between this diameter and that one of medullar canal. Thus, for example, radius and ulna, with diaphysis diameter much smaller than that one of humerus and femur, presents close values of diaphysis compacta, but is very different as concerns the medullar canal diameter. In these species, can be considered that mechanical resistance to bending or breaking of limb long bones’ diaphysis is realized not only by bony mass increasing, that is by diaphysis compacta thickening, but also realizing an optimal medullar index.

As concerns the mechanism of these mechano-structures making, a very important role has the genetic factor, which means that osteoprogenitor cells,
derived from mesenchymal cells, will differentiate in accordance to personal genetic program. Then, the skeleton pieces’ plan suffers ontogenetic induction phenomena, which will be remodeled by environment factors’ influence, and finally to realize structures adapted to functional requirements, typical for each species [8]. In present day conception, all processes that intervene and regulate the adaptation of a lining structure to mechanical requirements are comprised in mechano-state name. In case of bone as organ, the diverse mechanical requirements induce in his structures a tension state, named by the American authors “Minimum Effective Strain” (MES), which means minimal tension, capable to transmit for mechano-state signals to which gives reply by bony remodeling system. This system, in his turn, is dependent on endocrine metabolic factors [5].

Conclusions

The observations from presented research confirm the fact that each bone of skeleton has unique histoarchitecture, in relation with his position in locomotory system and with character of requirements to which is liable to. In this context is situated also the structure differences of limb long bones in the two Leporidae species, whose locomotory systems are extremely different requested.

Bibliography

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Studiul structurii oaselor lungi ale membrelor de la două specii de Leporidae s-a făcut pe preparate din os uscat, obținute prin șlefuire, care apoi au fost examinate în microscopie de polarizare obișnuită și în varianța circulară, utilizând un filtru de măcă potasă de ¼ λ. În compacta diafizei și a metafizelor au fost identificate trei tipuri histoarhitecturale de bază: ostonal în diafiză, interstițial în metafizele proximale și circumferențial, caracteristic metafizelor distale. Măsurătorile micrometrice efectuate la nivelul diafizelor au evidențiat la iepurele domestic o structură osoasă mai fragilă, consecință a vieții în captivitate, lipsită de solicitări locomotorii excesive, comparativ cu structura osoasă mai robustă prezentă la iepurele sălbatic.

Cuvinte cheie: