INFLUENCE OF SEX ON BONE MINERAL DENSITY AND CONTENT OF THE SKELETON OF THE THORACIC AND PELVIC LIMB IN THE OSTRICH - STRUTHIO CAMELUS VAR. DOMESTICUS

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Abstract

The influence of sex on bone mineral density (BMD) and the bone mineral content (BMC) have been analysed in selected bones of the thoracic and pelvic limbs of African ostriches. The examination was conducted with the use of a densitometer, using the technology of affinited beam of X-ray and the programme for animal research. It was shown that the analysed bones of ostrich skeleton differed significantly regarding the BMD and BMC. Significantly higher values of both parameters were recorded in case of the bones of the pelvic limb in comparison with the bones of the thoracic limb. A central part of the shaft of the tibio-tarsal bone and its proximal end (the pelvic limb) were characterised by the highest values for both BMD and BMC, whereas for the ulnar and radial bones (the thoracic limb) the lowest values were obtained. The study also demonstrated that males showed a significantly higher BMD and BMC values than females referring to the pelvic bones, i.e. the tibio-tarsal bone. For further study aiming at monitoring changes in BMD and BMC during the growth and development of ostriches from hatching till the 14th month of life, the use of densitometer intravitally is recommended.

Key words: ostrich, sex, bone, limb, mineral content, mineral density.

Ostriches (Struthio camelus) developed long and strong limbs, which are their biggest environmental advantage, as the limbs are their perfect support for the whole body (14). For effective functioning, the limbs must be characterised by a proper anatomical structure. Unfortunately, as a result of the intensive farm breeding, more often health problems are observed in many birds (8, 9) connected with limb deformities and other malfunctions (15). In some cases, there were also fractures observed, especially of the tibio-tarsal bone (1, 2) or the tarso-metatarsal bone, mainly in young growing ostriches (6, 11, 15, 25, 26). The fractures, similarly to the intravitral deformities, such as distorsion of the tibial bone and splayed legs (6, 10), may be the symptom of disorders in the bone mineral metabolism connected with the insufficient content of minerals in the bone tissue (BMC) or improper mineral density (BMD). It should be noted that current literature about ostriches mainly focuses on breeding and feeding technology (4, 5, 7, 17), reproduction (13, 16, 18-20, 24, 28), or genetics (16, 21), and there is a shortage of information about the anatomy, including bone mineral content and density. It seems that conducting such research would be a valuable way to complete our knowledge within the scope (3). The aim of the study was therefore to determine the influence of sex on the BMD and BMC in selected bones of the thoracic and pelvic limbs of ostriches.

Material and Methods

The research material consisted of the selected limb bones of ostriches (Struthio camelus var. domesticus) (8 males and 7 females) taken from 14-month-old birds. The birds were fed mixed concentrates for growing and bred ostriches STRUŚ PREMIUM (Nutrena, Poland) with the addition of 0.3% of OPTAVIT SHELL (Trouw Nutrition, Poland) and calcium gluconate. The ostriches were examined before slaughtering to eliminate the existence of diseases, especially those of the locomotion system. The examined birds showed no clinical symptoms and abnormalities concerning the locomotion system. Before
slaughtering ostriches were weighed using electronic live stock scale TP 1500/4, max load up to 15,000 kg, exact to 0.5 kg. Slaughter was conducted in compliance with EU standards and approval by the Bioethical Commission of the University. Then, the bones were separated from the soft tissues and the mineral content of the bones was analysed and given in g/cm² for BMD and in g for BMC. The following bones belonging to the skeleton of the thoracic limb were examined: the humeral bone, radial bone, and ulnar bone, and the following bones of the pelvic limb: the femoral bone, tibio-tarsal bone, and tarso-metatarsal bone. In all cases, the whole bones were analysed. As far as the tibio-tarsal bone is concerned, due to its frequent exposure to injuries in the species, the analysis concerned the central part of the shaft and its proximal end separately.

The BMD and BMC analysis was conducted with the use of a densitometer Norland, Excell Plus (Fort Atkinson, USA), using the technology of affinitied beam of X-ray and the programme for animal research (Small Subject Scan 3.9.6. version) at scanning resolution of 3.0 x 3.0 mm and scanning speed of 60 mm/s. The densitometer was calibrated before each measuring series with the use of a phantom provided by the producer.

Statistical analysis was based on the two-factor analysis of variance. The t-Tukey's test (at P≤0.05) was used to compare the averages for bones and sexes. Moreover, numerical material was characterised with the use of arithmetical average (\(\bar{x}\)) and standard deviation (±S.D.). The calculations were conducted with the use of STATISTICA 6.0 programme.

**Results and Discussion**

The mean values of the BMD and BMC of the examined limb bones depending on sex of the ostriches are shown in Table 1. On the basis of Table 1, it can be considered that the analysed bones of the ostrich skeleton differ significantly as far as the BMD and BMC are concerned. Significantly much higher values (P<0.01) of both analysed parameters were recorded in bones of the pelvic limb in comparison with the bones of the thoracic limb. Significantly higher value of the BMD had the tibio-tarsal bones of males in comparison with females in both the proximal end and shaft. In the analysis of the mineral content in the tibial bone, significantly higher values were observed in the end proximal to the shaft in males than in females (Table 1).

### Table 1

Average values (\(\bar{x}\)) of BMD and BMC, with standard deviation (±S.D.), of particular bones of the thoracic and pelvic bones of 14-month-old ostriches

<table>
<thead>
<tr>
<th>Quality</th>
<th>Bone type</th>
<th>Males</th>
<th>Females</th>
<th>Average for the species ((\bar{x}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD (g/cm²)</td>
<td>Humerus</td>
<td>0.665±0.115</td>
<td>0.718±0.048</td>
<td>0.688±0.09</td>
</tr>
<tr>
<td></td>
<td>Radius</td>
<td>0.244±0.026</td>
<td>0.22±0.021</td>
<td>0.232±0.024</td>
</tr>
<tr>
<td></td>
<td>Ulna</td>
<td>0.275±0.03</td>
<td>0.267±0.017</td>
<td>0.270±0.022</td>
</tr>
<tr>
<td></td>
<td>Femur</td>
<td>1.329±0.15</td>
<td>1.201±0.135</td>
<td>1.252±0.148</td>
</tr>
<tr>
<td></td>
<td>Tibiotarsus end proximal to the shaft</td>
<td>1.847±0.203</td>
<td>1.487±0.001</td>
<td>1.727±0.024</td>
</tr>
<tr>
<td></td>
<td>Tibiotarsus middle of the shaft</td>
<td>1.994±0.065</td>
<td>1.811±0.079</td>
<td>1.933±0.113</td>
</tr>
<tr>
<td></td>
<td>Tarsometarsus</td>
<td>1.603±0.212</td>
<td>1.578±0.176</td>
<td>1.588±0.18</td>
</tr>
<tr>
<td></td>
<td>Humerus</td>
<td>55.233±10.724</td>
<td>58.64±4.057</td>
<td>56.69±8.14</td>
</tr>
<tr>
<td></td>
<td>Radius</td>
<td>4.658±1.032</td>
<td>4.06±0.572</td>
<td>4.30±0.8</td>
</tr>
<tr>
<td></td>
<td>Ulna</td>
<td>6.059±0.619</td>
<td>5.79±1.143</td>
<td>5.90±0.93</td>
</tr>
<tr>
<td></td>
<td>Femur</td>
<td>265.250±26.786</td>
<td>247.97±30.69</td>
<td>254.88±29.02</td>
</tr>
<tr>
<td></td>
<td>Tibiotarsus end proximal to the shaft</td>
<td>472.500±58.161</td>
<td>435.60±7.495</td>
<td>460.20±49.03</td>
</tr>
<tr>
<td></td>
<td>Tibiotarsus middle of the shaft</td>
<td>495.225±42.641</td>
<td>510.300±42.144</td>
<td>500.25±38.82</td>
</tr>
<tr>
<td></td>
<td>Tarsometarsus</td>
<td>281.825±73.473</td>
<td>279.400±61.172</td>
<td>280.37±62.29</td>
</tr>
</tbody>
</table>

*ab…e AB.E Within columns means bearing the different superscripts are significantly different: small letters at P≤0.05, capital letters at P≤0.01.
*Means within rows are significantly different at P≤0.05.
In the central part of the shaft of the tibial bone, the mineral content was slightly higher in females; however, no significant statistical differences were observed. The zeugopodium, which is the radial bone and ulnar bone, had the lowest values for both BMD and BMC. They also did not differ significantly referring to this parameter (Table 1). Comparing the achieved results for BMD in ostriches with the values obtained in other bird species, it appeared that e.g. in laying hens’ tibiotarsal bones are characterised also by the highest values for BMD in comparison with other bones of the limbs. A comparison of average values of BMD for the humeral bones in ostriches and hens showed that the values for ostriches were over two times higher (30). Similar dependences were confirmed in analysis of mineral density of the bone tissue of the pelvic bones in broiler chickens conducted by Korver et al. (23), where average values of BMD in seven parts of the tibial bones of 30-week-old birds were analysed.

Within the bones of the pelvic limb, higher values of BMD and BMC were recorded for the tibiotarsal bone than for the femoral bone. Similar results were observed in research carried out on hens (12, 22, 29, 30).

It should be also noted that the presented studies show that in ostriches, the values of BMD and BMC of the femoral bone are higher than those of the humeral bone. This was also observed in the research conducted on laying hens (27).

In summary, there were significant differences concerning BMD and BMC values (higher in males) in the pelvic skeleton of ostriches. Moreover, significantly higher values of both analysed parameters were observed in the pelvic limb bones in comparison with the thoracic bones. The highest values were observed in the central part of the shaft of the tibio-tarsal bone and its proximal end, whereas the lowest values were recorded in the radial and the ulnar bones (the thoracic bones).

In the further research on changes in BMD and BMC during growth and development of ostriches, from the 1st d till 14th month of age, which is the time of achieving somatic maturity, the use of densitometer intravitally is recommended. Thus, the method may be a non-invasive tool in diagnostics of early disorders in bone development of birds (important for animals’ well-being) and may contribute to the improvement of ostrich health status.

References

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