Short communication

Bone mineral density and bone mineral content of the bilateral first phalanges of the thoracic limbs in horses

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Abstract

The bone mineral density (BMD) and the bone mineral content (BMC) in the bone tissue of the bilateral first phalanges of horses' thoracic limbs were analysed. The research material consisted of isolated pastern bones derived from 22 horses. The research was conducted with the use of a Norland model Excell Plus densitometer (Fort Atkinson WI, USA), using affinited beam X-ray technology and an animal research programme (Research Scan, 3.9.6. version) at the following parameters: scanning resolution of 1.5 x 1.5 mm, scanning speed 60 mm/s. The differences between BMC and BMD values in bilateral first phalanges in the thoracic limbs in horses were found to be nonsignificant. It also appeared that there are statistically significant positive correlations between values of the left and right bone of both analysed variables.

Key words: horse, first phalanx, bone mineral density, bone mineral content

Introduction

The relation between hand preference and the bilateral BMD and BMC of the right and left bones were measured in humans by Dual-energy X-ray absorbtiometry. These studies demonstrated that hand preference results in important differences in BMD and BMC between the bilateral bones belonging to both the thoracic and pelvic limbs (Kannus et al. 1994, Walters et al. 1998, Akar et al. 2002, Sanchis-Moysi et al. 2010). The aim of our study was to check if values of BMD and BMC of the bilateral first phalanges of an individual horse are correlated, and to determine whether there are significant statistical differences between the bilateral bones to the advantage of any of the sides. The possibility of predicting BMD and BMC of one limb on the basis of the proximal phalanx in the thoracic limb of the limb of the other side of a particular individual was also analysed.

Materials and Methods

The research material consisted of isolated proximal phalanges of the thoracic limbs derived from 22 horses (age 2.5-15 years). There were no animals in

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Table 1. Results of the analysis of linear correlation and regression analysis for BMD and BMC of the first phalanges for right (P) and left (L) limbs.

Bone feature	Pearson's correlation coefficient r	Regression functions
BMD	0.7706, *p-value*<0.001	BMD_L = 0.0467 + 0.9766 · BMD_P BMD_P = 0.0610 + 0.9656 · BMD_L *r*2=94.2
BMC	0.7864, *p-value*<0.001	BMC_L = 1,5112 + 0.9837 · BMC_P BMC_P = 0.7554 + 0.9915 · BMC_L *r*2=97.5

which any anomalies concerning the pastern bones had been noted intravitally, and their slaughter or death were not the result of disease. After isolating the pastern bones, they were kept for 4 months at a temperature of -20°C. The research was conducted with the use of a Norland, Excell Plus densitometer (Fort Atkinson WI, USA), using affinited beam X-ray technology and an animal research programme (Research Scan, 3.9.6. version) at the following parameters: scanning resolution of 1.5 x 1.5 mm, scanning speed 60 mm/s. The densitometer was calibrated with the use of a phantom provided by the producer before each series of measurements. The mineral content of the bones was then analysed and given in g/cm^2 for BMD and in g for BMC. Descriptive statistics (the average standard deviations and coefficient of variability) were used to analyse the numeral material concerning density and mineral content in the first phalanges. Normality of the studied parameters was checked using the Shapiro-Wilk test. Pearson's correlation coefficient (r) was determined for BMD and BMC. Regression functions describing relations between BMD and BMC were determined. Remainders were analysed. The calculations were conducted with the use of a STATISTICA 6.0 programme.

Results and Discussion

Normality of the BMD variable arrangement was checked using the Shapiro-Wilk test for left limbs (Shapiro-Wilks W statistic = 0.935; p-Value = 0.157) as well as for the right limbs (Shapiro-Wilks W statistic = 0.958; p-Value = 0.446). Normality of the BMC variable arrangement was then checked using the Shapiro-Wilk test for left limbs (Shapiro-Wilks W statistic = 0.965; p-Value = 0.583) and for right limbs (Shapiro-Wilks W statistic = 0.979; p-Value = 0.886). Both variables fulfilled the assumptions of normality of feature arrangements, from which the studied attempts came. Pearson's linear correlation coefficient (r) was used to

determine the relation between values of BMD and BMC for the right and the left bone of a particular individual. A strong positive linear correlation between the values for the right and the left bone was found concerning both analysed variables (results: r$_{BMD}$=0.7706, p-value<0.001 and r$_{BMC}$=0.7864, p-value<0.001). This means that when values of BMD and BMC in the left limb are high (or low), then the values of the same features in the right limb will have also high (or low) values respectively. Thus, on the basis of one bone we can predict BMD and BMC of the contiguous pastern bone of a given individual. The achieved regression functions and coefficients of determination r^2 are shown in Table 1. The values of coefficients of determination over 90% show a strict relation between BMD and BMC values for the right and the left limb.

To check if there are significant differences between the bilateral bones to the advantage of any of the sides a t-test for matched pairs was used. There were no significant differences between BMD values for right and left limbs (t = 1.26, p-value = 0.22), similarly for BMC of the left and right limbs (t = 1.38, p-value = 0.18) in contrast to humans.

Studies concerning the BMD and BMC in the bilateral third metacarpal bones were performed by Tóth et al. (2010). The research was conducted using the method of dual X-ray absorptiometry. The results of the analysis were similar to ours. It appeared that differences between BMD values in bones of the bilateral limbs were not significant. The lack of statistically significant differences between the bilateral first phalanges concerning the BMD and BMC can be explained by the character of remodelling and modelling of such types of tissues. A short-lasting extensive loading of a particular thoracic limb during the work of a horse is sufficient to cause statistically significant differences in the incidence of traumas of the soft structures of the locomotor system in the bilateral thoracic limbs. However, this does not have any influence on differentiation of the BMD and the BMC in the bilateral first phalanges in the thoracic limbs in horses.

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