BONE MINERAL DENSITY CHARACTERISTICS OF THE THIRD METACARPAL/ METATARSAL DISTAL EPIPHYSIS OF THOROUGHBRED HORSES

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SOPHIE HELEN BOGERS

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Abstract

This thesis includes two studies using non-invasive imaging techniques to quantify, in detail, the bone mineral density (BMD) characteristics of the distal third metacarpal (Mc3) and metatarsal (Mt3) epiphyses of Thoroughbred horses associated with exercise exposure and condylar fracture. Additionally, the relationship between the bone structure of the distal Mc3/Mt3 epiphysis and incurred cyclic loading, as well as techniques for imaging the area non-invasively, are reviewed.

Mt3 bones from fourteen trained or untrained Thoroughbred horses and Mc3 bones from fourteen Thoroughbred racehorses with or without condylar fracture were scanned using peripheral quantitative computed tomography (pQCT) at a site on the distal epiphysis. The relative proportions of volumetric bone mineral density (BMD_V) and the spatial distribution of BMD_V were quantitatively assessed using conventional and ArcGIS software. The relative proportion of voxels within nine threshold categories of BMD_V and spatial statistics of BMD_V distribution were compared for regions of interest in the palmar/plantar epiphysis between respective treatment groups; trained vs. untrained controls or fractured vs. non-fractured controls.

In study one, trained horses had a significantly higher ($P \leq 0.006$) proportion of high BMD_V voxels and a significantly lower ($P \leq 0.006$) relative proportion of low BMD_V voxels than controls in the central condylar regions of the plantar Mt3 epiphysis. In other regions of the plantar epiphysis the trained horses also had a significantly higher ($P \leq 0.006$) relative proportion of high BMD_V voxels than controls; however, there were no significant differences for the relative proportion of low BMD_V voxels. These relationships were also evident with multiple correspondence analysis. There was strong to marked clustering of high BMD_V voxels in the central condylar region of all of

the trained horses (I = 0.64 - 1.0, P = 0.01) and no clustering of low BMD_V voxels. In contrast, half of the control horses had clustering of high BMD_V voxels, which was weak to strong (I = 0.64 - 1.0, P = 0.01) and there was weak to moderate clustering of low BMD_V voxels in the lateral and medial central condylar regions (I = 0.45-0.62, P = 0.01 and I = 0.45-0.57, P = 0.01, respectively).

In study two, there were no significant differences between the median age (P = 0.7), number of race starts (P = 0.5), the relative proportion of BMD_V voxels, or the spatial distribution of BMD_V voxels in regions of the palmar Mc3 epiphysis between the fractured and control groups.

The results of this thesis suggest that the response of bone to exercise is specific in relation to anatomical site, the thresholds of BMD that change, and the spatial distribution of BMD. In both studies the exercise exposure was responsible for much of the variation in the relative proportions and the spatial distributions of BMD_V.

The clinical relevance of these findings are that detailed quantification of previous exercise exposure needs to be considered when determining if a BMD response of the Mt3/Mc3 epiphysis is part of a physiological or pathological finding.

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List of abbreviations

BMD	Bone mineral density
BMD_V	Volumetric bone mineral density
CT	Computed tomography
GIS	Geographic information systems
Mc3	Third metacarpal bone
MCA	Multiple correspondence analysis
MRI	Magnetic resonance imaging
MSI	Musculoskeletal injury
Mt3	Third metatarsal bone
POD	Palmar/plantar osteochondral disease
pQCT	Peripheral quantitative computed tomography
PSBs	Proximal sesamoid bones
ROI	Region of interest
SCB	Subchondral bone

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