

Evaluation of Bone Density in the Equine Third Metacarpal Condyle

Summary: The third metacarpal bone of the equine fetlock joint has been identified as one area of interest due to its involvement in a number of injuries. It has been shown that computed tomography can detect lesions not evident on radiographs in horses. The aim of this study is to evaluate bone density, utilizing CT scanning and peripheral computer modeling, of the distal articular surface of the left fore third metacarpus as it pertains to age.

Equine athletes, particularly racehorses, are subjected to great strain and stress, and thus tend to incur particular injuries to their bones and joints. The third metacarpal bone of the fetlock joint has been identified as one area of interest due to its involvement in a number of injuries. It has been shown that computed tomography can detect lesions that were not evident on radiographs in horses. Computed tomography (CT) has been used for many years to estimate relative bone density using the Hounsfield Unit scale. More recently, technology has provided the means to convert two dimensional CT slices into three dimensional models to evaluate bone density. A K_2HPO_4 density equivalent phantom has been designed to convert Hounsfield units to true density in g/cm^3 . The phantom is scanned along with the patient, and a conversion equation to bone mineral content has been derived that represents a linear relationship between Hounsfield units and density in g/cm^3 . In a study supported by the Southern California Equine Foundation, and performed by Dr. CE Kawcak and Marti Shearin, an MS student in the lab, CT scanning and modeling will be evaluated. The aim of this study is to evaluate bone density, utilizing CT scanning and peripheral computer modeling, of the distal articular surface of the left fore third metacarpus as it pertains to age.

Sixty horses were selected post-mortem on the basis of age and absence of any apparent musculoskeletal disease of the left forelimb. The left front fetlock was then removed and scanned at 1mm slice intervals using a GE Pace 3rd generation CT scanner. Each horse was assigned to a group based on age (ten horses per group): N1= 12-14 mos., N2= two years, N3= three years, N4= four years, N5= 5-10 years, and N6=11-15 years of age. After completion of the CT scan, the fetlock joint was examined for any visible gross changes on the condylar surface of MC III. A scoring system was used on the visibly pathologic condyles to evaluate wear lines, transverse ridge formation, and erosive lesions based on a 0-3 scale (0=mild, 3=severe) previously published. The CT scans were three-dimensionally rendered using OsteoApp (RSI inc., Boulder, CO), a specialized

program for the PC platform using the IDL programming language. After disarticulating MCIII on the computer, the distal condylar surface of MCIII was measured in a perpendicular plane (transverse view) so that no non-articulating bone would be included in surface measurement. The total surface area, area of bone densities in the ranges of 1) 750-1199 HU, 2) 1200-1299 HU, and 3) 1300-3000 HU, and relative percentages of the aforementioned ranges were calculated at a depth of 3.5 mm from the surface in order to represent the subchondral bone. In addition, twenty-seven horses were scanned with a Cann-Genant K_2HPO_4 density phantom, and converted to g/cm^3 . The same area measurements and comparisons were performed on the converted CT scans. Analysis between groups showed that there was a significant difference in both overall gross scores and individual density range areas. A trend was identified towards increasing area of the third density range (which represents the densest bone) as a function of age.

Secondarily to the CT data analysis, histologic sections were taken from MCIII condyles that appeared grossly abnormal. The section was taken from the medial axial region at a width of about 1 cm. Decalcification and H&E staining were utilized to process the sections. Total trabecular bone content was estimated microscopically, as well as the character of the subchondral bone.

A second study is also being done to examine the density patterns on the condylar surface of MCIII due to pathologic processes, namely palmar arthroses, osteoarthritis, and condylar fractures. The majority of the samples are from racehorses, and the same three-dimensional rendering techniques and comparisons will be made after all samples have been collected. Again, there are ten samples per group (disease), and at the present time ten palmar arthrosis, five osteoarthritis, and two condylar fracture samples have been collected. Histologic preparations of the medial axial region and description of any pertinent lesions have been performed on those condyles.

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