Third Metacarpal Condyle Bone Mineral Density in Relation to Equine Condylar Fractures

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Introduction:

•Fractures of the third metacarpal condyle in metacarpophalangeal (MCP) joints frequently occur in young racehorses during high-speed training or racing, and can be career or life ending [1]. Prior research suggests that equine condylar fractures may occur from periods of continued loading, as opposed to a single traumatic event [2]. Also, repeated trauma may lead to higher subchondral bone density, possibly reducing bone quality making it more susceptible to microfractures. The coalescence of these microfractures can lead to gross fracture **(Figure 1A)**.

•**Purpose:**

To evaluate subchondral bone within the distal third metacarpus (MC3) of forelimbs in racing and non-racing horses, and to determine how density patterns might relate to areas of condylar fracture commonly seen in racehorses.

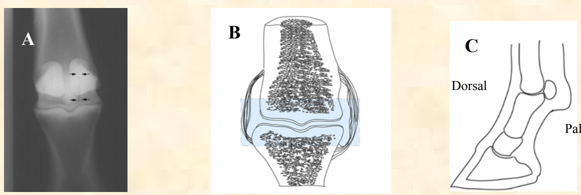

Figure 1: MCP sample site location. **A**: non-displaced condylar fracture (arrows); **B**: frontal slice through MCP joint; **C**: MCP orientation

Methods:

•*Samples:* Computed Tomographic (CT) scans of the metacarpophalangeal joints were taken bilaterally on eight racehorses and eight control horses **(Figure 1C)**.

•*Measurements*: Using OsteoApp, a program that utilizes CT data to create three-dimensional volumes, bone mineral density was measured from fifteen slices, taken in the frontal plane, radiating at 2-mm increments starting from the palmar aspect of the distal third metacarpus **(Figure 2)**. A specific color scheme, based on ranges of CT pixel values, was established to qualitatively assess density patterns within the slices **(Figure 3)**.

•*Statistics*: Density data were then calibrated and analyzed using SAS software (Cary, NC). A repeated-measures ANOVA was run for differences in mean density for each slice in regards to limb (left or right) or group (non-racing or racing), with $p<.05$. Least Squares Means were used to determine differences in means for each slice of racehorses.

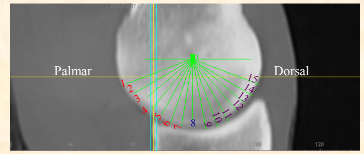

Figure 2: Positions of each of the fifteen slices

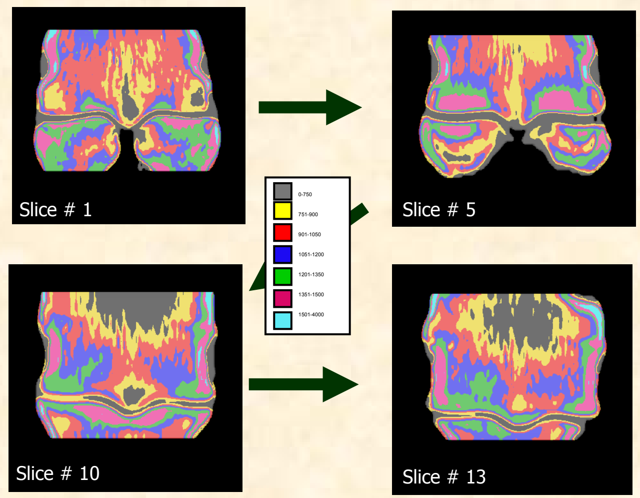

Figure 3: Key slices that demonstrate the application of the color scheme to identify sharp density gradients and patterns throughout the MCP.

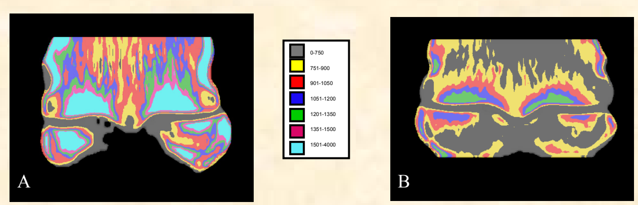

Figure 4: A) Racehorse vs. B) control (Slice #5). Notice the increased amount of highly dense bone in the racehorse sample bone represented by the green, magenta and turquoise colors.

Results:

•There was a statistically significant difference ($p<.0001$) between the mean densities of racehorses vs. control horses at each slice position.

•Although there was no evidence that the limb (L, R) played a significant role ($p>0.4$), mean slice density of racehorses was significantly different between slice locations ($p<.0001$).

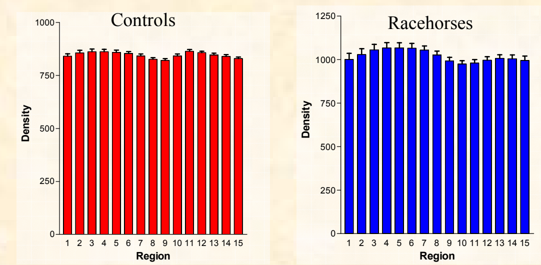

Figure 5: Mean densities (HU) of each slice throughout MC3. Region 1 corresponds to the most palmar aspect, and Region 15 the most dorsal aspect of the MC3 condyle.

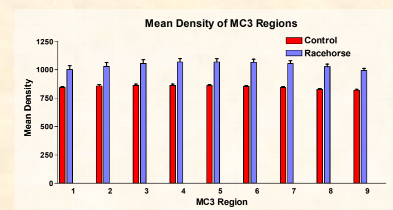

Figure 6: Comparison of mean densities in the palmar aspect of the MC3 condyle between racehorses and controls. Note that there is an increase in mean density at each slice in comparison to controls, in addition to the steeper density gradients in the racing group.

Discussion:

Racing and high speed training lead to a significant increase in density in the MCP joint. Sharp density gradients, as shown in the patterns, might predispose the racehorses to fracture in these areas. Further research is necessary to evaluate the mechanical properties of high density areas in order to determine whether the fractures occur at the junction of high and low density bone, or within the high density areas.

References:

[1] Rick et al, JAVMA, 1983; 183: 287-295.
[2] Riggs, Equine Vet J 1999; 31: 116-120.