



# Influence of Early Exercise on Bone Mineral Density in Equine Distal Third Metacarpal Condyles



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## Introduction:

Although musculoskeletal injuries have a large impact on the horse industries, little is known as to the effects of early exercise[1]. Prior research suggests that repeated loading and exercise leads to an increase in higher density, low quality bone that is slow to repair[2]. However, adapting the musculoskeletal system to high intensity exercise early may lead to less injuries in the equine metacarpophalangeal joint (MCP), a common site of fracture in Thoroughbred (TB) racehorses.

## Purpose:

The study objective was to determine bone density patterns in the equine MCP joints of young TBs to evaluate the effects of early exercise.

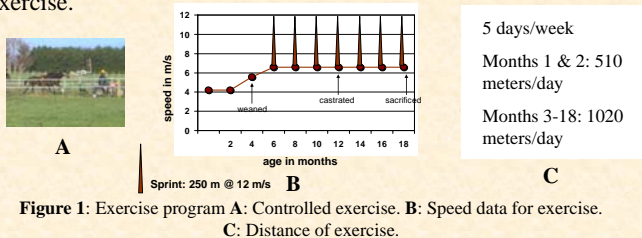


Figure 1: Exercise program A: Controlled exercise. B: Speed data for exercise. C: Distance of exercise.

## Methods:

- Exercise:** Twelve New Zealand TBs were randomly assigned to a control or exercise group. They were kept together on pasture, and horses in the exercise group started work at age 10 days, in which the speed and distance were gradually increased until sacrifice at 18 months. (Figure 1A-C)
- Samples:** MCP joints (Figure 2A) of the twelve horses were taken immediately post-mortem and stored at -20C. They were then shipped to CSU for computed tomography (CT) scans. Both front MCP joints of all 12 horses were scanned using CT.
- Measurements:** The CT scans were rendered into three-dimensional images using OsteoApp, a computer program which measures bone density (Figure 2B). From these images, three 2mm slices were selected from the metacarpal condyles at 20, 30, and 40 degrees palmar to the central limb axis (Figure 2C). A color scheme was applied to these images in order to determine density patterns, depth of sclerosis, and density gradients (Figure 2E). Mean density was also measured.
- Statistics:** Analysis of variance (ANOVA) was performed to determine the effects of exercise, limb, region of interest, slice location, and their interactions. Significance was set at P<.05.

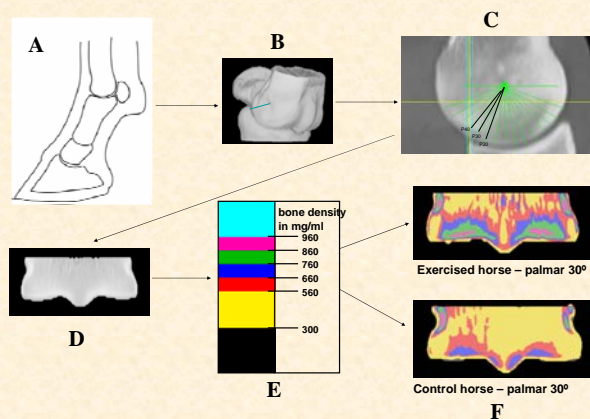


Figure 2: Sample site location. A: MCP joint. B: 3D of MCP joint, with sample site. C: Slice locations. D: Individual slice. E: Density color scheme. F: Example slices with color.

## Results:

- There was no significant difference in mean bone density between the control and exercise groups (Figure 3).
- Many individual effects were found. Mean bone density was greater in right lateral condyles of exercised horses over control horses. The depth of sclerosis was increased in exercised horses over control horses, in slices 20 degrees palmar of the left lateral and right medial condyles (Figure 4). A greater density gradient was found in slices located at 30 and 40 degrees palmar compared to the 20 degrees palmar slices, independent of exercise (Figure 5).

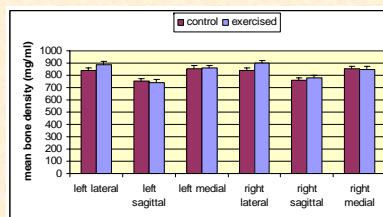


Figure 3: Mean bone density, control vs. exercised showing slight but insignificant differences in density between the groups.

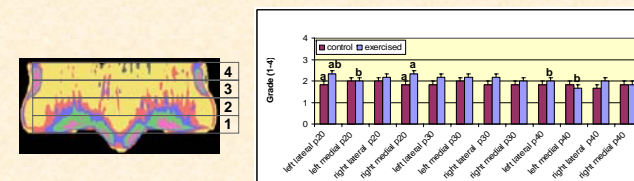


Figure 4: Depth of sclerosis, grades 1-4 based on how high the blue density reached. Data with the same letters indicate significant differences.

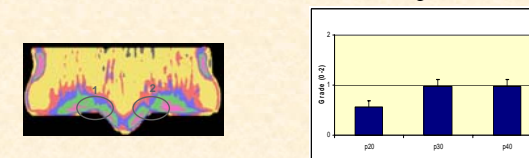


Figure 5: Density gradients, scored 0-2. 0 = no gradient, 1= linear area with density 1 range lower, 2= linear area with density 2 ranges lower than surrounding bone density.

## Discussion:

- Early exercise did not have a detrimental effect on distal metacarpal condyles of young TBs.
- Early exercise appeared to be associated with mild increases in bone density and depth of sclerosis.
- Failure to detect more significant increases in bone density may be related to the low intensity of exercise, the fact that voluntary exercise at pasture in the control group was enough stimulus to increase bone density, or insufficient sensitivity of the CT to detect small changes in bone density.
- The density gradients were affected by some factor other than exercise, possibly nutrition or genetics. Since density gradients are thought to predispose horses to fracture, further research of these factors is necessary.
- Histologic evaluation of the samples is currently ongoing and may shed more light on the effects of early exercise on bone strength.

## References:

1. Jeffcott et al. 1982, Johnson et al. 1994, Pool 1996
2. Riggs & Boyde 1999, Barneveld & van Weeren 1999, Cornelissen et al. 1999, Firth et al. 1999, Kawcak et al. 2000