Bone microstructure and fracture predisposition in young racehorses

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Introduction
Musculoskeletal injury is a common problem for racehorses. Bone abnormalities at known fracture predisposition sites (arrowed in the digital X-ray image below) have been shown to occur in young individuals before athletic training has even begun1.

The aim of this study was to determine whether differences in chemical structure and composition (microstructure) of bone correlate with fracture predisposition.

Materials and methods
• Ex vivo samples were taken at condylar fracture sites in the third metatarsal bone from apparently normal newborn and 5 month old foals, as well as from a 3 year old horse with known abnormalities.
• Microstructure was investigated using Fourier transform infrared (FTIR) microspectroscopy combined with discriminant analysis.

Materials and methods

Results
• One of the apparently normal 5 month old foals exhibited a dramatic variation in the microstructure of the articular calcified cartilage in one of the fracture predisposition sites. This individual had a mineral:matrix ratio opposite to that seen in all other animals, illustrated in the spectra below.

• Discriminant analysis clearly separated samples from the newborns, 5 month old foals and the abnormal 3 year old horse on the basis of differences in their microstructure. Microstructure in the 5 month old foals was more heterogeneous than that of the newborns. Microstructural differences between the groups were associated with both the mineral and collagen components.

• Microstructural differences were also observed between the abnormal (predisposition) and normal (control) regions in the abnormal 3 year old horse.

Conclusions
• Striking macrostructural differences between apparently healthy individuals raise important questions around the extent of normal variation and whether individuals may be predisposed to later fracture as a result of detrimental microstructural changes during early growth and development.
• The nature of the microstructural differences observed between fracture and control sites in a horse with known abnormalities needs to be elucidated in order to conclude whether these differences can be correlated with fracture predisposition.

Future work
Following this preliminary study, further work will focus on:
• Identifying the key microstructural changes that occur during normal growth, development and ageing
• Evaluating the degree of normal compositional variability between age-matched individuals
• Determining the microstructural differences between healthy and abnormal or fractured bone.

Reference

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