ANATOMICAL AND PHYSIOLOGICAL BASES OF BONE MARROW OEDEMA-LIKE STRUCTURES IN MAGNETIC RESONANCE IMAGING: AN IN-VITRO MACRO- AND MICROSCOPIC STUDY

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ABSTRACT

Bone marrow oedema is a term used to define the appearance of regions of low signal on T_1 weighted and high signal on fat-suppressed magnetic resonance images. The potential association between bone marrow oedema and prognosis in pathologies such as osteoarthritis is becoming increasingly recognised through clinical studies. A limited number of clinical studies have linked bone marrow oedema to altered bone density or altered bone marrow perfusion. The principal aims of this study were to investigate these findings in vitro, using the equine forelimb.

The presence of bone marrow oedema within the equine forelimb was initially confirmed by undertaking magnetic resonance imaging scans. Bone samples were selected from 10 animals, 5 exhibiting the presence of bone marrow oedema-type abnormalities (BMOA) at the distal metacarpal. Raman microspectroscopy was used to determine the chemical composition of bone and projection radiography to provide a measure of bone density. Micro computed x-ray tomography was undertaken on a subset of three bone samples exhibiting BMOA. A second component of the study utilised contrast enhanced magnetic resonance imaging to enable comparison of perfusion to bone marrow with and without evidence of oedema. A saline flushing agent containing Evan's blue was used so that subsequent sectioning of the bone would enable visualisation of the distribution of contrast agent as part of a histological examination of the oedematous region.

An initial observation was that the majority of bone marrow oedema that was observed in the distal metacarpal appeared in a consistent location, namely the postero-inferior aspect of the bone, corresponding to the point of greatest load thereby suggesting a potential relationship to forces upon the joint. The principal observations were that there appears to be increased bone volume densities in those bone samples with evidence of bone marrow oedema. The Raman microspectroscopy did not demonstrate any statistically significant differences in the chemical composition of bone. Hence the overall impression is that bone marrow oedema is associated with a greater volume of bone, although of similar maturity and composition. There was limited evidence of increased perfusion (suggestive of increased vascularity and / or hyperpermeability) in those samples with bone marrow oedema.

This work suggests that these particular bone marrow oedema lesions are associated with bone changes and potentially vascular changes although the aetiology is currently unclear. Further work is needed to determine the clinical significance and prognosis associated with these particular lesions, and whether these findings can be replicated for bone marrow oedema demonstrated at other anatomical locations