The influence of the parasagittal groove angle on cartilage stress in the equine metacarpophalangeal (MCP) joint

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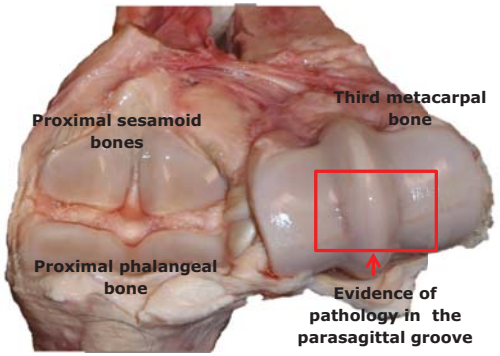
Background

Injuries to the equine metacarpo-phalangeal (MCP) joint account for a large proportion of injuries occurring in Australian racehorses [1].

Fractures within the MCP joint occur most often on the lateral condyle of the third metacarpal bone [2], often originating at the junction of the condyle and the sagittal ridge [3].

A recent study [4] investigated the relationship between sagittal ridge angle and bone pathology in the MCP joint. It was found that a shallower sagittal ridge angle could be correlated to a higher injury rate.



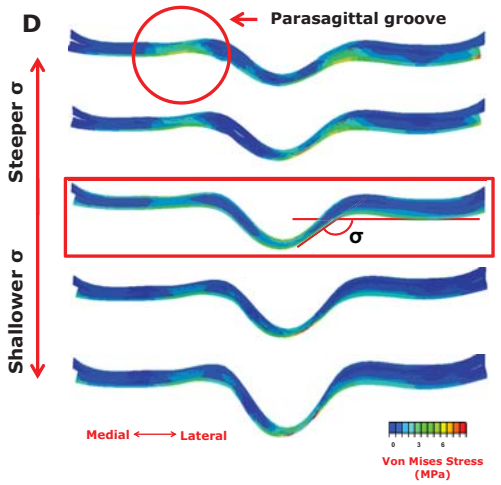
Purpose

The purpose of this paper was to create a three dimensional FE model of the equine MCP joint to investigate the relationship between parasagittal ridge angle and cartilage stress distributions.

We hypothesised that reducing the parasagittal groove angle increases shear stress at the subchondral interface, within the parasagittal groove.

Method

- The CT and MRI DICOM image files were used to segment the bony elements and articulating cartilage. The cartilage mesh was created and refined in CMGUI, using linear quadratic elements **(A)**.
- ABAQUS was used to load the third metacarpal and calculate the consequent stress distribution throughout the articulating cartilage. The results were verified against a similar study. **(B)** Loads and boundary conditions were taken from a similar musculoskeletal model for a standing horse.
- A parabolic function was used to increase or decrease the central ridge section of the finite element mesh. **(C)**
- The stresses from the original joint were compared to the cases of a steeper or shallower morphology. **(D)**



Results and discussion

- In support of our hypothesis, we found higher shear stresses at the parasagittal groove in the models with a shallower sagittal ridge.
- The highest stresses were at the articular calcified cartilage – sub-chondral bone interface, which is the area where impact induced damage to the cartilage first becomes visible. [5]
- The area imaged is located at 30° palmar to the transverse ridge, which is known to be an area of fracture initiation. [6]

References

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Acknowledgements

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