Mineral Composition of Tendon-to-Bone Tissue

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Introduction:

Torn tendons and tendon related injuries are some of the most difficult injuries to recover from because tendons are so hard to repair or replace. The reason for this is the complex design and necessary characteristics of the tendon-to-bone transition. A key part of this transition is the insertion. The insertion is the tissue connecting the uniaxial tendon tissue to the multidirectional bone tissue.

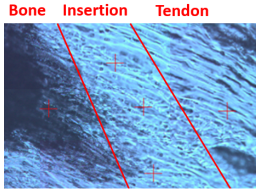
To help better understand the unique characteristics of the insertion, test where done on samples of tendon-to-bone tissue to determine the mineral composition of the tissues.

Method:

To simulate a human tendon-to-bone tissue, a swine foot was used. A tendon-to-bone sample was prepared using the toe of a swine. The samples were cut to 100 µm thick and placed on a microscope slide.

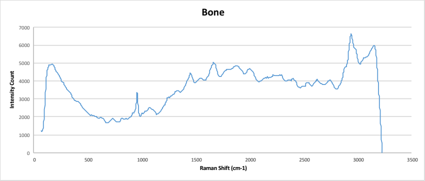
The sample where examined under a Raman microscopy to test the mineral make-up. In the Raman, the sample was shot with a 523 nm laser. The reflected light received by the detector in the Raman made it possible to determine the mineral make-up of the sample.

Five samples were tested and each sample was tested in five locations, one in the bone, three in the insertion, and one in the tendon.

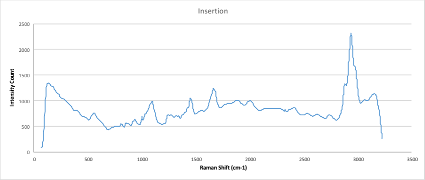


Results:

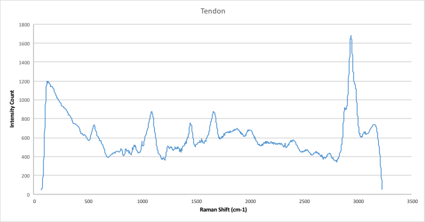
The data from the five test on the bone section were averaged to show a distinguishable peak at 967 cm^{-1}, 1450 cm^{-1}, 1667 cm^{-1}, and 2950 cm^{-1}.



The data from the fifteen insertion locations were averaged. It was found that there were distinguishable peaks at 1100 cm^{-1}, 1450 cm^{-1}, 1667 cm^{-1}, and 2950 cm^{-1}.



When averaged together, the data from the five tendon sections showed distinguishable peaks at 1100 cm^{-1}, 1450 cm^{-1}, 1667 cm^{-1}, and 2950 cm^{-1}.



These peaks correspond to different mineral bonds. The bond that most likely corresponds to the two peaks not shared between all three sections contain aromatic rings for the 967 cm^{-1} peak in the bone sections and C-C for the 1100 cm^{-1} peak in the tendon and insertion sections.

Conclusion:

The results of this experiment are consistent with a previous experiment done on rat tissue. This experiment was done by Brigitte Wopenka and her colleagues at Washington State University. Wopenka found that the two major peaks on the rat tissue occurred at 960 cm^{-1} and 2950 cm^{-1}. Wopenka's main point was how the peak at 960 cm^{-1} narrowed in the transition from bone to tendon. This find is similar to the results shown to the left that the 967 cm^{-1} peak in bone seems to disappear and a new peak develops close by at 1100 cm^{-1}. The narrowing of the 960 cm^{-1} peak and the transition from 967 cm^{-1} to 1100 cm^{-1} is a result of the reduced amounts of collagen in the tendon compared to the bone and the higher amounts of elastin in the tendon compared to the bone.

Literature Cited:

Schwartz, Andrea G., et al. "Mineral Distributions at the Developing Tendon Enthesis." *PLOS*, 2012.

Wopenka, Brigitte, et al. "The Tendon-to-Bone Transition of Rotator Cuff: A Preliminary Raman Spectroscopic Study Documenting the Gradual Mineralizaion Across the Insertion in Rat Tissue Samples." *NIH Public Access*, 2008.

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