NC STATE UNIVERSITY

Current Knowledge

as in a native tissue

Current Limitations

understanding of tissue

There is insufficient

repair post injury

tomography

hard bone

Investigation, Modeling, and Reconstruction of the Tendon-to-Bone Insertion

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Introduction and Background

Tendon-bone insertion tissue is

Gradation in microstructure is not

recreated in a healing insertion

microstructure and the property

three-dimensional mathematical

governing regeneration and

There is no comprehensive,

model that may be used for

modeling the insertion tissue

Objectives and Approaches

values at points within tissue

obtained using micro-computed

image microstructure of tissue at

multiple depths throughout tissue

Images obtained from scanning

together in ImageJ to create 3D

electron microscope pieced

rendering of tissue

Scans of tissue and density

Focused ion beam scanning

electron microscope used to

structurally and functionally

graded to alleviate stress

Imaging and Scanning

- Imaging and scanning was performed using digital flexor tendon-bone units procured from the local abattoir (Nahunta Pork Center, concentration from soft tendon to
 - Pikeville, NC) immediately after slaughtering. Tendon-to-bone connections were dissected

Methods and Results

- from the two middle digits on the pigs' feet immediately after obtaining the feet. Samples were immediately fixated and critical point dried before imaging and scanning.
- Imaging was done using a focused ion beam and scanning electron microscope (FIB/SEM). A milling current and voltage of 7 nA and 30.0 kV, respectively, was used for milling, and the SEM beam voltage used was 5.00 kV (Fig. 1)
- Scanning was done using Micro-CT (Bruker SkyScan 1174, Billerica, MA). Scanning was done with a source voltage of 50 kV, source current of 755 µA, and image pixel size of 9.16 µm (Figs. 2-3).



FIB/SEM Specifications:





Protochips in-situ Heating & Electrical

Stage Fig.1: FIB/SEM used for Scans **Micro-CT Specifications:**



- 50kV Tungsten X-ray source - 6µm 3D spatial resolution - 2D/ 3D image analysis and realistic visualization

> Fig. 3: Micro-CT Sample Mount

Densitv Density values at locations within cross-sections of

Results and Discussion

- the scanned tissue were obtained with DataViewer postprocessing software (Bruker, Billerica, MA).
- Density values, coupled with visual evidence, clearly indicate the location of the insertion, as well as provide a baseline for further analysis using FEM software (Figs. 4-5).



Fig. 4: Cross-Section of Insertion Scan

Microstructure

The microstructure of the tissue is seen via SEM images obtained using the FIB/SEM (Fig. 6).



Collagen fibers are clearly shown in Figure 7. Image reconstruction was performed in ImageJ (Fig. 8), with the end result being a 3D model that is to be import into ANSYS for further examination.





Fig. 7: Tissue Microstructure Fig. 8: 3D Image Reconstruction in ImageJ



Fig. 2: Micro-CT Scanner