

Morphology and Strain in the Subchondral Trabeculae of Osteoarthritic Humeral Heads

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INTRODUCTION AND OBJECTIVES

- The objective of this project is to compare strains and morphological parameters in the subchondral trabecular bone (STB) (below the articular surface) of humeral heads from normal cadavers and patients with advanced osteoarthritis (OA).
- The primary hypothesis is that the morphology in the subchondral region (adjacent to the articular surface) is significantly different in OA versus normal bone.

METHODS

i. Specimen and Subject Preparation

- Humeral head osteotomies, excised at the head to neck junction, were collected from patients undergoing total shoulder arthroplasty (TSA) for end-stage OA (n=10).
- The normal control group consisted of age-matched non-pathologic cadaveric humeral heads (n=10).

ii. MicroCT Imaging

- Each humeral head osteotomy was scanned using a micro-CT scanner.
- 20 μm isotropic voxels.

iii. Micro-CT Imaging and Image Processing

- Images were processed using commercially available software (Dragonfly 2021.3, Object Research Systems).
- A Gaussian blur filter was used to remove high frequency noise, then a specimen specific threshold was applied to segment bone. Unsegmented voxels were assigned a null value.
- Micro-CT scans were cropped to a dimension of 18 mm by 18 mm by 10 mm.
- Each model was divided into four regions that represented 2.5 mm sections from the articular surface to the bottom but surface (Figure 1).

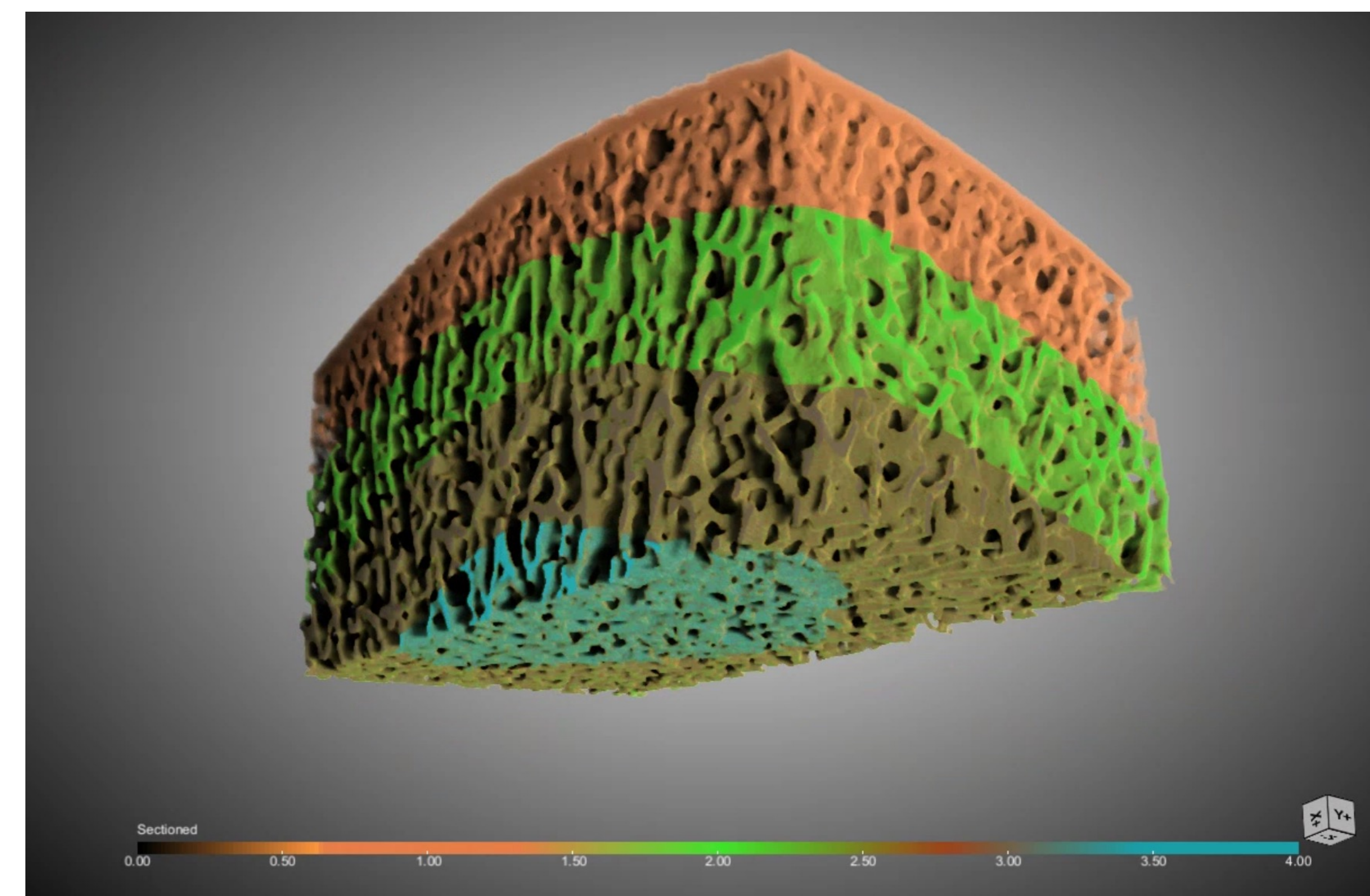


Figure 1. Sectioned micro-CT image of a post-processed, non-pathologic, cadaveric humeral head in Dragonfly ORS.

iii. Morphological and FEM Comparisons

- Bone analysis software (CT-Analyzer; Bruker) was used to calculate morphometric parameters of each region.
- Morphometric parameters: bone volume fraction, trabecular thickness, trabecular separation, trabecular number, and connectivity density.
- FE parameters: strain energy density, Von Mises stress, nodal forces, failure load, axial stiffness, and distribution of failed materials.
- Relationships between FEM parameters and morphometric parameters of the regions will be generated for both humeral head groups (OA and normal).
- To quantify the relationship of FE parameters and morphometric parameters, linear regression will be performed.
- An analysis of covariance will be used to compare the computed relationships between groups (OA and normal).

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