Regional Variation of Bone Structure in Osteoarthritic Femoral Heads - A Synchrotron Radiation CT Study

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INTRODUCTION

Osteoarthritis is an irreversible disease [1]. Structural changes in response to the onset of osteoarthritis within structures differs from region to region due to different amounts of loading exerted within each region [2, 3]. This project uses Synchrotron Radiation based Computed Tomography (SR-CT) to examine regional differences within femoral heads.

Objective
This project investigates the differences in bone microstructure and calcium content between regions subjected to different amounts of loading within the osteoarthritic hip femoral heads. This study also aims to examine how age impacts the structure and mineralization pattern within different regions.

Method

❏ Four femoral heads were collected from patients of different ages and scanned using SR-CT.

❏ Five regions that are subjected to different amount of loading were identified and analyzed.

❏ The images were manually segmented to delineate the cortical bone from the trabecular bone to measure bone microstructure (BV/TV, (%), Tb.Sp, (μm), Tb.N, Tb.Th, (μm)) and bone mineral density.

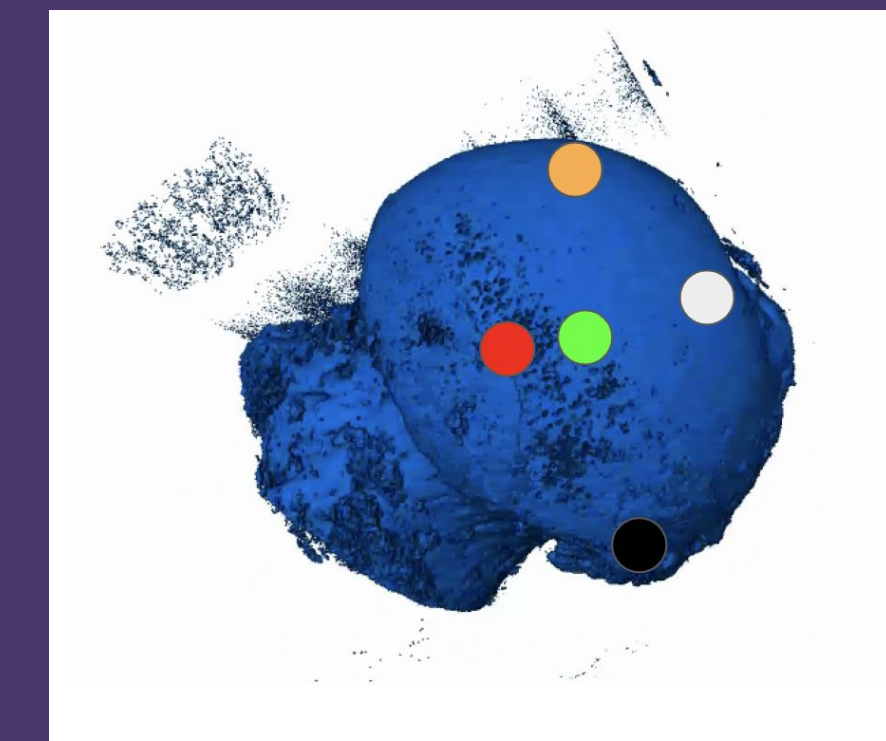❏ qBSE and histology will be performed to confirm the findings.

Figure 1. Regions subjected to different amount of loading. Orange: Superior, experiencing the most loading, Black: Inferior, experiences the least loading. White: Medial, Red: Anterior, Green: Posterior.
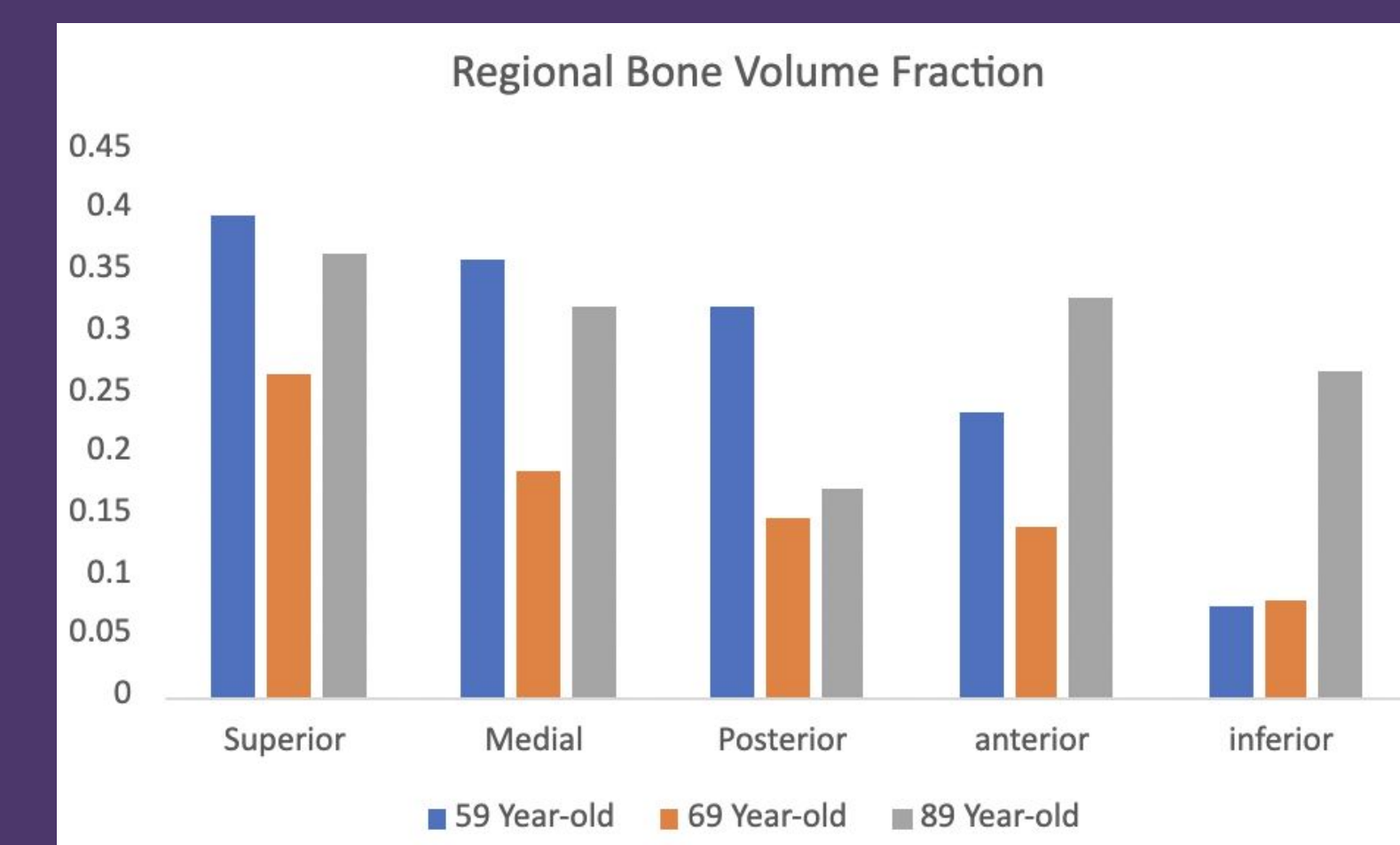

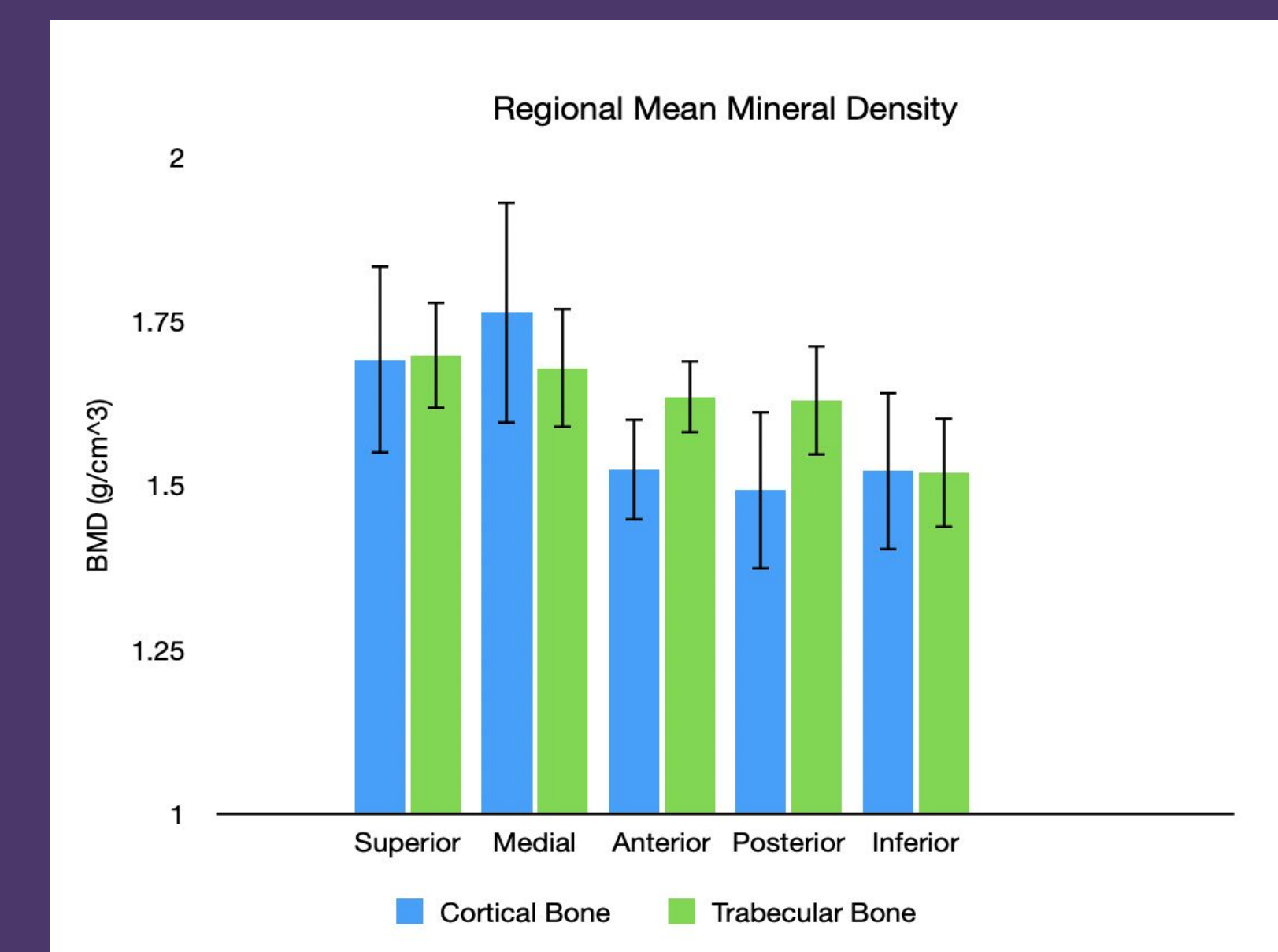Figure 3. Bone volume fraction from the 59, 69 and 89 year old samples.

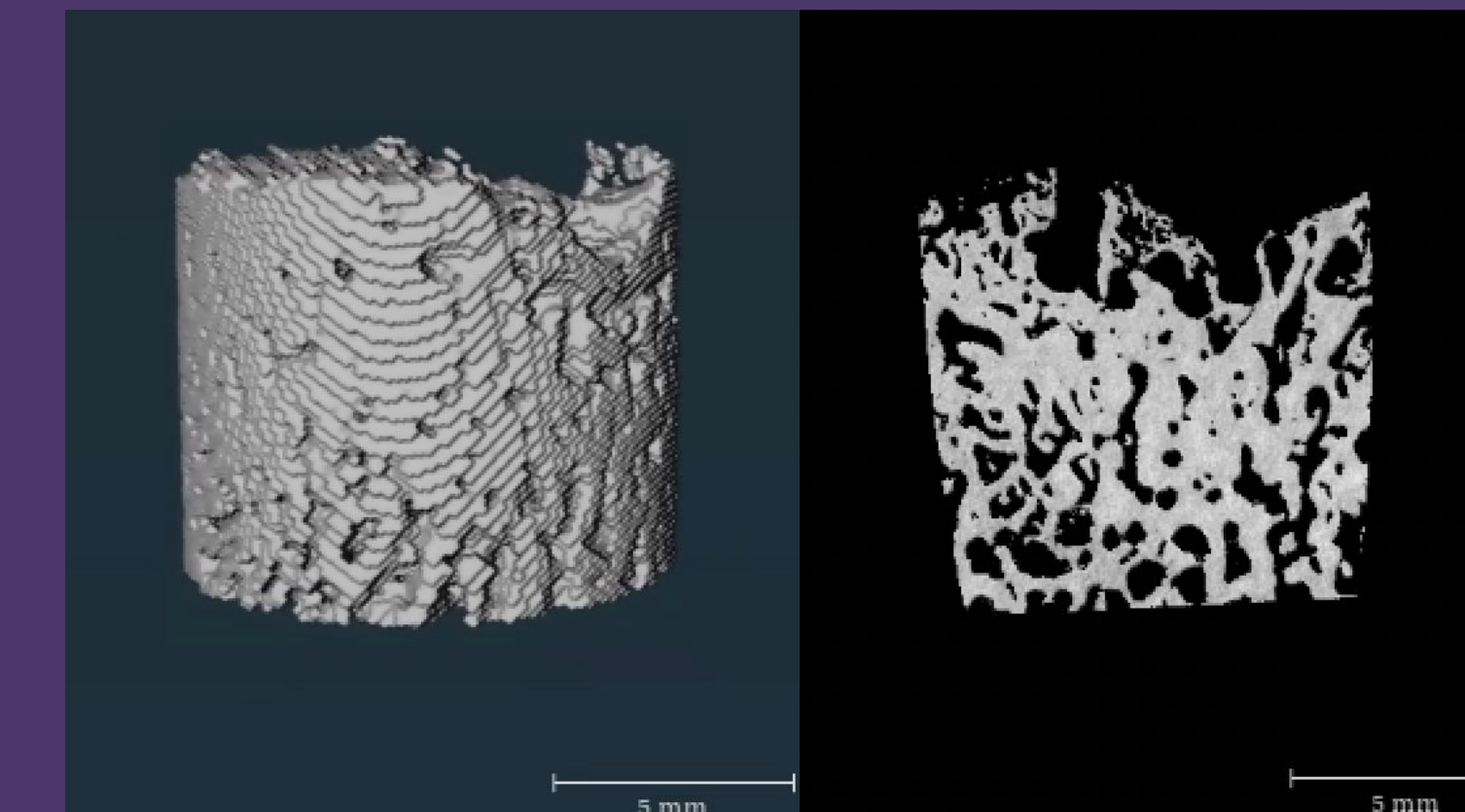Figure 4. Mean regional bone mineral density variations.

Figure 2 . Cylindrical volume and slice of the superior region from the 89 year old sample.

Results

❏ **Regions experiencing higher loading generally exhibit higher bone volume fractions.**

❏ **The superior region exhibits high mean trabecular bone mineral density and the posterior region shows low mean BMD. Cortical bone mineral density is high in both superior and medial region and the posterior region shows relatively low mean BMD.**

Discussion

❏ Current data shows that high bone volume fraction is concurrent with high trabecular and cortical bone mineral density.

❏ Regions that experience higher loading tend to exhibit higher BV/TV and BMD.

❏ The denser structure observed in the superior and medial regions could be showing characteristics of high bone remodeling rate as a result of higher loading.

Conclusion
Current results show regional bone microstructural and mineral content variations especially between the superior, medial and inferior regions. Future analyses will focus on expanding and validating the finding.

Acknowledgments

References:
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[3] B. Li and R. Aspden, "Mechanical and material properties of the subchondral bone plate from the femoral head of patients with osteoarthritis or osteoporosis," Ann. Rheum. Dis., vol. 56, no. 4, pp. 247–254, Apr. 1997, Accessed: Aug. 29, 2021. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1752348/