

## Mapping the Microscale Cortical Mineralization at the Human Femoral Neck Sites of Adult Donors

**Background** Bone strength in clinics is routinely assessed through bone mineral density (BMD), measured via the DXA modality. However, the output BMD estimates are largely homogenized, leading to missing variations in bone microarchitecture and mineralization patterns. Such homogenization of structural organization and mineralization may cause potential inaccuracies in fracture risk assessment. The proposed study focuses on characterizing the microscale mineralization and porosity of the femoral neck cortex from two distinct anatomical sides from a large set of samples from skeletally mature donors. This master's thesis is another step of a multiscale project aimed at characterizing the morphological and mechanical properties of the human femoral necks and relating them with age.

**Aim** The project aims to evaluate microscale compositional and morphological properties of compact bone at the femoral neck. The working hypotheses are that i) microscale porosity and mineralization properties vary with age, and ii) they are distinct in the superior versus the inferior cortex.

**Materials and Methods** The set of samples from 87 donors will be first imaged with the optical microscope to create a reference database. The microradiography measurements will be carried out by the student at the Université de Lyon, giving access to bone mineralization. The image processing routine is expected to be developed and applied to the collected microradiography images. The final bone mineralization and morphology properties database will be correlated with the sample extraction sides and the donors' age.

### Nature of the Thesis

Sample imaging: 10 %  
Microradiography: 40 %  
Image processing: 30 %  
Statistical analysis: 20 %

### Requirements

Basics in image analysis

### Supervisors

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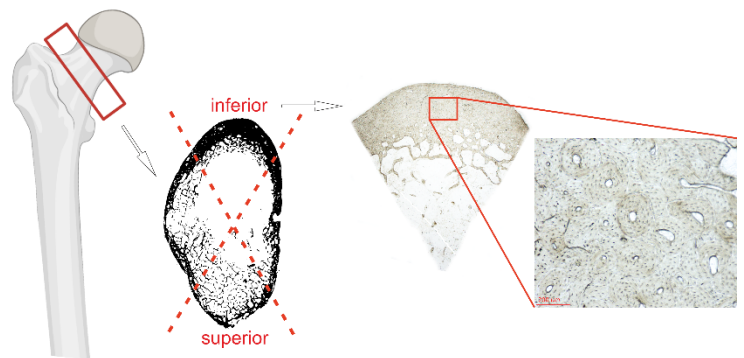


Figure 1. Femoral neck sample extraction and example optical images.

### Institute

ARTORG Centre for Biomedical Engineering Research, University of Bern

### References

- [1] Florian Montagner, Val erie Kaftandjian, D. Farlay, D. Brau, G. Boivin, H. Follet, Validation of a novel microradiography device for characterization of bone mineralization, *Journal of X-Ray Science and Technology*. 23 (2015) 201–211. <https://doi.org/10.3233/xst-150481>.
- [2] Spiesz Ewa, Reisinger Andreas, Pahr Dieter and Zysset Philippe, Computational and experimental methodology for site-matched investigations of the influence of mineral mass fraction and collagen orientation on the axial indentation modulus of lamellar bone, *J Mech Behav Biomed Mater* 28 (2023):195-205. <https://doi.org/10.1016/j.jmbbm.2013.07.004>

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