Micromechanical Properties of Human Femoral Neck Compact Bone: Influence of Age and Anatomical Site

Background Fragility fractures pose a significant health burden, particularly among the elderly population, where diminished bone strength contributes to increased fracture risk. While current clinical methods predominantly rely on bone mass as a surrogate marker for bone strength, a better understanding of bone strength determinants is needed. This master's thesis is another step of a multiscale project aimed at characterizing the morphological and mechanical properties of the human femoral neck and relating them with age and anatomical site. In particular, the proposed study will use novel approaches in high-throughput micropillar compression testing to assess bone mechanical properties [1].

Aim The project aims at evaluating the microscale compressive properties of compact bone at the femoral neck. The working hypotheses are that i) microscale mechanical properties, in particular post-yield characteristics, decrease with age, and ii) they are distinct in the superior versus the inferior cortex.

Materials and Methods Femoral neck slices from 87 donors will be used in this study. The inferior and superior neck cuts and consecutive surface preparations will be carried out at the Musculoskeletal Biomechanics Lab at sitem-insel. Next, arrays of bone micropillars (N=50 per sample) will be fabricated via the ultra-short pulsed laser ablation at the ALPS Institute at Berner Fachhochschule (BFH) Burgdorf. Lastly, micropillar compressions will be carried out at the Laboratory for Mechanics of Materials & Nanostructures at Empa Thun. Mechanical tests will ultimately give access to elastic and yield bone properties and will be analysed with respect to donor's age and femoral neck site.

Nature of the Thesis
Sample preparation: 20 %
Micropillar fabrication: 30 %
Micropillar testing: 40 %
Statistical analysis: 10 %

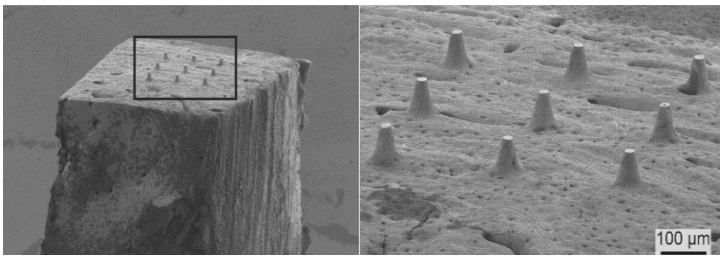

Figure 1. SEM image of the bone micropillars array.

Requirements
Basics in mechanics of materials

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References
[1] T. Kochetkova, M.S. Hanke, M. Indermaur, A. Groetsch, S. Remund, B. Neuenschwander, J. Michler, K.A. Siebenrock, Philippe Zysset, Jakob Schwiedrzik, Composition and micromechanical properties of the femoral neck compact bone in relation to patient age, sex and hip fracture occurrence, Bone. 177 (2023) 116920–116920. https://doi.org/10.1016/j.bone.2023.116920.

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