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VERIFIED AND VALIDATED FEA OF HUMAN LONG BONES – FROM THE LAB TO CLINICAL PRACTICE

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Patient-specific QCT-based high-order finite element models (*p*-FEMs) accurately predict ex-vivo experimental observations on human long bones (as femurs and humeri), including risk of fracture [1,2,3]. They account for the exact geometry and inhomogeneous material properties, are created in a semi-automated manner from QCT scans and validated on a large cohort of fresh frozen femurs and humeri. QCT-based *p*-FEMs were applied to predict bone strength in patients with bone metastases to their femur [4], demonstrating excellent prediction capabilities. The first part of the talk addresses the methodology to semi-automatically generate the femurs' FEM from CT scans, assign material properties, apply loads and validate the FE results by DIC measurements.

Application of FE methodology in clinical practice is subject to obstacles and surprises, however, at the same time is accompanied by tremendous satisfaction when it helps patients and saves pain and agony. The second part of the talk will address the steps required to bring the methodology into clinical practice. We report on two retrospective clinical trials - one on 50 patients with metastatic tumors to their femurs on whom prophylactic surgery was planned and the second on 25 patients for which a contralateral hip fracture risk was predicted. Cases analyzed during the clinical trials and the potential use of *p*-FEA in clinical practice will be presented.

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