

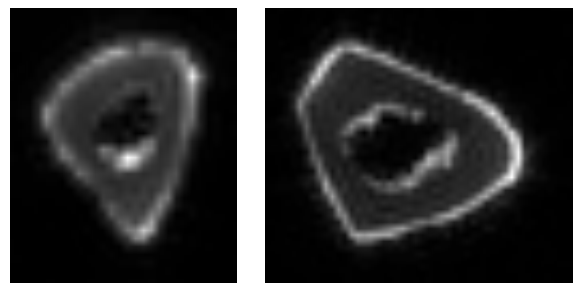
## Quantification of cortical bone water using ultrashort echo-time radial MRI – In vitro feasibility study at the proximal femur using biomechanical testing and high resolution pQCT as a standard of reference

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Beyond bone mineral density, among the most important parameters responsible for bone quality are those measuring trabecular and cortical bone micro- and macrostructure (1). Cortical bone porosity has been identified as a major contributor to bone strength (2-4). Recently efforts have focused on better understanding cortical bone porosity, in particular at the hip, where it is considered to be intimately related to fracture risk (5). However, so far it has been difficult to quantify cortical bone porosity in vivo: Standard computed tomography (CT) and magnetic resonance (MR) techniques do not visualize cortical porosity, though cortical bone mineral density obtained from standard CT has been used and suggested as a surrogate marker (3). Recently two new techniques have been developed that may provide new insights into cortical porosity in vivo: (i) high resolution peripheral quantitative CT (HR-pQCT); and (ii) ultra-short echo time (4) MR imaging, which quantifies the water content of the cortical bone and thus provides an indirect measure of cortical porosity (6).

Ultrashort echo time (UTE) imaging allows the detection of signal components with T2 relaxation times on the order of only a few hundred microseconds, which are found in highly ordered tissues such as tendon, ligaments and cortical bone and cannot be detected with conventional imaging techniques, where TE is limited to 1-2 microseconds (7). Techawiboonwong et al. (6) recently reported UTE imaging with radial MR pulse sequences to characterize cortical bone water.

The hypotheses driving this research project are that UTE MRI will be well suited to quantify cortical bone porosity and biomechanical bone strength at the proximal femur as well as osteoporotic fracture status of the skeleton. Therefore, we propose an in vitro feasibility study on proximal femur specimens obtained from fifteen human cadavers. UTE MR and HR-pQCT imaging to assess cortical bone water content and cortical porosity measures will be performed; in addition, biomechanical testing will provide measurements of proximal femur bone strength.



UTE images of a human arm specimen (diaphysis) with a spatial resolution of 1mm (isotropic), TR = 30 ms, TE = 64  $\mu$ s, flip = 15°, 600  $\mu$ s readout duration, saddle T/R coil, isotropic resolution, 2 NEX. The cortical shell is clearly depicted in this image.

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