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COMPLEX ARCHITECTURE OF THE OSTEOCYTE LACUNAR-CANALICULAR NETWORK IN MICE

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Introduction
The osteocyte network in bone has attracted great interest due to the role of osteocytes in mechanosensing and regulation of bone remodeling. Osteocytes reside in lacunae and are interconnected by cellular processes running through a network of canaliculi; canals roughly 200 nm in diameter. The canalicular network plays a vital role in the communication between osteocytes and facilitates a way for osteocytes to orchestrate bone remodelling. Rodents are widely used as model organisms to study experimentally induced effects in bone. Human and rodent bone does, however, display large structural variations with the largest difference being the absence of harversian remodelling in rodents, which has profound implications for bone microstructure [1]. Here we have studied the lacuna-canalicular network in mouse bone to describe the communication network and the structural features found on the sub-micro meter length scale. Describing the hierarchical structure of bone demands multiscale imaging techniques [2-4] and advances in high resolution X-ray imaging has paved the way for characterization of the lacunar-canalicular network [5-7] Herein we apply X-ray holotomography with a 25 nm voxel size to mouse bone.

Methods
Cortical bone from the femoral mid-diaphysis from 3 NMRI mice were cut into 0.4x0.4x3 mm³ rods with a diamond saw. Local nano-tomography was performed at ID16A, ESRF. Radiographs were collected for four different sample-to-detector distances resulting in a final voxel size of 25 nm and a field of view of 50 μm. Phase reconstruction was performed as described in [5] followed by tomographic reconstruction yielding 3D phase maps of the imaged volume.

Results
The tomographic results easily allowed visualizing the osteocy-canalicular network with high fidelity. An example is show in Figure 1 that shows the void space around an osteocyte. The spaghetti-like network extending from it are the canaliculi. The samples contained features in the canalicular network not seen in humans [4-7]. Approximately 1 μm large voids were observed in all animals throughout the probed volume. The voids are roughly spherical tendency to prolate in shape and well connected with the canalicular network.

The void are predominantly centered around junctions between multiple canaliculi.

Figure 1: Osteocyte and the connecting canaliculi. Encircled in red a void can be seen well interconnected with the surrounding canaliculi.

Discussion
The communication between the osteocytes has been speculated to be enabled by fluid flow through the canaliculi[8]. While the role of the voids reported herein remains unclear, their presence are bound to influence the information flow through the network. These voids have not been observed in samples of human origin exemplifying another difference between human and rodent bone [1, 9]. This further stresses the need for better understanding of the bone communication network.

References
8. Han et al. PNAS, 101.16689-16694, 2004

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