Ann Biomed Eng. 2009 Jul;37(7):1390-402. Epub 2009 May 5.

# Poroelastic evaluation of fluid movement through the lacunocanalicular system.

Goulet GC, Coombe D, Martinuzzi RJ, Zernicke RF.
Schulich School of Engineering, Department of Mechanical and Manufacturing Engineering, University of Calgary, Calgary, AB, Canada. gcgoulet@ucalgary.ca

**Abstract**
A poroelastic lacunocanalicular model was developed for the quantification of physiologically relevant parameters related to bone fluid flow. The canalicular and lacunar microstructures were explicitly represented by a dual-continuum poroelastic model. Effective material properties were calculated using the theory of composite materials. Porosity and permeability values were determined using capillaric and spherical-shell models for the canalicular and lacunar microstructures, respectively. Pore fluid pressure and fluid shear stress were calculated in response to simulated mechanical loading applied over a range of frequencies. Species transport was simulated with convective and diffusive flow, and osteocyte consumption of nutrients was incorporated. With the calculated parameter values, realistic pore fluid pressure and fluid shear stress responses were predicted and shown to be consistent with previous experimental and theoretical studies. Stress-induced fluid flow was highlighted as a potent means of species transport, and the importance of high-magnitude low-frequency loading on osteocyte nutrition was demonstrated. This new model can serve as the foundation for future hierarchical modeling efforts that may provide insight into the underlying mechanisms of mechanotransduction and functional adaptation of bone.

PMID: 19415492 [PubMed - indexed for MEDLINE]