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Flow Chamber for Confocal Tracking of Particles in Bone

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ABSTRACT

Interstitial fluid flow in the lacunar-canalicular system (LCS) of bone is recognized as a potential regulator of bone remodeling. Movement of fluid across bone cells called osteocytes regulates gene expression that leads to either bone formation or resorption. Interstitial fluid moves in response to bone loading during daily activity, and bone growth occurs to compensate for these loads, affecting bone shape and strength. While interstitial fluid flow is thoroughly studied using computational models, there is a critical need to study flow in real bone samples with imaging techniques. Flow velocities determined from imaging will be more accurate than computational models due to the simplifying assumptions that are made when building a model. This study presents a sealed system that allows for imaging of particle flow in bone using confocal microscopy. The flow apparatus was designed in Autodesk Fusion 360 and fluid flow was controlled using an electric constant flow pump. For comparison with experimental data, a computational model based on confocal microscopy images was created to calculate flow velocities in the LCS using ANSYS Fluent. The results of this study will develop a novel method for tracking interstitial fluid flow in the LCS, providing a new strategy to study how fluid flow affects bone remodeling. The ability to measure fluid flow in bone allows for the connection of age or disease related alterations in the LCS to changes in bone mass and structure.

KEYWORDS

Lacunar-Canalicular Network, Confocal Laser Scanning Microscopy, Computer Aided Design