Estimation of Atherosclerotic Plaque Material Properties

***L. Speelman[1], A.C. Akyildiz[1], H.H.G. Hansen[2], H.A. Nieuwstadt[1], A.F.W. van der Steen[1,3], J.J. Wentzel[1], C.L. de Korte[2], and F.J. Gijsen[1]**

[1]Department of Biomedical Engineering, Erasmus MC, Rotterdam, the Netherlands.
[2]Medical Ultrasound Imaging Center, Radboud University Medical Center, Nijmegen, the Netherlands.
[3]Interuniversity Cardiology Institute of the Netherlands (ICIN), Utrecht, the Netherlands.

*Corresponding author: l.speelman@erasmusmc.nl

Atherosclerotic plaque rupture is the main cause of myocardial infarction and stroke. Plaque rupture occurs when plaque stresses exceed plaque strength. Biomechanical models therefore have a great potential to predict plaque rupture risk. However, data on material properties of plaque components are scarce. We aim to estimate plaque components material properties by combining non-invasive plaque strain imaging and inverse finite element modeling.
Atherosclerotic porcine iliac arteries were excised and inflated in an experimental setup. Vessel deformations were recorded with ultrasound. Radiofrequency ultrasound data were used to compute displacement maps between systolic and diastolic pressure. These measured displacement maps were compared to displacements computed with a finite element model based on the vessel geometry from histology. Differences were minimized by fitting the plaque components material properties. With this inverse approach we successfully matched the measured and computed displacement maps. Estimated intima stiffness values correspond to the low range of literature values.

Keywords: Atherosclerosis, Computational Biomechanics, Ultrasound imaging, Inflation experiment