Title of Abstract

Non-invasive, MRI-based calculation of the aortic blood pressure waveform using computational fluid dynamics

Authors Names

Mariscal Harana, Jorge; Florkow, Mateusz; Valverde, Israel; van Engelen, Arna; Schneider, Torben; Alastruey, Jordi

Presenters Name and Contact Details – if different from submitter.

Authors Affiliation

Division of Imaging Sciences and Biomedical Engineering, St. Thomas' Hospital, King's College London, UK

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Key Words – up to 4 keywords may be entered. A minimum of 1 keyword is required.

Patient-specific modelling; 1-D blood flow modelling; haemodynamics; magnetic resonance imaging

Abstract – maximum 400 words, plain text. Please ensure you structure your abstract using the following headings**: Objectives, Methods, Results and Conclusions**.

Objectives

The aortic blood pressure (BP) waveform carries valuable information for the diagnosis and treatment of cardiovascular disease and plays an important role in pressure-related conditions, such as hypertension and atherosclerosis. However, direct aortic BP measurements are only possible using pressure-sensing wires or catheters advanced from a more peripheral vessel, such as the femoral or brachial artery. On the other hand, magnetic resonance imaging (MRI) provides non-invasive, accurate measurements of aortic geometry and blood flow waveforms. We will present our novel approach for calculating the aortic BP waveform by combining non-invasive MRI measurements with patient-specific blood flow modeling.

Methods

We have developed a new methodology to analyse haemodynamic data, measured non-invasively, which uses a validated one-dimensional/zero-dimensional (1-D/0-D) computational framework of aortic haemodynamics. Outflow boundary conditions are represented by 0-D lumped parameter models of the perfusion of downstream vessels. Patient-specific model parameters are calibrated using aortic geometry, aortic flow waves, dynamic measurements of luminal cross-sectional area, and peripheral blood pressures. The geometry of the aorta and the supra-aortic vessels is extracted using segmentation software developed in collaboration with Philips, and is divided into multiple segments of known length and area which constitute the 1-D computational domain.

Results

Our initial results using MRI data acquired in a young healthy volunteer indicate that our methodology can represent aortic flow and area waves with errors smaller than 8% relative to corresponding *in vivo* waves. Further results will be presented in which our modelling approach is tested by comparison against invasive aortic pressure measurements in patients (n>6) with several degrees of aortic coarctation. Energy losses at the stenosis will be investigated by comparing 1-D vs 3-D blood flow modelling in idealised compliant vessels with different degrees of stenosis.

Conclusions

We are developing a novel methodology to calculate the aortic blood pressure waveform using validated 1-D aortic blood flow modelling. We will present our latest results using *in vivo* data acquired in volunteers and patients.