

Evaluating the hemodynamic impact of isolated non-distensibility and residual narrowing after coarctation repair using a computational study.

Background Even after a successful treatment of aortic coarctation, a high risk of cardiovascular morbidity and mortality remains. Uncertainty exists on the factors contributing to this increased risk among others the presence of (1) a residual narrowing, leading to an additional resistance in the arterial system and (2) a local non-distensible zone, disturbing the buffer function of the aorta. As the many interfering factors and adaptive physiologic mechanisms present in vivo prohibit to study the isolated impact of these individual factors, an advanced computer model was developed.

Material and methods The geometry and the flow boundary conditions in this model are obtained from MRI data of a healthy subject (Figure 1). A segment with varying length (5-50 mm) and stiffness was included distal to the left subclavian artery (red zone in Figure 1), mimicking the scar tissue after coarctectomy or the treatment with a stent. Recurrent coarctation was studied by altering the diameter of this zone (coarctation index of 0.5 for severe and 0.65 for mild coarctation).

Results The model was first validated by comparing the calculated flow through the descending aorta in a healthy subject with the flow measured with MRI. A good agreement between both was found (Figure 2). Next, the impact of residual coarctation was studied by comparing pressure gradients, peak velocities and alterations in compliance.

Conclusion The model allows to study the isolated effect of local non-distensibility and narrowing which is impossible to obtain in vivo.

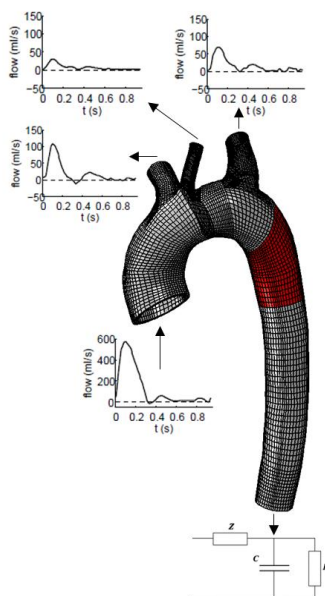


Figure 1: Patient specific model.

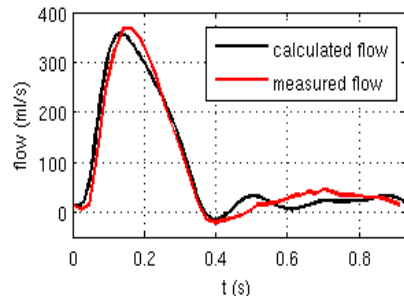


Figure 2: Comparison of measured and calculated flow.