Insights into the effect of local stiffness and residual narrowing on central hemodynamics seen in repaired aortic coarctation: a computational study.

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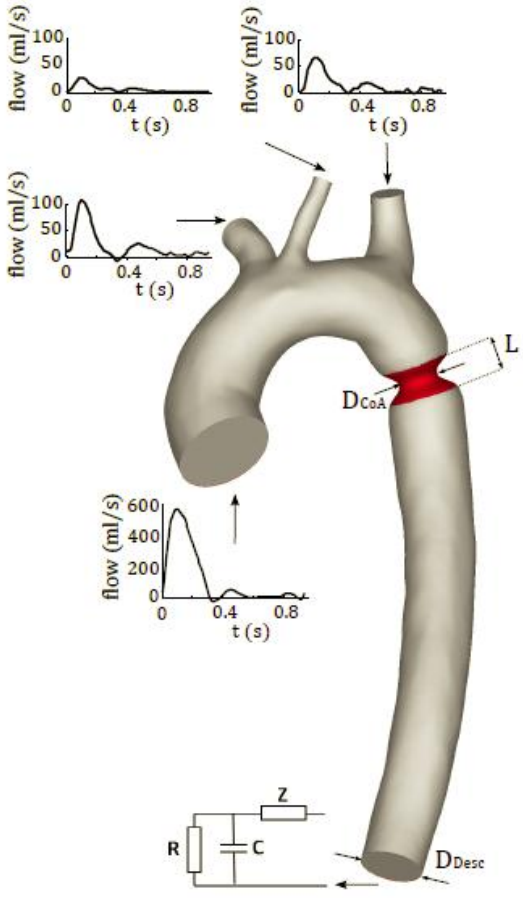
INTRODUCTION Even after successful treatment of aortic coarctation (CoA), a high risk of cardiovascular morbidity and mortality remains. Uncertainty exists on the factors contributing to this increased risk among others the presence of (1) a residual narrowing, leading to an additional resistance in the arterial system and (2) a less distensible zone disturbing the buffer function of the aorta.
As the many adaptive physiologic mechanisms present in vivo prohibit the study of the isolated impact of these individual factors, a numerical fluid-structure interaction model is developed to predict the central aortic hemodynamics in coarctation treatment.



METHODS AND MATERIALS The geometry and flow boundary conditions are obtained from MRI data of a healthy subject (Figure 1). To model the functional impact of repaired CoA, a segment with varying length L and stiffness (E-modulus x 5, 20 or 100) is included (red zone). Recurrent coarctation is studied by altering the diameter (D_{CoA}/D_{Desc} = 0.5 for severe and 0.65 for mild coarctation).

RESULTS The most severe reduction in compliance (-31%) is obtained for the case of D_{CoA}/D_{Desc} = 0.5, L = 10 mm and E x 20. This case also produces the most profound impact on ascending aorta systolic blood pressure (+58 mmHg). Wave separation demonstrates pronounced reflection (reflection magnitude 0.59 vs. 0.29 at control) which, however, is largely obscured in the wave intensity analysis.

CONCLUSION The overall impact of a stiffening on the hemodynamics is fairly limited. A residual narrowing, on the other hand, affects both the compliance and hemodynamics significantly.