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Aortic stiffness descriptors by cardiac magnetic resonance are correlated with mechanical testing of ex-vivo aortic aneurysms specimens

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Background: Aortic stiffness independently predicts mayor adverse cardiovascular events and mortality in the general population. Cardiovascular magnetic resonance (CMR) permits the assessment of a number of parameters theoretically linked to aortic stiffness, such as distensibility (AD), pulse wave velocity (PWV) and proximal aorta longitudinal strain. However, no previous study validates these parameters as descriptors of aortic wall stiffness against ex-vivo mechanical testing.

Materials and methods: Ascending aorta (AAo) specimens were collected from 20 patients undergoing AAo replacement for aneurysms. Patients underwent a CMR protocol in the days leading to the surgery, including 4D flow CMR. Two 15×5 mm specimens (one oriented in the circumferential and the other in the longitudinal aortic direction) were extracted during surgery, and later tested controlling for extension force. Elongation was measured by laser video extensometer and the tangent of the stress-strain curve at diastolic pressure was extracted. AAo PWV and the Eh product (E being Young modulus and h wall thickness) were measured from 4D flow CMR while AD and AAo longitudinal were quantified from cine images.

Results and conclusions: Marked correlations were found between circumferential elastic modulus and AAo AD ($R = -0.502$), PWV($R = 0.652$) and Eh ($R = 0.602$). Similarly, strong correlation was identified between AAo longitudinal strain and longitudinal elastic modulus($R = -0.513$). In conclusion, PWV and the Eh product are positively related to aortic wall stiffness while aortic distensibility and strain show negative relationships. Thus, these biomarkers are a reliable expression of aortic wall stiffness.

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