Aortic wall stiffness and microcalcification in inherited thoracic aortopathies

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Background: Inherited thoracic aortic diseases are at substantially increased risk of aneurysm formation, aortic dissection or rupture. Importantly, up to 70% of dissections occur in aortas with a diameter below the threshold for prophylactic surgical replacement. Increased aortic stiffness and microcalcification have previously been identified as features of aortopathy and both indicate worsening vessel wall health. Improvement in our understanding of the disease processes that underpin high risk thoracic aortic aneurysms would be a major clinical advance.

Purpose: To investigate aortic wall microcalcification in a group of patients with inherited thoracic aortopathy and examine its relationship to both aortic stiffness and aortic diameter.

Methods: As part of an ongoing clinical study, 26 patients with thoracic aortopathy (14 congenital bicuspid aortic valve [BAV], 6 Marfan syndrome [MFS], 6 Turner syndrome [TS]) underwent aortic magnetic resonance imaging (MRI). Ascending aortic diameter and circumferential strain were determined by MRI at the level of the right pulmonary artery. Aortic pulse pressure was determined using applanation tomography. Aortic stiffness was calculated as circumferential aortic distensibility (circumferential strain/aortic pulse pressure). Microcalcification activity was measured using 18F-sodium fluoride positron emission tomography/computed tomography (18F-NaF PET/CT). 18F-NaF uptake was deemed "positive" if it was above the 95th centile of blood pool. A volume of interest was drawn around the ascending aorta and the volume of "positive" signal was indexed to patient height (indexed aortic microcalcification [iAMC] score).

Results: Distensibility differed between subgroups (BAV 0.06[0.03], MFS 0.13[0.07], TS 0.19[0.09] mm/mmHg, p=0.011) was associated with body-mass index (r=0.46, p=0.025), and was inversely associated with age (R=0.45, p=0.024) and aortic diameter (R=0.61, p=0.001), but did not differ between sex, hypertension, hypercholesterolaemia or smoking status (all p>0.05). 18F-NaF uptake co-localised with the aortic wall of ascending thoracic aneurysms (Figure). The iAMC score was associated with aortic diameter (R=0.43, p=0.033), and aortic distensibility (R=0.42, p=0.048), and appeared to carry a borderline association with age (R=0.39, p=0.064). There was no difference in iAMC between aortopathy subtypes, hypertension, smoking status, hypercholesterolaemia, or sex (all p>0.05).

Conclusion: In patients with inherited thoracic aortopathy, increased aortic wall stiffness and diameters, but not cardiovascular risk factors, are associated with increased aortic wall microcalcification. Further longitudinal and ex vivo studies are required to corroborate and validate these findings and determine if 18F-NaF uptake can predict disease progression and prognosis.