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Vascular biomechanics and molecular disease activity in the thoracic aorta: a novel imaging method

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Aims

The influence haemodynamics have on vessel wall pathobiology in aortic disease is incomplete. This aim of this study was to develop a repeatable method for assessing the relationship between aortic wall shear stress (WSS) and disease activity by fusing 4D flow cardiovascular magnetic resonance (CMR) with hybrid positron emission tomography (PET).

Methods and results

As part of an ongoing clinical trial, patients with bicuspid aortic valve (BAV) were prospectively imaged with both ¹⁸F-sodium fluoride (¹⁸F-NaF) PET, a marker of calcification activity, and 4D flow CMR. We developed novel software allowing accurate 3D co-registration and high-resolution comparison of aortic peak systolic WSS and ¹⁸F-NaF PET uptake (maximum tissue-to-background ratio). Intra-observer repeatability of both measurements was determined using Bland–Altman plots and intra-class correlation coefficients (ICCs). The relationship between localized WSS and ¹⁸F-NaF uptake was analysed using linear mixed-effect models. Twenty-three patients with BAV (median age 50 [44–55] years, 22% female) were included. Intra-observer repeatability for WSS (ICC = 0.92) and ¹⁸F-NaF (ICC = 0.91) measurements obtained within 1.4 ± 0.6 cm² regions of interest was excellent. On multivariable analysis, ¹⁸F-NaF PET uptake was independently and negatively associated with WSS as well as diastolic blood pressure (both *P* < 0.05), adjusted for age.

Conclusion

Fused assessment of WSS and ¹⁸F-NaF PET uptake is feasible and repeatable, demonstrating a clear association between these two factors. This high spatial resolution approach has major potential to advance our understanding of the relationship between vascular haemodynamics and disease activity.

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