Aortic flow abnormalities contribute to the aortopathy in bicuspid aortic valve disease

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Background:
Bicuspid aortic valve disease (BAV) is associated with aortic dilation. We examined the impact of flow abnormalities on measures of vascular function in the ascending aorta.

Methods:
We prospectively enrolled 142 participants (95 patients with BAV and 47 healthy volunteers [HV]); mean age 40 years (range 8-70). Cardiac magnetic resonance was used to measure arterial strain, distensibility, pulse wave velocity (PWV), rotational flow values to quantify helical flow, flow angle and wall shear stress (WSS).

Results:
Both BAV and HV had similar aortic diameters at the sinuses of Valsalva and the proximal descending aorta. BAV had significantly larger aortic diameters at the sinotubular junction (16.6 vs 15 mm/BSA, p=0.001) and the ascending aorta (18.2 vs 15.2 mm/BSA, p<0.001). There was no difference in PWV across the arch compared to HV (median 4.5 vs 4.7 m/s, p>0.05), distensibility in the ascending aorta (mean 4.1 vs 4.6 1/mmHg, p>0.05) or arterial strain (mean 0.19 vs 0.21, p>0.05). The most common flow pattern in our BAV cohort was a right-handed helical flow in 72%. A normal laminar flow pattern was observed in 11%, complex disorganised flow in 13% and left-handed flow in 4%. The normal flow pattern group had similar ascending aortic diameter, rotational flow values, flow angle and total WSS compared to the HV group (p>0.05). The right-handed flow group had significantly higher ascending aortic diameter (18.3 vs 15.2 mm/BSA, p<0.001), rotational flow values (31.7 vs 2.9 mm²/s, p<0.001), flow angle (23.1 vs 7.0 degrees, p<0.001) and total systolic WSS (0.85 vs 0.59 N/m², p<0.001) compared to the HV group.

Conclusion:
Marked differences in ascending aortic flow abnormalities occur with BAV but there were no differences in distensibility or pulse wave velocity. These findings suggest that the ascending aortic flow pattern is an important determinant of adverse aortic outcome.

a) normal flow  b) right-handed helical flow