Improvement of haemodynamic flow abnormalities after aortic valve replacement in bicuspid aortic valve disease

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Introduction:
Bicuspid aortic valve disease (BAV) is associated with dilatation of the proximal aorta and abnormal flow patterns, particularly increased helical flow and changes in the aortic wall shear stress. The aortic dilation may be slowed by aortic valve replacement via normalisation of flow patterns. We assess the effect of different types of aortic valve replacement (AVR) on aortic flow patterns.

Methods:
We prospectively enrolled 69 participants: 23 BAV patients with prior AVR (10 mechanical, 6 bioprosthetic, 7 Ross procedure), 23 BAV patients with a native aortic valve and 23 healthy volunteers. All underwent 4D flow cardiovascular magnetic resonance.

Results:
The majority of patients with mechanical AVR or Ross showed a normalised flow pattern (70% and 57% respectively) with near normal rotational flow values (7.4±3.9 and 11.0±12.0 mm2/s respectively; normal range -5 to +11 mm2/s); and reduced in-plane wall shear stress compared to native BAV (0.13±0.18 N/m2 for mechanical AVR vs. 0.37±0.26 N/m2 for native BAV, p<0.05). In contrast, all subjects with bioprosthetic AVR showed abnormal flow patterns (mainly marked right-handed helical flow), with similar rotational flow values to native BAV (25.3±15.0 mm2/s and 20.1±11.0 mm2/s respectively, p>0.05) and similar wall shear stress pattern. Data before and after AVR (n=13) supported these findings: mechanical AVR showed a significant reduction in rotational flow (29.3±15.1 to 7.9±4.2 mm2/s, p<0.05) and in-plane wall shear stress (0.45±0.19 to 0.20±0.12 N/m2, p<0.05), whereas these remained unchanged in the bioprosthetic AVR group.

Conclusion:
Abnormal flow patterns in BAV are significantly reduced after mechanical AVR or Ross procedure, but remain similar after bioprosthetic AVR. This is the first insight indicating that type of valve replacement may influence post-operative flow patterns, and could have important implications for future aortic growth.