Bidirectional Shunt Trajectory in Ventricular Septal Defect With Eisenmenger's Syndrome

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Figure. (A) Transthoracic echocardiography showed a membranous ventricular septal defect (arrow), (B,C) early systolic left-to-right shunt, and late systolic right-to-left shunt, on (B) color and (C) pulsed wave Doppler. (D) Simultaneous right and left ventricular (RV and LV) pressure measurements. (E) Left anterior oblique (LAO) contrast-enhanced 3-D computed tomography. (F–H) LAO view of the trajectory of the pulmonary artery (PA) blood flow visualized on 4-D flow magnetic resonance imaging (MRI) by locating the region of interest (red circle) surrounding the main PA (F, early; G, mid; and H, late systole, respectively). (I–K) Cross-sectional 4-D flow MRI of blood flow in the aorta (Ao; I, early; J, mid; and K, late systole, respectively). (L) Electrocardiogram (0.5 mV/cm). (M–P) Cine mode MRI (M, end diastole; N, LV contraction prior to RV; O, contraction of the LV and RV; P, LV dilation prior to RV). RA, right atrium.

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A 64-year old man with ventricular septal defect (VSD) and Eisenmenger's syndrome was admitted to hospital with declining arterial O₂ saturation. Transthoracic echocardiography showed a membranous VSD (**Figure A**), early systolic left-to-right shunt, and late systolic right-to-left shunt, on color (**Figure B**) and pulsed wave Doppler (**Figure C**). Simultaneous right and left ventricular (RV and LV) pressure measurements (**Figure D**) did not explain the timing of the bidirectional shunt flows. Left anterior oblique (LAO) contrast-enhanced 3-D computed tomography (**Figure E**) was helpful in confirming the anatomical orientation. 4-D flow magnetic resonance imaging (MRI) was then used to visualize the trajectory of flows in the pulmonary artery (PA) by locating the region of interest surrounding the main PA (**Figure F–H**; **Movie S1**). PA flow arose mainly from the LV via the VSD (arrow) at the beginning of systole (**Figure F**), subsequently also from the right atrium (RA; **Figure G**), and then from the RA alone (**Figure H**). Cross-sectional 4-D flow MRI of the aorta showed that the flow arose only from the LV at

the beginning of systole (**Figure I**), subsequently from both the LV and RV (**Figure J**), and then from the RV alone via the VSD (**Figure K**; **Movie S2**). Electrocardiogram showed right bundle branch block (**Figure L**), and cine mode MRI elucidated the time gap between LV and RV contraction, indicating the mechanism underlying the changing directions of flow and decline in arterial O₂ saturation.

Disclosures

The authors declare no conflict of interest.

Supplementary Files

Supplementary File 1

Movie S1. 4-D flow MRI of PA flow.

Supplementary File 2

Movie S2. 4-D flow MRI of Ao flow.

Please find supplementary file(s);
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