Disturbed Intra-cardiac Flow Organization after AtrioVentricular Septal Defect Correction as assessed with 4DFlow MRI and Quantitative Particle Tracing.

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Introduction: The normal pattern of left ventricular (LV) inflow and ejection affects the efficiency of cardiac pumping performance. Patients after atrioventricular septal defect (AVSD) correction have an abnormal atrioventricular valve shape and an altered inflow direction. Whether this influences blood flow efficiency and long term follow-up is unknown. We aimed to quantitatively describe the LV blood flow pattern using 4-dimensional velocity-encoded cardiac magnetic resonance imaging (4DFlow MRI) and particle tracing in healthy volunteers and corrected AVSD patients.

Methods: 32 patients (25±14 years) and 30 healthy volunteers (26±12 years) underwent 4DFlow MRI. At end-diastole the LV was evenly filled with particles and subsequently tracked by backward and forward particle tracing to analyze the LV multi-componental flow as introduced by Eriksson [JCMR, 2010] discriminating 1. direct flow entering and leaving t LV within one cycle, 2. retained flow entering during diastole but remaining in LV during next systole, 3. delayed ejected flow already in LV before diastole and leaves LV during systole 4. residual volume, 5. Regurgitant flow. The path of inflowing particles (i.e. direct and retained flow) during diastole was evaluated using the 16-segment LV cavity model.

Results: Patients showed a smaller percentage of direct flow compared to controls (Figure, * indicating p<0.05). In patients versus controls more inflow was observed in the basal inferior segment (22±11% versus 17±5%, p=0.005), with less direct flow but more retained inflow. In patients, more inflow reached into the mid-ventricular level compared to controls (68±13% versus 58±9%, p<0.001), most notably retained inflow in infero-lateral and antero-lateral segments. Subsequently, in patients more (mostly retained) inflow reached into the apex (23±13% versus 14±7%, p<0.001), which correlated with early peak filling velocity (r=0.637, p<0.001). Patients with a corrected complete or intermediate AVSD presented with less direct flow (24±8% versus 33±8%, p=0.003) and more apical inflow (30±14% versus 18±12%, p=0.014) compared to corrected partial AVSD.

Conclusions: Multi-component particle tracing combined with 16-segment analysis quantitatively demonstrated altered LV filling and ejection patterns after AVSD correction, with less direct flow and more (retained) inflow in the apical and lateral LV cavity segments, which may contribute to a decreased cardiac pumping efficiency.