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4D-Flow-MRI in patients with Fontan circulation for evaluation of pulmonary artery blood distribution

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Objectives: 4D-flow-MRI is an arising tool to assess complex flow patterns in the heart and great vessels. We evaluated the feasibility of this imaging technique in patients after Fontan operation (FO) and attempted to visualize and quantify caval blood flow distribution and vorticity towards the pulmonary arteries (PAs).

Methods: 4D-flow-MRI scans were acquired in 10 FO patients (age 7-21 years, mean 12,8 ± 4,2) with extracardiac tunnel in 9 and 1 atriopulmonary connection. According to our MRI protocol, scans were performed at a velocity encoding (VENC) of 100 cm/s with spatial resolution of 2.2x1.8x1.8 mm and 10 time-frames/heart beat (HB). Flow pattern of caval inflow and distribution to the pulmonary arteries were visualized using time-resolved colour-coded path lines. All acquired data were processed offline using the manufacturer's software.

Results: In our patient group blood from the superior and inferior vena cava (SVC;IVC) drained predominantly to the RPA (53% vs. 47%). LPA blood supply /HB tended to be lower but with higher flow velocity compared to the right side (12,68 ml/HB vs. 15,68 ml/HB; 62,2 cm/s vs 49,7 cm/s) consistent with anatomically smaller or distorted LPAs. Colour-coded path lines revealed IVC blood predominantly draining to the RPA within our patient cohort in contrary to recently published data. However, within our group IVC and SVC (Glenn and Fontan tunnel) were rather placed orthogonal to each other than with a distinct offset to one or the other side as reported by others.

Conclusion: In this proof-of-concept study 4D-flow-MRI in Fontan patients was feasible with promising results. Further multicenter studies with larger patient numbers are warranted to correlate different surgical methods to the resulting PA blood flow distribution and its possible impact on late complications of the Fontan operation like protein-losing enteropathy.