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iCMR Evaluation of Single Ventricle Patients: A Pilot Study

Arar Y. (1), Veeram Reddy S.R. (1), Abou Zahr R. (1), Gooty V. (1), Hernandez J. (1), Velasco Forte M.N. (2), Roujol S. (2), Greil G. (1), Hussain T. (1)
UT Southwestern/Children's Medical Center Dallas (1); Division of Imaging Sciences and Biomedical Engineering, King's College London (2)

Introduction (or Basis or Objectives):

We describe our early institutional experience performing real-time interventional CMR (iCMR) procedures to evaluate the Fontan circulation using the MRI compatible wire (angle-tip Emeryglide MRWire, Nano4Imaging, Aachen, Germany) to guide catheters for a right heart catheterization (RHC), left heart catheterization (LHC), and Fontan fenestration test occlusion (FFTO) when indicated. The FFTO procedure is traditionally performed in the cardiac catheterization laboratory to evaluate patient's candidacy for potential Fontan fenestration device closure (FFDC).

Methods:

Patients underwent an iCMR procedure using a dilute gadolinium-filled balloon-tip catheter in combination with the MRWire for Fontan pathway/RHC, LHC, and FFTO under real-time MRI visualization. A recently developed passive catheter tracking technique (real-time spoiled gradient echo (TFE), FA 35-45 degrees, TE 1.3ms; TR 2.7ms; 40 degrees partial saturation (pSAT) pre-pulse) was used to visualize the gadolinium-filled balloon, MRWire, and cardiac structures simultaneously. MRWire visualization is enabled due to distal markers creating susceptibility artifact.

Results:

MRWire was used on 14 out of 20 single ventricle (SV) patients undergoing iCMR. Median age and weight were 5.6yrs and 17.7kg, respectively (range: 2-16yrs and 11.5-43.6kg). SV anatomy (n = 20): 11 pre-Fontan evaluations, 8 post-Fontan patients for PLE/cyanosis evaluations (6 fenestrated and 2 non-fenestrated), and 1 pre-Glenn evaluation.

Real-time MRI-guided RHC (n = 14), LHC/aortic pull back (n = 14), and FFTO (n = 2) was successfully performed in all patients when the MRWire was used. No complications were encountered. Time taken for first pass RHC, LHC/aortic pull back, and FFTO was 4.9, 2.9, and 6.5 minutes, respectively. Patients were transferred to the fluoroscopy lab if further intervention was required including FFDC, balloon angioplasty, and/or coiling of collaterals when indicated.

Conclusions:

Feasibility for diagnostic RHC, LHC, and FFTO iCMR procedures with the MRWire in SV pediatric patients is demonstrated. Novel real-time TFE with optimized FA-pSAT has facilitated simultaneous visualization of the catheter balloon tip, MRWire, and cardiac/vessel anatomy during iCMR procedures. These cases describe a more thorough evaluation of Fontan pressures and cardiac output before FFDC by using accurate flow, ventricular volumes, and cardiac output measurements from real-time MRI with simultaneous catheter based pressure measurements.

