

Time-resolved 3D contrast-enhanced MRA in Adult Congenital Heart Disease

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Purpose: To investigate whether highly-temporally-resolved 3D contrast enhanced MRA [1] can unravel complex flow patterns and functional vascular status in patients with surgically treated adult congenital heart disease (ACHD).

Materials and Methods: Thirty-five consecutive patients (20 men; 15 women; mean age of 29.8±13.4 years) with ACHD (primary diagnosis of pulmonary atresia/ severe pulmonary stenosis n=4; tricuspid atresia n=2; aortic coarctation n=11; tetralogy of Fallot n=8; transposition of great arteries n=7; others n=3) were examined on a 1.5 T MR scanner (Magnetom Avanto, Siemens Medical Solutions). The examination protocol comprised coronal time-resolved 3D MRA following injection of a 6 ml bolus of gadodiamide (TR 2.01 ms, TE 0.81 ms, flip angle 20°, bandwidth 1120 Hz/Pixel, voxel size 1.6x1.3x7.0 mm³, GRAPPA x 2, temporal resolution 1.2 seconds over a 25 second acquisition window). In addition, high spatial resolution 3D CEMRA of the thorax was acquired following 30 ml of contrast agent (TR 2.87 ms, TE 0.97 ms, flip angle 30°, bandwidth 610 Hz/Pixel, voxel size 1.4x1.0x1.6 mm³, 20 sec acquisition). Both MRA datasets were evaluated independently by two experienced observers, blinded to patients' history, with respect to image quality [0=poor, non-diagnostic; 3=excellent] and anatomic and functional diagnostic content. The MRA findings were integrated with the findings on multi-planar cardiac SSFP cine.

Results: Both time-resolved and conventional MRA had a median image quality score of 3 for both observers. No statistically significant difference was evident between the scoring of the two observers. Observers 1 and 2 found important functional information in the time-resolved MRA series in 20 and 17 patients respectively which was not seen on high-spatial resolution MRA or cine imaging. Observer 1 (observer 2) reported a higher confidence in the assessment of lung perfusion in 14 (8) cases compared to the high-spatial resolution MRA. Furthermore, intracardiac and extracardiac shunts were exclusively depicted in 6 (6) and 1 (2) patients, respectively, whereas a baffle leak or intracardiac shunt was ruled out in 6 (5) patients. An open Glenn or Fontan shunt was better visualized on time-resolved MRA series in 4 (2) cases (Figure 1), whereas occlusion of the left innominate vein was seen in one patient only on time-resolved MRA. In 11 patients, vascular details not well shown on time-resolved MRA were seen on the high-spatial resolution MRA. Specifically, observer 1 (observer 2) had higher confidence in the assessment of the branching of supra-aortic vessels in 5 (3) patients, and, in 5 (3) patients major aorto-pulmonary collateral arteries (MAPCAs) in Tetralogy of Fallot were better visualized using the high-spatial resolution MRA. In three patients with accessory renal arteries those could be solely appreciated on the high-spatial resolution MRA.

Conclusion: Using only a small dose of contrast, time-resolved 3D angiography can be uniquely effective in unraveling complex vascular anatomy and flow processes in patients with ACHD. It yields clinically relevant information in a substantial number of patients in comparison to conventional MRA, such that both techniques should be regarded as complementary.

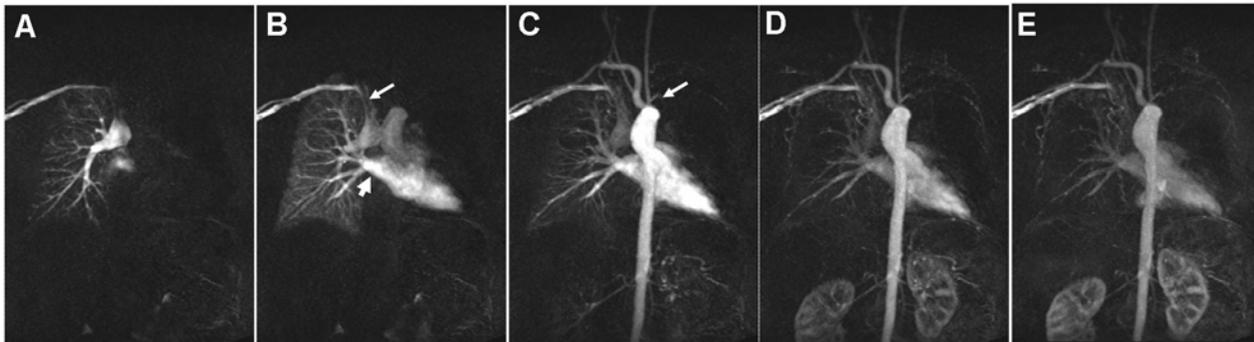


Figure 1: Five of thirteen images from a time-resolved MRA series in a 40 year old female patient with history of tricuspid atresia, s/p left Blalock-Taussig (BT) and Glenn shunt. The open Glenn shunt to the right pulmonary artery (RPA) is visualized (B, white arrow). Rapid transit of contrast from RPA to pulmonary veins (B, arrow head) suggesting intrapulmonary shunting. The left subclavian artery is occluded at its origin (arrow in C) consistent with a history of left BT shunt.

References:

[1] Finn JP, Baskaran V, Carr JC, Mc Carthy RM, Pereles FS, Krocker R, Laub G. *Thorax: Low-dose, Contrast-Enhanced 3D MR Angiography with Sub-second Temporal Resolution - Initial Results.* [Radiology 2002; 224:896-904.](https://pubs.rsna.org/doi/abs/10.1148/radiol.2002.224896904)