

## Congenital Heart Disease: Role of Time-Resolved MR Angiography

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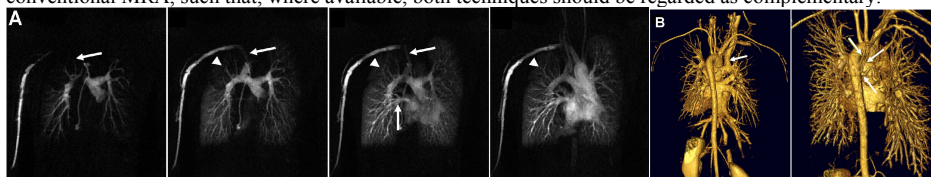
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**Background and Objective:** Cardiac MRI and contrast-enhanced MR angiography (CE-MRA) are gaining interest as non-invasive diagnostic measures for both primary diagnosis and follow up of patients with congenital heart disease (CHD) (1). Due to the presence of complex anatomy and extensive collateral pathways between pulmonary and systemic circulation in patients with CHD, a highly temporally resolved imaging can provide valuable dynamic and functional information in circumstances where steady state imaging cannot. Using a 32-channel MR scanner and multi-coil receiver technology, in addition to implementing most recent advancement in fast imaging tools such as parallel acquisition (2) and sparse k-space sampling methods such as time-resolved angiography with interleaved stochastic trajectories (TWIST) (3), we investigated the clinical usefulness of a 3D CE-MRA protocol that encompasses both high spatial and high temporal resolution acquisition in evaluation of the anatomy and hemodynamics of the patients with CHD. The aim of this presentation was to investigate whether TR-MRA can unravel complex functional vascular anatomy in patients with CHD and to assess the incremental diagnostic value of TR-MRA over conventional MRA in this population.

**Methods:** One hundred ten consecutive patients (68M, 12-76 y/o) with known or suspected CHD underwent MRA protocol including both time-resolved and high-spatial resolution MRA on a 32-channel 1.5T MR scanner (Magnetom Avanto, Siemens Medical Solutions), using a combination of 24 coil elements for signal reception. **TR-MRA** was performed in coronal plane after intravenous injection of 6ml of Gd (Gadodiamide) at 4ml/s, applying a 3D fast GRE sequence using the following imaging parameters: TR/TE 2/0.8 ms; FA 20°; BW 1120 Hz/pixel; FOV 440×480 mm; matrix 275×384; slab thickness: 84 mm; and 12 partitions. Generalized autocalibrating partially parallel acquisitions (GRAPPA) (1) with an acceleration factor of 2 in phase encoding direction was employed, as was TWIST, a recent view-sharing technique, which undersamples the periphery of k-space depending on the radial distance of the center of k-space (3). These settings resulted in acquisition of 3D datasets with in-plane resolution of 1.3 x 1.5 mm<sup>2</sup> and temporal resolution of 1.2s during suspension of respiration for 20 sequential measurements. Subsequently following IV injection of 0.1 mmol/kg Gd, single-phase high-spatial resolution MRA was performed in the coronal plane, using a fast spoiled GRE sequence (TR/TE: 2.8/0.97ms, FA 30°, BW 610 Hz/pixels, FOV 406 x 500mm; matrix: 358 x 512, 72 partitions, voxel size 1.4 x 1 x 1.6 mm<sup>3</sup> and GRAPPA x2 during 19s breath-hold). To ensure both arterial and venous phase coverage, two sequential measurements were acquired. All MR images were independently evaluated by two radiologists in separate reading sessions. Both TR-MRA and conventional MRA were evaluated for vascular abnormality, pulmonary perfusion, and post-surgical conduits and shunts. Subsequently each observer summarized what additional clinical information, if any, was gained from TR-MRA data. Wilcoxon rank-sum test was used to evaluate the difference between image quality ratings of the two observers. Interobserver variability for rating of pulmonary perfusion, blood shunting and assessment of surgical conduits was evaluated by kappa coefficient and determination of 95% confidence interval.

**Results:** All studies were completed successfully and resulted in diagnostic image quality with no statistically significant difference between 2 observers. Observer 1 (observer 2) reported higher confidence in the time-resolved study for the assessment of lung perfusion in a total of 42 (35) cases compared to the high-spatial resolution MRA ( $\kappa=0.70$ ; 95% CI: 0.62, 0.84) (figure). Observer 1 (observer 2) found important functional information in the TR-MRA series in 60 and 56 patients respectively which was not seen on conventional MRA ( $\kappa=0.84$ ; 95% CI: 0.70, 0.98). Intracardiac and extracardiac shunts were exclusively depicted in 20 and 2 patients respectively, whereas a baffle leak or intracardiac shunt was ruled out in 14 patients.

**Conclusion:** The results of our study indicate that time-resolved, 3D MR angiography has an important role to play in the evaluation of patients with CHD. By clarifying the sequence of vascular and chamber enhancement in a visually intuitive way, TR-MRA has the potential to simplify the interpretation of conventional CE-MRA studies and to infer important additional clinical information about functional cardiovascular anatomy with only a small incremental dose of contrast medium. In conclusion, TR-MRA can be uniquely effective in unraveling complex hemodynamic findings and post-surgical changes in many patients with CHD in comparison to conventional MRA, such that, where available, both techniques should be regarded as complementary.



15 year-old male patient with D-TGA and VSD, status post surgical bidirectional Glenn shunt. (A) TR-MRA shows early enhancement of the right and left pulmonary arteries (arrows) due to open Glen shunt. Reduced perfusion of the right upper lobe (arrow heads) is noted likely reflecting perfusion via aorto-plmonary collaterals. (B) Volume rendered reconstruction of the high spatial resolution MRA show widely patent Glenn shunt and 3 prominent collaterals from the descending aorta, supplying the right upper lobe.

### References:

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