Image quality and accuracy of a 3D whole-heart self-navigated sequence in comparison with cardiac computed tomography for the assessment of coronary artery anomalies

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Target Audience: Radiologists and cardiologists interested in pediatric cardiovascular imaging.

Purpose: The aim of this work was to assess image quality and coronary artery anatomy using a prototype self-navigated free-breathing non-contrast 3D whole-heart (SN3D) MRA acquisition in comparison with coronary CTA (cCTA) in pediatric patients with suspected coronary artery anomalies.

Methods: Four pediatric patients (12-17 years) with suspected coronary artery anomalies underwent contrast-enhanced cCTA and non-contrast cardiac MRI (CMR) for the assessment of the origin and proximal course of the coronary arteries. cCTA acquisition (SOMATOM Flash, Siemens Healthcare, Forchheim, Germany) was performed after the injection of iohexol (OMNIPAQUE 350, GE Healthcare, Waukesha, WI, USA) at a flow rate of 4ml/s. A test bolus was used to optimize the scan delay, using a region of interest placed in the descending aorta. cCTA was acquired employing prospective ECG-triggering, with the phase of the cardiac cycle (systolic or diastolic) and length of padding based on the heart rate and variability. Other scan parameters were: tube potential 80 kV, gantry rotation time 0.28s, and detector collimation 64×0.6mm. CMR acquisition was performed using a 1.5T clinical system (MAGNETOM Avanto, Siemens Healthcare, Erlangen, Germany). Patients were placed in head-first supine position. A 24-element, multichannel spine phased-array radiofrequency (RF) coil (Tim technology) integrated into the patient table and a 6-element 12 channel phased array RF body coil were used for signal reception. All sequences were ECG-triggered. After the scout images, a high temporal resolution balanced steady-state free-precession (bSSFP) acquisition in 4-chamber view was performed in order to select the optimal trigger delay to time the SN3D acquisition for cardiac diastasis. Subsequently, the free-breathing non-contrast SN3D MRA (TR/TE 3.1/1.5ms, RF excitation angle 115°, FOV 220mm, voxel size: 1,1mm^3, 12064 radial views distributed over 377 heartbeats) was acquired in order to obtain an isotropic volume of the thorax for the evaluation of the coronary artery anatomy. Image quality of the SN3D MRA and cCTA was evaluated by two experienced observers according to a 4-grade scale (1, non-diagnostic; 2, sufficient; 3, good; 4, excellent)[1]. Furthermore, visualization of the left main, left anterior descending, circumflex, first diagonal, posterior descending, and right coronary arteries was evaluated **(Figure 1)**. Time of acquisition and signal to noise ratio (signal intensity of the blood in the aortic coronary-sinus divided by the average signal intensity measured in the lungs) were also assessed.

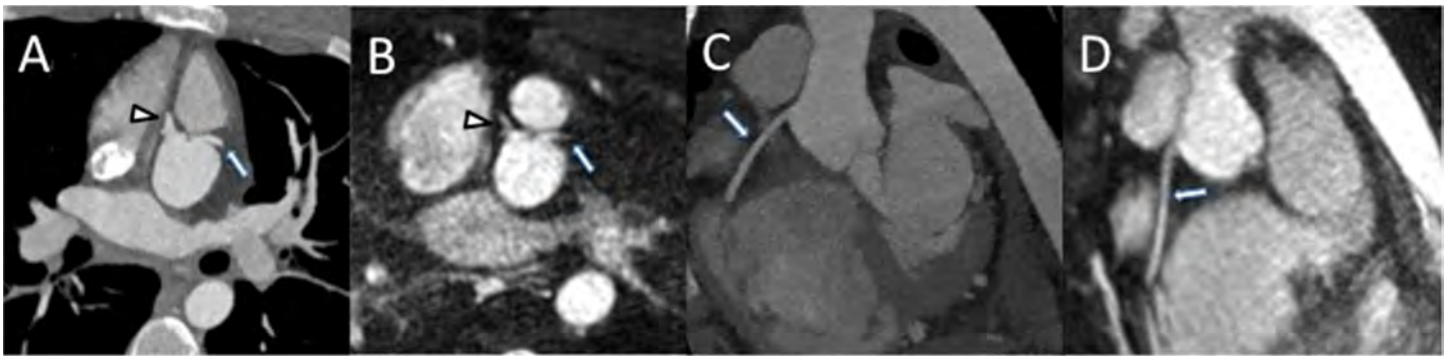

Figure 1 – cCTA (**A, C**) and non-contrast SN3D MRA (**B, D**) visualization of the origin and proximal course of the left anterior descending (**A, B arrows**) and the right coronary arteries (**A, B arrowheads, C, D arrows**) in a patient with post-surgical correction of transposition of the great arteries.

Results: Average SN3D MRA and cCTA image quality was 2.5 (2-3) and 3 (2-4), respectively. SN3D MRA allowed the visualization of the origin and proximal course of the coronary arteries with good agreement to cCTA in all cases. SN3D MRA failed to visualize the posterior descending coronary artery in one single case and, therefore, was unable to identify coronary artery dominance. The average acquisition time of the SN3D sequence was 6.4±1.5min with an average heart rate of 71bpm, while the mean signal to noise ratio was 25±4.

Discussion: In this preliminary report we show that there is good agreement in the evaluation of coronary artery anatomy between SN3D MRA and cCTA in a pediatric population. Non-contrast CMR was able to assess the origin and proximal course of the coronary arteries in a fast free-breathing acquisition with an excellent signal to noise ratio. Although cCTA is the standard of care for the evaluation of the anatomy of the coronary arteries, free-breathing SN3D whole-heart MRA allows for the evaluation of the coronary anatomy with good accuracy[2]. The novel radial SN3D sequence allows for the acquisition of an isotropic volume in a free-breathing fashion within a reasonable timeframe, with an improved ease of use and without penalties in image quality. The new SN3D MRA sequence provides fast and free-breathing imaging of the coronary arteries. In addition to the morphological and functional cardiac evaluation, such acquisition allows for the assessment of the proximal coronary artery anatomy in pediatric patients without radiation exposure, contrast agent administration or the need for general anesthesia.

Conclusion: Non-contrast free-breathing SN3D MRA acquisition seems to be a promising novel technique for the evaluation of coronary artery anomalies in pediatric patients.

Reference:

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