Free-Breathing Whole-Heart 3D Cardiac MRI at 3.0 Tesla for Characterization of Interatrial Septum: A Comparison with Multislice Computed Tomography

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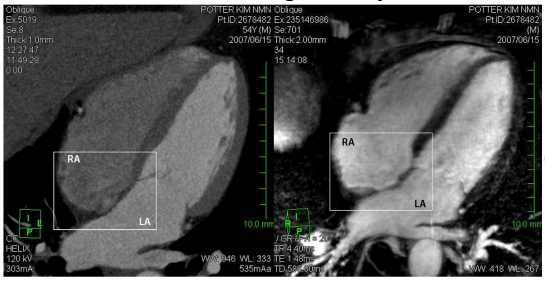
Introduction: Assessment of the interatrial septum (IAS) has become an important requirement for the diagnosis of variety of congenital and pathological diseases. Additionally, the preplanning of a variety of interventional procedures demands precise characterization of the septum, e.g. for trans-septal puncture and closure of atrial septal defects. Multi-detector CT has been shown as a valuable tool for the assessment of the IAS morphology, however, requires the use of radiation and potentially nephrotoxic contrast agents. Available MR techniques, to date, utilize breath-holding 2D techniques with relatively low spatial resolution. The purpose of this study is to demonstrate the feasibly of using a free breathing 3 dimensional (3D) technique at 3T and comparing the IAS measurements from this method to CT.

Materials and Methods: A total of 42 consecutive patients (26 men, 19-71 years old) were included in this study. Each subject was scanned using 16-detector CT and 3T MRI scanner. MRI was done using a 6-element cardiac coil, and vector electrocardiographic gating (VCG) with intravenous infusion (0.3 mmol/kg) of gadolinium-based contrast. Whole heart imaging was performed using a 3D FFE using an inversion recovery sequence. Scan parameters were as follows: TR= 4.4ms, TE=1.5ms, α=20°, TFE factor=34, SENSE factor = 2, and a voxel size 1x1x2 mm^3. Cardiac MSCT examination was performed using 16-row MSCT scanners, with injection of 130 ml of nonionic iodinated contrast (5ml/sec). Images from MRI and MSCT were reconstructed at the most quiescent interval in the diastolic resting period of the cardiac cycle, and analyzed using the same commercially available software.

Results: All patients tolerated both MRI and MSCT without complications. The images from total 84 scans (MRI and MSCT) of all 42 subjects were analyzed randomly, in the 4-chamber orientation. The mean length of interatrial septum by MRI and MSCT was 39.3± 4.7 mm and 39.2±4.7mm, respectively. The mean thickness was 3.1± 0.9 mm by both modalities. Linear regression analysis demonstrates the close relationship between measurements obtained using MRI and MSCT, e.g. IAS length, anterior IAS thickness, posterior IAS thickness, fossa ovalis length, and aortic root diameter (R^2= 0.98, 0.96, 0.97, 0.97, 0.98 respectively). Other morphological variables shows less correlative relationship; IAS angulation, and angle between IAS axis and antero-posterior axis of chest (R^2= 0.85, 0.83 respectively).

Conclusion: Whole heart 3D MRI using free-breathing technique with contrast was feasible in all subjects, providing high spatial resolution (1x1x2mm) and homogenous myocardial suppression, allowing for clear assessment of the IAS morphology and measurements, that was not significantly different from high resolution CT imaging, and without exposure to radiation hazards.



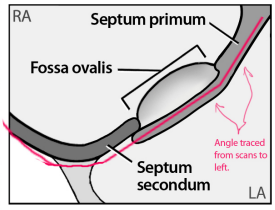


Figure 1. The interatrial septum, as shown by MSCT with contrast (left), MRI with contrast (middle), and illustrated diagram (right). In the latter, anatomical and morphological features of the IAS are illustrated. Notice that the interatrial septum is not just a straight wall, but rather has an angulation in its course. LA= left atrium; RA= right atrium.

	MRI	MSCT	*p-value*
IAS Length, mm	39.38 ± **4.7**	39.22±**4.7**	NS
IAS Thickness (anterior), mm	3.11 ± **0.99**	3.16±**0.97**	NS
IAS Thickness (posterior), mm	3.6± **0.72**	3.59± **0.73**	NS
FO Length, mm	12.52± **3.6**	12.35±**3.5**	NS
IAS Angulations (Degree)	154**.8** ±**9.3**	154.7±**9.3**	NS
IAS- AP Angle (Degree)	60.5± **8**	60.4±**9**	NS
LA diameter , mm	28.5±**3.9**	29±**4.9**	NS
Ao Root Diameter, mm	33±**3.6**	32.8±**3.6**	NS

Table 1. Measurements of various interatrial septum characteristics by 3T MRI and MSCT. All measurements are shown as mean ± SD. IAS= Interatrial septum; FO= Fossa Ovalis; AP= Antero-posterior axis of the chest; Ao= Aortic; NS= Not significant