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Oral presentation

Whole-heart magnetic resonance imaging for visualization of venous anatomy and myocardial scar using slow infusion of Gd-BOPTA in single exam

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Introduction

For cardiac resynchronization therapy (CRT), knowledge of the coronary venous anatomy in relation to areas of myocardial scar is important to plan the optimal LV lead position during the CRT-procedure. Cardiac magnetic resonance imaging (CMR) has previously been used to assess coronary veins without a contrast agent (CA) using MTC-prepulse or injecting an intravascular CA. However, neither of these methods provide information about myocardial scar.

Purpose

In this work we investigated a CMR-examination with slow infusion of a high relaxivity CA to evaluate visualization of coronary venous anatomy and myocardial scar in heart failure patients.

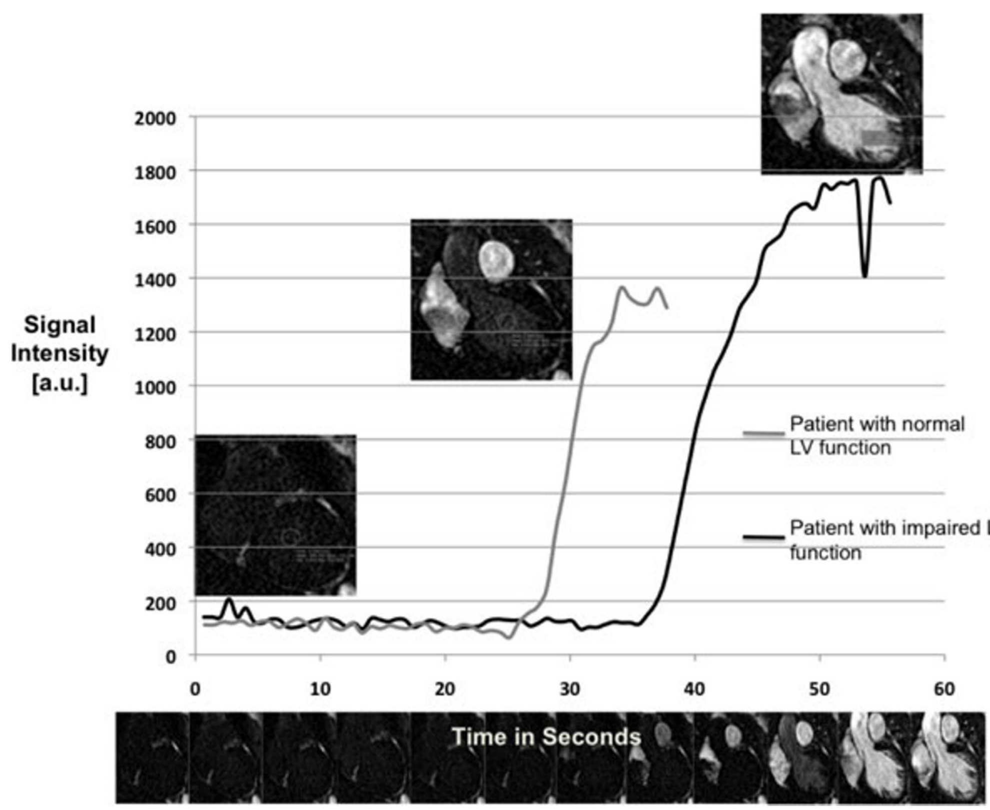

Figure 1

Showing the difference in time taken for contrast agent to reach the left ventricle in patients with normal and imparted LV function. The bolus track sequence allows optimization of timing of the whole heart scan.

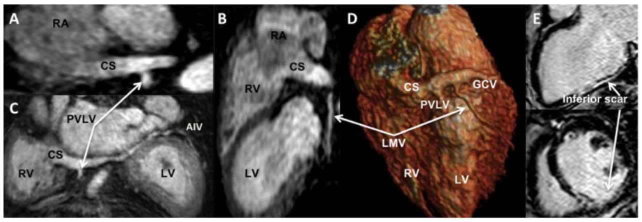

Figure 2
A and B show the coronary sinus (CS) and great cardiac vein (GCV) with the posterior lateral vein on the LV (PVLV) on multiplanar reformatted images (mpr). **C** is a mpr formatted image showing the extent of the coronary vein from the CS to the anterior inter-ventricular (AIV) tributary. **D** shows a three dimensional recontruction of the coronary venous system with the various brances. **E** and **F** show late enhancement in the inferior territory. LV = Left ventricle, LA = Left atrium, RV - Right ventricle, RA = Right atrium.

Methods

Twelve patients with known left ventricular (LV) impairment (6 with and 6 without ischemic cardiomyopathy) and two patients with normal LV function underwent CMR on a 1.5 T Philips scanner (12 men; 2 women age 59.5 ± 15.5 yrs). For vein visualization, an ECG-triggered respiratory navigated 3D SSFP MR-scan (FA = 50, 1.5 × 1.5 × 2 mm) with Inversion recovery (IR) preparation (TI = 300 ms) was used to acquire the whole-heart during a short interval (60-80 ms) in end systole. For contrast enhancement dimeglumine-gadobenate (Gd-BOPTA) was slowly infused (dose of 0.2 mls/kg at rate 0.3 mls/sec) with subsequent saline flushing as proposed by Bi et al (MRM 2007 58:1-7) for coronary arteries. In order to determine the optimal start point of the 3D IR-SSFP scan, a dynamic ECG-triggered IR-scan was used to measure bolus arrival in the LV(Figure 1). A multislice delayed contrast-enhanced MR-scan (1.5 × 2 × 10 mm) was performed at end systole 19 ± 7 min after start of contrast injection to depict areas of scar.

Results

In all subjects the coronary sinus (CS) and great cardiac vein (GCV) were visualized (figure 2). Two experienced independent observers assessed the image quality (0 to 4). The average score for the CS was 3.1 ± 0.97 (r = 0.89) and GCV 2.6 ± 0.63 (r = 0.74) and excellent correlation between number of vessels seen by both observers (r = 0.98) (table 1). The posterior interventricular (PIV) and lateral marginal vein (LMV) were seen in 11 patients (79%), posterior vein of the LV (PVLV) in 6 patients (43%) and the anterior interventricular vein (AIV) in 10 patients (71%). The mean distance from the ostium of the CS to the PIV was 12.6 ± 4.0 mm, LMV was 68.3 ± 20.3 mm, PVLV 32.2 ± 19.3 mm and AIV was 142.5 ± 20.5 mm (table 2) (figure 3). Patients with ischemic cardiomyopathy showed late enhancement.

Conclusion

We have demonstrated that slow infusion protocol of Gd-BOPTA can be used to assess both the coronary venous anatomy and myocardial scar in a single MR-examination.

Table 1: Anatomical observations and percentage of vessels seen by both observers

Vessel seen	Number and percentage of vessel seen by Observer 1		Number and percentage of vessel seen by Observer 2	
Coronary sinus	14	100%	14	100%
Small veins draining from right ventricle to right atrium	2	14%	2	14%
Great cardiac vein	14	100%	14	100%
Posterior Interventricular vein	11	79%	11	79%
Posterior vein of the LV	6	43%	7	50%
Left marginal vein	11	79%	10	71%
Anterior interventricular vein	10	71%	9	64%
Additional posterior veins	1	7%	1	7%
Additional lateral veins	3	21%	2	14%

Table 2: Ostial diameter in multiplanar reformatting views and visible length of the identified veins

Vessel/Tributary	Ostial diameter of identified vein (mm) Superior/inferior	Ostial diameter of identified vein (mm) anterior/posterior	Average distance from the ostium of the CS (mm)	Average Length of the identified vein (mm)	Average Angle Between the Tributary and the CS or Great vein
Coronary Sinus	12.8 ± 5.7	14 ± 14.8	140.7 ± 67.7 Total length of vessel measurable (length from CS to end of AIV)	N/A	N/A
Posterior interventricular vein	4.9 ± 1.6	4.5 ± 2	12.6 ± 6.9	32.8 ± 24.6	76.8 ± 45.7
Posterior vein of the LV	5.5 ± 1.8	5.3 ± 1.3	32.2 ± 33.3	29.8 ± 50.5	117.4 ± 39.8
Left marginal vein	4.8 ± 1.7 Unable to accurately measure in 1 patient	4.7 ± 1.7 Unable to accurately measure in 1 patient	68.3 ± 32.7	35.2 ± 37.3	99.2 ± 54.9
Anterior interventricular vein	3.2 ± 1.4 Unable to accurately measure in 2 patient	3.1 ± 1.0 Unable to accurately measure in 2 patient	142.5 ± 20.0	22.7 ± 18.7	115.7 ± 60.2

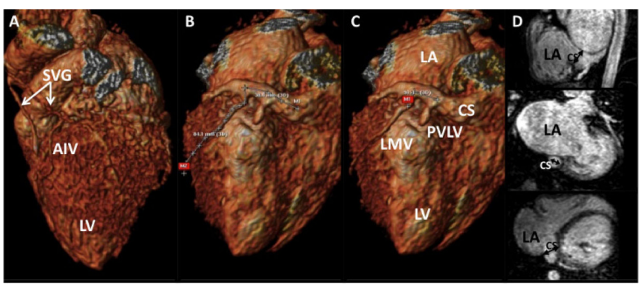

Figure 3
A shows a 3D reconstruction with 2 saphenous ven grafts (SVG) and the anterior inter-ventricular branch of the coronary venous system. **B** shows the measuremewnt of the vessel from the CS to the origin of the lateral marginal vein (LMV) and the length down the vessel. **C** shows the angle the LMV makes with the coronary vein. **D** shows the measurement of the diameter of the CS in various planes. LV = Left ventricle, LA = Left atrium