

## MRI for the detection of catheter ablation scars of the right atrial isthmus in patients with atrial flutter

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**Purpose:** Late enhancement MR imaging has been shown to facilitate visualization of myocardial scars of noniatrogenic (e.g. infarction) or iatrogenic (e.g. catheter ablation within left atrium) origin. We intended 1. to evaluate the feasibility to visualize ablation scars of the isthmus between the inferior vena cava and the tricuspid valve in patients with atrial flutter using delayed enhancement MRI and 2. to compare a standard breath-hold 2D scar imaging sequence with a high resolution free-breathing 3D scar sequence.

**Method and Materials:** Thirty-seven patients underwent CMR evaluation of the right atrial isthmus after an radiofrequency (RF) ablation procedure for the treatment of atrial flutter. 15 of the patients were examined before RF ablation, 8 patients after RF therapy and 14 patients both before and after RF ablation. MRI exams were obtained in a time range of 12 days before and/or 30 days after RF intervention. The MR study consisted of two sequences: 1. A standard 2D, breath-hold, T1-weighted inversion recovery sequence as routinely used for myocardial viability imaging with a slice thickness of 10mm, voxel size 1.48x1.93mm reconstructed to 0.74x0.74mm, TR/TE 5.4/2.6 ms, flip angle 15°, scan duration 1:30 min. for 7 slices and 2. a high-resolution 3D, free-breathing navigator-gated, T1-weighted inversion recovery coronary sequence with a voxel size of 1.48x1.48x3mm reconstructed to 0.74x0.74x1.5mm, TR/TE 6.1/1.9ms, flip angle 30°, scan duration 4:15 min. for 24 slices. The inversion delay was individually assessed according to the T1 of blood (approx. 300 ms) for optimal signal suppression of the vessel lumen and nonenhancing tissue. Both sequences were obtained approximately 20-30 min. after administration of Gd-DTPA (0.2mmol/kg). Both sequences were obtained with two different scan orientations, longitudinal and perpendicular to the course of the right coronary artery (RCA). These orientations correspond to the left-anterior oblique (LAO) and right-anterior oblique views used for fluoroscopy-guided catheter ablation. Each exam was evaluated for subjective image quality on a semi-quantitative scale (1=excellent, 2=good, 3=fair, 4=unevaluable) and the presence of scar enhancement (positive or negative).

**Results:** Of all 38 patients, 2 had to be excluded from the evaluation because of insufficient image quality (1 pre-ablation, 1 post-ablation), resulting in a total of 36 patients and 49 MR exams (28 before, 21 after RF ablation). Apart from these two cases the average image quality was good to excellent for both sequences (average score 1.57 for the 2D, av. score 1.51 for the 3D sequence). The performance of the two sequences for the detection of ablation scars is summarized in tables 1 to 3. While the majority of MRI evaluations revealed the correct diagnosis regarding the presence or absence of ablation scars, the 2D sequence results contained relatively more false negative and the 3D results more false positive findings. This corresponds to a high sensitivity and lower specificity for the 3D sequence and a high specificity and lower sensitivity for the 2D sequence.

**Table 1**

2D	pos	neg
true	14	25
false	3	7

**Table 2**

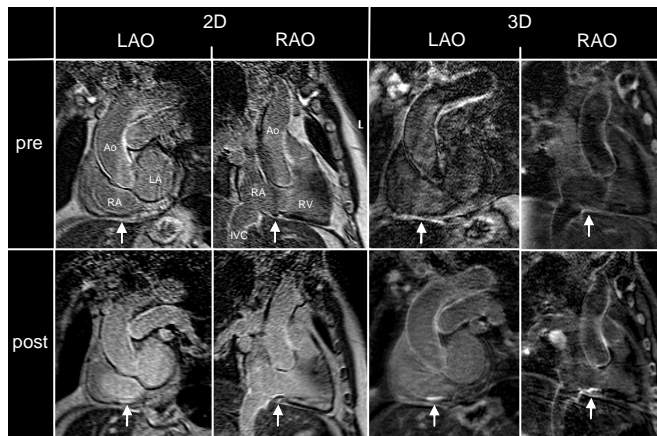
3D	pos	neg
true	20	22
false	6	1

**Table 3**

	2D	3D
Sensitivity	67%	95%
Specificity	89%	79%
Accuracy	80%	86%

**Tables 1-3:** Diagnostic performance of the 2D and 3D imaging sequences for the detection of ablation scars.

**Conclusions:** In this study, we demonstrate that RF ablation scar can be visualized non-invasively with the use of T1w MRI. The high-resolution 3D sequence seems favorable to the standard 2D scar sequence because of a higher sensitivity. Our results may be of clinical importance since visualization of scars of the isthmus between the inferior vena cava and the tricuspid valve in patients with atrial flutter may confirm procedural success of RF ablation and may correlate with clinical outcomes.



**Figure 1:** MRI scans of a patient with right atrial flutter before (pre) and after (post) RF ablation of the isthmus between the inferior vena cava (IVC) and the right atrium (RA). 2D and 3D sequences were acquired in left anterior oblique (LAO) and right anterior oblique (RAO) views. Arrows point to the area of the isthmus. Note the absence of scar in the pre-ablation MRI exam and the presence of contrast enhancement corresponding to scar tissue in the post-ablation exam. The 3D sequence is superior regarding the visualization of scar when compared to the standard 2D sequence. (RV=right ventricle, Ao=aorta, LA=left atrium)