

Cardiovascular Magnetic Resonance–Guided Electrophysiological Interventions Radiofrequency Ablation of Typical Atrial Flutter

Ingo Paetsch, MD; Cosima Jahnke, MD; Sebastian Hilbert, MD; Sascha Krueger, PhD;
Steffen Weiss, PhD; Jouke Smink, PhD; Bernhard Schnackenburg, PhD; Tom Lloyd, PhD;
Gerhard Hindricks, MD; Philipp Sommer, MD

Cardiovascular magnetic resonance–guided electrophysiological ablation of typical atrial flutter was performed in 5 patients using a fully magnetic resonance-compatible mapping and ablation catheter (Vision-MR; Imricor) on a 1.5-Tesla cardiovascular magnetic resonance system (Ingenia; Philips; Figure 1). All patients were under continuous physiological monitoring (including surface vector and intracardiac electrograms, pulse oximetry, and invasive blood pressure measurements) during intravenous propofol sedation. For interventional guidance, a 3-dimensional (3D), navigator-gated whole-heart sequence (steady-state–free precession) was acquired, and a 3D surface mesh model of all cardiac cavities was reconstructed with a fully automatic segmentation algorithm (Figure 2). Active catheter tracking and real-time passive catheter visualization were displayed simultaneously on in-room and scanner console monitors; optoacoustic headsets

allowed for constant communication (Figure 1). Total procedure duration was <60 minutes with <1 minute for coronary sinus intubation (reference catheter for activation mapping, Movie I in the [Data Supplement](#)). Four out of 5 patients had complete isthmus block (defined as >100 ms isthmus conduction delay) after cardiovascular magnetic resonance–guided electrophysiological ablation (Figures 3 and 4; Movie II in the [Data Supplement](#)).

Disclosures

Drs Krueger, Weiss, Smink, and Schnackenburg are all employees of Philips Healthcare. Dr Lloyd is an employee of Imricor Medical Systems. The other authors report no conflicts.

KEY WORDS: atrial flutter ■ blood pressure ■ coronary sinus ■ intubation ■ propofol

From the Department of Electrophysiology, HELIOS Heart Center Leipzig, Germany (I.P., C.J., S.H., G.H., P.S.); Philips Research Laboratories, Best, The Netherlands, and Hamburg, Germany (S.K., S.W., J.S., B.S.); and Imricor Medical Systems, Burnsville, MN (T.L.).

The Data Supplement is available at <http://circimaging.ahajournals.org/lookup/suppl/doi:10.1161/CIRCIMAGING.116.005780/-/DC1>.

Correspondence to Ingo Paetsch, MD, Department of Electrophysiology, HELIOS Heart Center Leipzig, University of Leipzig, Struempellstr 39, 04289 Leipzig, Germany. E-mail paetsch@o2mail.de

(*Circ Cardiovasc Imaging*. 2017;10:e005780. DOI: 10.1161/CIRCIMAGING.116.005780.)

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Circ Cardiovasc Imaging is available at <http://circimaging.ahajournals.org>

DOI: 10.1161/CIRCIMAGING.116.005780



Figure 1. Set-up of cardiovascular magnetic resonance-guided electrophysiological (CMR-EP) ablation procedure. Upper, In-room set-up of CMR scanner environment with MR-compatible display monitors showing side by side the CMR-EP interventional framework (left-sided monitor, 3-dimensional CMR surface mesh model in combination with real-time cine images for passive catheter visualization or active catheter tracking; right-sided monitor, intracardiac electrograms). For active tracking, the MR-compatible catheters were connected to the scanner via an interface located at the table end, and the interventionalist requested active tracking or real-time cine imaging via a footpedal. Note the optoacoustic headsets ensuring constant communication of the interventionalist with the CMR operator(s) in the console room. Lower, Set-up of CMR scanner console room together with EP impulse generator system for electrophysiological stimulation maneuvers.

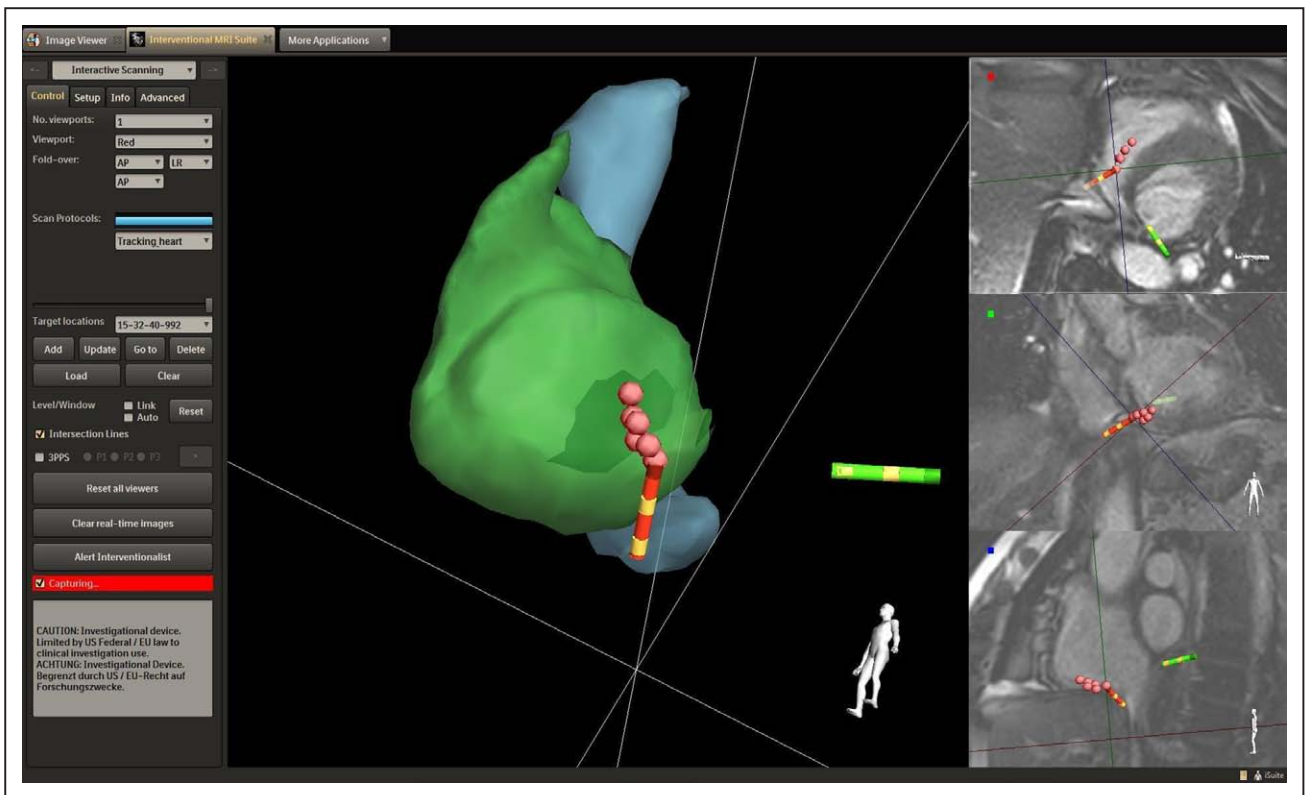


Figure 2. Cardiovascular magnetic resonance-guided electrophysiological (CMR-EP) interventional framework (patient no. 2, Movie II in the [Data Supplement](#)). Side-by-side display of 3-dimensional (3D) surface rendered model showing right atrium (green) with superior/inferior vena cava (light blue) and still images of cine real-time CMR acquisitions and multiplanar slice reconstructions of 3D whole-heart data set. Note the clear visibility and demarcation of the cavotricuspid isthmus against the tricuspid valve plane/right ventricle. Ablation catheter tip, red/yellow; ablation points, red; and reference catheter tip, green/yellow.

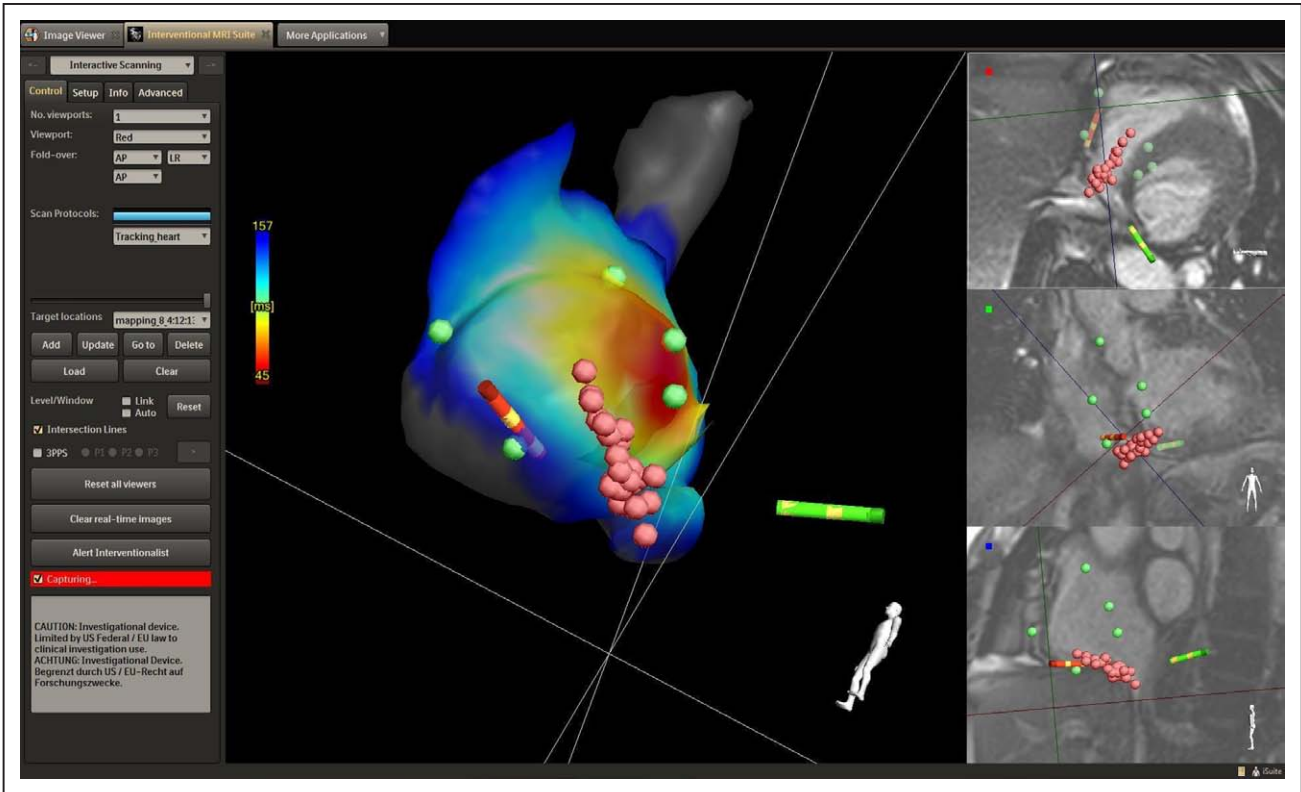


Figure 3. Activation map after successful cardiovascular magnetic resonance (CMR)-guided atrial flutter ablation (patient no. 2). Activation times demonstrated isthmus conduction delay of 112 ms equivalent to complete block (defined as >100 ms). Ablation catheter tip, red/yellow; ablation points, red; and reference catheter tip, green/yellow.

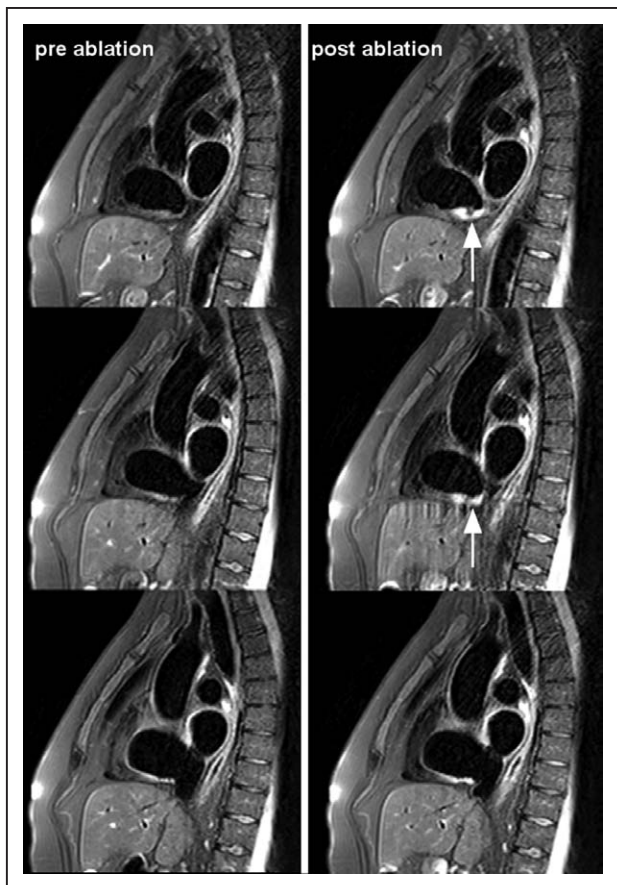


Figure 4. Comparison of preablation and postablation T2-weighted black blood cardiovascular magnetic resonance (CMR) imaging of cavotricuspid isthmus (patient no. 2). Acute radiofrequency (RF)-induced ablation lesions clearly demarcated as high signal intensity, focal edema (white arrows) <10 min after RF pulse termination.

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Circ Cardiovasc Imaging. 2017;10:

doi: 10.1161/CIRCIMAGING.116.005780

Circulation: Cardiovascular Imaging is published by the American Heart Association, 7272 Greenville Avenue,
Dallas, TX 75231

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Print ISSN: 1941-9651. Online ISSN: 1942-0080

The online version of this article, along with updated information and services, is located on the
World Wide Web at:

<http://circimaging.ahajournals.org/content/10/1/e005780>

Data Supplement (unedited) at:

<http://circimaging.ahajournals.org/content/suppl/2016/12/27/CIRCIMAGING.116.005780.DC1>

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Supplemental Material

Movie 1:

Placement of the reference catheter in the coronary sinus for activation mapping (patient #1). The ablation/mapping catheter (catheter tip in red) had already been placed in the right atrium. The reference catheter was introduced via an 11F sheath and the catheter tip (green) was visualized in real-time on the CMR dataset. Note the smooth motion/distinct navigation of the catheter while advancing to the coronary sinus ostium demonstrating excellent tracking performance. Right atrium, green; left atrium, dark blue; superior/inferior vena cava, light blue; coronary sinus, dark green.

Movie 2:

CMR-EP ablation of typical atrial flutter (patient #2). First, linear ablation of the cavotricuspid isthmus was performed (ablation catheter, red; ablation points, red). The position of the catheter tip in the three-dimensional mesh model was actively tracked in real-time on still frames of cine CMR-images/anatomical slices of the isotropic 3D-original image dataset allowing for interactive multiplanar reconstruction if needed. First activation mapping demonstrated incomplete isthmus block (conduction delay, 84 ms); hence, additional linear ablation lesions were performed resulting in complete isthmus block (conduction delay > 100 ms) as confirmed by the second pacing maneuver.