

Received: 2021.07.19  
Accepted: 2021.08.27  
Available online: 2021.10.26  
Published: 2021.12.01

# Treatment of Macro-Reentry Atrial Tachycardia with Very High-Power, Short-Duration, Temperature-Controlled Ablation of Anterior Line Using an Open-Irrigated Ablation Catheter with Microelectrodes

Authors' Contribution:  
Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

ABCDEF **Christian Heeger**   
C **Julia Vogler**  
B **Bettina Kirstein**  
B **Charlotte Eitel**  
D **Roland R. Tilz** 

University Heart Center Lübeck, Division of Electrophysiology, Medical Clinic II  
Department of Cardiology, Angiology and Intensive Care Medicine, University  
Hospital Schleswig-Holstein, Lübeck, Germany

**Corresponding Author:** Christian Heeger, e-mail: [christian.heeger@gmx.net](mailto:christian.heeger@gmx.net)  
**Financial support:** Dr. Heeger has received travel and research grants and speaker honoraria from Boston Scientific, Biosense Webster, and Cardiofocus. Dr. Tilz is a consultant for Boston Scientific, Biotronik, and Biosense Webster and has received speaker honoraria from Biosense Webster, Medtronic, Boston Scientific, and Abbott Medical  
**Conflict of interest:** None declared

**Patient:** Male, 74-year-old  
**Final Diagnosis:** Atrial fibrillation  
**Symptoms:** Tachycardia  
**Medication:** —  
**Clinical Procedure:** —  
**Specialty:** Cardiology

**Objective:** Unusual clinical course  
**Background:** Treatment of atrial fibrillation and atrial tachycardia (AT) with catheter ablation results in high rates of success with the procedure and on long-term follow-up. A novel ablation catheter with a very high-power, short-duration (vHPSD) ablation mode using 90 W for 4 s has been introduced, which could improve safety and efficacy of catheter ablation, especially for pulmonary vein isolation (PVI). To date, vHPSD mode has only been evaluated for treatment of PVI, but it could be an efficient technique for linear lesions. Here, we present the first use of the novel vHPSD mode alone for catheter ablation in a patient with peri-mitral AT (PMAT).  
**Case Report:** A 74-year-old man presented with symptomatic AT. An electroanatomic reconstruction of his left atrium showed PMAT with a potential critical isthmus on the anterior wall. Therefore, ablation of an anterior line was performed. The patient's AT stopped after 10 applications and less than 40 s of radiofrequency (RF) ablation. Afterward, the anterior line was completed with a total of 29 applications of vHPSD and a RF time of 116 s. PVI and blockage of the cavotricuspid isthmus also were performed. The total procedure time was 107 min. No periprocedural complications occurred.  
**Conclusions:** The present case demonstrates the safety and efficacy of treatment of AT with a novel catheter that delivers vHPSD ablation to an anterior line.

**Keywords:** Atrial Fibrillation • Catheter Ablation • Radiofrequency Ablation

**Full-text PDF:** <https://www.amjcaserep.com/abstract/index/idArt/934081>

 1789  —  3  8



## Background

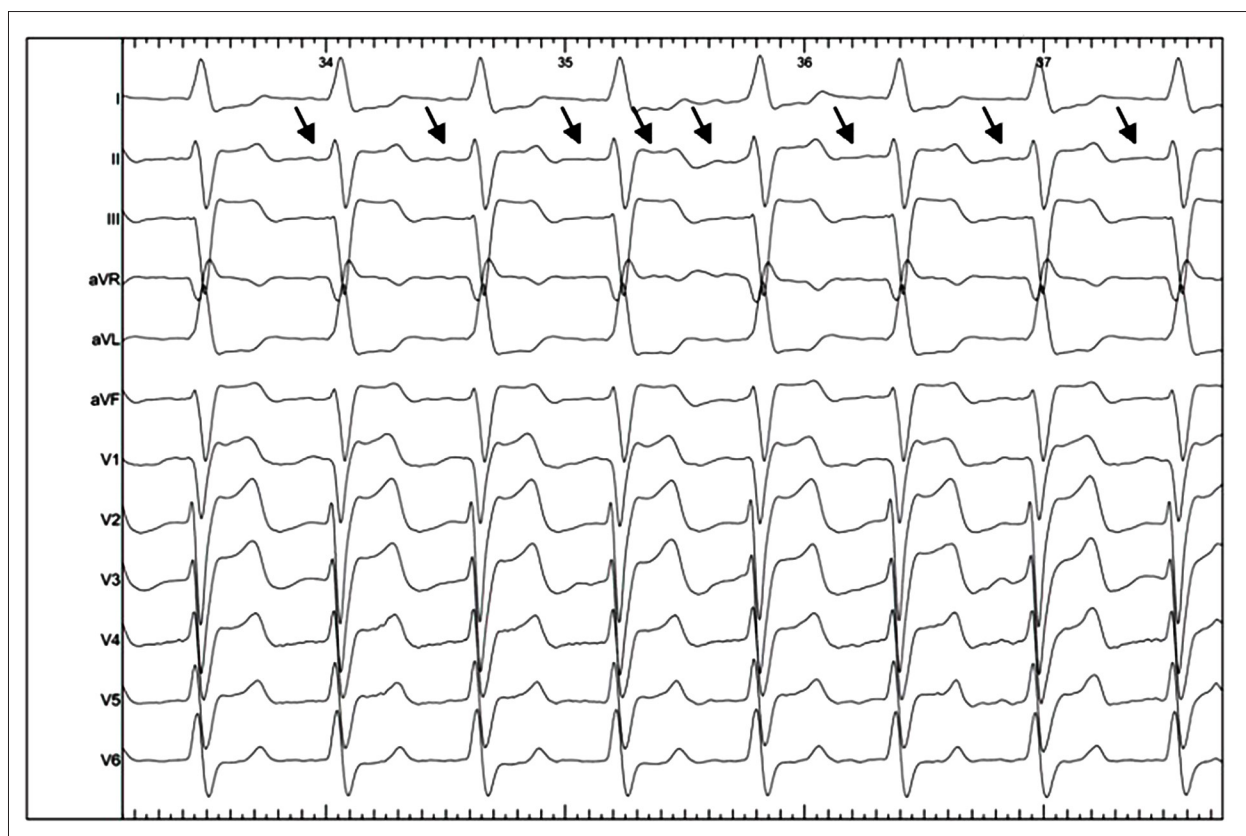
Catheter ablation has proven to be a very successful procedure for patients with atrial fibrillation (AF), with excellent outcomes on long-term follow-up. Recently, a radiofrequency (RF)-based, power-controlled ablation mode called high-power, short-duration (HP-SD) has been introduced that delivers a maximum of 50 W for treatment with pulmonary vein isolation (PVI) and deployment of linear lesions [1,2]. With HP-SD, the length of the procedure and RF time are shorter and rates of isolation on the first pass are increased, compared with standard RF ablation [1].

A novel ablation catheter (QDOT Micro, Biosense Webster, Diamond Bar, United States) has been introduced that permits temperature-controlled ablation with contact force (CF) sensing. This catheter has 6 thermocouples and 3 microelectrodes at its distal tip for accurate and immediate temperature surveillance [3,4]. The QDOT Micro catheter allows for conventional temperature-controlled ablation (QMODE, maximum of 50 W) and very HP-SD (vHPSD) ablation (QMODE+, 90 W/4 s) [5]. In QMODE, temperature-controlled ablation is achieved by adjusting the power and rate of flow of irrigation. In QMODE+ mode only, power can be adjusted to alter temperature [5].

With QMODE+ ablation, the aim is to create wider and shallower lesions by simultaneously reducing the conductive and increasing the resistive heating areas. Previous reports about AF treatment with PVI have shown significantly reduced total RF time and procedure duration and excellent safety outcomes [5,6]. As yet, however, no reports exist documenting creation of lesions other than PVI. vHPSD ablation could be an efficient ablation technique for deploying linear lesions in addition to PVI. The microelectrodes also could offer unique findings from mapping and ablation of macroreentrant atrial tachycardia (AT). Here, we present the treatment of peri-mitral AT in a patient with ablation of an anterior line performed solely using the vHPSD QMODE+ mode of the QDOT Micro catheter.

## Case Report

A 74-year-old man (CHA<sub>2</sub>DS<sub>2</sub>-VASc score: 2) presented to the emergency care unit because he had been experiencing dyspnea, palpitations, and persistent tachycardia (European Heart Rhythm Association class IIb) for a few days. He had a >5-year history of recurrent, persistent AF and typical atrial flutter despite receiving antiarrhythmic drug therapy with flecainide (2×100 mg) and oral anticoagulation with rivaroxaban (2×100



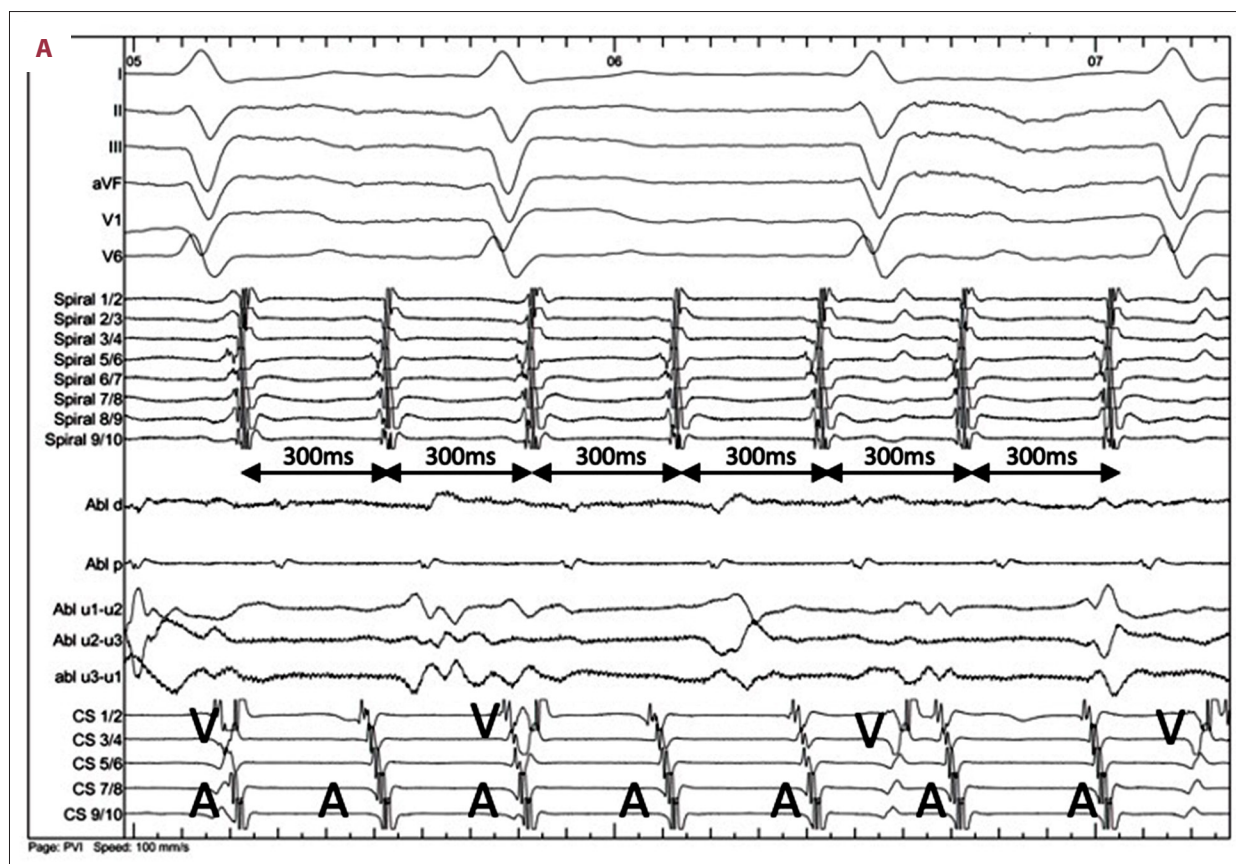
**Figure 1.** Baseline electrocardiogram (heart rate 105/min). The black arrows indicate small P waves, which are indicative of atrial tachycardia. Speed 50 mm/s.

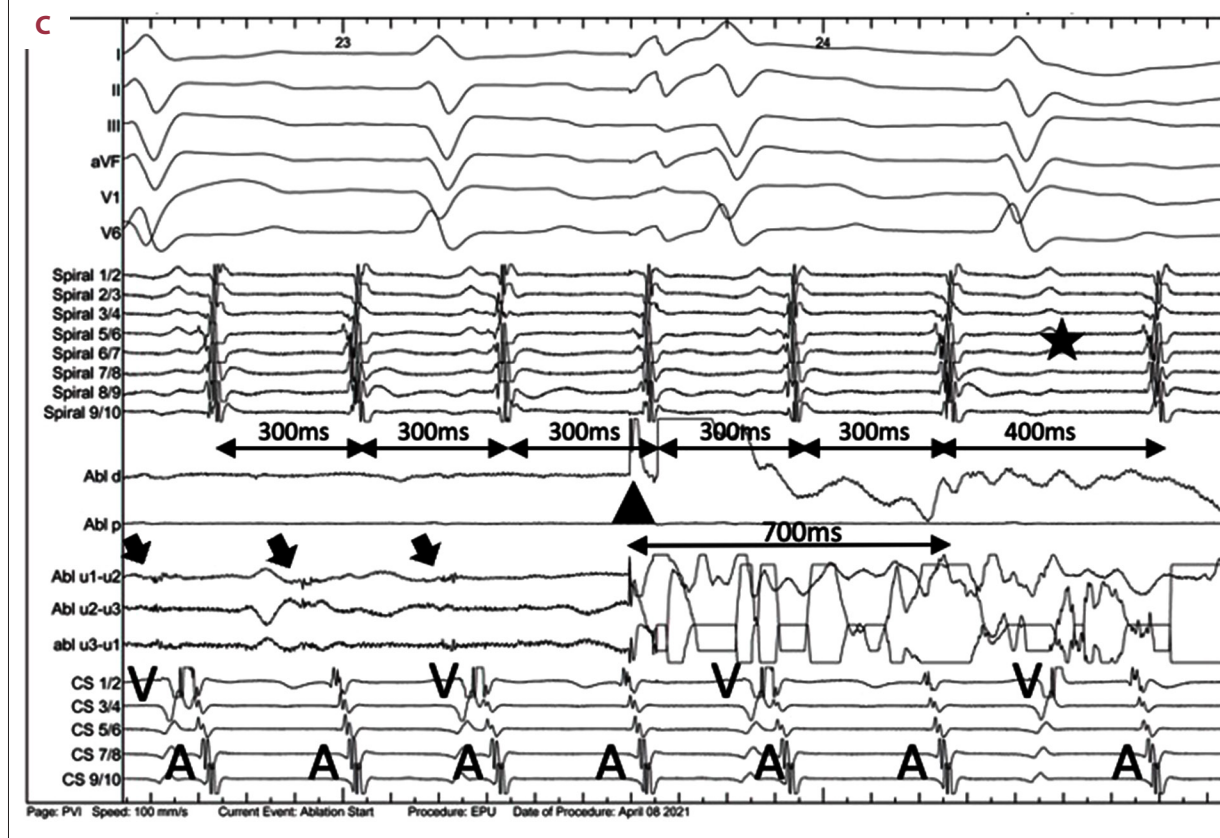
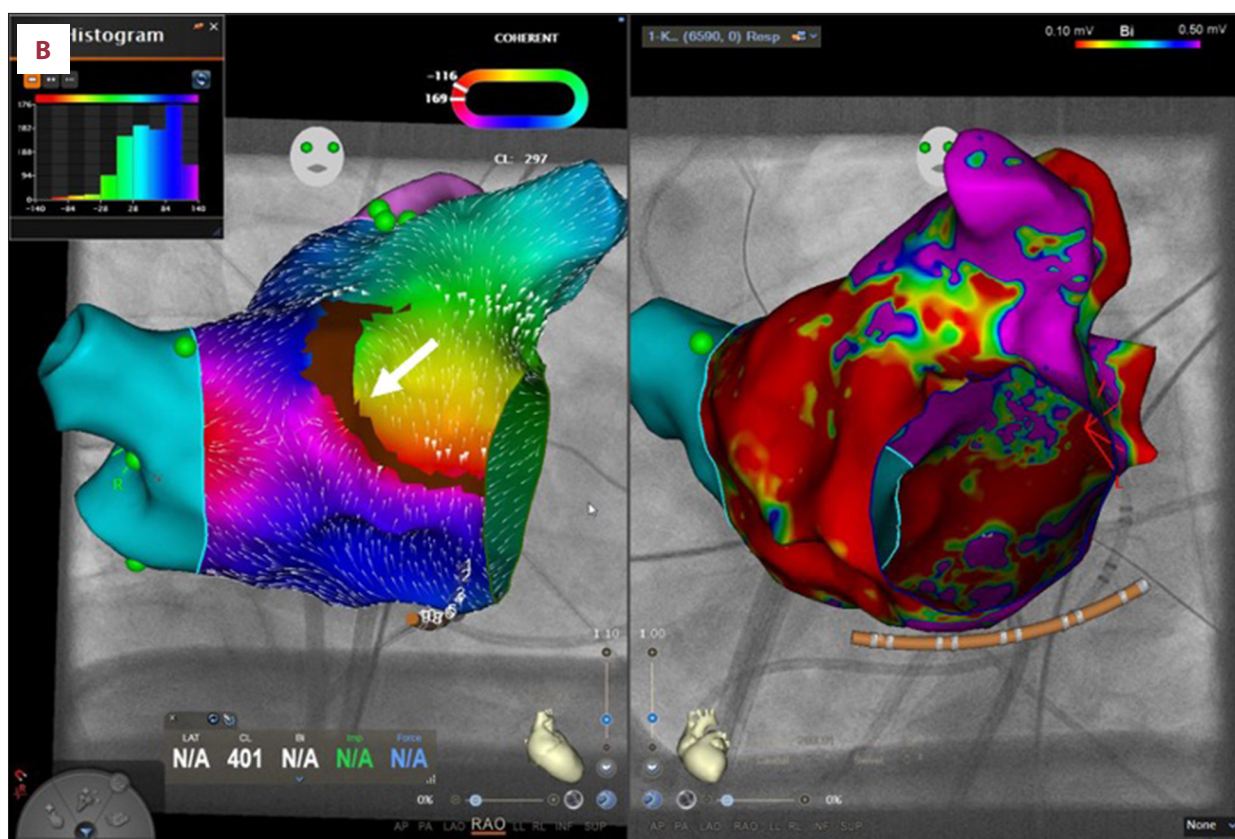
mg). A 12-lead electrocardiogram (ECG) showed a heart rate of 105/min with small P waves, suggesting AT (Figure 1). Treatment options (cardioversion, drug therapy, and catheter ablation) were discussed with the patient and he gave informed consent for an ablation procedure, which was scheduled for the next day. Transesophageal echocardiography (TEE) performed before the ablation showed no left anterior (LA) thrombus.

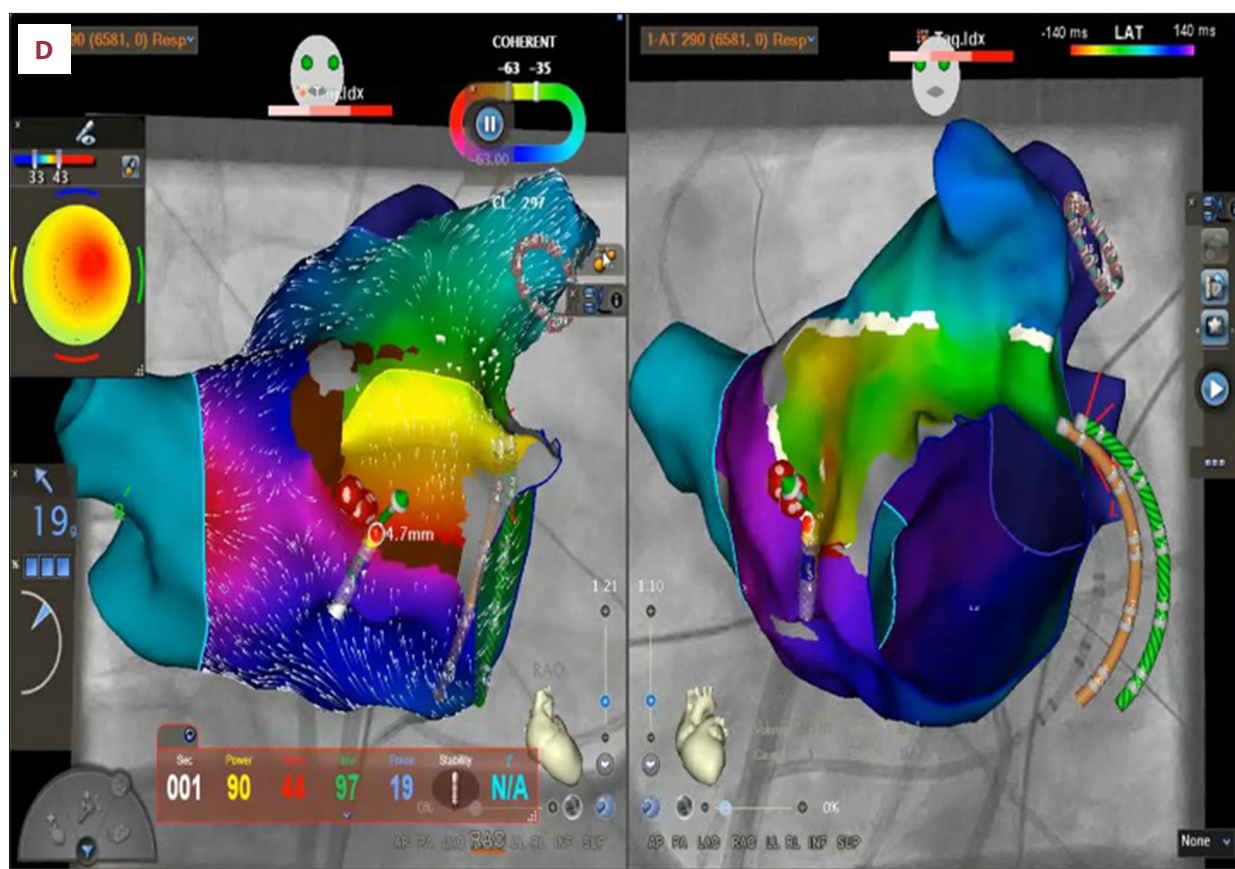
At the beginning of the ablation procedure, the patient had clinical AT (cycle length, [CL] 300 ms) (Figure 2A). Intraprocedural management has been described in detail in reports from our group's previous studies [6-8]. The ablation was performed with the patient under deep sedation. Four ultrasound-guided femoral vein punctures were performed, 3 on the right and 1 on the left side. A decapolar diagnostic catheter was introduced and positioned inside the coronary sinus (CS). Entrainment maneuvers suggested that the patient had a left AT. A double transseptal puncture (TSP) was performed under fluoroscopic guidance using the modified Brockenbrough technique with an 8.5F transseptal sheath and puncture needle (SL1 sheath and BRK-1 TSP needle, St. Jude Medical, St. Paul, Minnesota, United States). Heparin boluses were administered to target an activated clotting time of >300 s. An S-shaped temperature probe (CIRCA S-CATH, Circa Scientific, Englewood, New Jersey, United States) was advanced into the patient's esophagus to

monitor the temperature there (Teso). The Teso cut-off value was set at 38.5°C. Three-dimensional electroanatomic LA reconstruction (CARTO 3 V7; Biosense Webster) was performed via fast anatomical mapping with a multi-electrode spiral mapping catheter (15-mm fixed size, 20 electrodes, Lasso Nav; Biosense Webster). For the bipolar LA voltage map, the voltage interval was set from 0.1 mV to 0.5 mV. A total of 6590 mapping points were acquired using a local activation time (LAT) map with a window of interest of -145 ms/+145 ms and the complete CS electrodes (center of energy) as a reference. The Coherent module (Biosense Webster) was utilized for LAT calculation and a peri-mitral macroreentrant tachycardia with a potential critical isthmus at the anterior wall was seen on the dynamic visualization setup (Figure 2B).

Therefore, and given that the scar area on the LA anterior wall was massive, the most effective strategy for this patient was ablation of an anterior line. Catheter applications were done solely with the vHPSD mode (90 W, 4 s; QMODE+ mode). The target temperature was 60°C. For anterior lesions, we aimed to achieve an inter-lesion distance of 3 mm to 4 mm, and for posterior lesions, an inter-lesion distance of 5 to 6 mm was chosen. The CF target range was 10 g to 20 g.







**Figure 2.** Periprocedural electrocardiograms (ECGs): Prolongation of atrial tachycardia (AT) cycle lengths (CLs). **(A)** Surface and intracardiac ECGs at baseline. The atrial CL is stable at 300 ms. CS – coronary sinus catheter placed distal in the coronary sinus; spiral – spiral mapping catheter placed inside the left atrial appendage (LAA); Ablation (Abl) d – distal electrodes on the map catheter; Abl p – proximal electrodes on the map catheter; Abl u1-u2, Abl u2-u3, Abl u1-u3 – microelectrodes; A – atrium; V – ventricle. Speed 100 mm/s. **(B)** An electroanatomic map of the left atrium utilizing CARTO 3, V7 (Biosense Webster). Left side, right anterior oblique view. A local activation time map with evidence of a peri-mitral AT, suggesting the critical isthmus at the anterior wall (white arrow). Coppery area – zone of slow or no conduction. Right side, left anterior oblique (LAO) view. A voltage map with evidence of a large scar area on the anterior wall. The bipolar voltage reference interval was set between 0.1 mV and 0.5 mV. **(C)** Surface and intracardiac electrocardiograms at prolongation of CL during ablation of the anterior wall near the mitral annulus. Note the prolongation of atrial CLs from 300 ms to 400 ms to 700 ms after starting radiofrequency (RF) ablation with 90 W/4 s. The black arrows indicate small potentials on the microelectrodes. There are no signals visible on the Abl d and Abl p electrodes. The total RF ablation time at CL prolongation was 12 s. CS – coronary sinus catheter placed distal in the coronary sinus; spiral – spiral mapping catheter placed inside the LAA; Abl d – distal electrodes on the map catheter; Abl p – proximal electrodes on the map catheter; Abl u1-u2, Abl u2-u3, Abl u1-u3 – microelectrodes; A – atrium; V – ventricle; black triangle – start of ablation; black star – prolongation of CL. Speed 100 mm/s. **(D)** An electroanatomic map of the left atrium during ablation of the anterior wall. Left side, right anterior oblique view; right side, LAO oblique view. Note the ablation catheter in the anterior wall during delivery of a very high-power short-duration application of 90 W/4 s. The contact force was 19 g and the distance from the previous application was 4.7 mm. The “bullseye” in the left upper corner indicates the temperature of the ablation catheter tip. Source: Property of C. Heeger.

The ablation on the anterior wall was started at the critical isthmus area. Within the zone of slow or no conduction, fragmented potentials were detected on the microelectrodes (**Figure 2C**), whereas no signals were detected on the standard electrodes of the ablation catheter. During the third vHPSD application, the CL was prolonged from 300 ms to 400 ms (**Figure 2D**) after an application time of <1 s. The total RF time at the end of this application was 12 s. The anterior line was continued up

to the anterior mitral annulus. Then the critical isthmus area was targeted again, with the aim of completing the anterior line. Sharp potentials were detected on the microelectrodes and fragmented potentials were detected on the distal electrode of the ablation catheter (**Figure 3A-3D**). The 10<sup>th</sup> application was started and the AT was terminated after an application time of 1200 ms. At the end of this application, the total RF time was 40 s. Afterward, the anterior line was completed

with a total of 29 vHPSD applications and a RF time of 116 s, connecting the anterior mitral annulus to the antero-superior aspect of the right superior PV [6]. Blockage of the anterior line was verified with pacing maneuvers from the spiral mapping catheter positioned inside the left atrial appendage (LAA) and with the CS catheter and the appearance of local double potentials on the ablation catheter along the line. In addition, pacing from the spiral mapping catheter placed in the LAA was performed and early and late signals on either side of the line were checked.

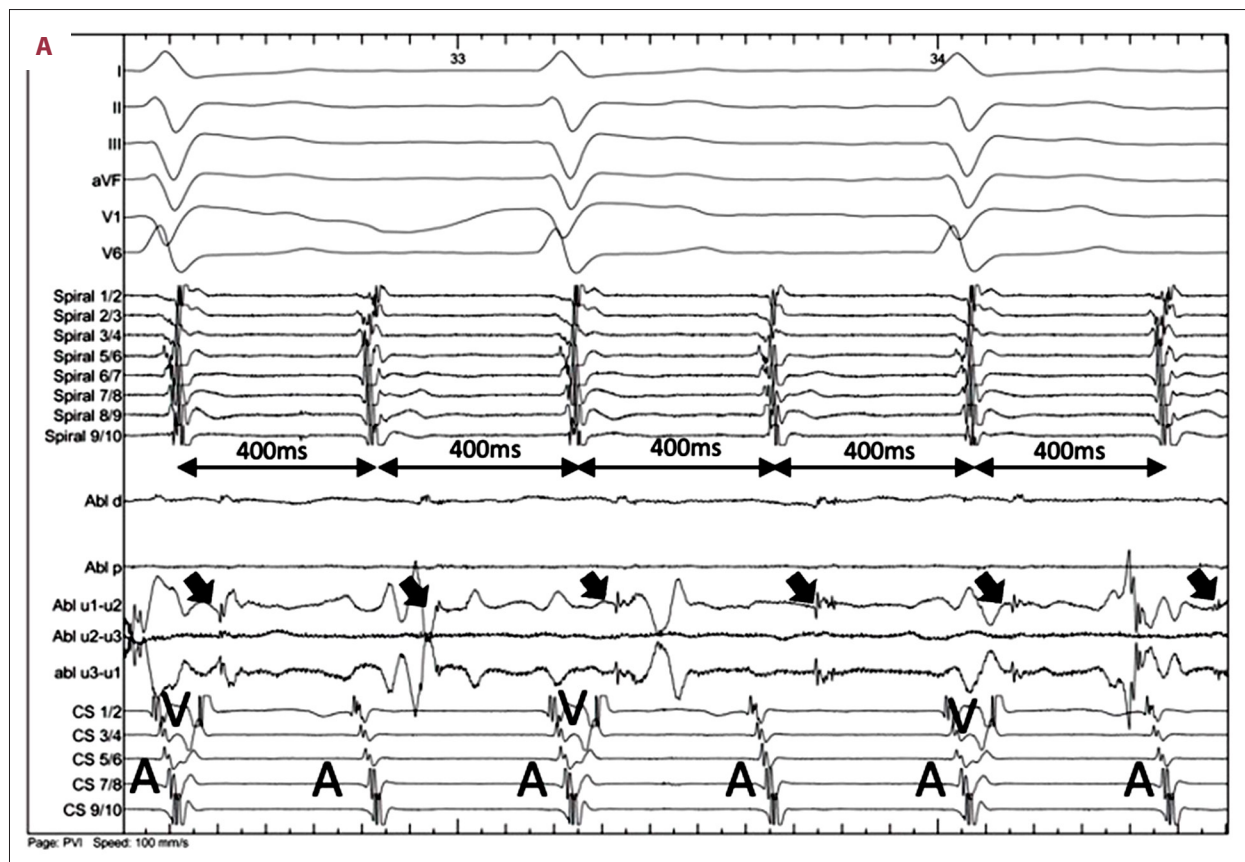
PV angiography then was performed to identify the PV ostia and the ipsilateral PVs were tagged. During PVI, the spiral mapping catheter was placed inside the PVs [6]. Only the QMODE+ mode was used. Sixty-four vHPSD RF applications (RF time 256 s) were performed for septal PVs and 62 vHPSD RF applications (RF time 248 s) were performed for lateral PVs. On both sides, first-pass isolation was observed. Temperature increases to 42.1°C and 41.5°C were observed during ablation at the posterior part of the left inferior PV.

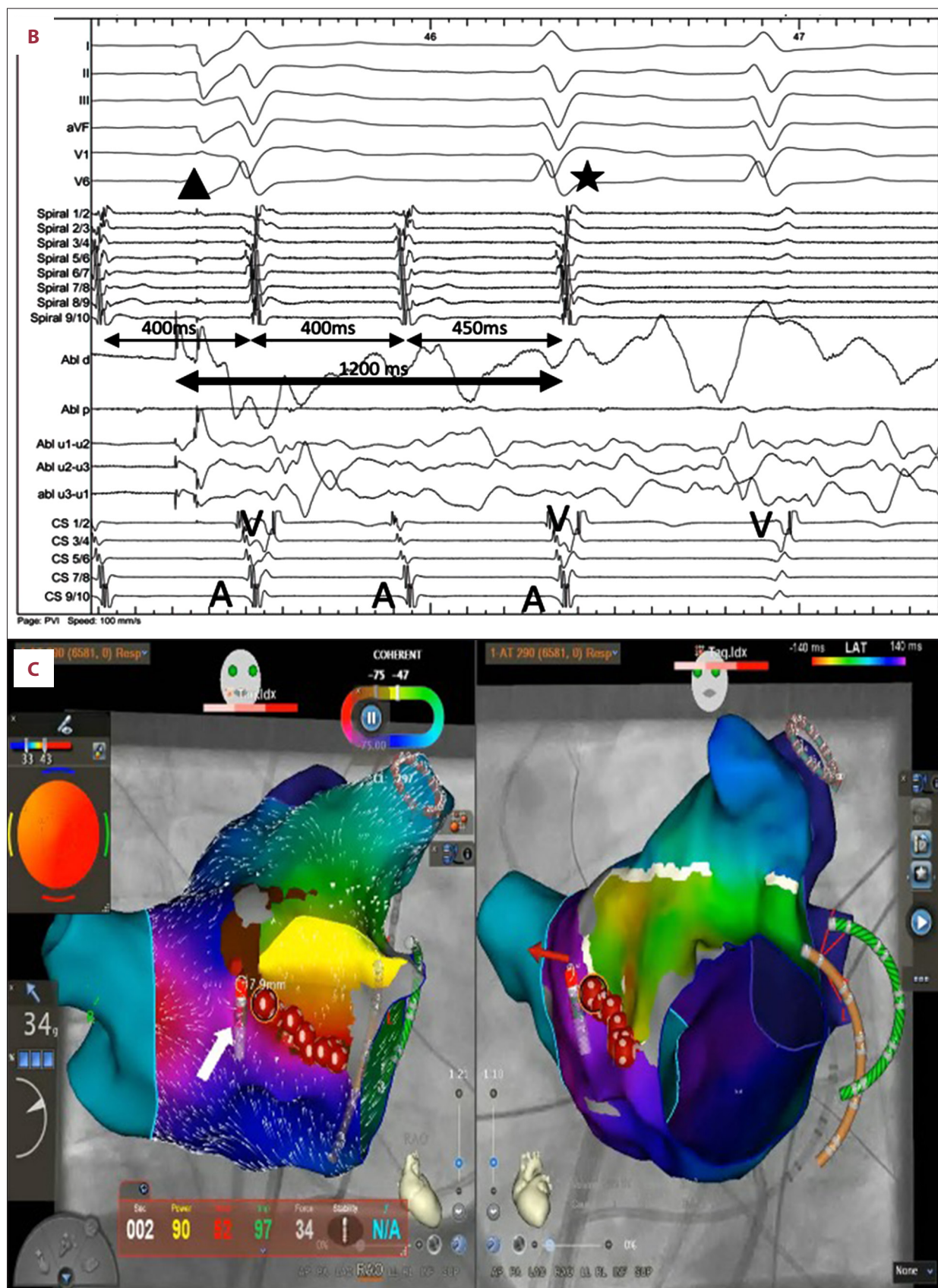
Because the patient was known to have a typical atrial flutter, a cavotricuspid isthmus (CTI) block was ablated under pacing with the proximal CS electrode. Only QMODE+ was used to deliver 29 applications of vHPSD (RF time 116 s) and achieve

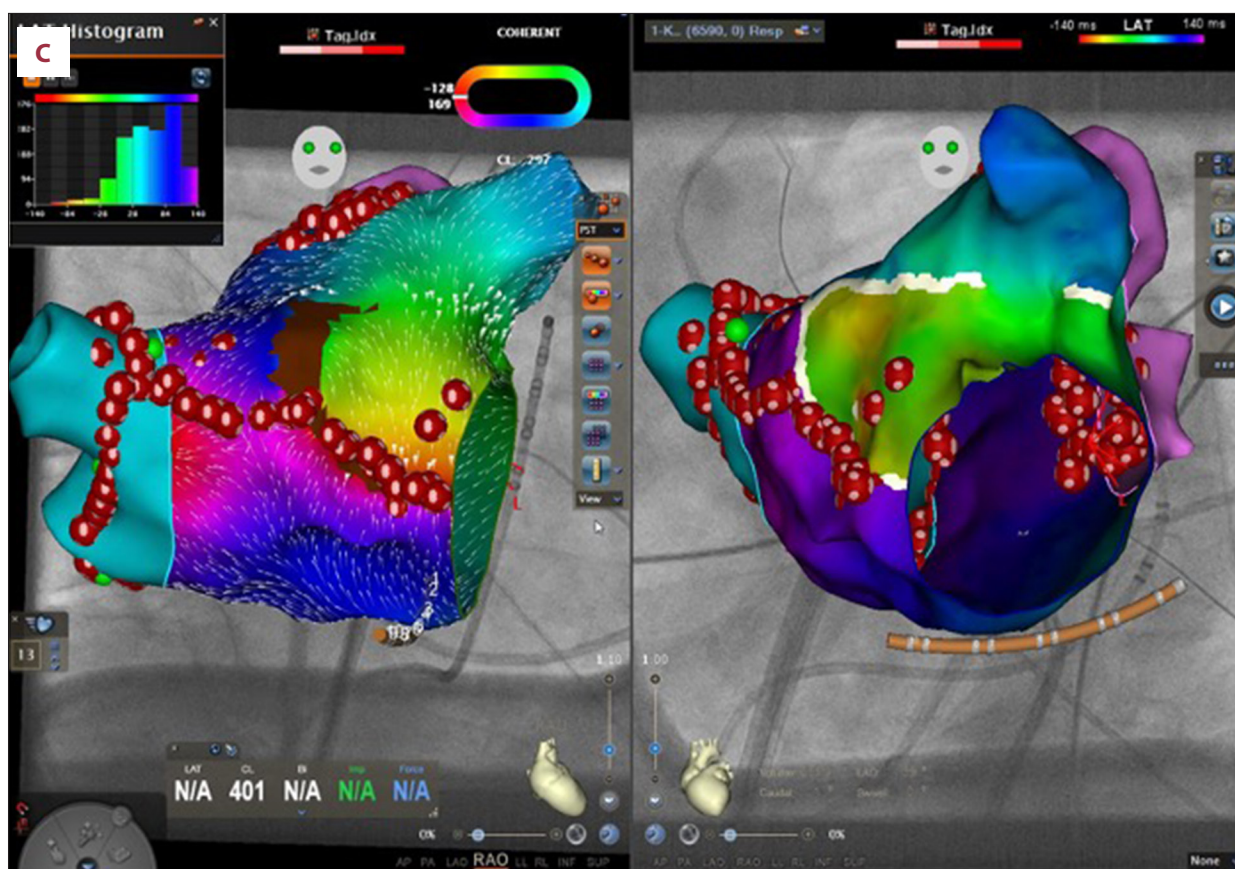
a first-line isthmus block. The CTI block was verified with differential pacing maneuvers.

No steam pops occurred during the procedure and no charring was visible on the ablation catheter tip at the end of the procedure. The total procedure time (skin-to-skin) was 107 min. A total of 144 vHPSD RF applications were performed, with a total RF time of 576 s. To test the likelihood of AT recurring, programmed stimulation with up to 3 extra beats and burst pacing from the spiral catheter in the LAA and the CS catheter was performed. It was not possible to induce AT with the maneuvers.

Both a figure-of-eight suture and a pressure bandage were placed on the area that was ablated. The pressure bandage was removed after 4 h and the figure-of-eight suture was removed the next day. The patient was given rivaroxaban 10 mg 6 h after the procedure and the dosage was increased to 20 mg/d the next day. He was prescribed flecainide (2×100 mg) and metoprolol for 3 months and proton-pump inhibitor therapy for 6 weeks. At follow-up 2 weeks later, he had not experienced a recurrence of either AF or AT.







**Figure 3. Periprocedural electrocardiograms: Termination of AT.** (A, B) Surface and intracardiac electrocardiograms with the ablation catheter at the location of termination of the atrial tachycardia (AT) at the anterior wall. The black arrows indicate the sharp potentials on the microelectrodes. Small, fragmented potentials are visible on ablation (Abl) d electrodes at the same time. The cycle length of 400 ms was prolonged to 450 ms and stopped application of ablation application for 1200 ms (large arrow). The total radiofrequency ablation time at termination was 40 s. CS – coronary sinus catheter placed distal in the coronary sinus; spiral – spiral mapping catheter placed inside the left atrial appendage; Abl d – distal electrodes on the map catheter; Abl p – proximal electrodes on the map catheter; Abl u1-u2, Abl u2-u3, Abl u1-u3 – micro electrodes; A – atrium; V – ventricle; black triangle – start of ablation; black star – termination of AT. Speed 100 mm/s. (C) An electroanatomic map of the left atrium using CARTO 3, V7 (Biosense Webster). Left side, right anterior oblique and right side, left anterior oblique views during ablation at the anterior wall. Note the ablation catheter in the anterior wall during delivery of a very high-power, short-duration application of 90 W/4 s. The “bullseye” in the upper left corner shows the temperature of the ablation catheter tip. White arrow – application of AT termination. (D) An electroanatomic map of the left atrium with the final lesion set up with an anterior line and pulmonary vein isolation depicted by red dots with white points. Source: Property of C. Heeger.

## Discussion

We report the case of a patient who underwent AT ablation with a QDOT Micro ablation catheter using solely vHPSD mode. Our main finding was that vHPSD LA ablation was feasible and a first-pass linear lesion block was achieved with an RF ablation time of <2 min.

In a previous study, HP-SD artificial intelligence-guided ablation at a maximum of 50 W was evaluated [2]. The technique seemed to be safe and effective, but no real-time temperature surveillance was possible with conventional CF sensing

catheters. The tip of the novel QDOT Micro catheter incorporates 6 thermocouples, enabling real-time monitoring of catheter-to-tissue temperature and, therefore, a temperature-controlled ablation [5,6]. In the QMODE+ vHPSD ablation mode, lesions are created that are similar in volume but shallower and wider than result from conventional ablation with standard catheters. Therefore, using vHPSD could reduce collateral tissue damage. In the present study, no steam pops or periprocedural complications occurred. However, the Teso probe detected relatively high temperatures during ablation of the posterior wall. Whether the shallower and wider lesions created with vHPSD are suitable for ablation in the relatively thick

anterior mitral isthmus area and epicardial structures such as Bachmann bundle has not been studied.

Here we describe the feasibility and efficacy of ablation with vHPSD in a case report. Our findings, while positive, are only preliminary because larger studies are needed to prove the value of the technique. The limited depth of vHPSD could be a limitation of this approach compared to conventional ablation. Furthermore, our findings are limited to a single patient who had anterior fibrosis and limited areas of healthy myocardial tissue. The microelectrodes of the QDOT Micro catheter provided sharp and fragmented potentials at the area of interest even though the standard electrodes showed no visible signals [4]. The combination of microelectrodes and vHPSD ablation seems to be an ideal option for AT ablation. Long-term clinical outcomes and durability of linear lesion blocks created using vHPSD strategies are unknown and further investigation of the technique is needed in larger studies and trials.

## References:

1. Chen S, Schmidt B, Bordignon S, et al. Ablation index-guided 50 W ablation for pulmonary vein isolation in patients with atrial fibrillation: Procedural data, lesion analysis, and initial results from the FAFA AI High Power Study. *J Cardiovasc Electr.* 2019;30:2724-31
2. Zanchi S, Chen S, Bordignon S, et al. Ablation Index-guided high-power (50 W) short-duration for left atrial anterior and roofline ablation: Feasibility, procedural data, and lesion analysis (AI high-power linear ablation). *J Cardiovasc Electr.* 2021;32:984-93
3. Barkagan M, Contreras-Valdes FM, Leshem E, et al. High-power and short-duration ablation for pulmonary vein isolation: Safety, efficacy, and long-term durability. *J Cardiovasc Electr.* 2018;29:1287-96
4. Leshem E, Tschabrunn CM, Jang J, et al. High-resolution mapping of ventricular scar evaluation of a novel integrated multielectrode mapping and ablation catheter. *Jacc Clin Electrophysiol.* 2017;3:220-31
5. Reddy VY, Grimaldi M, Potter TD, et al. Pulmonary vein isolation with very high power, short duration, temperature-controlled lesions. *Jacc Clin Electrophysiol.* 2019;5:778-86
6. Tilz RR, Sano M, Vogler J, et al. Very high-power short-duration temperature-controlled ablation versus conventional power-controlled ablation for pulmonary vein isolation: The fast and furious – AF study. *Int J Cardiol Heart Vasc.* 2021;35:100847
7. Münkler P, Kröger S, Liosis S, et al. Ablation index for catheter ablation of atrial fibrillation – clinical applicability and comparison with force-time integral. *Circ J.* 2018;82:2722-27
8. Heeger C-H, Rillig A, Geisler D, et al. Left atrial appendage isolation in patients not responding to pulmonary vein isolation: benefit and risks. *Circulation.* 2019;139:712-15

## Conclusions

Here, we have presented the case of a patient who underwent AT ablation with the QDOT microcatheter. Our findings underscore the benefit of using microelectrodes during AT ablation. Furthermore, we have provided proof-of-concept of vHPSD for ablation of LA linear lesions.

## Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.