

First-in-human high-density epicardial mapping and ablation through a left anterior minithoracotomy in an LVAD patient presenting in electrical storm: a case report

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Background

Despite substantial technical improvements in long-term mechanical circulatory support, ventricular tachycardia (VT) remains a major challenge in left ventricular assist device (LVAD) patients. Recurrent VTs in LVAD patients are not only associated with limited quality of life, but also increased mortality. Although LVAD therapy improves VT tolerance of the left ventricle, haemodynamical deterioration of the right ventricle is the limiting factor in these patients.

Case summary

We present a case report of a hybrid epicardial VT ablation of incessant VTs in a 53-year-old man with advanced heart failure and St.p. LVAD implantation. With this unique clinical case report, we describe an epicardial VT ablation using secondary surgical open-heart access in a patient with therapy-refractory VTs combining left-sided minithoracotomy with high-density (HD) mapping and catheter ablation.

Discussion

To the best of our knowledge, the presented approach is the first interdisciplinary case of epicardial VT ablation using secondary surgical open-heart access in an LVAD patient with therapy-refractory VTs. By combining left-sided minithoracotomy with HD mapping and catheter ablation, we could demonstrate that even in these complex patients epicardial VT ablations can be performed safely and improve quality of life of LVAD patients with recurrent implantable cardioverter-defibrillator shock therapies.

Keywords

Ventricular tachycardia • LVAD • Left anterior minithoracotomy • Hybrid VT ablation • Case report

Learning points

- Ventricular tachycardias (VTs) are a common problem in left ventricular assist device (LVAD) patients. The number of LVAD implants is constantly increasing and as a consequence also the number of patients suffering from VTs.
- Catheter ablation procedures in patients with an LVAD as a potentially curative therapy are challenging because of several factors (electrocardiogram quality, anticoagulation, epicardial adhesions, etc.). The hybrid approach could potentially enhance safety and efficacy of epicardial VT ablations compared to either interventional or surgical ablations alone.

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Introduction

Continuous-flow left ventricular assist devices (LVADs) have revolutionized the care of patients with end-stage heart failure (HF) and the number of LVAD implants is increasing worldwide.¹ Ventricular tachycardias (VTs) in LVAD patients have been reported to occur in up to 40% within 2 years after LVAD implantation, resulting in a significant clinical impact on quality of life, but also on mortality.^{1,2} A survival benefit has been demonstrated for implantable cardioverter-defibrillator (ICD) use during LVAD support, with appropriate therapy occurring in ~25% of patients.^{3–5} Radiofrequency (RF) ablation of critical circuit components via a percutaneous subxyphoidal approach⁶ have shown to be effective in achieving freedom from VT recurrence,⁷ but these procedures are associated with notable operative risks, since pericardial access can be challenging especially in a postoperative setting. Modern hybrid catheter-based surgical approaches are another option to perform epicardial VT ablations, but scientific evidence, in particular in LVAD patients, is scarce. According to literature VAD-related VTs are predominantly related to pre-existing intrinsic myocardial scar rather than to the inflow cannula insertion site—this was also the case in our patient.⁸

This surgical and interventional hybrid approach could potentially enhance safety and efficacy of epicardial VT ablations compared to either interventional or surgical ablations alone.

This case report demonstrates effective epicardial VT ablation through a surgical access using epicardial high-density (HD) mapping in an LVAD patient with haemodynamically relevant, drug refractory, incessant VTs.

Timeline

2.5 years before admission	First presentation of dilated cardiomyopathy with ventricular tachycardia (VT)
2 years before admission	First endocardial VT ablation
	Second endocardial VT ablation with epicardial VT ablation planned
9 months before admission	Left ventricular assist device (LVAD) implantation because of therapy-refractory advanced heart failure
Admission	Recurrent electrical storms and multiple implantable cardioverter-defibrillator shocks
During procedure	The hybrid epicardial VT ablation was successfully performed using secondary surgical open-heart access in an LVAD patient with therapy-refractory VTs by combining left-sided minithoracotomy with high-density mapping and catheter ablation
Day 7 post-procedure	Hospital discharge without any VT relapse
6 months follow-up	Until today no arrhythmia recurrence has been detected

Case presentation

We report on a 53-year-old man with dilated cardiomyopathy and severely reduced left ventricular ejection fraction (15%). An LVAD (HeartMate III, Abbott, Abbott Park, IL, USA) was implanted because of therapy-refractory advanced HF. The LVAD implantation was considered as a destination therapy due to continued tobacco consumption. Ten months after implantation, the patient was readmitted at our centre in the context of recurrent electrical storms and multiple ICD shocks.

VTs were refractory to our escalating internal VT regimen consisting of substitution of electrolytes (potassium, magnesium), i.v. antiarrhythmic drugs (amiodarone, mexiletine, lidocaine) and sedation (midazolam), overdrive pacing (increasing pacing rate to 90/min) and repetitive electrical cardioversions (internal and external). Although LVAD therapy improves VT tolerance of the left ventricle, haemodynamical deterioration of the right ventricle and the decrease in output of the LVAD because of less preload were also limiting factors in our patient.

In his history, the patient already had two previous unsuccessful endocardial VT ablations with instantaneous VT relapse. Eligibility for a heart transplantation was not given because of the patient being incontinent and addicted to continued smoking. In this clinical scenario with LVAD as a destination therapy and after interdisciplinary discussion (Heart team), the decision was taken to perform hybrid epicardial VT mapping and ablation with a suspected epicardial origin of incessant, haemodynamically relevant VTs.

The procedure was performed under general anaesthesia in a hybrid operating room. A diagnostic catheter was advanced into the right ventricular apex from the femoral vein. Incessant VT with two opposite morphologies of QRS complexes and same cycle length (420 ms) was induced suggesting a common isthmus for both tachycardias with opposite direction of VT circuit (mirror effect) (see [supplemental figure S2](#)). The 12-lead electrocardiogram (ECG) of the clinical VT suggested a basolateral exit (see [Figure 1](#)). The cardiothoracic surgeon provided epicardial access through open-heart dissection using a left anterior minithoracotomy to provide optimal exposition to the suspected area of interest and to avoid also interaction with the inflow LVAD cannula. The patient was placed in a lateral decubitus position with the right side of the thorax being elevated 30–50°. Third to fifth intercostal space was exposed and percolated and the pericardium was opened at least 2 cm anteriorly, parallel to the phrenic nerve. Once the access was given the patient was moved to 0° angulation to allow precise location of the catheters via the location pad of the 3D mapping system. A multipolar mapping catheter (Pentaray[®], Biosense Webster, Baldwin Park, CA, USA) was positioned along the lateral heart and HD activation and voltage maps were performed (see [Figure 2](#)). Activation map revealed clear evidence for continuous diastolic activity at the inferior posterolateral LV (see [Figures 3 and 4A](#) and [supplemental figure S1](#)). At this site, we found the earliest ventricular activation for both VTs morphologies (mirror effect) (see [Figure 4B](#)).

The multipolar mapping catheter was subsequently replaced by an irrigated ablation catheter (Thermocool Navistar, Biosense Webster) demonstrating mid-diastolic activation during ongoing VT. The VT was terminated by RF energy application at this specific

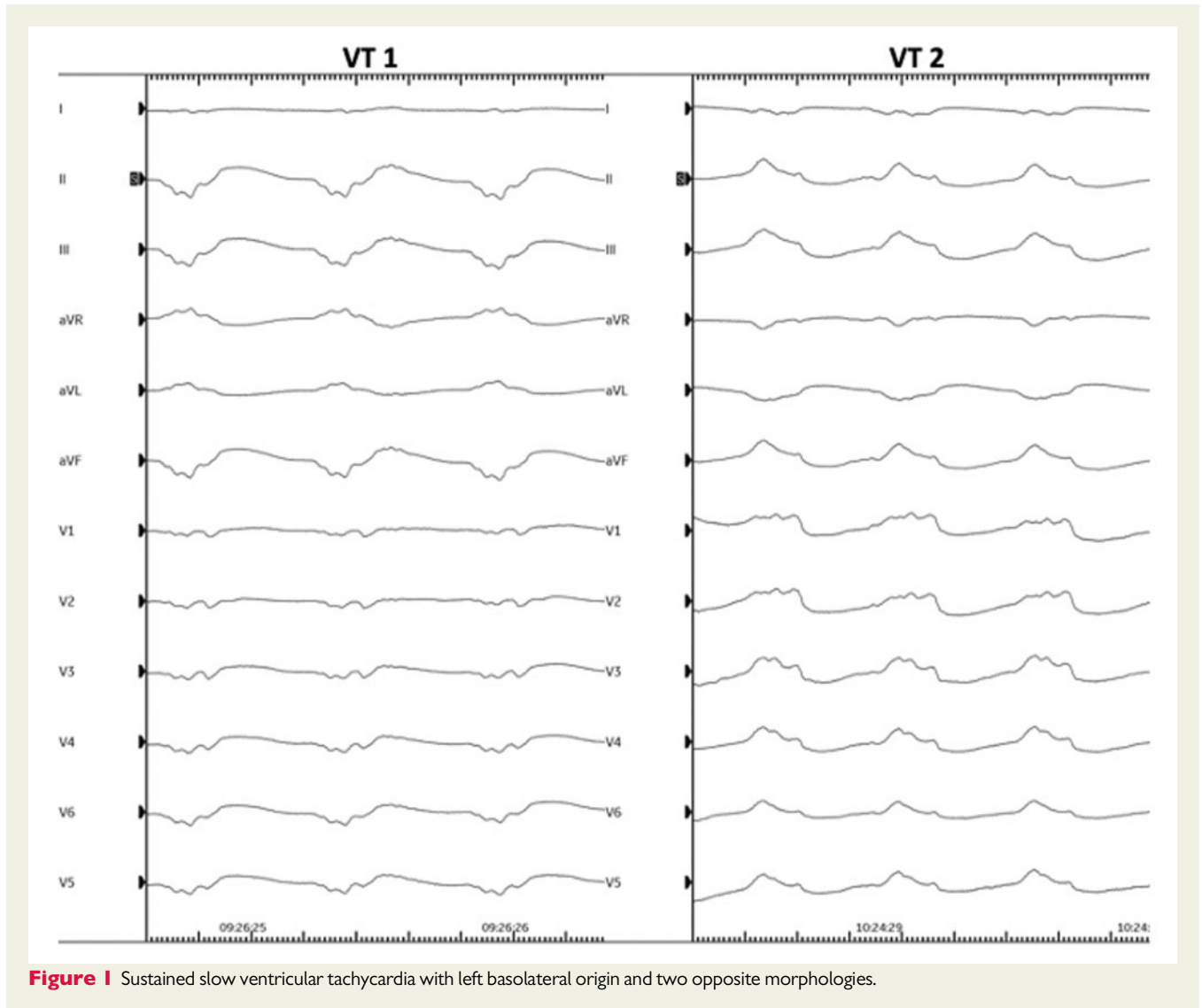


Figure 1 Sustained slow ventricular tachycardia with left basolateral origin and two opposite morphologies.

location (see Figure 5), and voltage mapping of the epicardial surface depicted extensive scar burden, in particular in lateral and posterior areas. Additional lesions were deployed targeting this substrate, guided by fractionated electrograms and late potentials. After RF energy delivery, VT was no longer inducible by programmed stimulation (up to three extrastimuli from the right ventricular apex). The pericardium and the soft tissue were surgically closed and the patient was extubated after return to intensive care unit. Total procedural time from percutaneous access to removal of the femoral sheaths was 150 min. Seven days after this hybrid epicardial VT ablation, the patient was discharged home with no evidence of any VT recurrence. During more than 6 months of follow-up, the patient remained free of VT relapse, still remaining on oral amiodarone with cessation of his mexiletine therapy.

Discussion

The use of permanent LVADs as destination therapy has increased significantly because of the shortness of available organs and the increasing number of patients being non-eligible for heart transplantation.⁹ Despite substantial technical improvements in long-term mechanical circulatory support, VT remains a major challenge in LVAD patients.¹ Recurrent VTs in LVAD patients are not only associated with limited quality of life, but also increased mortality.^{1,2}

Conventional ablation procedures as a potentially curative therapy are challenging because of several factors: (i) proximity to the inflow cannula at the LV apex. (ii) Only endocardial access available because of epicardial adhesions. (iii) ECG and Intracardiac electrogram (IEGM) quality impairment due to VAD-associated artefacts.

Mathuria *et al.*¹⁰ described for the first time an epicardial surgical ablation technique after LVAD implantation surgery. However, their ablation approach remains empiric, blindly addressing 'suspicious

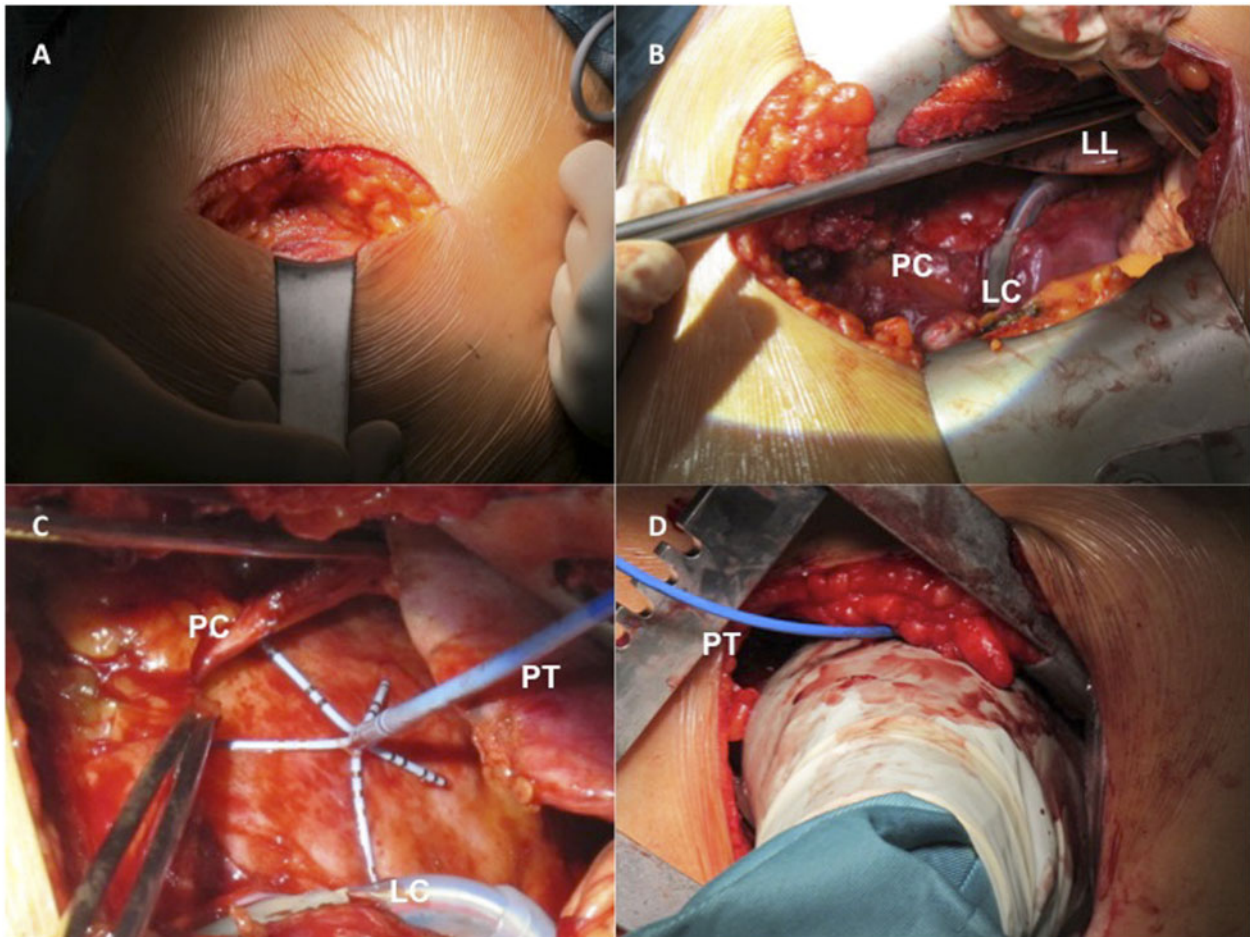


Figure 2 Left anterior minithoracotomy. (A) The anterolateral skin incision. (B) The epicardial access. (C and D) Visually guided high-density mapping using a multipolar mapping catheter. LC, LVAD cannula; LL, left lung; LVAD, left ventricular assist device; PC, pericardium; PT, Pentaray[®], Biosense Webster, Baldwin Park, CA, USA.

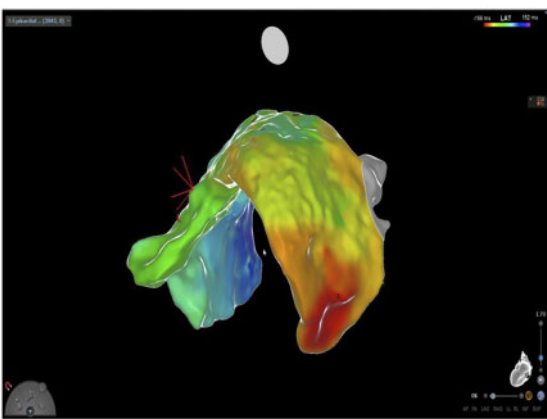


Figure 3 Activation map of ventricular tachycardia; the earliest ventricular activation is displayed in red, the latest ventricular activation in blue. View from posterior-lateral.

areas' without specific targeting and therefore without evidence that these areas are related to clinical VTs. Moreover, long-term results remain unclear especially in this selected patient subgroup with very limited myocardial reserve.¹⁰

The percutaneous subxyphoidal approach is frequently impossible in patients with LVAD due to adhesions and the position of the inflow cannula. The epicardial surgical ablation technique alone is empirical and mostly leads to destruction of viable myocardium due to the large lesions that are created.¹⁰ Therefore, we decided to combine the surgical epicardial access via left anterior minithoracotomy, the HD mapping with a multipolar mapping catheter and the precise ablation of the VT with an irrigated single tip 4 mm ablation catheter. This novel approach gives us the opportunity to understand VT mechanisms and to eliminate ICD shocks also in patients after LVAD implantation.

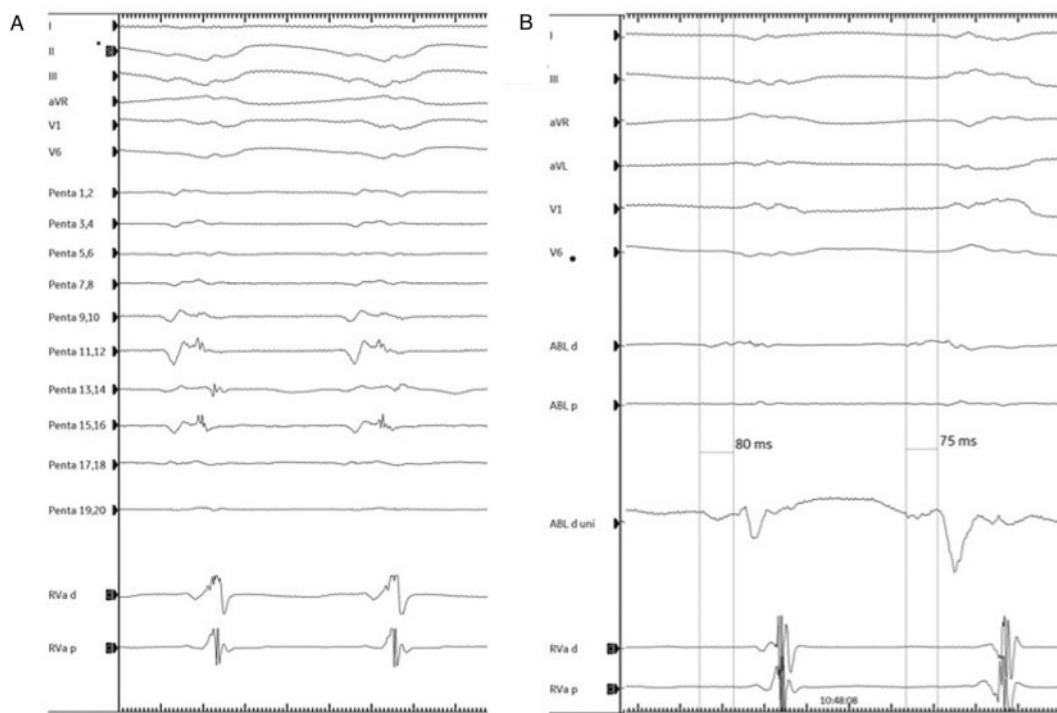


Figure 4 (A) Mild-diastolic activity shown with the multipolar mapping catheter. (B) The earliest ventricular activation for both ventricular tachycardias morphologies (mirror effect).

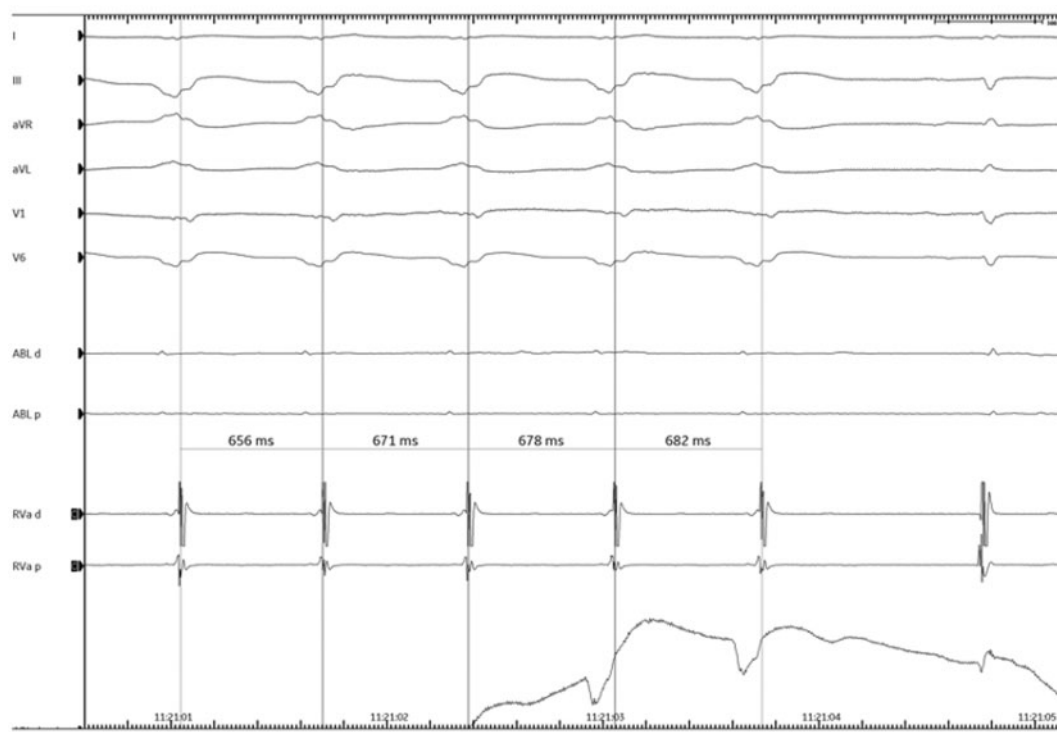


Figure 5 Specific ventricular tachycardia termination during catheter ablation.

Conclusion

We report the first interdisciplinary case of epicardial VT ablation using secondary surgical open-heart access in an LVAD patient with therapy-refractory VTs combining left-sided minithoracotomy with HD mapping and catheter ablation.

Lead author biography



Philipp Sommer, MD, FHRM, FESC, FEHRA, is professor of cardiology at the Heart and Diabetes Center NRW, University of Bochum, Bad Oeynhausen. He was born on 1975, Med School 1995–2002. He was Fellow at the Heart Center Leipzig 2003–2007, Resident in Cardiology 2007–2013, Head of EP labs, and Deputy Director in the Department of Electrophysiology 2013–2017. Since November 2018 he has been

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Supplementary material

[Supplementary material](#) is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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