# Ablation of PVCs from the outflow tract using a large-footprint lattice-tip catheter: Be cautious of the coronary artery

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## Introduction

In ventricular arrhythmia (VA) ablation, achievement of durable transmural lesions is critical in ensuring procedural success. However, it remains challenging when the substrate is localized in certain regions (i.e., septum, epicardium)[1] or near coronary arteries (CAs), for instance, in the left ventricular (LV) summit.[2] New techniques, such as pulsed field ablation (PFA), have been proposed as an alternative to conventional radiofrequency ablation (RFA) for such cases. However, PFA application in proximity to CAs is frequently associated with severe CA spasm (CAS),[3] whereas CAS or CA injury (CAI) is rarely described as a complication of thermal ablation procedures.[4,5] This might probably be due to a more gradual energy delivery, which permits early CAS/CAI detection and subsequent prompt delivery interruption. In case of ablation procedures on the right ventricular outflow tract (RVOT), there is risk of left CAS/CAI due to anatomical proximity; however, only few such cases are reported in literature.[6,7] A novel large-footprint dual-energy 9 mm-nitinol-lattice-tip focal catheter, the Sphere-9 (Medtronic), capable of both mapping and ablation, has recently been proposed as an alternative for VA ablation, with limited data in the form of case reports/series.[1,8,9] We report the case of transient and self-limiting chest pain and ST-segment depression, likely because of proximal left CAS, during RFA of RVOT-originating premature ventricular complexes (PVCs) using the Sphere-9 catheter.

## KEY TEACHING POINTS

- In ventricular arrhythmias ablation, achievement of durable transmural lesions is critical in ensuring procedural success. However, it remains challenging when substrate is localized in certain regions or near coronary arteries.
- New techniques, such as pulsed field ablation (PFA), have been proposed as an alternative to conventional radiofrequency ablation. However, PFA in proximity to coronary arteries is frequently associated with severe spasm, whereas it is rare in thermal ablation procedures.
- We report the case of transient and self-limiting chest pain and ST-segment depression, likely due to transient proximal left coronary artery spasm, during radiofrequency ablation of premature ventricular complexes originating from the right ventricular outflow tract using a novel large-footprint dual-energy 9 mm-nitinol-lattice-tip focal catheter.
- Gradual radiofrequency delivery before PFA, compared with a PFA-only strategy, permitted prompt radiofrequency delivery interruption, avoiding long-lasting consequences.
- Large-footprint lattice-tip catheters should be used with particular caution near coronary arteries; however, our experience suggests they may remain a safe and effective option in selected focal arrhythmias when strict precautions and careful monitoring are applied.

**KEYWORDS** Ventricular tachycardia; Ventricular premature complexes; Right ventricular outflow tract; Catheter ablation; Radiofrequency ablation; Coronary vasospasm; Coronary vessel injuries; Electroporation; Intracardiac echocardiography; Ablation catheters

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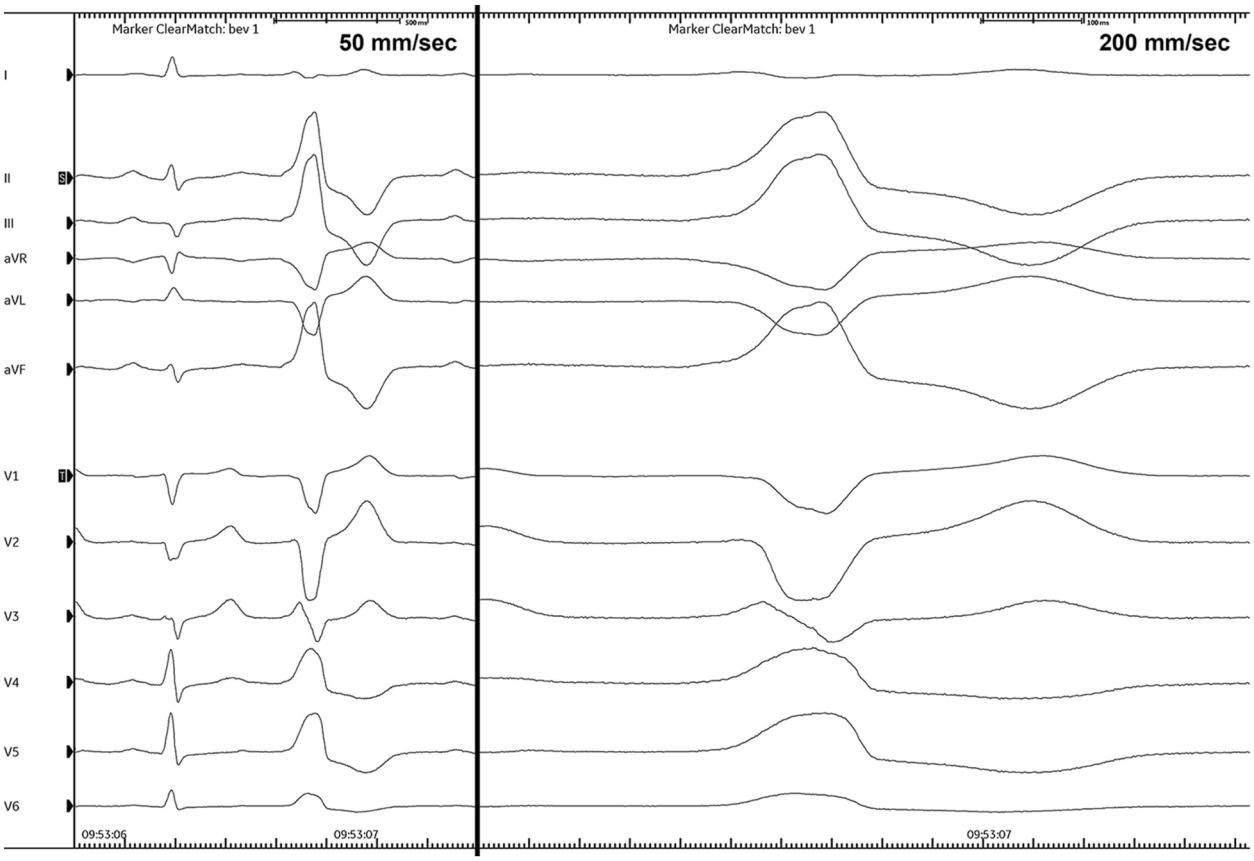


**Figure 1** ECG morphology of clinical premature ventricular complex, indicating right ventricular outflow tract origin, at different sweep speeds, that is, 50 mm/sec on the left and 200 mm/sec on the right. ECG = electrocardiogram.

## Case report

A 57-year-old male patient with initial dilated cardiomyopathy associated with titin-truncation mutation presented with recurrence of frequent RVOT-originating PVCs (Figure 1), despite previous catheter ablation 14 years before and maximal-tolerated anti-arrhythmic pharmacological therapy with Metoprolol 50 mg bid. In particular, following an acute heart failure episode, LV ejection fraction worsening (42%), and PVC recurrence symptomatic of palpitations were noted, with 20,739 PVCs in 24-hours (20% of total beats), isolated and organized in frequent runs—up to 10 complexes—with a prevalent morphology indicating RVOT origin. Therefore, considering the recurrence of symptomatic PVCs and the LV ejection fraction worsening, a redo PVCs ablation procedure was scheduled.

The procedure was conducted under conscious sedation. After obtaining 3 femoral venous accesses in an ultrasound-guided fashion, a decapolar Dynamic Xt diagnostic catheter (Boston Scientific) was introduced in the coronary sinus and an intracardiac echocardiography (ICE) Viewflex Xtra 3Mhz probe (Abbott) was advanced in the right atrium to guide the procedure and to ensure good ablation catheter contact. Mapping and ablation were performed using the Sphere-9 catheter and the Affera Prism-1 (Medtronic) mapping system. Anticoagulation regimen and temperature-controlled RFA settings were analogous to the ones described elsewhere.[8] Specifically, ablation was performed in the temperature-control mode with a target temperature of 60°C, a 40% current limit, and a maximum pulse duration set to 30 seconds. After introducing the catheter in the RVOT in the postero-septal region, a brief mapping revealed focal origin of clinical PVCs from said region, with 97% matching compared with the PVC-sample, which strongly supported (although did not definitively prove) that the recorded PVCs corresponded to the clinical PVCs, and with electrograms (EGMs) from the channels of the lattice-tip catheter showing negative potentials originating 40 msec before the QRS onset (Figure 2). Although the QRS axis could also suggest a mid-septal origin, the EGM timing and activation mapping supported a postero-septal RVOT focus. A first RF pulse was delivered and completed after 30 seconds, which reduced but did not completely abolish the PVCs. Therefore, a second application was attempted slightly cranial/anterior to the first site (Figure 3), but it was promptly interrupted after 14 seconds due to onset of chest pain associated with electrocardiogram (ECG) alterations (Figure 4) consisting in diffuse ST-segment depression in 8 leads with slight ST-segment elevation in lead aVR, suggestive for CAS/CAI of the proximal left anterior descending coronary artery (LAD) and/or left

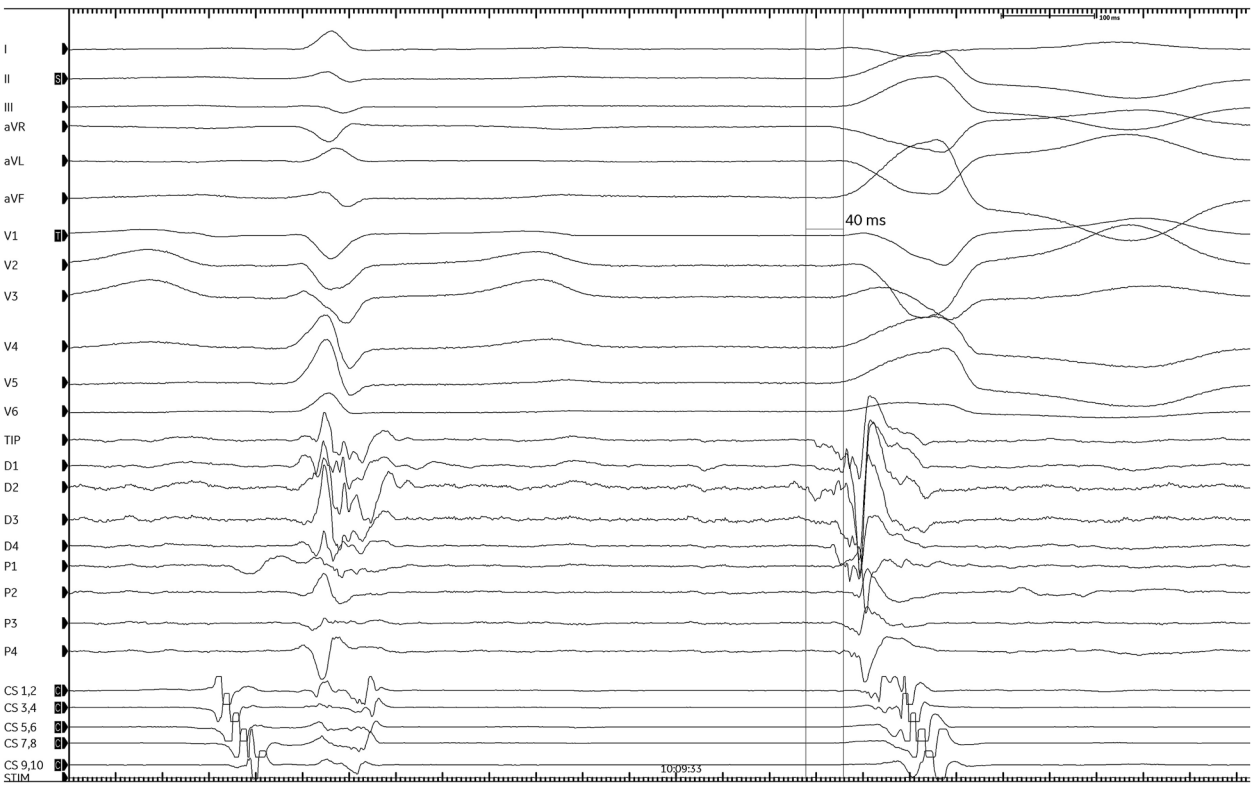


**Figure 2** Electrograms obtained after introducing the lattice-tip catheter in the postero-septal region of the right ventricular outflow tract. The distal bipole (D2), in direct contact with the ablation site, showed a local ventricular potential originating 40 msec before the premature ventricular complex QRS onset. Although some baseline noise was present, this finding was consistent across recordings and supported the focal origin from this region.

main stem (LMS). ICE showed proximity of the lattice-tip catheter to the left coronary cusp (Figure 5 and Supplemental Video 1A), which also prompted repositioning of the catheter away to limit thermal effects (Supplemental Video 1B). Importantly, ICE did not reveal bubble formation or any signs of overheating during ablation. Both the pain and the ECG changes rapidly subsided after RF delivery interruption. ICE did not show any new regional ventricular wall motion abnormalities other than the one already present (mild diffuse hypokinesis without regional prevalence). Therefore, considering the absence of symptoms, ECG changes or ventricular wall motion abnormalities, and the

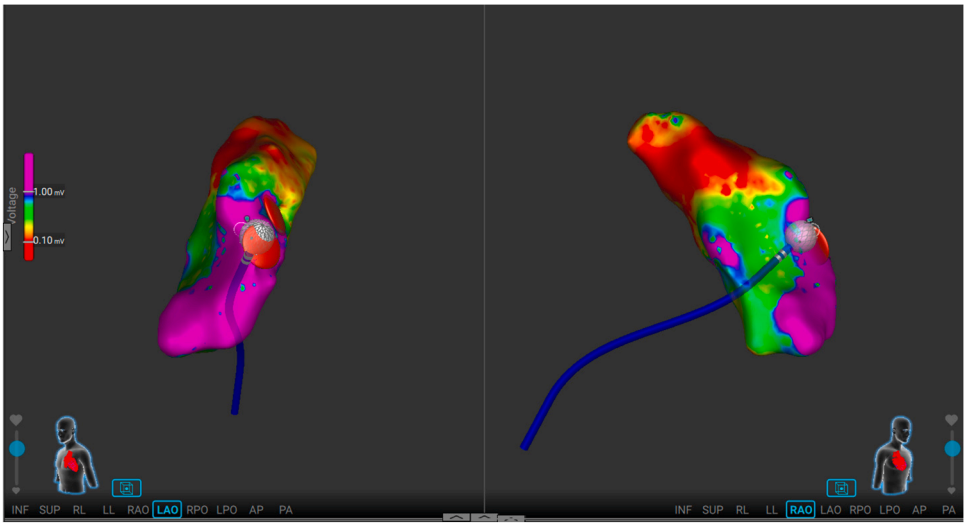


**Figure 3** Bipolar voltage maps obtained with the Affera (Medtronic) system, in left anterior oblique (LAO) view on the left and right anterior oblique (RAO) view on the right; the 2 *round red markers* represent sites of radiofrequency delivery, the more cranial one interrupted prematurely because of onset of chest pain and ECG changes. ECG = electrocardiogram.

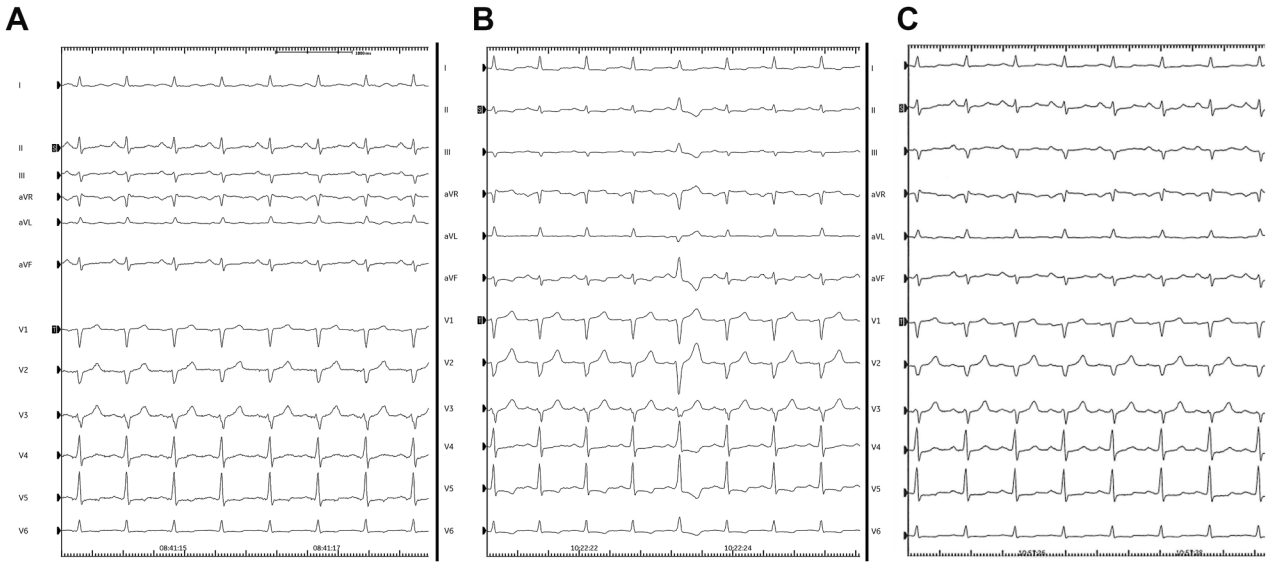


**Figure 4** Basal ECG (**A**) compared with ECG after chest pain onset during radiofrequency ablation (**B**), showing alterations (diffuse ST-segment depression in 8 leads with slight ST-segment elevation in lead aVR) suggestive for coronary artery spasm/injury at the level of the proximal left anterior descending coronary artery and/or left main stem, which prompted immediate radiofrequency delivery interruption, with subsequent normalization (**C**). ECG = electrocardiogram.

absence of clinical PVCs after the second RFA, we decided not to perform coronary angiogram (CAG) and to conclude the ablation procedure, proceeding with clinical observation. The patient remained asymptomatic throughout the observation period, no clinical PVCs were recorded at continuous ECG monitoring, which showed few residual PVCs with different morphology. Subsequent serial high-sensitivity cardiac troponin-I assay showed minimal increase with peak value of 235 ng/L, compatible with ablation lesion formation,[10] and subsequent return to normal. Serial 12-leads ECG and echocardiography were unaltered, confirming the decision not to perform CAG. The patient was discharged after a 72-hour observational period.

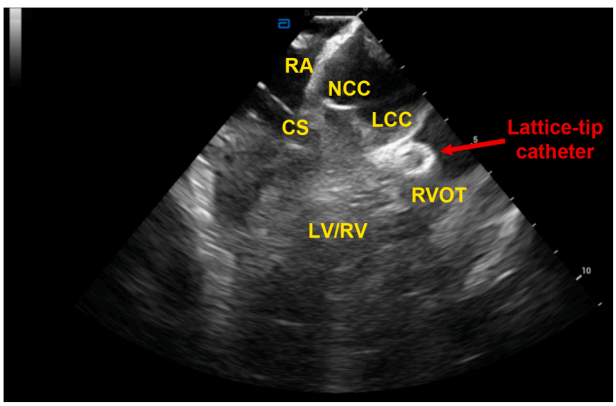


**Figure 5** Intracardiac echocardiography at the moment of radiofrequency delivery interruption for onset of chest pain and ECG changes, with the probe positioned in the right atrium with a view intermediate between classical right ventricular outflow tract (RVOT) view and left ventricular one, showing proximity of the lattice-tip catheter (*red arrow*) to the left coronary cusp (LCC). CS = coronary sinus; ECG = electrocardiogram; LV/RV = left ventricle/right ventricle; NCC = non coronary cusp; RA = right atrium.

## Discussion

Severe CAS, associated with chest pain and ST-segment elevation on ECG, mostly requiring intracoronary nitrates administration, is a known complication of PFA when delivered in proximity to such vessels, and in particular right CAS in the context of cavo-tricuspid isthmus ablation.[3] It was also described in VA ablation procedures.[1,8] However, CAS/CAI, either transient or persistent, are also known complications of thermal ablation procedures, both cryoablation and RFA.[4,5] In the context of RFA, careful and continuous ECG monitoring might prompt immediate RF delivery interruption, and therefore, limit damage, whereas with PFA this occurrence is impossible due to the non-thermal nature, the rapid energy delivery, and the different mechanism of CAS, that is, intense electrical field exposition-induced spasm of vascular smooth muscle cells in CAs tunica media.[11]

While focal CAS typically produces localized ST-segment elevation, the pattern observed in our case, that is, diffuse ST depression with slight ST elevation in aVR, is compatible with global subendocardial ischemia secondary to transient flow limitation of the LMS or proximal LAD. The abrupt onset and rapid resolution of symptoms and ECG changes after RFA interruption support the hypothesis of a transient vasospasm. Nevertheless, because CAG was not performed, we cannot exclude the possibility of direct thermal CAI. This diagnostic uncertainty must be acknowledged as a limitation of the case.

There is only scanty data in form of case reports/series[1,8,9] regarding VA ablation using the Sphere-9 catheter, which is the only large-footprint dual-energy lattice-tip focal ablation catheter commercially available. Epicardial PFA was described in a case report[8]; moreover, complicated by CAS, and in another case series of 18 patients,[8] in which 3 out of a total of 4 patients undergoing epicardial PFA developed CAS. No CAS/CAI RFA-related events were described in these case reports/series.

There are only 6 cases of left CAI during RVOT-VA ablation reported in literature,[6,7] all involving the mid-segment of the LAD and the use of conventional irrigated-tip catheters. To our knowledge, this is the first case report of transient chest pain and ECG modifications likely secondary to CAS of proximal LAD/LMS. The more proximal involvement of the left CA might be related to the larger footprint of the catheter, compared to traditional ones.

Although a low take-off of the LAD was not clearly observed in our patient, such an anatomical variation may increase susceptibility to coronary involvement during RVOT ablation. This consideration highlights that, beyond the large footprint of the catheter, individual CA anatomical features may also contribute to the risk of ischemia in this setting. Therefore, while the use of large-footprint catheters for focal arrhythmias requires particular caution in proximity to CAs, our case suggests that, with gradual RF delivery, continuous ECG/ICE monitoring, and prompt interruption in case of warning signs, they may still be employed safely.

Lattice RFA produced, in an animal model, larger and deeper lesions on healthy ventricular myocardium compared to single and multiple PFA applications, and to RFA with a conventional irrigated 3.5 mm-tip catheter (i.e., ThermoCool ST-SF; Biosense Webster, Johnson & Johnson MedTech).[12] However, in animal models and using the same conventional irrigated-tip catheter, RFA on heterogeneous ventricular scar tissue resulted in irregular tissue injury and unpredictable lesion morphology and dimension.[13] These limitations might theoretically be overcome by PFA,[14] as demonstrated by animal infarct models with the pentaspline Farawave (Boston Scientific) catheter[15] and with a ThermoCool ST catheter connected to a CENTAURI (Galaxy Medical) PFA generator,[16] and in animal model redo procedures on chronic RFA substrate.[17] However, in all these studies, lesion depth was always inferior to the one obtained by lattice RFA.[12] Moreover, studies demonstrating long-term PFA lesion stability are lacking as well. For these reasons and considering the historical experience with RFA,[8] we decided to use RFA first, instead of PFA. This allowed to dynamically analyze changes in local EGMs and ECG during RF delivery, granting prompt detection of ST-segment changes and swift RF delivery interruption, thus preventing long-lasting complications. With this approach, after a more gradual initial RF delivery without complications (i.e., CAS/CAI), the intended lesion might theoretically be safely completed by additional PFA applications. This sequential energy application might overcome known RF-penetration issues on scar tissue[13] and effectively ablate surviving myocytes within and beyond the scar.[15–17] Further studies are mandated to prove this hypothesis.

Among the limitation of our case, the 97% PVC morphology matching score, while strongly supportive, cannot definitively confirm that the mapped PVCs were identical to the patient's clinical PVCs, and therefore, must be acknowledged as a methodological caveat.

Moreover, CAG was not performed at the time of the event. Although this precluded direct visualization of potential CA involvement, the rapid resolution of symptoms and ECG changes, the absence of new wall motion abnormalities on ICE and transthoracic echocardiography follow-up, and the normalization of biomarkers supported a conservative approach, thereby avoiding unnecessary invasive angiography.

We also acknowledge that, given the anatomical overlap between mid-septal and postero-septal RVOT regions, precise localization may remain challenging despite activation mapping. In our case, the surface ECG axis could be interpreted as more compatible with a mid-septal focus, whereas the EGM timing (-40 ms) and local activation map supported a postero-septal origin. This apparent discrepancy underscores the inherent limitations of correlating ECG morphology with intracardiac mapping and highlights the need for cautious interpretation when these findings are not fully concordant.

## Conclusion

To our knowledge, this is the first case report of transient chest pain and ECG modifications likely secondary to proximal LAD/LMS spasm. Gradual RF delivery, compared to a PFA-only strategy, permitted prompt RFA abortion, avoiding long-lasting consequences. This case emphasizes that large-footprint catheters, although carrying a potential risk of coronary involvement when used near coronary arteries, may still be safely employed in selected focal arrhythmias when this limitation is carefully acknowledged and strict precautions are applied. RFA followed by PFA with a large-footprint lattice-tip catheter might be the best strategy for VA ablation for different reasons: (a) it might provide deeper lesions thanks to the peculiar RF energy delivery of the lattice-tip catheter[12]; (b) as shown in this case report, a more gradual initial RFA energy delivery, compared with a PFA-only strategy, might theoretically be safer, permitting early complications detection (such as initial CAS/CAI) and prompt RF delivery abortion, without any long-lasting clinical consequences; (c) in case of safe initial RF delivery, further PFA applications might complete the intended lesion, overcoming known RF-penetration issues on scar tissue[13] and guaranteeing effective ablation of surviving myocytes within and beyond the scar[15–17]; (d) use of a single catheter for mapping and ablation might theoretically reduce procedural times and complications, deriving from the need of an adjunctive ventricular access (venous, arterial or transeptal) for a dedicated mapping catheter or from accidental air bubble intrusion when switching from

mapping to ablation catheter; (e) studies demonstrating long-term PFA lesion stability are lacking, therefore combining PFA with RFA, which has been historically employed for many years with known long-term lesion stability,[8] might theoretically be safer in this regard; and (f) last but not least, focal large-footprint ablation catheters, compared to conventional ones, might be preferable for ventricular tachycardia ablation, irrespective of the energy used, due to having the potential to transect most ventricular tachycardia isthmuses with only one delivery, thereby reducing the risk for non-contiguous lesions and reconnections.[14] Randomized clinical studies are necessary to prove these hypotheses.

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**Patient Consent:** The patient provided written informed consent.

**Data availability:** Data available on request. The data underlying this article will be shared on reasonable request to the corresponding author.

## Appendix

### Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2025.10.018.

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