Anterograde and retrograde insulated pathway conduction evidenced by intracardiac electrogram morphologies during premature ventricular contractions and sinus rhythm

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Introduction

When mapping premature ventricular contractions (PVCs) originating from around the right ventricular outflow tract (RVOT) or left ventricular outflow tract (LVOT), insulated myocardial pathway conduction that is connected to an exit to the ventricular myocardium is sometimes observed.[1,2] Insulated myocardial pathways are usually detected as discrete or fractionated prepotentials preceding the QRS onset during PVCs, but sometimes they are detected as late potentials during sinus rhythm (SR).[3–5] Although the existence of insulated myocardial pathways has been reported,[1–6] the electrophysiological and anatomic characteristics of the insulated myocardial pathways have not been fully clarified. Here we present the case of a PVC with an insulated myocardial pathway for which the detailed electrophysiological and anatomic characteristics were evident.

KEY TEACHING POINTS

- An insulated myocardial pathway, which is a pathway potential connected to the exit, is sometimes observed as a fractionated presystolic potential preceding the QRS onset during premature ventricular contractions (PVCs).
- The insulated myocardial pathway can be characterized by the coexistence of a fractionated presystolic potential and a late potential, both originating from the right coronary cusp–left coronary cusp (RCC–LCC) commissure.
- Radiofrequency ablation at the RCC–LCC commissure can successfully eliminate both the PVCs and late potentials in such cases.
- These findings suggest a possible bidirectional conduction of the insulated myocardial pathways.

Case report

A 76-year-old woman without any overt structural heart disease was referred to our institution for radiofrequency (RF) ablation of symptomatic PVCs, atrial fibrillation, and common atrial flutter. Twenty-four–hour Holter monitoring after a prior failed ablation had revealed PVCs of 10,685 beats per day. The PVCs had a left bundle branch block/inferior-axis configuration with a relatively early transition at lead V_2 (Figure 1A). After a pulmonary vein isolation and cavotricuspid isthmus ablation, activation mapping of the RVOT revealed the earliest activation at the posteroseptal RVOT, and activation preceded the QRS onset by 26 ms (Figure 2A). However, the pace-map morphology was not identical to the morphology of the PVC (Figure 1B), and delivery of RF energy failed to eliminate the PVCs. Therefore, activation mapping of the LVOT was performed. A fractionated presystolic potential preceding the QRS onset by 32 ms was recorded at the right coronary cusp–left coronary cusp commissure, where a fractionated late potential was recorded during SR (Figure 2B). A good but not perfect pace-map with a stimulus to QRS interval of 40 ms was acquired (Figure 1C). RF current application (30 W) at that site eliminated both the PVCs and late potential within 8 seconds (Figure 2C). Intracardiac echocardiography revealed that the distance between the sites of the earliest activation in the LVOT and RVOT was 13 mm (Figure 2D). At 6 months after treatment, the arrhythmia has not recurred.

KEYWORDS Catheter ablation; Insulated pathway; Late potential; Premature ventricular contraction; Presystolic potential
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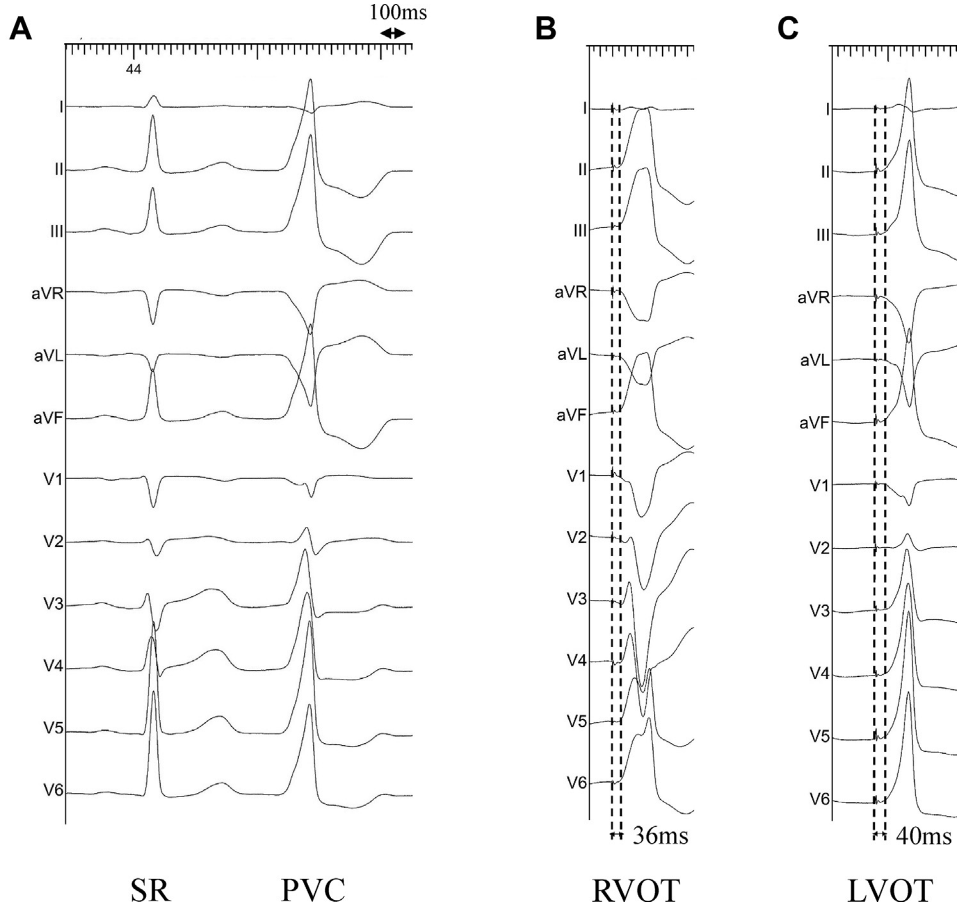

Figure 1 **A:** Twelve-lead electrocardiogram recorded during the procedure showing sinus rhythm (SR) and a premature ventricular contraction (PVC). **B, C:** Pace-maps obtained from the ablation sites in the right ventricular outflow tract (RVOT) (**B**) and the left ventricular outflow tract (LVOT) (**C**).

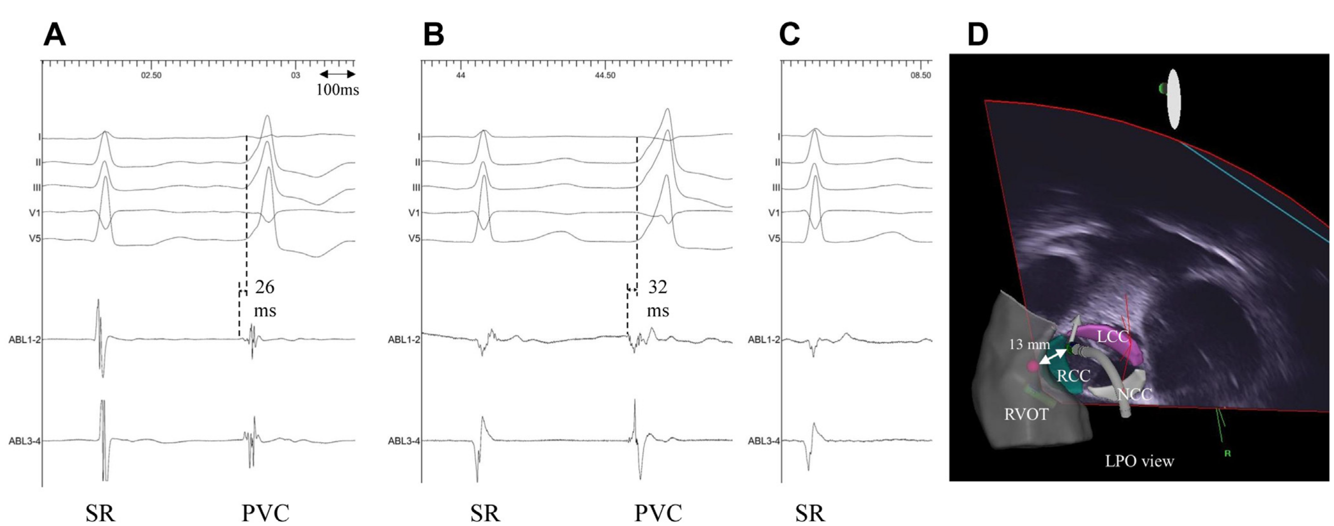

Figure 2 Intracardiac electrograms obtained at the right ventricular outflow tract (RVOT) (**A**) and left ventricular outflow tract (**B**) before ablation, and the left ventricular tract after successful ablation (**C**). **D:** Intracardiac echocardiogram recorded for electroanatomic assessment of the site of the successful ablation. Recording from the ablation catheter (ABL) shows the point of successful ablation was at the right coronary cusp (RCC)–left coronary cusp (LCC) commissure. *Pink tag* indicates the site of earliest activation in the right ventricular outflow tract. LPO = left posterior oblique; NCC = noncoronary cusp; PVC = premature ventricular contraction; SR = sinus rhythm.

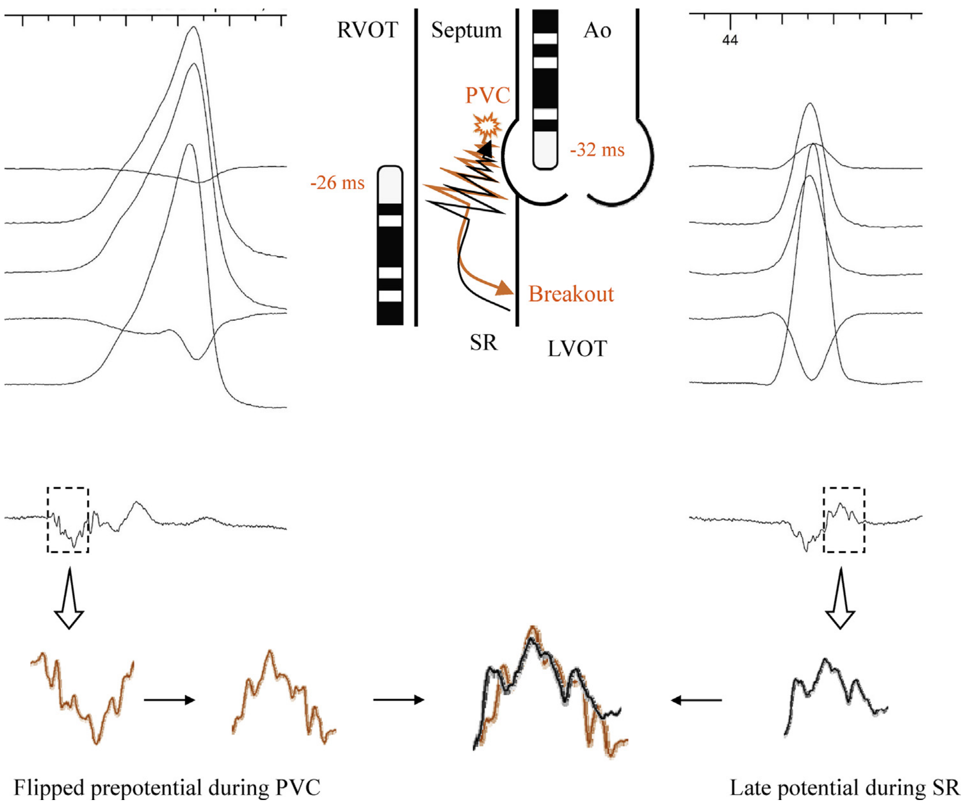

Figure 3 Comparison of the vertically and horizontally flipped presystolic electrogram preceding the premature ventricular contraction (PVC) and electrogram showing the late potential during sinus rhythm (SR). The configurations nearly match. Bidirectional conduction of the insulated myocardial pathway is represented schematically. Ao = aorta; LVOT = left ventricular outflow tract; RVOT = right ventricular outflow tract.

Discussion

In a previously reported series of patients undergoing ablation of ventricular tachycardia or PVCs, presystolic potentials (during PVC) and late potentials (during SR) were recorded at the site of the successful ablation, suggesting the presence of an "insulated myocardial pathway" based on the definition of the previous reports.[1,3,6] We hypothesized that those potentials represented insulated myocardial pathway conductions in opposite directions, with the presystolic potential preceding the onset of the QRS complex characterizing a PVC indicative of anterograde pathway conduction and the late potential occurring during SR indicative of retrograde pathway conduction. To examine this hypothesis, we flipped the presystolic electrogram exhibiting the PVC vertically and horizontally, and diagrammed the bidirectional pathway conduction (Figure 3). Interestingly, the configuration of the flipped electrogram nearly matched that of the electrogram exhibiting the late potential during SR. Furthermore, the successful RF ablation of the late potential during SR as well as the PVCs suggested bidirectional block within the insulated myocardial pathway. Thus, it is conceivable that those 2 potentials reflected bidirectional pathway conduction. A better pace-map in the LVOT than the RVOT suggested that the breakout site was in the LVOT. The PVCs and insulated myocardial pathway might have originated from closer to LVOT endocardium than RVOT endocardium. That would explain the earlier activation (6 ms earlier than in the RVOT) at the site of the successful ablation in the LVOT.

The reported insulated myocardial pathways, including preferential pathways, were usually found on the septal aspect of the LVOT or RVOT.[1,2] Our patient's intracardiac echocardiogram revealed that the sites of earliest activation in the LVOT and RVOT were on opposite sides of the ventricular septum. The 13-mm distance between those sites was due to the thickness of the myocardium. Ablation of PVCs originating from within the septal LVOT or RVOT is often challenging because the location prevents the creation of a sufficiently deep lesion. Although intracardiac echocardiography might be useful for delineating the course of the insulated myocardial pathway, meticulous mapping to target the pathway potential, whether anterograde, retrograde, or both, is warranted.

Conclusion

We encountered a case of a PVC with presystolic potentials during PVCs and late potentials during SR suggesting the existence of an insulated myocardial pathway. Clarifying the electroanatomic characteristics of the insulated myocardial pathways can lead to an exquisite ablation of the PVC from around the outflow tract regions.

References

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