An unexpected complication of premature ventricular complex ablation originating from lateral tricuspid annulus: Critical stenosis of right coronary artery in a young patient

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Introduction

The tricuspid annulus (TA) is the region of interest in 8% of patients with idiopathic premature ventricular complex (PVC) or ventricular tachycardia. Notably, most of these cases originate from the septal TA. Although PVCs arising from the free wall of the TA are relatively rare, ablation of these PVCs can be performed with high success in experienced centers, with a low risk of complications.[1] Typically, a long sheath is needed for ensuring catheter stability and achieving optimal ablation in patients with PVCs arising from the TA.[2]

The rate of complications in PVC ablation procedures is generally low. The most common complications include access site complications, pericardial effusion, and tamponade. Yet, the risk of coronary complications is particularly low, especially when ablating PVCs originating from the TA.[1,3] In this case report, we aim to highlight an unexpected coronary complication associated with the ablation of an idiopathic PVC stemming from the TA lateral wall, along with our approach to managing this complication.

KEY TEACHING POINTS

- Ablation for premature ventricular contraction (PVC) is generally considered safe and effective, yet the incidence of procedure-related complications might be under-reported.
- The right coronary artery's closeness to the tricuspid annulus necessitates awareness, as injury to this artery can potentially occur during ablation for PVCs rooted in the tricuspid annulus.
- A specific ablation technique is crucial for the successful treatment of PVCs originating from the tricuspid annulus.
- Given the anatomic proximities, clinicians should exercise caution when using irrigated-tip catheters with high-power, long-duration settings.
- For some cases, considering preprocedural, real-time, and postprocedural selective coronary angiography could be beneficial to avoid coronary complications.

Case report

A 19-year-old woman with a history of previous ablation of PVCs from TA in another center was admitted to our unit with complaints of palpitation and exertional chest pain. Physical examination and routine blood tests were normal. Twelve-lead electrocardiogram revealed monomorphic PVCs with a left axis and late transition in precordial leads, compatible with TA origin (Supplemental Figure 1). Therefore, a redo procedure was scheduled. Endocardial 3-dimensional electroanatomical mapping, done using the EnSite™ X EP System (Abbott, Abbott Park, IL), identified the earliest activation of PVC at the TA lateral wall in the 9 o'clock direction. A subtricuspid reversed U-curved approach using a steerable long sheath (Agilis; Abbott) was performed by creating a loop inside the right ventricle to reach the lateral TA (Figure 1) (Supplemental Movie 1). The ablation was successfully carried out using a TactiCath Sensor Enabled Contact Force Ablation Catheter (TactiCath SE; Abbott, Abbott Park, IL) at a maximum power of 40 W and with an average contact force of 15–20 g. The total ablation duration was 297 seconds, and the average impedance drop was 19 ± 7.5 Ω. After radiofrequency ablation, no PVCs were observed. An intravenous infusion of isoproterenol was

KEYWORDS PVC ablation; Coronary artery stenosis; Irrigated tip catheter; Complication; Tricuspid annulus; 3D mapping
(Heart Rhythm Case Reports 2024;10:213–216)

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https://doi.org/10.1016/j.hrcr.2023.12.012

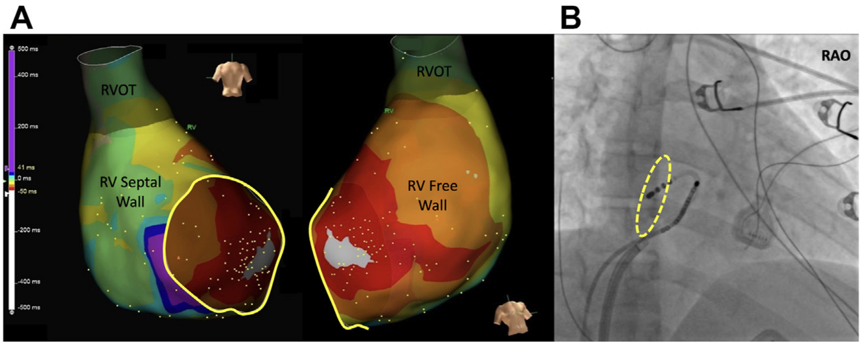

Figure 1 **A:** The activation mapping indicates that the earliest activation of premature ventricular contraction is on the tricuspid annulus free wall at the 9 o'clock direction (white area). RV = right ventricle; RVOT = right ventricular outflow tract. **B:** Fluoroscopic view (right anterior oblique; RAO) of subtricuspid reversed U-curved approach. (Yellow circular (**A**) and yellow dashed circular lines (**B**) indicate tricuspid annulus.)

started for PVC induction, and surface electrocardiogram recordings demonstrated a change in the ST segment (normalization of the ST segment), which regressed during the recovery period (Figure 2A and 2B).

Owing to the patient's preprocedural anginal symptoms and the ST-segment change following the isoproterenol infusion, we conducted selective coronary angiography after the ablation. Right coronary angiography revealed significant stenosis in the right coronary artery (RCA) (Figure 2C). Although intracoronary nitrate was administered to alleviate the coronary artery spasm potentially, the stenosis remained unchanged. Therefore, balloon angioplasty was carried out using a noncompliant coronary balloon at nominal pressure, and the procedure was concluded without additional complication (Figure 2D).

The next day following the ablation, the proximity between the RCA and the ablation target was assessed with cardiac computed tomography. Images revealed the adjacent relationship of the RCA, which is lying on the atrioventricular groove, and the ablation zone on the TA lateral wall. The distances were measured at 5 mm between the atrial endocardium and RCA and 13 mm between the right ventricular endocardium and RCA (Figure 3).

Discussion

In this case, we reported RCA stenosis after the ablation of PVC arising from the TA lateral wall for the first time. Our findings highlighted the role of real-time coronary artery imaging in cases where the TA is the target for the ablation. Furthermore, this case emphasizes the proximity between the TA and the RCA and the importance of the subtricuspid reversed U-curved approach to ablate PVC arising from the TA lateral wall.

PVC ablation is feasible, and the complication risk is low, at about 2.5%. The most observed complication is pericardial effusion.[4] The risk of coronary injury is relatively low and may occur in about 0.1% of PVC ablation, irrespective of the focal site.[3]

Ablation-induced coronary artery trauma can occur in several mechanisms. First is the direct thermal trauma from radiofrequency energy, a comparatively common complication in the ablation of left ventricular outflow tract–originated PVC.[5] Secondly, endocardial ablation from the TA, such as posteroseptal accessory pathway ablation, may cause RCA injury. The RCA lies on the atrioventricular groove and has proximity to the TA. Hardy and colleagues[6] reported coronary artery occlusion after catheter ablation of the posteroseptal accessory pathway. They observed ST-elevation myocardial infarction 12 hours after the ablation. The authors focused on limiting extensive ablation in the coronary sinus and cardiac imaging in redo ablation procedures. In a previous systematic review, coronary artery injury related to catheter ablation procedures, none of them PVC ablation, was observed in 61 patients.[7] The posteroseptal accessory pathway ablation was responsible for 35.6% of these cases.

To the best of our knowledge, there is no consensus and standard approach to imaging coronary arteries before, during, or after the endocardial ablation of PVC arising from the TA. Although it is a well-known fact that the RCA is closely adjacent to the TA on the atrioventricular groove, this is the first paper that reports right coronary stenosis related to the ablation of PVC from the TA free wall.

In this case, the timing of the coronary stenosis remains ambiguous. We contemplated that the coronary stenosis was chronic, given the patient's anginal symptoms preceding the procedure. Another hypothesis posits that acute coronary injuries involving a thrombotic process can lead to acute myocardial infarction and myocardial ischemia–related ventricular arrhythmia, including ventricular tachycardia or fibrillation.[8] However, if direct thermal energy does not initiate the thrombotic process or rupture of coronary plaque, stenosis might occur in longer durations, as mentioned in previous case reports.[8] In our case, the coronary angiography revealed a stable stenosis. But, if we had not performed angiography and did not realize the stenosis, the presentation might have been different. Nevertheless, it was impossible to prove that the stenosis was chronic, since we did not image the coronary artery before the ablation. This underscores the importance of considering cardiac and coronary imaging in patients with a history of ablation prior to undergoing the procedure. As a treatment, we decided not to implant a coronary stent because of the patient's age and successful resolution with the balloon.

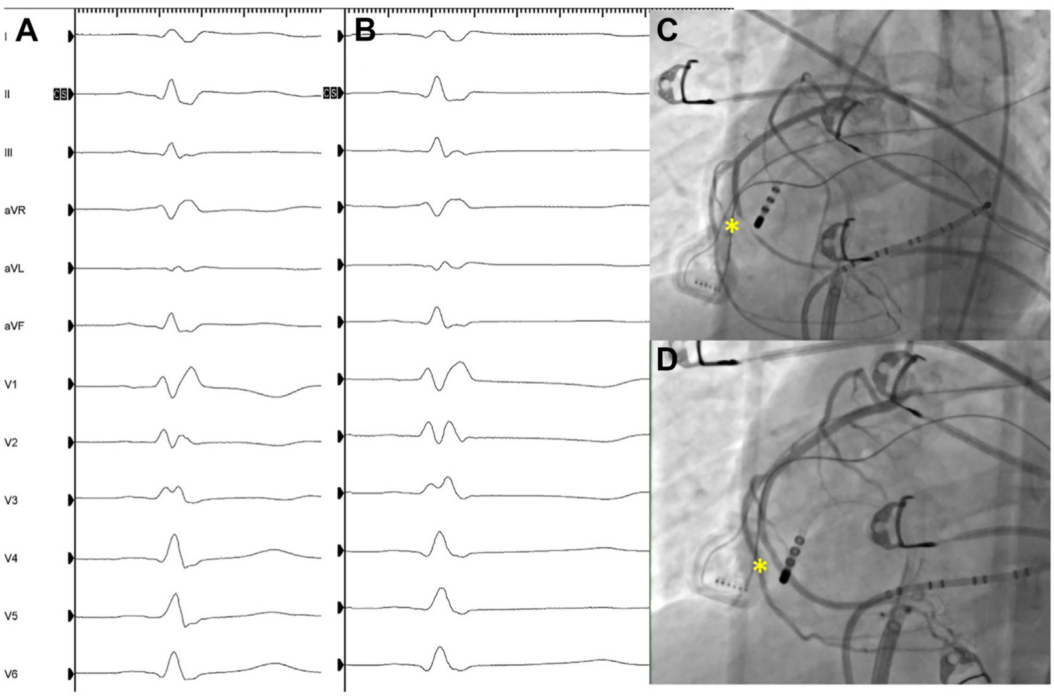

Figure 2 ST-segment changes on surface electrocardiogram before **(A)** and after **(B)** isoproterenol infusion. Asterisks indicate the critical stenosis on the right coronary artery in left anterior oblique before **(C)** and after **(D)** percutaneous transluminal coronary angioplasty.

The subtricuspid reversed U-curved approach using a long steerable sheath is the preferred way to achieve optimal stability to ablate PVC from the tricuspid valve annulus lateral wall. While the subtricuspid reversed U-curved approach offers stability, it presents both advantages and challenges in preventing coronary artery injury. Ablating on the ventricular aspect of the TA can potentially mitigate the risk of RCA damage. As illustrated in Figure 3, the RCA lies 13 mm away from the ventricular aspect of the TA in our case. Previously, Al Aloul and colleagues[9] reported the distance from the RCA to the atrial and ventricular endocardium in 33 patients. Their findings were similar to ours, indicating that the distance to the ventricular endocardium was slightly greater. A previous ex vivo trial[10] demonstrated that even if ablation is performed with 50 W for 90 seconds, the average depth of the lesion was measured at 6.6 ± 0.5 mm. Thus, lesions formed via the subtricuspid reversed U-curved method might not penetrate deeply enough to impact the RCA. Additionally, using the subtricuspid reversed U-curved method with an irrigated-tip catheter allows the creation of homogenous and durable lesions with optimal contact force. Furthermore, the direct contact of the catheter with the myocardium

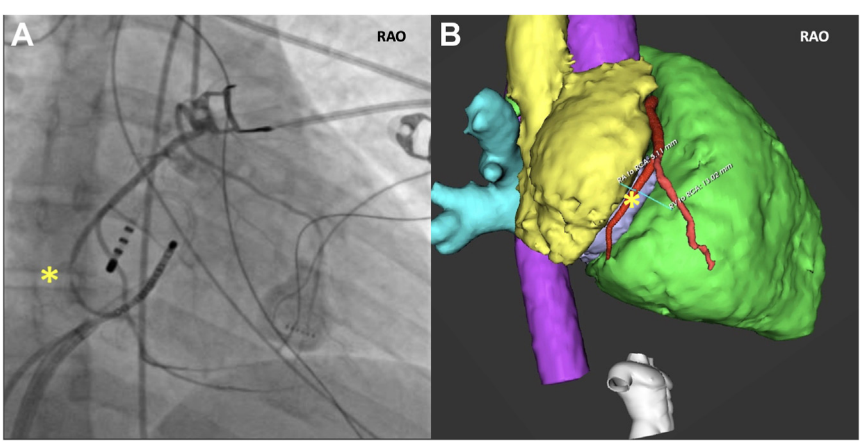

Figure 3 **A:** Selective coronary angiography shows the right coronary artery (RCA) stenosis (*asterisk*) on the anatomical neighborhood of the ablation zone. **B:** The anatomical neighborhood between RCA, right atrium, and right ventricle was shown using 3D reconstruction of cardiac computed tomography images following the percutaneous angioplasty. The stenotic segment (*asterisk* indicates stenotic segment following percutaneous coronary angioplasty) of RCA was 5 mm and 13 mm away from right atrium (RA) and right ventricle (RV), respectively. RAO = right anterior oblique.

in the subtricuspid region facilitates the formation of lasting lesion sets. However, it should be noted that positioning an irrigated-tip catheter into the subtricuspid space, between the tricuspid valve and ventricular myocardium, especially with high contact force and extended high-power settings, might lead to complications, including coronary injuries. Thus, for patients with thinner myocardial wall diameters, such as younger individuals, adopting a diminished power setting during the subtricuspid reversed U-curved ablation may reduce the risk of coronary injuries. However, even with lower power settings (eg, 25–30 W), prolonged ablation durations can result in deeper lesions.[10] Therefore, when higher power settings and higher contact force are employed, particularly for extended durations in younger patients, incorporating real-time coronary angiography is advisable to mitigate the risk of coronary injury.

Three-dimensional mapping systems are very effective in pinpointing the earliest activation of PVC and identifying ablation targets. They also help to reduce ablation duration and minimize the area of the ablation zone. As a result, precise mapping and the choice of optimal ablation targets via a 3D mapping system can mitigate complications, including coronary artery injuries.[11] In circumstances of failure, supplementary real-time imaging modalities such as intracardiac echocardiography offer valuable insights into the ablation catheter's position, surrounding anatomical structures, and potential causes of the failure. Conversely, relying on elevated power settings and prolonged durations to ensure successful ablation might heighten the risk of complications.

Conclusion

RCA stenosis is one of the possible complications related to endocardial ablation of PVC originating from the TA lateral wall. A subtricuspid reversed U-curved approach is generally needed to achieve stability. Coronary angiography should be considered, especially in patients with previous ablation history and when using a high-power setting with a high contact force and extensive ablation.

Funding Sources: None.

Disclosures: HY, KA: Proctoring for Medtronic, Abbott, Johnson and Johnson; CÇ: None.

Appendix

Supplementary Data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2023.12.012.

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