Raise-up technique to achieve better stability and contact with the roof line during cryoballoon ablation

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Introduction

Cryoballoon pulmonary vein (PV) isolation is effective in managing persistent atrial fibrillation (AF). Previous meta-analyses have shown that adding left atrial (LA) roof and bottom lines using cryoballoon can improve the AF-free rates.[1] However, the cryoballoon sometimes becomes unstable on the left side of the roof line. We herein report the "raise-up technique" for the first time, which is designed to improve contact and stability during cryoballoon roof line ablation.

Case report

A man in his 60s was diagnosed with persistent AF during a medical checkup. He was started on rivaroxaban (15 mg once daily) and referred to our hospital for catheter ablation of AF. The procedure was performed consistently with the patient in the supine position under deep sedation using propofol and flunitrazepam with the assistance of adaptive servo-ventilation. After right femoral venous access was obtained, heparin was administered to maintain an activated clotting time of 300–350 seconds. A single transseptal puncture was performed under intracardiac echocardiographic and fluoroscopic guidance. Each PV was successfully isolated using a cryoballoon catheter (Arctic Front Advance Pro® Medtronic, Minneapolis, MN). Subsequently, linear roof ablation was performed using a cryoballoon (Figure 1). An Achieve catheter (Medtronic) was inserted into the right superior PV (RSPV). The cryoballoon was rotated counterclockwise and pushed gradually from the RSPV antrum toward the left superior pulmonary vein (LSPV) direction. The cryoballoon catheter was pressed against the LA posterior wall (LAPW), with 3-minute freezing performed at each location. However, the cryoballoon became unstable after reaching the antrum of the leftside PV. Owing to the applied pressure, the Achieve catheter was dislodged from the RSPV, making it challenging to stabilize the cryoballoon on the roof line. Cryoablation was then performed by inserting the Achieve catheter into the LSPV and applying clockwise torque to position it against the LAPW. However, even with rapid right ventricular pacing,[2] the cryoballoon temperature only dropped to -38°C, indicating insufficient freezing. Widespread residual electrical potential was observed along the roof line when conducting voltage mapping (EnSite; St. Jude Medical, St. Paul, MN). Consequently, the Achieve catheter was reinserted into the RSPV. As before, counterclockwise torque was applied to the cryoballoon to move it toward the LSPV side. Freezing was initiated when only the distal portion adhered to the wall. After the balloon temperature dropped to -20°C, the "raise-up technique" was employed to press the entire balloon against the wall, resulting in good contact with the antrum of the LSPV and a further temperature drop to -50°C during 3-minute freezing (Figure 2). Subsequent mapping confirmed the successful completion of a broad roof line, similar to the LAPW isolation.

KEY TEACHING POINTS

- We report a case of cryoballoon roof line ablation that was completed using the raise-up technique.
- The raise-up technique is helpful during cryoballoon roof line ablation, in which the balloon is pushed against the roof after the polar portion of the balloon has frozen to the roof at approximately -20°C.
- This technique allows for stronger contact of the cryoballoon with the roof line, facilitating manipulation in cases with balloon instability. The use of this technique may improve the completion rate of the cryoballoon roof line.

KEYWORDS Atrial fibrillation; Catheter ablation; Cryoballoon; Persistent; Roof line

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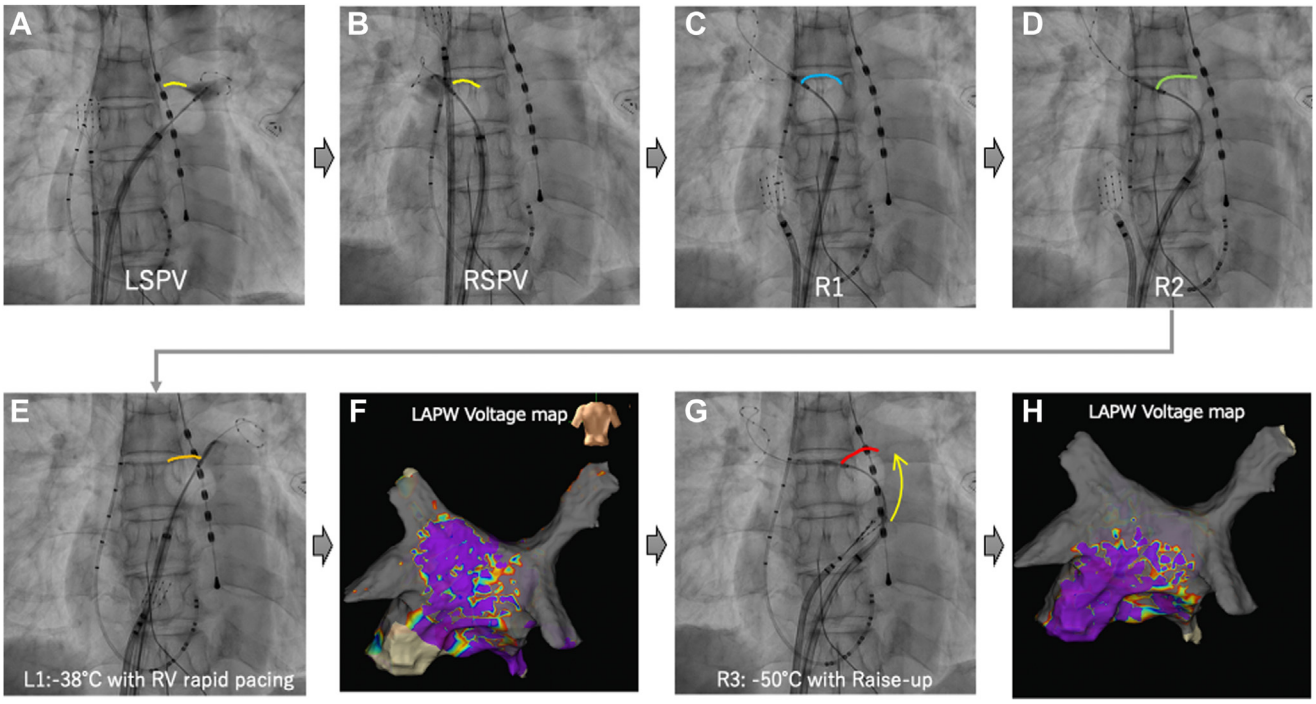

Figure 1 Fluoroscopic posteroanterior views and 3D mapping images during pulmonary vein (PV) isolation and roof line ablation using a cryoballoon. After cryoballoon PV isolation (**A, B**), cryoablation was performed twice with the Achieve catheter (Medtronic, Minneapolis, MN) anchored on the right superior PV (RSPV) (**C, D**) and once on the left superior PV (LSPV) (**E**). However, the residual potential was observed on the roof (**F**). Subsequently, the Achieve catheter was reanchored at the RSPV and the "raise-up" technique was employed for freezing (**G**). This led to a decrease in the balloon temperature to -50°C and the disappearance of the electrical potentials on the left atrial posterior wall (LAPW) (**H**). RV = right ventricle. R1, R2, and R3 indicate the first, second, and third right-side freezing, respectively. L1 indicates the first left-side freezing.

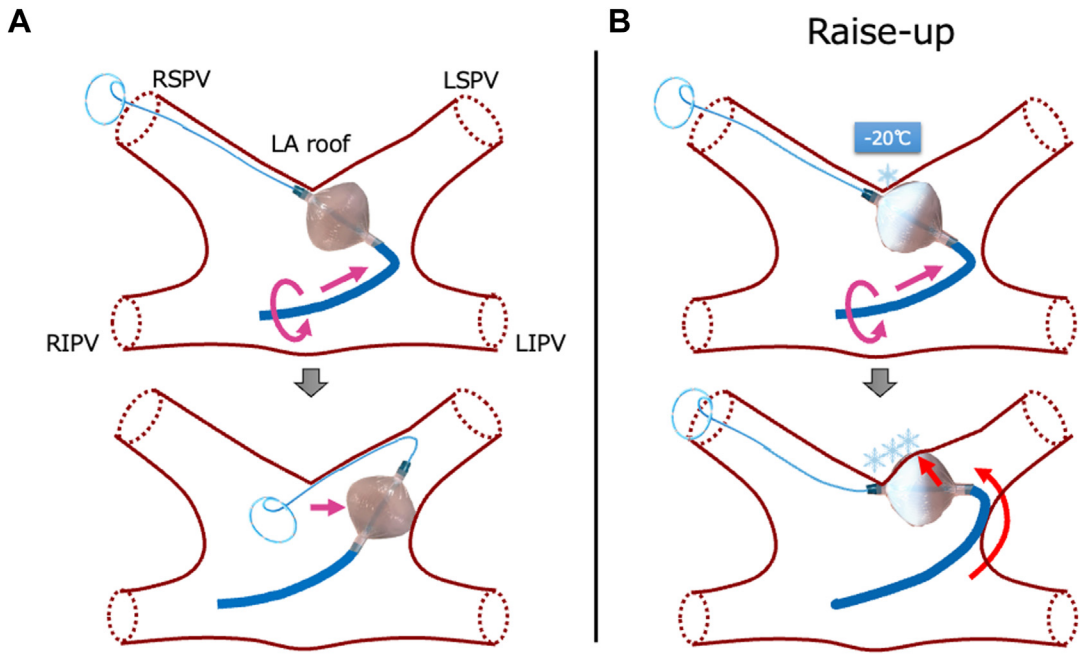

Figure 2 Illustrations of cryoballoon positions during roof line ablation with the standard technique (**A**) and "raise-up technique" (**B**). **A:** Excessive pressure caused the flipping of the cryoballoon on the left side of the left atrium (LA) roof. **B:** Once the freeze was initiated and the cryoballoon temperature reached approximately -20°C, the polar side of the cryoballoon adhered to the roof. The cryoballoon was then pushed toward the left atrial posterior wall. Owing to ice adhesion on the polar side, the cryoballoon was less likely to flip even when forcefully pushed, enabling robust contact with the roof. LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

Therefore, bottom-line ablation was not performed. The procedure was completed without any complications.

Discussion

To treat cases of persistent AF ablation using cryoballoons, the efficacy of approaches beyond PV isolation, such as LA roof line ablation and LAPW isolation, has been investigated. These substrate-based approaches target additional areas that potentially harbor arrhythmogenic triggers and drivers to improve ablation outcomes. Although evidence for the efficacy of LAPW isolation in the context of radiofrequency ablation remains limited,[3] these substrate-based approaches using cryoballoons have shown promising results in meta-analyses.[1]

Cryoballoon ablation can create transmural lesions extending to the epicardial surface of the left atrium, allowing for disruption of epicardial muscle bundles. Consequently, the success rate of LA roof line ablation was high. This ability to form comprehensive and continuous lesions contributes to the efficacy of cryoballoon ablation in targeting specific arrhythmogenic substrates, such as the LA roof line.

In this case, the voltage map after roof line ablation showed that the LAPW was almost isolated. Therefore, the bottom line was not added. A previous study in cases without LA enlargement showed that cryoballoon LA roof line ablation alone might yield outcomes comparable to those of LAPW isolation.[4] To ablate the LA roof line using a cryoballoon, the standard approach involves placing an Achieve catheter as an anchor in the RSPV and freezing from the RSPV antrum to the LSPV. However, when the catheter position reaches the leftside PV, excessive pressure on the cryoballoon can cause dislodgement of the Achieve catheter from the RSPV and flipping of the cryoballoon, making it challenging to maintain robust contact between the catheter and LA roof (Figure 2A). The raise-up technique is based on initiating the freeze when only the polar region of the cryoballoon is in contact with the roof line. As the cryoballoon temperature reached approximately -20°C, the polar part of the cryoballoon and the roof line adhered owing to ice formation (Figure 2B). By application of pressure to the cryoballoon at this point, the polar region remained stationary, allowing robust contact to be established between the roof line and the northern hemisphere of the cryoballoon. The raise-up technique was deemed safe, as the pressure was applied after the initiation of ice adhesion. The raise-up of the cryoballoon will apply a solid force to the LA roof. However, because the balloon is a sphere shape, it will not cause too much localized pressure like a radiofrequency catheter. Therefore, the risk of atrial perforation was considered to be low. However, it should be noted that the Achieve catheter should be firmly anchored to the RSPV during this maneuver.

It is believed that cryoballoon temperatures of -10°C are insufficient to initiate adequate ice adhesion. However, waiting for temperatures to drop below -30°C may lead to the formation of an ice cap on the cryoballoon surface, impairing the transmission of freezing to the tissue. Therefore, it was considered that approximately -20°C was the most appropriate point to start raise-up.

This technique enhances catheter stability and thermal lesion formation and contributes to the success of roof line ablation using a cryoballoon. This method was applicable in all cases and particularly useful for balloon instability on the left side of the roof line. Using this method, the completion rate of roof line ablation by cryoballoon was above 95%. Therefore, we believe that the raise-up method is useful for completing the LA roof block line.

Conclusion

The "raise-up technique" is a practical approach during cryoballoon roof line ablation, particularly when the balloon exhibits instability or when maintaining robust contact between the roof and the balloon proves challenging. Adopting this technique can improve cryoballoon stability and enhance lesion formation, thereby improving the overall success rate of the procedure.

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