Impact of vein of Marshall ethanol infusion on achieving floor line block: Is it possible to create a floor line with vein of Marshall ethanol infusion?

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Introduction

Catheter ablation is an established treatment strategy for patients with drug-refractory atrial fibrillation (AF).[1] However, the success rate in patients with persistent AF remains insufficient. Current ablation strategies for persistent AF are diverse, but the anatomical approach is one of the most easily understood and frequently used.[2] Achieving complete linear lesions can sometimes be challenging owing to epicardial conduction.[3,4] In particular, creating the posterolateral line at the mitral isthmus (MI) is often difficult owing to the involvement of the coronary sinus (CS) musculature and the Marshall bundle.[5] To overcome these difficulties, chemical ablation by ethanol infusion into the vein of Marshall (Et-VOM) has demonstrated its efficiency.[6,7] In this case report, we describe the possibility that Et-VOM may also assist in the creation of a floor line.

Case report

A 75-year-old woman had a history of 2 catheter ablations in the past 10 years, with pulmonary vein (PV) isolation, cavotricuspid isthmus line, and a focal atrial tachycardia next to the left inferior PV. After 7 years under antiarrhythmic drugs treatment without clinical recurrence, she was addressed to our department for a third procedure, as frequent and symptomatic paroxysmal episodes reappeared.

A 3-dimensional electroanatomic map (CARTO 3; Biosense Webster, Diamond Bar, CA) was created using a high-density mapping catheter (PentaRay; Biosense Webster) prior to ablation, revealing a reconnection of the left superior PV and no reconnection of both inferior PVs (Figure 1). Of note, no significant low-voltage area was observed other than the previously ablated area. Therefore, reisolation of both superior PVs was performed at a more proximal level.

KEY TEACHING POINTS

- Vein of Marshall ethanol infusion usually impacts the posterolateral mitral isthmus region and around the left pulmonary vein. This helps eliminate epicardial conduction to achieve mitral isthmus block.
- When the vein of Marshall has abundant arborization, extensive impacts may appear beyond typical impacts by ethanol infusion. Although rare, it may extend into the posteroinferior wall region of the left atrium, creating a dome-transection line.
- By performing vein of Marshall ethanol infusion as the first step of ablation and subsequently delineating a 3D electroanatomic map, it is possible to identify the area that has been impacted and reduce radiofrequency applications to the same area.

However, AF recurred as persistent 17 months after the third procedure. Since the patient had symptoms consistent with NYHA class II–III, an external electrical cardioversion was performed, and a fourth ablation procedure was planned.

At the beginning of the fourth procedure, the patient was in sinus rhythm, and the procedure was carried out under general anesthesia. Considering the failure of 3 PV isolation procedures and an evolution toward persistent AF, our standard anatomical ablation approach, "Marshall-PLAN" ablation strategy,[8] consisting of Et-VOM, roof, and mitral line completion, was decided as treatment strategy. The first step was Et-VOM. As described previously,[9] a 5F left internal mammary artery guiding catheter was used for the VOM identification through a CS venography (Figure 2A). Subsequently, a preloaded over-the-wire balloon (MINI TREK, length 6 mm, nominal diameter 2.0 mm; Abbott, Chicago, IL) with an angioplasty guide wire (Sion black 0.014; Asahi

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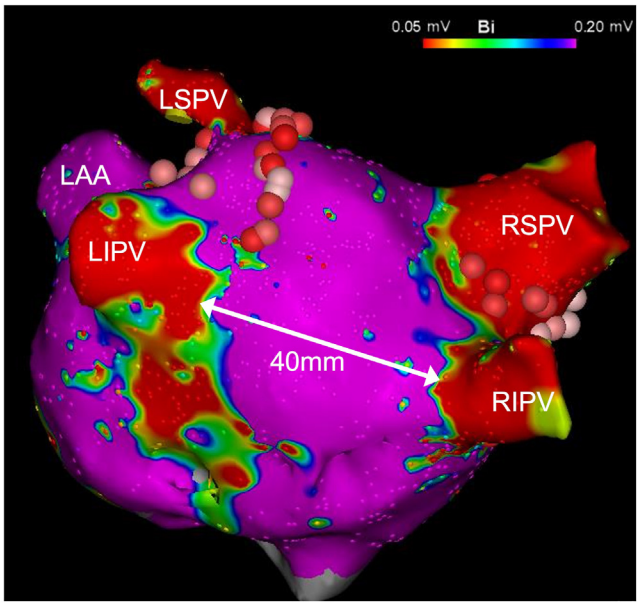

Figure 1 The voltage map (posterior-anterior view) prior to the ablation during the third procedure and the ablation points. As a result of the previous ablation, the treatment effect was observed as the expansion of low voltage areas owing to pulmonary vein isolation and ablation performed below the left inferior pulmonary vein (LIPV). However, no low-voltage areas were observed in other regions. In this procedure, only ablation targeting the vicinity of both superior pulmonary veins was performed. The number of points obtained during mapping was 1348 points. The left atrium volume was 110 mL, and the distance between the low-voltage area of the LIPV posterior and the right inferior pulmonary vein (RIPV) posterior was 40mm. LAA = left atrial appendage; LSPV = left superior pulmonary vein; RSPV = right superior pulmonary vein.

Intecc, Seto, Japan) was advanced inside the VOM lumen and positioned at the proximal part of the VOM. After inflation at 2 atm and removal of the wire, a selective venography was performed through the wire port to confirm balloon occlusion and visualize the VOM arborization. It was visualized that inferior veins as branches of the VOM were running at the posteroinferior part of the left atrium and communicated with septal veins, as described in a previous report (Figure 2B).[10] Three successive infusions were slowly administered over 1 minute with a selective VOM venogram to a total of 10 mL (Figure 2C). Following this, a left atrial (LA) electroanatomic map was performed, revealing, in addition to the typical low-voltage area surrounding the left inferior PV and left ridge, a posterior extension of the low-voltage area toward the right inferior PV (Figure 3). On the activation map, the lowest part of the dome was the most delayed excitation site (Figure 3), and bidirectional block of the floor line was confirmed by differential pacing maneuvers. Following this, we performed a posterior MI line ablation (40 W; total 245 seconds) using a 3.5 mm irrigated-based catheter (ThermoCool SmartTouch SF; Biosense Webster). Additionally, ablation (25 W; total 181 seconds) was performed from within the CS, successfully creating an MI line block. Subsequently, to ensure the durability of the line crossing between the PVs, a classic roof line was created (40 W; total 1310 seconds) on the anatomical roof region of the left atrium as a transection line of the dome area. After creation of the roof line, bidirectional block was confirmed, and it was also confirmed that the posterior wall was isolated. The procedure was successfully completed without any major acute complications, including atrioventricular conduction disorder.

Discussion

Although ablation strategies for persistent AF are currently diverse, we typically perform ablation following a comprehensive anatomically guided ablation strategy (Marshall bundle elimination, Pulmonary vein isolation, and Line completion for ANatomical ablation of persistent atrial fibrillation (Marshall-PLAN) that was previously reported from our institution.[8] Valderrábano and colleagues[6,7] have taken an important pioneering step in the usefulness of chemical ablation for VOM for creating mitral line block. It has been reported that acute MI block was more

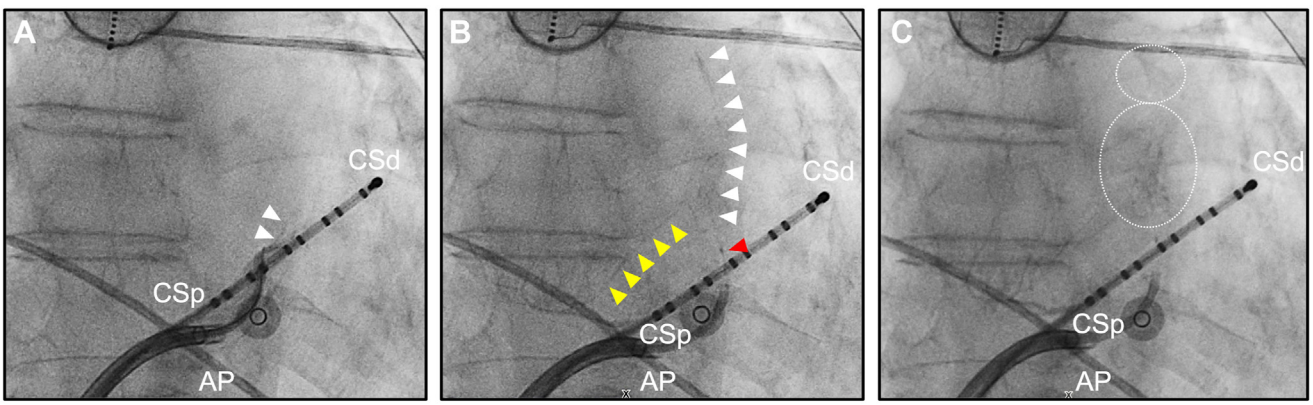

Figure 2 Fluoroscopic images during ethanol infusion into the vein of Marshall (Et-VOM) procedure (anterior-posterior view). A decapolar catheter was placed in the coronary sinus. **A:** Retrograde venography of the vein of Marshall (VOM) (*white arrows*). **B:** Retrograde venography from the wire lumen of a balloon inserted and inflated within the VOM (*red arrow*). This figure shows the pathway (*white arrows*) from the roof veins to the main trunk of the VOM and the presence of inferior veins (*yellow arrows*) as branches of the VOM and septal veins as collateral of inferior veins. **C:** Retrograde venography of the VOM after Et-VOM. The staining was apparently seen (white dashed circled). AP = anterior-posterior view; CSd = coronary sinus distal; CSp = coronary sinus proximal.

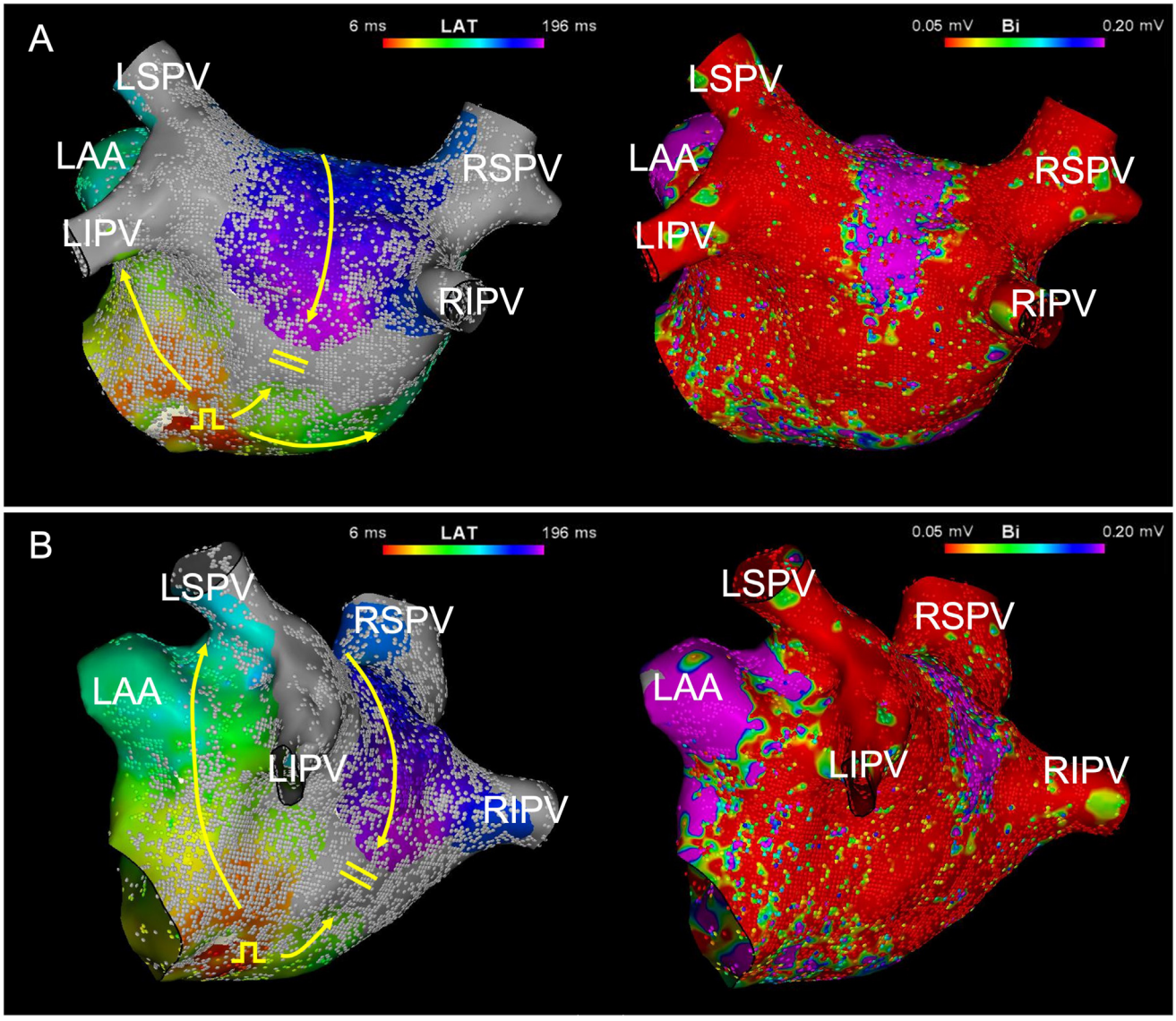

Figure 3 The activation map and the voltage map just after ethanol infusion into the vein of Marshall (Et-VOM). The map was created under coronary sinus (CS) proximal pacing. The voltage map was created with a threshold set at 0.20 mV. The number of points obtained during mapping was 17,724 points. **A:** The activation map (left) and the voltage map (right) (posterior-anterior view). The most delayed excitation area was observed just above the floor line created by Et-VOM. **B:** The activation map (left) and the voltage map (right) (lateral caudal view). In the voltage map, a wide range of low-voltage area was observed from the posterolateral mitral isthmus region to the vicinity of the ridge. However, under CS proximal pacing, it was evident that the block in this location was incomplete. LAA = left atrial appendage; LIPV = left inferior pulmonary vein; LSPV = left superior pulmonary vein; RIPV = right inferior pulmonary vein; RSPV = right superior pulmonary vein.

frequently achieved with radiofrequency catheter ablation (RFA) combined with adjunctive Et-VOM than RFA alone.[11] In addition, in the recently published VENUS-AF (vein of Marshall ethanol in untreated persistent AF) trial, Valderrábano and colleagues[12] also reported the superiority of adding Et-VOM to RFA compared with RFA alone in patients with persistent AF.

In a previous study from our institute, the low-voltage distribution after Et-VOM spread in various sizes and directions depending on the arborization pattern of the VOM.[13] Notably, low voltage resulting from Et-VOM could be observed in various ranges, mainly at the LA posterior wall close to the left inferior PV and the anterior aspect of the left pulmonary vein. On the other hand, the frequency of the low-voltage area extensions at the lower dome or the posterior wall was low. Hence, it is unusual (5.3%) for the low-voltage area distribution to extend to the right side of the LA posterior wall. In the patient presented in the present case report, the posteroinferior venous network was highly developed and may have been extensively affected by Et-VOM. It should be noted that while the presence of visible anastomosis of the VOM helps to anticipate low-voltage extension beyond typical areas, its positive predictive value is limited.[13]

Gillis and colleagues[14] revealed, in the study comparing Et-VOM as a first step preceding RFA with RFA as a first step preceding Et-VOM for MI ablation, that Et-VOM as a first step in RF-guided MI line ablation significantly reduced the number of RFA applications needed to achieve MI block. Namely, there is potential of reducing the number and duration of RFA applications on the area that received the impact of Et-VOM. Regarding RFA in the posterior wall of the left atrium, it can lead to collateral esophageal damage during ablation owing to its close proximity to the esophagus.[15] In this regard, since the effect of Et-VOM is occasionally observed to extend to the left side of the LA posterior wall, there are potential benefits in terms of minimizing RFA application in the vicinity of the esophagus that can be obtained even during the creation of a floor line. Considering these things, there is a possibility that ablation by an anatomical approach based on line creation can be completed more easily by taking advantages of the lesions already created by Et-VOM. However, as mentioned above, there are individual differences in the distribution of the range affected by Et-VOM. Therefore, it is necessary to recognize that this may not always be effective in assisting the creation of a floor line.

On the other hand, when extensive impact occurs, as in this case, it may be necessary to keep in mind the risk of postoperative stiff LA syndrome and carefully monitor its occurrence.[16] In this case, there was no worsening of dyspnea or other symptoms, and echocardiogram 6 months later showed no findings suggestive of stiff LA syndrome, such as a significant worsening of pulmonary artery systolic pressure and A-wave velocity.

Conclusion

This case report demonstrates the successful creation of a floor line by Et-VOM. The VOM branching exhibits various patterns; and not only during a posterolateral mitral line creation but also during a floor line creation, Et-VOM may show auxiliary effects. Considering this, by performing Et-VOM prior to line creation, it is possible to understand its impact. If the impact of Et-VOM extends to the area where the floor line will be created, it is possible to minimize the impact on the esophagus associated with RFA applications during floor line creation. As a result, this may lead to safer treatments.

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