# Ethanol infusion in the vein of Marshall in atrial fibrillation with dextrocardia

Check for updates

Qi Guo, MD, PhD,[1] Wenli Dai, MD,[1] Jing Cui, MD, Xueyuan Guo, MD, PhD, Caihua Sang, MD, PhD, Changsheng Ma, MD, PhD, FHRS

*From the Department of Cardiology, Beijing Anzhen Hospital, Capital Medical University; National Clinical Research Center for Cardiovascular Diseases, Beijing, China.*

## Introduction

Dextrocardia is a very rare congenital anomaly with an incidence of 1–2 cases per 20,000 people in the general population.[1] Catheter ablation has become one of the most significant approaches to the management of atrial fibrillation (AF).[2] The ablation of AF in patients with dextrocardia is very challenging owing to the contrary anatomy and complicated variations. Although the use of the 3-dimensional electroanatomical mapping system and intracardiac echocardiography (ICE) help to overcome the difficulties encountered with ablation of AF in dextrocardia, cases and literature regarding AF ablation in dextrocardia are rare, especially in those with persistent AF.[3–6] Additionally, the long-term outcome of ablation of persistent AF is still unsatisfactory. Vein of Marshall ethanol infusion (VOM-EI) has been recently reported as an important strategy in the ablation of persistent AF, effective in both the blockage in the mitral isthmus (MI) and isolation of left pulmonary veins.[7,8] However, there has been no experience about VOM-EI in dextrocardia. We report a case of successful VOM-EI with radiofrequency catheter ablation of persistent AF in mirror-image dextrocardia.

## KEY TEACHING POINTS

- Vein of Marshall ethanol infusion could help the blockage of the mitral isthmus not only in patients with normal anatomy, but also in patients with dextrocardia.
- Vein of Marshall ethanol infusion could also be performed safely in patients with dextrocardia during the catheter ablation of persistent atrial fibrillation.
- There is little experience with vein of Marshall ethanol infusion in dextrocardia; in this case, the left anterior oblique projection could facilitate the performance of vein of Marshall ethanol infusion in dextrocardia.

## Case report

A 66-year-old man with mirror-image dextrocardia without situs inversus was admitted for catheter ablation of symptomatic, drug-refractory persistent AF in Beijing Anzhen Hospital, Beijing, China. The patient had a palpitation over the past year and developed reduced exercise tolerance 1 month ago, manifested as shortness of breath during mild activity. The transthoracic echocardiography demonstrated that the patient had an enlarged left atrium (LA) with an anteroposterior diameter of 45 mm and a reduced left ventricular ejection fraction of 46%. The patient had a $CHA_2DS_2$-VASc score of 2 and a HAS-BLED score of 1.

After optimal medical therapy, the patient received ablation of persistent AF under conscious sedation. Before the transseptal puncture, the LA thrombus was excluded by ICE (Biosense Webster, Irvine, CA). A deflectable decapolar catheter (IBI; St. Jude Medical, St. Paul, MN) was positioned into the coronary sinus (CS) through the left femoral vein under the left anterior oblique (LAO) 30° view. A single transseptal puncture was performed under the guidance of both radiography and ICE, which was the same as that in a normal left-sided heart, but the maneuvers were in the reverse direction. An 8.5F transseptal sheath and a dilator (SL1; St. Jude Medical) were advanced over a 0.032-inch guidewire to the superior vena cava. Then a Brockenbrough needle (St. Jude Medical) was exchanged over the wire. On the fluoroscopic anteroposterior view, an entire apparatus, composed of the sheath, dilator, and transseptal needle, was oriented counterclockwise torque toward the interatrial septum (8 o'clock position) and withdrawn smoothly until the dilator tip "jump" was observed. It was reconfirmed that the needle was in the fossa ovale and the needle was rotated to a proper

**KEYWORDS** Dextrocardia; Vein of Marshall; Ethanol; Atrial fibrillation; Catheter ablation
(Heart Rhythm Case Reports 2024;10:780–783)

[1]Qi Guo and Wenli Dai contributed equally to this work. **Address reprint requests and correspondence:** Dr Xueyuan Guo, Department of Cardiology, Beijing Anzhen Hospital, Capital Medical University; National Clinical Research Center for Cardiovascular Diseases, No. 2 Anzhen Rd, Beijing 100029, China. E-mail address: guoxueyuan1984@163.com.


https://doi.org/10.1016/j.hrcr.2024.07.019

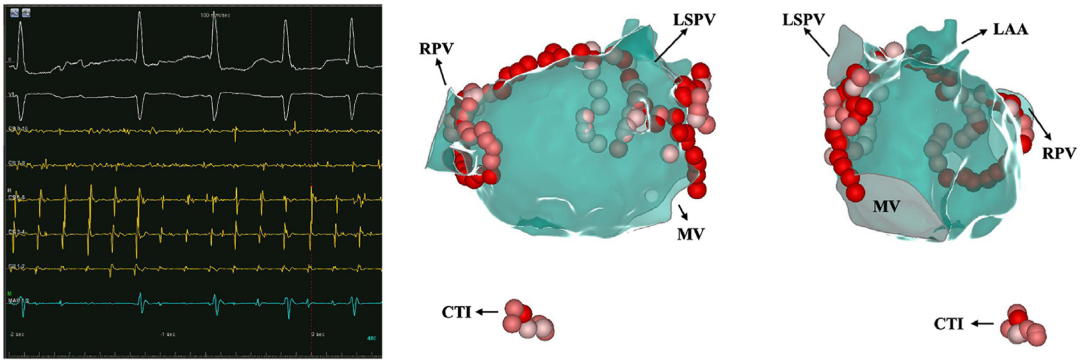


**Figure 1** Intracardiac electrograms and the ablation map from the 3-dimensional electroanatomical mapping system. Left panel shows the intracardiac electrogram of the patient; middle and right panels are the maps of ablation including pulmonary vein isolation, mitral isthmus, roofline, and tricuspid isthmus. (Middle panel is the ablation map in posteroanterior position; right panel is the map in right anterior oblique 30° position.) CTI = tricuspid isthmus; LAA = left atrial appendage; LSPV = left superior pulmonary vein; MV = mitral valve; RPV = right pulmonary vein.

anteroposterior direction under ICE in a short-axis view of the left pulmonary vein. Then the needle was advanced into the LA on the LAO 45° view. After a small amount of contrast material had been injected to confirm that the needle was in the proper location, the needle was withdrawn and the guidewire was inserted into the left superior pulmonary vein. Then the long sheath was advanced over the wire into the LA.

After the reconstruction of LA by both the ICE and PentaRay catheter (Biosense Webster) under the guidance of a 3-dimensional electroanatomical mapping system (CARTO 3; Biosense Webster), radiofrequency ablation was performed using a 3.5 mm irrigated-tip catheter (Thermocool SmartTouch; Biosense Webster). After the bilateral pulmonary vein isolation and linear ablation of the LA roof line, MI, and tricuspid isthmus, cardioversion was performed under sedation with midazolam to restore sinus rhythm (Figure 1). VOM-EI was performed owing to the unblocked MI.

The vein of Marshall (VOM) venography was performed using a femoral approach.[9] A 6F angiography catheter

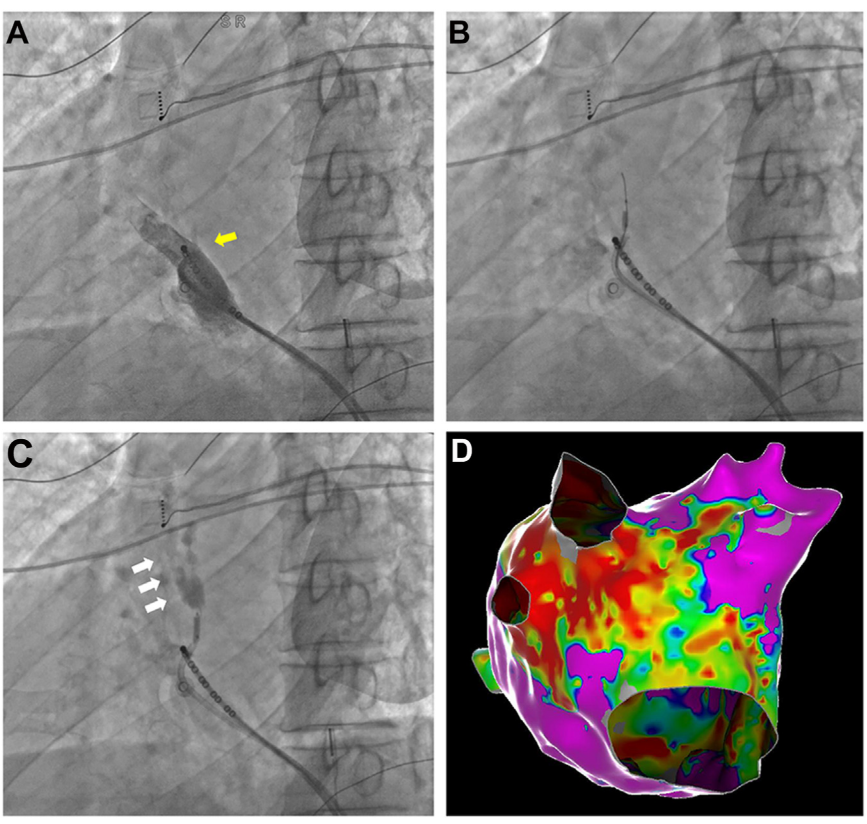


**Figure 2** Ethanol infusion in the vein of Marshall (VOM) in atrial fibrillation with dextrocardia. **A:** Angiography under the left anterior oblique view of 30° identified the ostium of the VOM (*yellow arrow*). **B:** An over-the-wire balloon was inflated in the VOM. **C:** Myocardial contrast after the ethanol infusion (*white arrow*). **D:** Low-voltage area in the left atrium after the ethanol infusion in the right anterior oblique view.

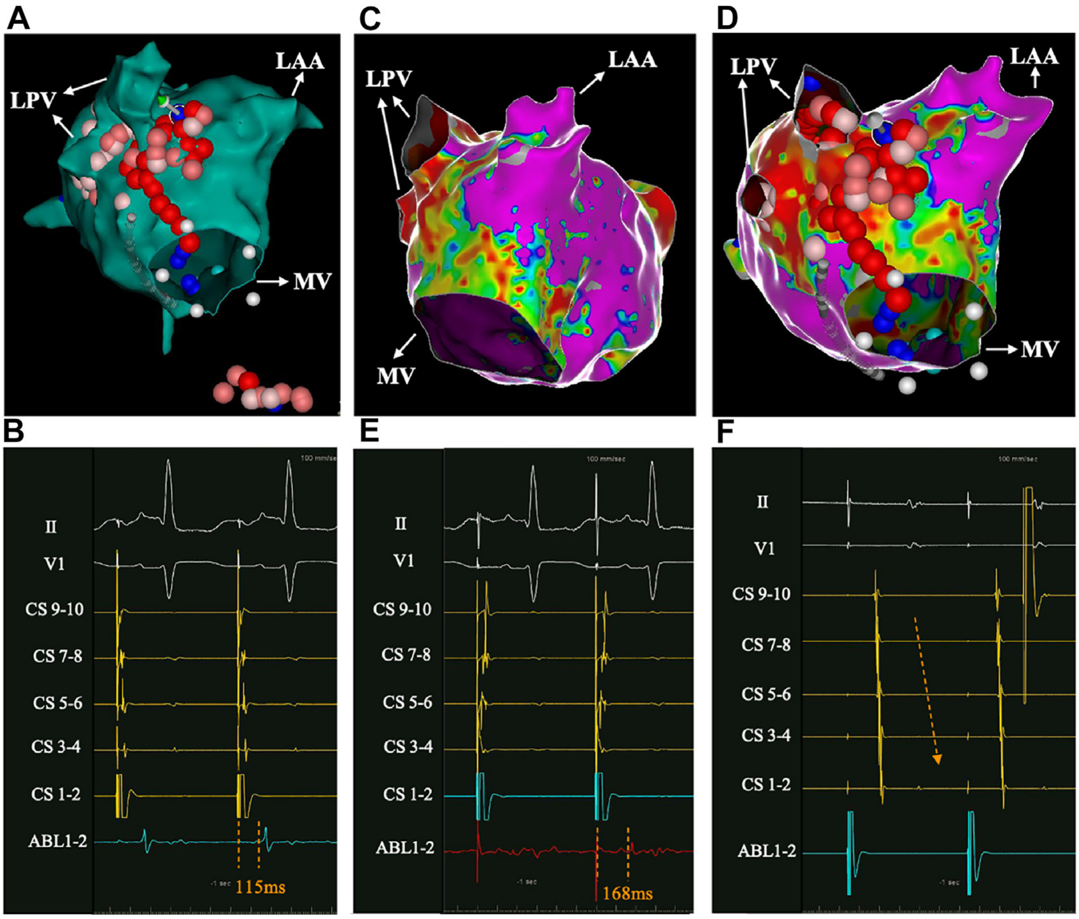


**Figure 3** Differential pacing of the mitral isthmus (MI) before and after vein of Marshall ethanol infusion (VOM-EI). **A:** The pacing position was at the ridge before VOM-EI in the right anterior oblique 45° view. **B:** Before the VOM-EI, pacing CS 1-2 showed the time from stim to ABL was 115 ms, which demonstrated the MI was unblocked. **C:** Voltage map of the left atrium after VOM-EI in the right anterior oblique 30° view. **D:** The pacing position was at the ridge after VOM-EI in the right anterior oblique 45° view. **E:** After the VOM-EI, pacing CS 1-2 showed the time from stim to ABL was 168 ms, which demonstrated the MI was blocked clockwise. **F:** After the VOM-EI, when pacing ABL, the conduction of the coronary sinus is from CS 9-10 to CS 1-2, which demonstrated the MI was blocked counterclockwise. ABL = ablation catheter; CS = coronary sinus; LAA = left atrial appendage; LPV = left pulmonary vein; MV = mitral valve.

(Judkins R4.0; Medtronic, Minneapolis, MN) was advanced into the CS through the 8.5F SL1 sheath under LAO 30°. The angiography catheter was positioned near the junction of the CS and the great cardiac vein with the head pointing toward the posterosuperior region of the CS, where nonselective venography was performed to identify the ostium of the VOM (Figure 2A). The VOM was identified as a posteriorly directed vein branch of the CS in the LAO 30° fluoroscopic projection. An over-the-wire balloon (2 mm diameter, 8 mm length, Boston Scientific, Marlborough, MA) was sent to the distal end of the VOM under the support of a balanced middleweight universal guiding wire (0.014 inches × 190 cm; Abbott, Minneapolis, MN). The balloon was inflated at a pressure of 8 atm in the VOM (Figure 2B), and selective venography was then conducted to ensure complete balloon occlusion of the VOM and enable clear visualization of the anatomy of the VOM. A total of 9 mL of ethanol (95%) was injected slowly within 5 minutes into the VOM. VOM venography was repeated after the ethanol infusion showing myocardial contrast (Figure 2C, white arrows). After the VOM-EI, the voltage mapping of the LA was performed to identify the low-voltage area (Figure 2D), and the MI bidirectional conduction block was confirmed using differential pacing techniques (Figure 3).[10] Additionally, complete bilateral pulmonary vein isolation and other LA linear blocks were carefully checked and confirmed. Finally, incremental burst pacing to the effective refractory period of the local atrial myocardium was performed at the proximal CS to ensure that no arrhythmia could be induced.

There were no operation-related complications during the perioperative period and 3 months after the procedure. The patient had anticoagulation and antiarrhythmic drugs after the procedure. After the first 3 months, the antiarrhythmic drugs were discontinued. No atrial arrhythmias occurred after a follow-up of 8 months.

## Discussion

Dextrocardia poses significant challenges to the ablation of persistent AF. On one hand, there is little information about AF ablation in dextrocardia. Until now, only several cases reported AF ablation in dextrocardia, especially persistent

AF.[3,4,6] On the other hand, patients with dextrocardia have many unexpected anatomical variations, and the related operations during the procedure are reversed, which might increase the risk and occurrence of complications. Additionally, the long-term outcome of persistent AF ablation is still unsatisfactory. VOM-EI has become an important adjunctive approach to ablation of persistent AF, contributing not only to the block of the MI but also to the isolation of the pulmonary veins.[7,8] There is no experience in the VOM-EI in patients with dextrocardia. To the best of our knowledge, this is the first case of VOM-EI in mirror-image dextrocardia. Owing to the anatomical variations and increased difficulty of operation, initially we did not plan to perform VOM-EI. However, as simple radiofrequency ablation could not achieve blockage of the MI, we proceeded with VOM-EI. The overall VOM-EI procedure was similar to that in normal patients, except for the reversed operation, with LAO 30° facilitating the procedure. This case provides insight that for dextrocardia patients with persistent AF, VOM-EI could also help to achieve the ablation endpoints, and LAO 30° could facilitate the operation.

## Conclusion

VOM-EI could be performed safely in patients with mirror-image dextrocardia during the catheter ablation of persistent AF, and the LAO projection could facilitate the operation.

## Acknowledgments

Thanks to Dr Lai Yiwei and Dr Gao Mingyang for helping to revise the language of the manuscript.

**Funding Sources:** This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Disclosures:** The authors have no conflicts to disclose.

## References

1. Bohun CM, Potts JE, Casey BM, Sandor GG. A population-based study of cardiac malformations and outcomes associated with dextrocardia. Am J Cardiol 2007;100:305–309.
2. Hindricks G, Potpara T, Dagres N, et al. 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): The Task Force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the European Heart Rhythm Association (EHRA) of the ESC. Eur Heart J 2021;42:373–498.
3. Zhao X, Su X, Long DY, et al. Catheter ablation of atrial fibrillation in situs inversus dextrocardia: challenge, improved procedure, outcomes, and literature review. Pacing Clin Electrophysiol 2021;44:293–305.
4. Zou F, Flomenbaum D, Chowdhuri N, Grupposo V, Di Biase L, Zhang X. Radiofrequency ablation of persistent atrial fibrillation in a patient with situs inversus totalis and interrupted inferior vena cava. J Cardiovasc Electrophysiol 2023;34:2621–2625.
5. Masumoto A, Kobori A, Sasaki Y, Pak M, Furukawa Y. Successful catheter ablation of persistent atrial fibrillation and common atrial flutter in a patient with dextrocardia, situs inversus, and interrupted inferior vena cava with azygos continuation. HeartRhythm Case Rep 2021;7:403–407.
6. Xue ZM, Sang CH, Dong JZ, Ma CS. Catheter ablation of persistent atrial fibrillation in a patient with dextrocardia. Chin Med J (Engl) 2012;125:1839–1840.
7. Valderrabano M, Peterson LE, Swarup V, et al. Effect of catheter ablation with vein of Marshall ethanol infusion vs catheter ablation alone on persistent atrial fibrillation: the VENUS randomized clinical trial. JAMA 2020;324:1620–1628.
8. Huang L, Gao M, Lai Y, et al. The adjunctive effect for left pulmonary vein isolation of vein of Marshall ethanol infusion in persistent atrial fibrillation. Europace 2023;25:441–449.
9. Kitamura T, Vlachos K, Denis A, et al. Ethanol infusion for Marshall bundle epicardial connections in Marshall bundle-related atrial tachycardias following atrial fibrillation ablation: the accessibility and success rate of ethanol infusion by using a femoral approach. J Cardiovasc Electrophysiol 2019;30:1443–1451.
10. Jais P, Hocini M, Hsu LF, et al. Technique and results of linear ablation at the mitral isthmus. Circulation 2004;110:2996–3002.