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CASE REPORT

INTERMEDIATE

TECHNICAL CORNER

Zero-Fluoroscopy Ablation for Atrial Re-Entry Via a Vein of Marshall Connection Using a Visible Sheath

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ABSTRACT

We describe a zero-fluoroscopy ablation of a left atrial re-entry tachycardia in a patient with a previous atrial fibrillation ablation procedure. The critical isthmus was demonstrated to use an epicardial connection via the ligament of Marshall after failed endocardial and epicardial ablation along the mitral isthmus line. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:1145–9) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

A 76-year-old woman with a previous radiofrequency catheter ablation for persistent atrial fibrillation (AF) in 2018, when pulmonary vein isolation, cavotricuspid isthmus, and complex fractionated atrial electrograms ablation were performed, was referred for a re-do procedure because of highly symptomatic recurrence of the arrhythmia. On admission, her blood pressure was 130/64 mm Hg, she had a regular heart rate of 70 beats/min, and her oxygen saturation was 97% on room air.

LEARNING OBJECTIVES

- To emphasize the feasibility, safety, and efficacy of zero-fluoroscopy procedures in complex atrial arrhythmias.
- To safely perform TSP with the help of a 3D visualized TSP needle in combination with the preacquired anatomic reconstructions.
- To better understand the spatial relationship between the sheath and the catheter with the help of a 3D visualized steerable sheath.
- To raise suspicion of an epicardial connection via the ligament of Marshall in difficult mitral isthmus ablation.

MEDICAL HISTORY

The patient had been previously diagnosed with the sinus venosus type of atrial septal defect with significant left-to-right shunt and partial anomalous pulmonary venous drainage of the right upper pulmonary vein (PV) to the superior vena cava. At 65 years of age, she had undergone surgical closure of the atrial septal defect and right upper PV redirection surgery.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis included AF due to late reconnection of the PVs, AF recurrence due to atrial substrate progression, and post-AF atrial tachycardia.

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ABBREVIATIONS AND ACRONYMS

3D = 3-dimensional

AF = atrial fibrillation

CS = coronary sinus

FAM = fast anatomic mapping

LA = left atrium

PV = pulmonary vein

RA = right atrium

RF = radiofrequency

TSP = transseptal puncture

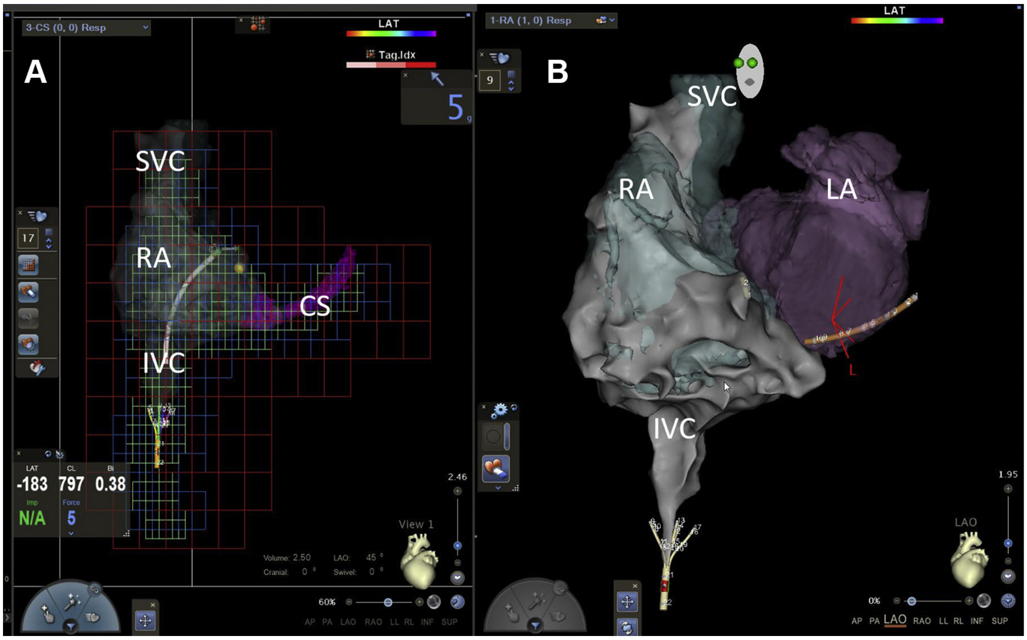
INVESTIGATIONS

The 7-day Holter documented AF and narrow QRS complexes throughout the recording with a mean heart rate of 86 beats/min. A transthoracic echocardiogram was performed, with normal biventricular size and function, but mild diastolic dysfunction of the left ventricle and moderate left atrial (LA) dilatation (indexed volume of 44 mL/m^2). Th4e patient underwent a preprocedural computed tomography scan that showed no PV stenosis and normal drainage to the LA.

MANAGEMENT

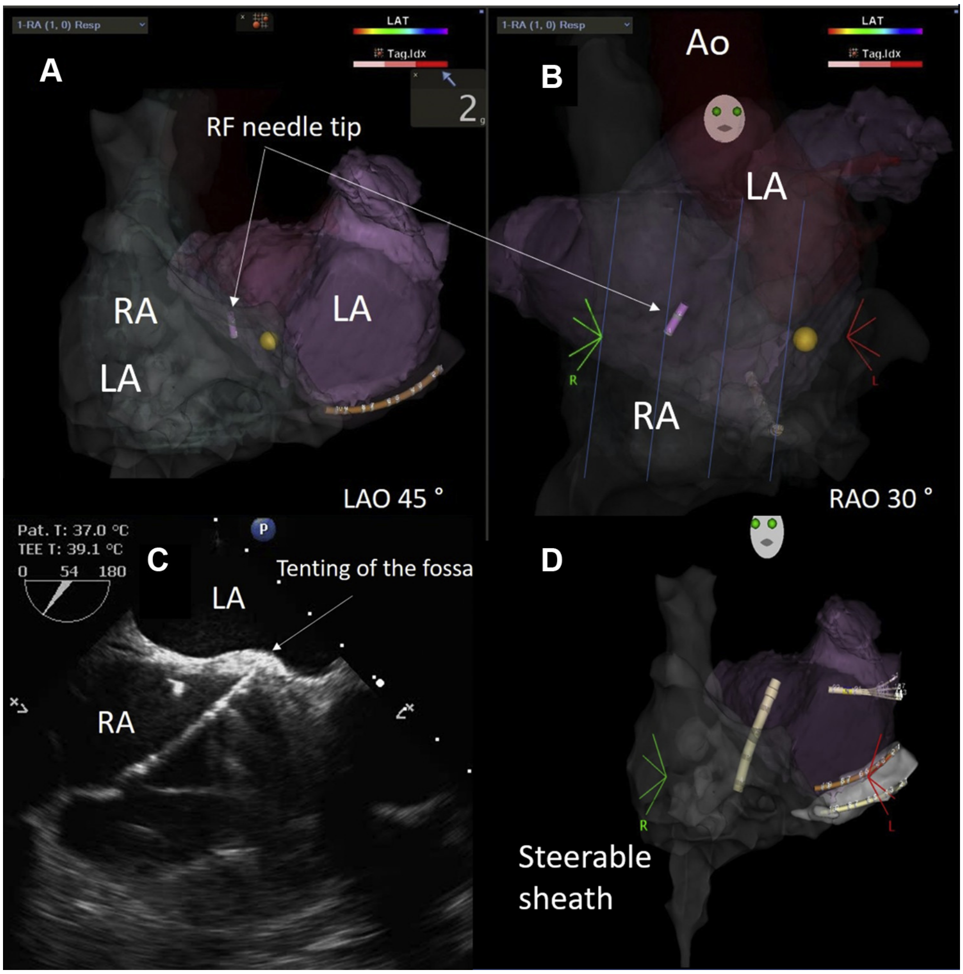
GAINING ACCESS TO THE LA (VIDEO 1). The procedure was planned as a nonfluoroscopic procedure (1). Vascular access was obtained using ultrasonographic guidance, and the procedure was performed under general anesthesia after transesophageal exclusion of a left atrial appendage clot. As a first step, a 3-dimensional (3D) fast anatomic map (FAM) of the right atrium (RA) and coronary sinus (CS) was acquired using a multipolar catheter (PentaRay, Biosense Webster) to create a matrix covering the LA (Figure 1A). This matrix allowed for the advanced catheter localization of any non-sensor-equipped catheter such as the decapolar catheter advanced into the CS or the tip of the radiofrequency (RF) needle (NRG RF needle, Baylis Medical). The His position was identified and marked on the 3D FAM of the RA as a reference for the transseptal puncture (TSP). The FAM generated was then registered with the preacquired cardiac computed tomography scan (Figure 1B). The technique that we used for advancing the nonsteerable long sheaths to the right atrium was as follows: First, we advanced the wire through a short 8-F sheath. Then we exchanged the short 8-F sheath for a long one, which was advanced approximately to the level of the common iliac vein. Subsequently, we removed the dilator from the long sheath and advanced the ablation catheter in the superior vena cava. Finally, the long sheath was advanced over the catheter. The TSP was performed using the 3D-visualized RF needle using the Duo-Mode connector (Baylis Medical) (Figures 2A and 2B) under transesophageal echocardiography and CARTO (Biosense Webster) guidance (Figure 2C). Subsequently, a first nonsteerable sheath (Baylis Medical)

FIGURE 1 **Matrix Creation and CMR Integration**



(A) FAM of the RA and CS using a PentaRay (Biosense Webster) multipolar catheter to create the matrix covering the LA. **(B)** FAM integration of the RA with the preacquired CMR scan segmentation of the RA and LA. CMR = cardiac magnetic resonance; CS = coronary sinus; FAM = fast anatomic map; IVC = inferior vena cava; LA = left atrium; RA = right atrium; SVC = superior vena cava.

FIGURE 2 **Fluoroless Transseptal Puncture**

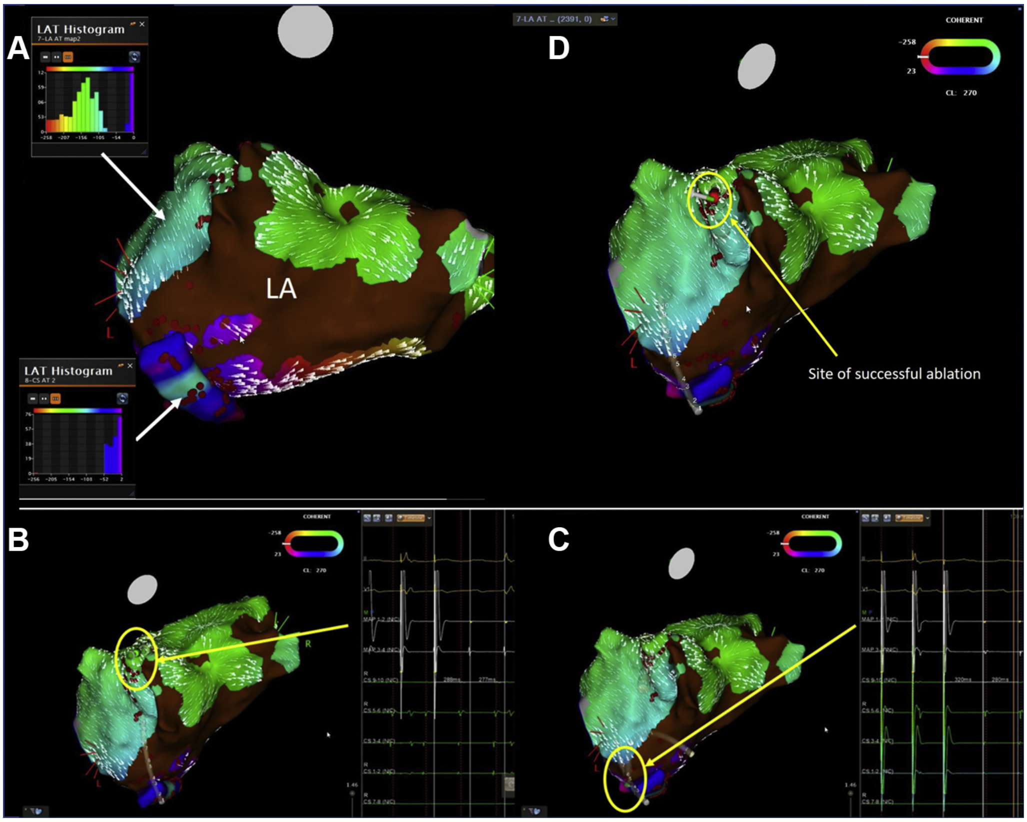


Fluoroless transseptal puncture using a visualized RF needle **(white arrows)**. **(A)** LAO view. Note the needle tip tenting the fossa. **(B)** RAO view. The aorta and the His **(orange tag)** are anterior to the needle tip **(white arrows)**, which is positioned in the middle third between the His and posterior RA wall **(blue lines)**. **(C)** Transesophageal echocardiography depiction of the RF needle, tenting the fossa **(white arrow)**. Note the thickened septum. **(D)** VIZIGO (Biosense Webster) sheath advanced into the LA visualized on the EAM. Ao = aorta; EAM = electroanatomic mapping system; LA = left atrium; LAO = left anterior oblique; RA = right atrium; RAO = right anterior oblique; RF = radiofrequency.

was advanced into the LA. The PentaRay catheter (F curve, Biosense Webster) was advanced through the first sheath, and a second TSP was performed in the same manner. To exchange the second sheath, a bidirectional irrigated-tip ablation catheter (CARTO) was positioned deep into the left superior pulmonary vein (LSPV). Subsequently, the sheath was advanced over the catheter until the proximal electrodes of the map catheter turned black on the 3D map, indicating that the sheath was deeply advanced into the left superior pulmonary vein. A FAM of the TSP was created while removing the map into the sheath from the LA to the RA. The long wire of the 3D visible sheath (VIZIGO, medium curve, Biosense Webster) was advanced into the sheath, and the nonsteerable sheath was removed while the wire was held in a fixed position. Finally, the VIZIGO sheath was advanced into the LA over the wire (**Figure 2D**).

ABLATION PROCEDURE. At the beginning of the procedure, the patient presented in persistent AF, and a voltage map of the LA was acquired (total volume: 157 mL). The left ipsilateral pulmonary veins

FIGURE 3 **3D Electroanatomical Mapping Information**



(A) Activation mapping of the tachycardia, **(B, C)** effect of entrainment stimulations, and **(D)** site of successful ablation. **(A)** Mapping of the LA fails to cover the TCL; the LAT histogram missing the late blue color, but the CS map covers the missing part. Entrainment attempts **(B)** on the ridge with **(C)** a PPI-TCL of 11 ms and identical P-wave close to the mitral valve line (TCL-PPI of 40 ms with a different P-wave). **(D)** Successful ablation site on the ridge anterior to the lateral PVs. CL = cycle length; CS = coronary sinus; LA = left atrium; LAT = local activation times. PPI = post-pacing interval; PV = pulmonary vein; TCL = tachycardia cycle length.

were found isolated from the previous procedure, but reconnection of the right ipsilateral pulmonary veins was demonstrated; thus, re-isolation of both the superior and inferior right PVs was performed. Subsequently, a posterior box and mitral isthmus ablation lines were deployed without resulting in AF termination. Therefore, a synchronous direct-current cardioversion at 360 J restored sinus rhythm, and the pulmonary vein isolations were confirmed. During remapping of the mitral isthmus line, the patient went into persistent atrial tachycardia with a cycle length of 280 ms. Mapping the LA failed to cover the full cycle length of the tachycardia (Figure 3A). Further mapping within the distal CS unfolded the entire tachycardia cycle length (Figure 3A). Endocardial ablation along the mitral isthmus was unsuccessful, and further epicardial ablation within the distal CS (20 W, 30 s) equally failed to terminate or slow the tachycardia. Entrainment attempts on the ridge between the lateral PVs and the LA appendage reflected close proximity to the tachycardia circuit (Figure 3B), whereas entrainment near the mitral valve line failed (Figure 3C), thus suggesting the involvement of an epicardial connection via the ligament of Marshall. Finally, endocardial ablation on the ridge at the anterior aspect of the left pulmonary veins terminated the tachycardia (Figure 3D). At the end of the procedure, bidirectional block of the mitral isthmus was confirmed. Finally, after a waiting time of 30 minutes with confirmation of bidirectional mitral isthmus block, no further arrhythmias were inducible. The total procedural duration amounted to 390 minutes without any exposure to fluoroscopy.

DISCUSSION

In recent years, the interest for performing cardiac catheter ablations under minimal fluoroscopy exposure has increased because of the development of 3D mapping systems. Nevertheless, there is little experience and few data published regarding zero-fluoroscopy approaches for complex atrial arrhythmias. To our knowledge, this is the first case report of a zero-fluoroscopy catheter ablation of a left atrial re-entry via a ligament of Marshall epicardial connection and the first-in-human case report of a zero-fluoroscopy procedure using the VIZIGO visualizable sheath in combination with an RF needle.

Zero-fluoroscopy ablation procedures are feasible and safe, and they have a high efficacy in treating complex atrial re-entries (1,2). The use of a visualizable sheath in combination with the RF needle represents a novel technique aiding the zero-fluoroscopy approach. Re-entries involving the vein of Marshall can successfully be ablated from the endocardium in the region of the ridge of the LA anterior to the lateral pulmonary veins, which represents the area with the closest proximity to the vein (3,4).

FOLLOW-UP

After a follow-up of 4 months from the last ablation, the patient continued to maintain sinus rhythm on a small dose of antiarrhythmic medication (Sotalol 40 mg twice a day).

CONCLUSIONS

We report on a successful ablation of a left atrial re-entry via the ligament of Marshall using a complete nonfluoroscopic approach and a 3D visualized steerable sheath.

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Dr. Ernst is a consultant to Biosense Webster and Baylis Medical. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS 3D visible sheath, catheter ablation, ligament of Marshall, nonfluoroscopy, radiofrequency needle

APPENDIX For a supplemental video, please see the online version of this paper.