

Radiofrequency ablation of common atrial flutter via right subclavian/jugular vein access in a patient with bilateral lower limb venous obstruction: Importance of contact force monitoring during mapping and ablation



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Introduction

Catheter ablation is usually performed via femoral vein and inferior vena cava to the right heart. For some reason, it may be difficult or unsuccessful when the inferior venous access is obstructed or lacking. We present a case of typical atrial flutter (AFL) in a patient with a history of endocardial cushion defect repair. The AFL was successfully ablated through the right subclavian/jugular veins because the right femoral vein and the left iliac vein were obstructed. Our case supports the concept that ablation guided by contact force monitoring might be useful, especially when the inferior venous access cannot be used.

Case report

A 30-year-old man who presented to his primary care physician with palpitation was found to be in AFL. In spite of medical therapy, AFL persisted. He was admitted to our hospital for radiofrequency ablation of refractory AFL. He had a history of endocardial cushion defect repair as a newborn infant. A 12-lead electrocardiogram revealed AFL with a cycle length of 256 ms and a saw-tooth pattern of flutter waves in leads II, III, and aVF, and a positive P-wave morphology in lead V1 ([Supplementary Figure available online](#)). The chest radiograph was normal, and a trans-thoracic echocardiography revealed no structural heart disease, no atrial or ventricular dilatation, no myocardial hypertrophy, and preserved left ventricular function.

KEYWORDS Catheter ablation; Subclavian and jugular vein; Atrial flutter; Contact force; Endocardial cushion defect repair; Bilateral lower limb venous obstruction

ABBREVIATION AFL = atrial flutter
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The transesophageal echocardiography excluded an intracardiac thrombus.

After written informed consent was obtained, a standard diagnostic electrophysiological study was performed. A guide wire was inserted in the right femoral vein, but it was not possible to advance it into the inferior vena cava. A subsequent venography documented an obstruction at the right femoral vein ([Figure 1A](#)), the left iliac vein ([Figure 1B](#)), and the left subclavian vein ([Figure 1C](#)). A deflectable decapolar catheter was inserted into the coronary sinus via the right jugular vein, and a deflectable ablation catheter with a 3.5-mm-tip electrode (Thermocool Smart Touch; Biosense Webster, Inc, Diamond Bar, CA) was advanced through the right subclavian vein ([Figures 2A and B](#)). A heparin bolus (100 U/kg) was administered and afterward a continuous infusion of heparin was provided, maintaining an activated clotting time value between 250 and 300 seconds. Surface electrocardiogram and bipolar endocardial electrograms were continuously monitored and stored on a computer-based digital amplifier/recorder system for offline analysis (LabSystem PRO; Boston Scientific Corporation, Marlborough, MA). Intracardiac electrograms were filtered from 30 to 500 Hz and measured at a sweep speed of 100 mm/s.

The electrograms from the coronary sinus were recorded with a tachycardia cycle length of 256 ms ([Figure 3A](#)). Endocardial mapping of the right atrium was performed under the guidance of an electroanatomical mapping system (CARTO 3 System; Biosense Webster, Inc). The activation mapping revealed a counterclockwise reentrant wavefront around the tricuspid annulus ([Figure 3B](#)). Entrainment pacing performed from the isthmus between the tricuspid annulus and the inferior vena cava during tachycardia showed concealed fusion (same P wave and activation sequence), and a postpacing interval was equal to the tachycardia cycle length. The tachycardia was diagnosed as an isthmus-dependent AFL.

KEY TEACHING POINTS

- Atrial flutter sometimes develops after cardiac surgery.
- Bilateral femoral vein obstruction is rare but should be suspected after cardiac catheterization.
- Catheter ablation guided by contact force monitoring is useful when the catheter stability is poor via the superior approach.

The tachycardia was successfully ablated through the creation of a linear lesion to the cavotricuspid isthmus, using a contact force monitoring more than 10g for each point (maximum tip temperature set at 43°C, maximum output 30 watts) (Figure 3B). The tachycardia could no longer be induced either by atrial extrastimulation or by rapid atrial pacing (up to 300 min⁻¹). The patient remained free of arrhythmias over a 12-month follow-up period.

Discussion

Here we describe the case of a patient with typical AFL, which was mapped and successfully ablated with the assistance of the electroanatomical mapping system and contact force monitoring.

There are few reports about the prevalence of venous occlusion after cardiac catheterization for congenital heart disease. Aiyagari et al¹ reported that, among 89 infants with single-ventricle heart disease, 16% had iliofemoral vein occlusion with umbilical venous catheter placed and 42% had iliofemoral vein occlusion with femoral venous catheter placed. Van Ommen et al² reported that partial or complete occlusion of the investigated vein was found in 17% of the lower extremities of 28 unselected children evaluated 5–10 years after their first cardiac catheterization. In our case, the obstruction of bilateral iliofemoral veins and the left subclavian vein were not congenital anomalies—these obstructions occurred after cardiac catheterization or cardiac surgery of endocardial cushion defect.

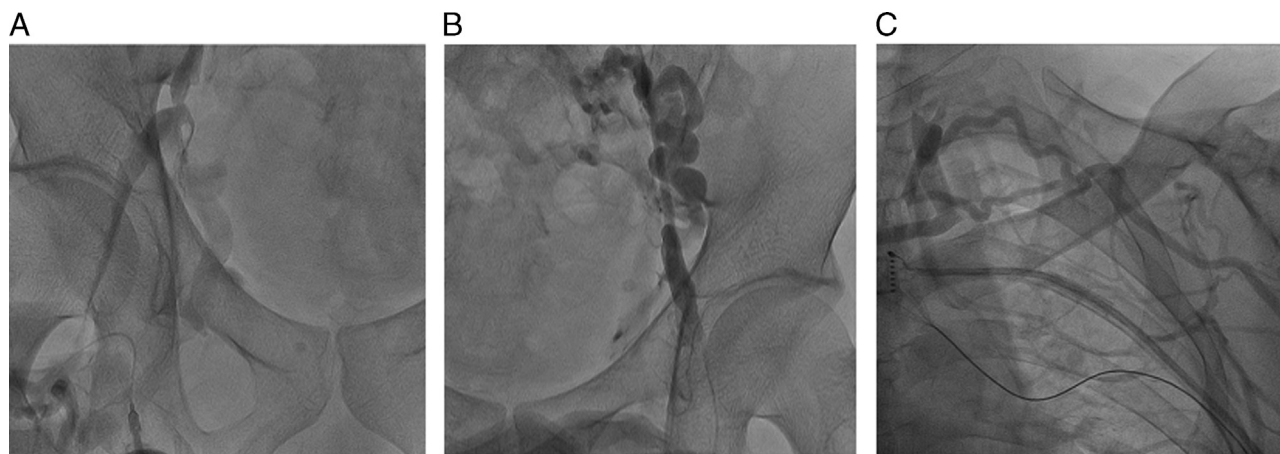


Figure 1 Venography images from 30-year-old patient. **A:** Selective venogram of the right femoral vein confirming occlusion of the right femoral vein. **B:** Selective venogram of the left femoral vein confirming occlusion of the left iliac vein. **C:** Selective venogram of the left basilic vein confirming occlusion of the left subclavian vein.

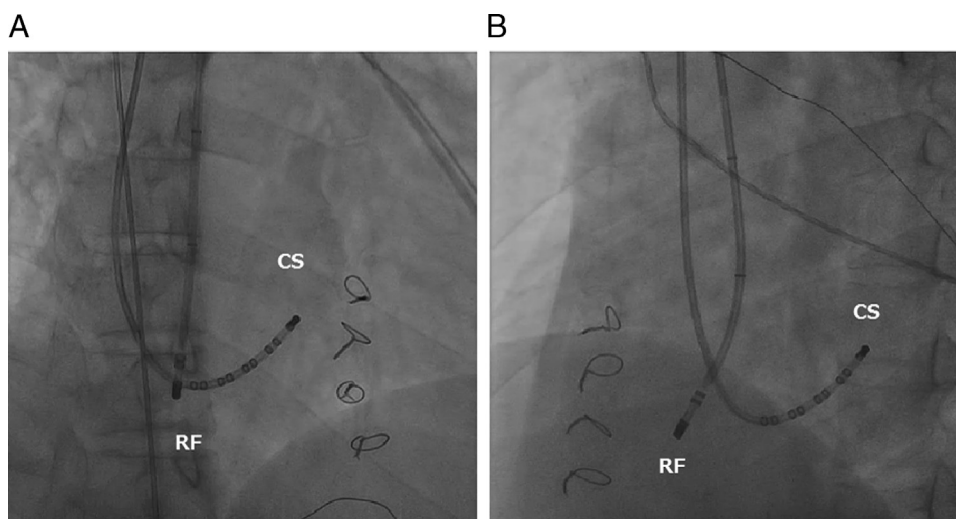


Figure 2 Electrophysiological study of 30-year-old patient. **A:** 30° right anterior oblique fluoroscopic view. **B:** 45° left anterior oblique fluoroscopic view. CS = coronary sinus; RF = radiofrequency ablation catheter.

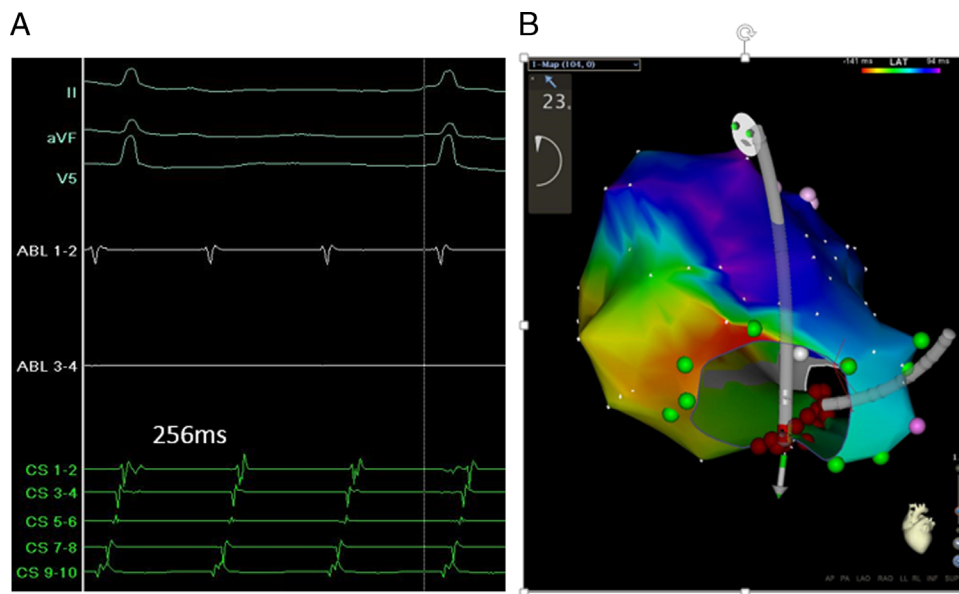


Figure 3 Intracardiac electrograms and electroanatomical mapping from 30-year old patient. **A:** Intracardiac electrograms generated during tachycardia. Atrial flutter cycle length was 256 ms and 3:1 atrioventricular conduction was detected. II, aVF, V5 = surface electrocardiographic leads II, aVF, V5; ABL 1-2 = distal electrogram of the ablation catheter; ABL 3-4 = proximal electrogram of the ablation catheter; CS1-2 through 9-10 = distal to proximal electrogram of the coronary sinus catheter. **B:** Activation map generated during tachycardia at left lateral view of the right atrium. The activation wavefront is found to revolve in a counterclockwise manner around the tricuspid annulus. The colors represent early (*red*) to late (*purple*) activation. The force display was used to monitor contact force and direction during cavotricuspid isthmus ablation. Green tag: tricuspid annulus; pink tag: coronary sinus ostium; brown tag: ablation site.

For ablation of typical AFL, a femoral vein approach is usually chosen. The inferior approach via femoral vein can generate a certain pressure on the cavotricuspid isthmus by pulling the ablation catheter from the ventricular aspect to the edge of the inferior vena cava, leading to better contact and energy delivery. Successful ablation in several cases with obstruction of the inferior vena cava has been reported: atrioventricular nodal reentrant tachycardia,³⁻⁵ accessory pathways,⁶ typical AFL,⁷ focal ectopic atrial tachycardia,⁸ intra-atrial reentrant tachycardia after surgical repair of atrial septal defect,⁹ atrial fibrillation,¹⁰ and premature ventricular beats originating from right ventricular outflow tract.¹¹ In our case, the right internal jugular vein and the subclavian vein have been proposed as an alternative approach for the electrophysiological study and ablation. The superior access could have potentially compromised catheter stability, leading to insufficient contact force to the isthmus and resulting in an ineffective lesion size. However, excessive contact force may, in turn, result in complications such as perforation, steam pop, or thrombus formation.¹² Yokoyama et al¹³ reported, in the experimental study using a canine thigh muscle, that contact force of the ablation catheter correlated with the tissue temperature, lesion size, steam pop, and thrombus formation, and that thrombus occurred only at ≥ 20 g with the power setting of 30 watts. In this case, we chose a contact force between 10g and 20g with the power setting of 30 watts during radiofrequency ablation of the cavotricuspid isthmus in order to get sufficient lesion size and to avoid thrombus formation.

We conclude that ablation guided by contact force monitoring is useful when the catheter stability is poor via the superior access.

Appendix Supplementary Data

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.hrcr.2015.08.004>.

References

- Aiyagari R, Song JY, Donohue JE, Yu S, Gaies MG. Central venous catheter-associated complications in infants with single ventricle: comparison of umbilical and femoral venous access routes. *Pediatr Crit Care Med* 2012;13:549-553.
- van Ommen CH, Ottenkamp J, Lam J, Brennickmeier M, Heijmans HS, Büller HR, Peters M. The risk of postthrombotic syndrome in children with congenital heart disease. *J Pediatr* 2002;141:582-586.
- Miranda R, Simpson CS, Nolan RL, Diez JC, Michael KA, Redfeam DP, Baranchuk A. Superior approach for radiofrequency ablation of atrio-ventricular nodal reentrant tachycardia in a patient with anomalous inferior vena cava and azygos continuation. *Europace* 2010;12:908-909.
- Bottoni N, Quartieri F, Lolli G, Iori M, Manari A, Menozzi C. Radiofrequency catheter ablation of atrioventricular nodal re-entry tachycardia: selective approach to the slow pathway via the cephalic veins. *Europace* 2009;11:1110-1111.
- Arbelo E, Caballero E, Medica A. Successful slow pathway ablation for atrioventricular nodal re-entrant tachycardia via a hypoplastic inferior vena cava in a patient with an azygos continuation. *Europace* 2008;10:467-468.
- Guerra Ramos JM, Font ER, Moya I, Mitjans A. Radiofrequency catheter ablation of an accessory pathway through an anomalous inferior vena cava with azygos continuation. *Europace* 2004;6:134-137.
- Kynast J, Margos P, Richardt G. Radiofrequency ablation of typical atrial flutter via right subclavian/jugular vein access in a patient with implanted filter in the inferior vena cava. *Indian Pacing Electrophysiol J* 2009;9:219-223.
- Pak HN, Hwang C, Kim YH. Twin atrioventricular node associated with interruption of the inferior vena cava and atrioventricular nodal reentrant tachycardia. *J Electrocardiol* 2006;39:400-403.
- Seethala S, Shah H, Knollmann F, Ramani R, Nemej J. Radiofrequency ablation of post-incisional atrial flutter and high-output heart failure in a patient with interrupted inferior vena cava and hereditary hemorrhagic telangiectasia. *Hellenic J Cardiol* 2013;54:474-479.

10. Lim HE, Pak HN, Tse HF, Lau CP, Hwang C, Kim YH. Catheter ablation of atrial fibrillation via superior approach in patients with interruption of the inferior vena cava. *Heart Rhythm* 2009;6:174–179.
11. Valverde I, Arya A, Ben-Simon R, McCready JM, Herrey A, Lambiase PD. Noncontact mapping guided ablation of right ventricular outflow tract ectopy in a patient with interruption of the inferior vena cava and azygos continuation. *Pacing Clin Electrophysiol* 2013;36:e129–e131.
12. Kuck KH, Ready VY, Schmidt B, et al. A novel radiofrequency ablation catheter using contact force sensing: Toccata study. *Heart Rhythm* 2012;9:18–23.
13. Yokoyama K, Nakagawa H, Shalh DC, Lambert H, Leo G, Aeby N, Ikeda A, Pittha JV, Sharm T, Lazzara R, Jackman WM. Novel contact force sensor incorporated in irrigated radiofrequency ablation catheter predicts lesion size and incidence of steam pop and thrombus. *Circ Arrhythm Electrophysiol* 2008;1:354–362.