# Hepatic vein access for pulmonary vein isolation in patients without femoral vein access

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## Introduction

Reasons for lack of femoral venous access for interventional procedures has been documented in the literature. Reasons include such conditions as chronic venous occlusions[1] and venous malformations seen in heterotaxy syndrome. Heterotaxy syndrome is a rare congenital disease in which the internal thoracoabdominal organs demonstrate abnormal arrangement across the left–right axis of the body. The relationship of heterotaxy syndrome and atrial fibrillation has been documented, with prior incidence estimated at 23% of patients.[2] A common feature of this syndrome is interruption of the inferior vena cava (IVC) with hemiazygos continuation into the superior vena cava (SVC).

In either case, ablation via the internal jugular cannulation has been described, but it is technically suboptimal due to lack of support mainly from the inferior rim of the fossa ovalis.[3] Hepatic vein cannulation has been used to obtain long-term access in various clinical scenarios, including hemodialysis[4] and chemotherapy,[5] with a complication rate of up to 5% reported for this approach in the pediatric population.[6] In recent years, hepatic vein access has been reported in rare cases as a viable strategy for left-sided ablations.[7,8] In this paper, we describe 3 cases of pulmonary vein isolation (PVI) in patients with interrupted IVCs necessitating hepatic vein access for ablation.

## Case report

### Case 1

A 37-year-old woman was referred to our cardiac electrophysiology (EP) service for evaluation of frequent, severely symptomatic paroxysmal atrial fibrillation for 2 years. She did not tolerate antiarrhythmic treatment due to baseline bradycardia. She was therefore referred for ablation of her arrhythmia. Physical examination did not reveal any abnormalities. Patient history was positive for polysplenia, and she had been told that her appendix was on the "wrong" side. Initial workup included an echocardiogram that did not show any evidence of structural heart disease, with normal left atrial size and ejection fraction reported. Pulmonary vein mapping computed tomography was performed and also did not show any significant abnormality, with standard pulmonary vein configuration reported.

PVI was aborted due to inability to reach the right atrium through the IVC. Catheters would bypass the right atrium and end up in the SVC, and a venogram performed during the procedure showed venous malformations with no access possible to the right atrium from the IVC. A fresh read on the computed tomography results suggested interruption of the IVC with hemiazygos continuation into the SVC and direct drainage of hepatic veins into the right atrium. This was later confirmed by magnetic resonance venography, and anatomy was consistent with the left atrial isomerism variant of the heterotaxy syndrome.

PVI was pursued but with a transhepatic approach. Hepatic access was obtained by the interventional radiology (IR) service under conscious sedation. With ultrasound and fluoroscopic guidance, an 18 gauge Chiba needle (Cook Medical, Bloomington, IN) was guided into the middle hepatic vein, with positioning confirmed with contrast injection (Figure 1A). A 0.035" Bentson wire (Cook Medical) was placed through the needle into the right atrium, following which an 8.5F SL1 long sheath (St. Jude Medical, St. Paul, MN) was placed in the right atrium using the modified Seldinger technique. Once the single access was obtained, the patient was transferred to the EP laboratory and placed under general anesthesia for the PVI to be performed. Right internal jugular access was obtained, with placement of an 8F sheath using the modified Seldinger technique for subsequent placement of a decapolar coronary sinus (CS) catheter. Unfortunately, attempts at CS cannulation were unsuccessful, and the catheter remained in the right ventricle. Transesophageal echocardiography (TEE) was used for visualization of the interatrial septum for transseptal puncture (Figure 2), and PVI was performed following a single transseptal access using a SafeSept guidewire (Pressure Products, San Leandro, CA), with adequate anticoagulation on intravenous heparin

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## KEY TEACHING POINTS

- The present report describes 3 cases of pulmonary vein isolation in patients with interrupted inferior vena cava (IVC) necessitating hepatic vein access for ablation.
- The hepatic vein approach is an alternative method of obtaining venous access for ablation procedures when femoral access is not possible due to venous occlusion or venous malformations seen in heterotaxy syndrome.
- Heterotaxy syndrome is associated with atrial fibrillation as well as interrupted IVC.
- While obtaining hepatic vein access for ablation, one should be aware of the posterior course of the hepatic vein when draining into the right atrium, resulting in a more anterior placement of the transseptal needle on the septum than expected.
- No changes in anticoagulation regimen prior to the procedure are needed using this approach.

(activated clotting time goal of 350s recorded). PVI was done in a standard fashion with 1 access to the left atrium. Ablation of the right-sided veins was performed with some difficulty due to a more posterior transseptal access, which was a result of the course of the hepatic vein into the right atrium. Entry and exit block was confirmed by replacing the ablation catheter with the Lasso (Biosense Webster, Irvine, CA) at the end of the procedure. Once the procedure was considered complete, protamine was given and the long sheath was removed by the IR service, with pushable coils placed along the hepatic tract for hemostasis (Figure 1B). Overall, the procedure took 211 minutes and required 51 minutes of fluoroscopy. A small pericardial effusion of unknown significance was noted post procedure, which remained stable the day after. Full anticoagulation with rivaroxaban was deferred until the next morning.

### Case 2

Patient 2 was a 42-year-old Caucasian man, with a known history of heterotaxy syndrome, being followed by the cardiac EP service for management of his atrial fibrillation. Three years prior, PVI had been attempted via a superior approach (internal jugular venous access), but that procedure was complicated by left atrial perforation during transseptal puncture, with resulting pericardial tamponade. As a result, he underwent pericardiocentesis and thoracotomy with left atrial repair. During that same procedure, he was able to get a surgical mini maze performed, as well as left atrial appendage excision. He did well in the immediate postoperative period, but 2 years later presented with recurrent symptomatic atrial fibrillation. He failed rhythm control with multiple medications, including Tikosyn and amiodarone. Due to the very symptomatic nature of his arrhythmia, PVI was again attempted.

Magnetic resonance venography prior to PVI demonstrated azygous continuation of the IVC with associated absence of the intrahepatic IVC and hepatic venous drainage directly into the right atrium. PVI was performed via the hepatic vein using the procedure described above, with transseptal puncture performed with TEE guidance. Anticoagulation was discontinued the morning of the procedure. With the Lasso catheter in the left atrium, reconnection of all 4 pulmonary veins was noted. A complete PVI and posterior wall isolation was performed. At the end of the ablation, atrial fibrillation was not inducible with up to a 20 mcg/min isoproterenol infusion. Once the procedure was complete, the SL1 sheath was removed by the IR service. Hepatic vein hemostasis was obtained after placement of 0.025" hepatic coils, with good result. The procedure took 262 minutes with 24.2 minutes of fluoroscopy. The patient

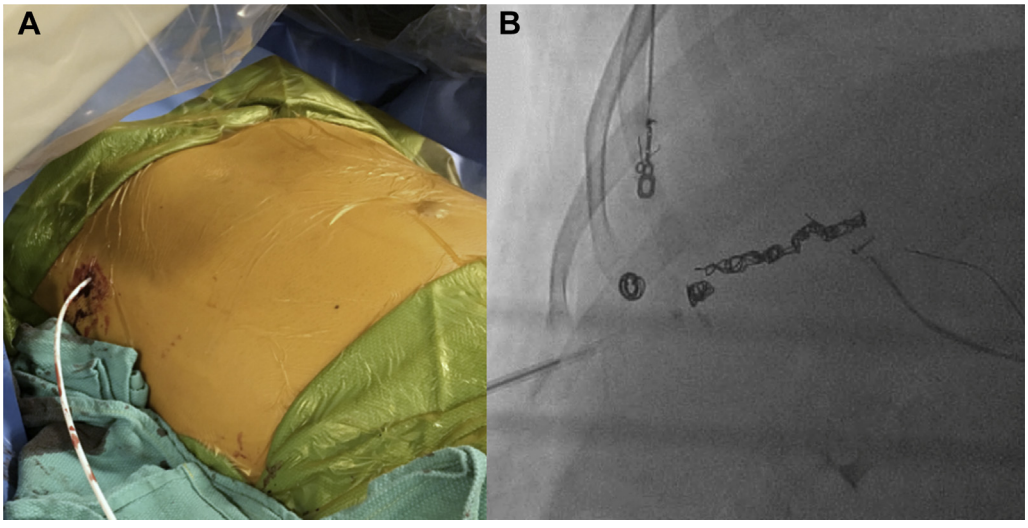


**Figure 1** **A:** Patient with SL1 catheter (St. Jude Medical, St. Paul, MN) access via the hepatic vein. **B:** Fluoroscopy image showing placement of coils post procedure.

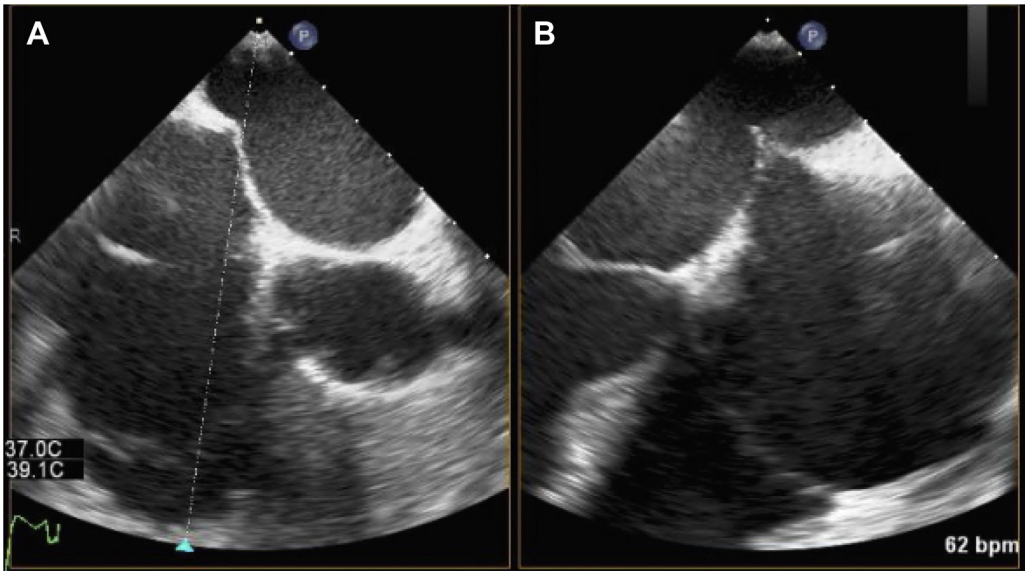


**Figure 2** Transesophageal echocardiography image: transseptal puncture. **A:** 45° image, showing anterior/posterior orientation. **B:** 135° image showing superior/inferior orientation. This transseptal puncture was posterior and mid atrial septum, a good place for transseptal puncture.

returned to the postprocedure room without complication, anticoagulation was restarted the evening of the procedure, and he was discharged home the next day.

## Case 3

Patient 3 was a 72-year-old man with a history of hereditary spherocytosis and prior motor vehicle accident with pelvic crush injury. As a result, he had chronic lower extremity venous stasis and obstruction. He presented to clinic with persistent atrial fibrillation resulting from atrial flutter. He failed medical management with amiodarone and was brought to the EP laboratory for ablation. He presented to the laboratory in atrial flutter, and preceding TEE showed a reduced ejection fraction of 35%–40%.

First, hepatic access was obtained via the procedure described above with a Chiba needle and fluoroscopic guidance, with final SL1 sheath placement in the right atrium. A decapolar catheter was placed in the CS via right internal jugular access. Entrainment from the proximal and distal CS revealed that his presenting rhythm was right-sided flutter. Once the ablation catheter was placed in the right atrium, further entrainment from the cavotricuspid isthmus (CTI) confirmed CTI-dependent flutter. Ablation was performed across the CTI, with termination of flutter during ablation. Once ablation was complete, bidirectional block was confirmed by pacing from the proximal CS catheter, while block across the line was assessed using the ablation catheter. The same was repeated pacing the distal ablation catheter, measuring block from the proximal CS. Once bidirectional block was confirmed, the ablation catheter was replaced with a BRK-1 needle and transseptal puncture was performed with TEE guidance. With the Lasso catheter in the left atrium, electroanatomic mapping was performed without difficulty, after which the mapping catheter was exchanged for an ablation catheter (Figure 3), with PVI performed successfully.

## Discussion

With the association of left atrial arrhythmias with heterotaxy,[9,10] and in cases of arrhythmia in patients with other reasons for IVC obstruction, the decision to ablate is often complicated by concerns for venous access. We have demonstrated that in cases of interrupted IVC or chronic bilateral femoral venous occlusion, ablation in the left atrium through hepatic vein access is a feasible option in this patient population. Congenital IVC interruption has a prevalence of 0.15%,[6] and in most cases hepatic veins drain directly into the right atrium. Incidence of venous thromboembolism resulting in bilateral femoral venous occlusion is harder to quantify, but it is believed that there are approximately 1 million cases of venous thromboembolism in the United States each year.[11] The large caliber of the hepatic veins makes them an appropriate alternative to the femoral veins to accommodate sheaths used in arrhythmia ablation. Moreover, the fact that the hepatic veins possess a large network of distal tributaries for access makes this approach one that would support not only left-sided ablation, but repeat ablation if needed.[4] Of course, one should be cautious of the technical differences between this and conventional access. The hepatic veins enter the right atrium from a more posterior direction, and this leads to the transseptal sheath and needle aiming more anteriorly than expected, resulting in a more challenging ablation of the right pulmonary veins due to a steeper curve required for adequate tissue contact. Postoperative right epigastric pain appears to be a concern and may require an extra day of hospital stay. We did not alter our oral anticoagulation recommendation in our patients, having the patients continue oral anticoagulants until the morning of the procedure, and restarting anticoagulation the evening after, barring any complications. While a double transseptal access is possible in these patients, it is hardly necessary for

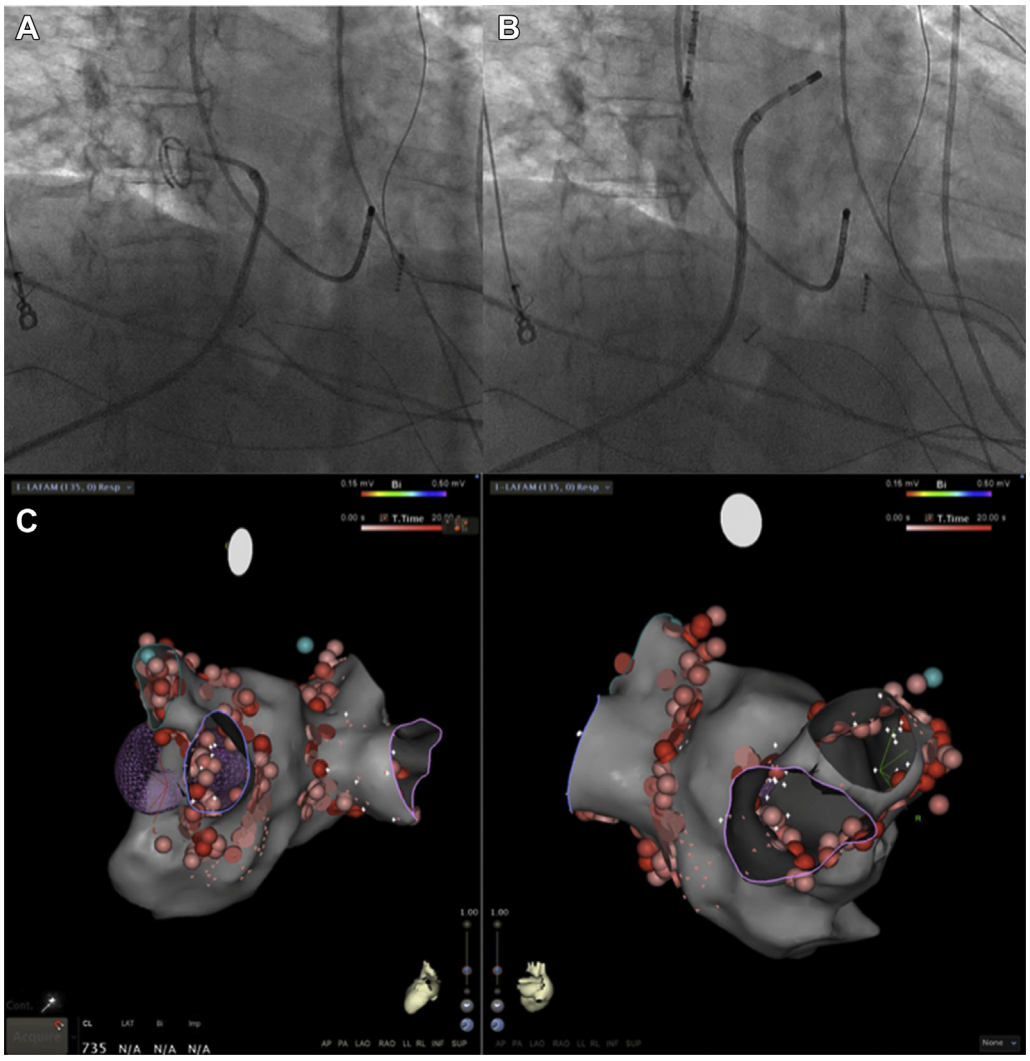


**Figure 3** **A:** Lasso catheter (Biosense Webster, Irvine, CA) in the pulmonary vein. Fluoroscopy image showing the Lasso catheter in the right inferior pulmonary vein and coronary sinus catheter placement via left subclavian vein. Single access was obtained for the ablation. **B:** Ablation catheter in the pulmonary vein. **C:** Electroanatomic map obtained during procedure.

PVI, and performing the ablation with a single transseptal access is likely to reduce complications from the puncture.

The use of appropriate landmarks, TEE, and fluoroscopy is essential in minimizing complications. In our patients presented above, there were not any long-lasting complications, and no recurrence has been reported in the year following ablation, making this approach a viable alternative for ablation in these patients.

## Conclusion

In patients without femoral vein access, use of the hepatic vein for PVI is a viable alternative for invasive EP procedures.

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