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 occlusions1 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 hemodialysis4 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 transeptal 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, 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 transeptal 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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(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 transseptal needle’s placement on the septum than expected. 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.
returned to the postprocedure room without complication, anti-
coagulation 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
fi
brillation resulting from atrial
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utter. He failed medical man-
agement with amiodarone and was brought to the EP laboratory
for ablation. He presented to the laboratory in atrial
fl
utter, 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
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uoroscopic guid-
ance, with
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nal SL1 sheath placement in the right atrium. A
decapolar catheter was placed in the CS via right internal ju-
gular access. Entrainment from the proximal and distal CS re-
vealed that his presenting rhythm was right-sided
fl
utter. Once the ablation catheter was placed in the right atrium,
further entrainment from the cavotricuspid isthmus (CTI)
con
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rmed CTI-dependent
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utter. Ablation was performed
across the CTI, with termination of
fl
utter during ablation.

Once ablation was complete, bidirectional block was
con
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rmed 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 abla-
tion catheter (Figure 3), with PVI performed successfully.

Discussion
With the association of left atrial arrhythmias with hetero-
taxy,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 thrombo-
embolism resulting in bilateral femoral venous occlusion is
harder to quantify, but it is believed that there are approxi-
mately 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.5 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. Postoper-
ative 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 af-
ter, barring any complications. While a double transseptal ac-
cess is possible in these patients, it is hardly necessary for

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