Left atrial appendage closure in a patient with situs inversus totalis and interrupted inferior vena cava – A transhepatic approach

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Introduction

Left atrial appendage closure (LAAC) has emerged as a viable alternative to oral anticoagulation for prevention of stroke, and its use is increasing.1 The procedure is traditionally performed via accessing the common femoral vein and entering the right atrium through the inferior vena cava (IVC). However, anatomical abnormalities such as interrupted IVC, situs inversus totalis (SIT), or dextrocardia can make access and implantation challenging. Interruption of the IVC is a rare condition with an incidence of approximately 1:5000 based on prenatal ultrasound screening and present in 0.1% of adults referred for abdominal computed tomography.2,3 Incidence of dextrocardia is approximately 1:12,000, with about a third of these patients having SIT.4 Furthermore, IVC stenosis or interruption is present in approximately 8%–18% of patients with dextrocardia, and azygos continuation with abnormalities of IVC is present in approximately 0.6% of cases.5 Herein, we report the first successful implantation of an LAAC device in a patient with dextrocardia, SIT, and concomitant interruption of IVC using a transhepatic approach.

Case report

An 82-year-old man was referred for LAAC owing to atrial fibrillation and inability to take oral anticoagulation because of history of multiple falls. Medical history included SIT with dextrocardia (Figure 1A and B), prior bioprosthetic aortic valve replacement, and permanent pacemaker placement (Figure 1A). Chest computed tomography revealed interrupted IVC with azygos continuation (Figure 1C). The main technical challenge was to gain right atrial access without hindering our ability to manipulate catheters and perform transseptal puncture / LAAC. Given the complexity, a 3D left atrial model was used to understand the anatomy, choose the most appropriate transseptal location, and practice transseptal puncture and device positioning (Figure 2). Preoperative transesophageal echocardiogram revealed a wind sock shape of the left atrial appendage without thrombus. The hepatic vein was cannulated under fluoroscopic and ultrasound guidance with a 21 gauge needle via a left lateral intercostal approach. After confirmation of proper needle positioning (Figure 3A), a 0.018 inch guidewire was advanced into the right atrium and an 8F sheath was placed. This was then exchanged for a ML1 HeartSpan Transseptal Sheath (Merit Medical, South Jordan, UT), which could not be advanced into the superior vena cava. Therefore, a Glidewire Advantage (Terumo, Shibuya city, Japan) and a JR4 catheter were placed through the ML1 sheath and, with careful manipulation, the sheath was successfully advanced into the superior vena cava. The JR4 catheter was then removed and exchanged for the ML1 dilator. The Glidewire Advantage was then exchanged for an NRG Transseptal Needle (Baylis Medical, Rouyn-Noranda, Canada). However, adequate septal positioning could not be obtained. This issue persisted despite using an ML0 HeartSpan Transseptal Sheath (Merit

KEY TEACHING POINTS

- Left atrial appendage closure is still feasible in patients with situs inversus totalis and interrupted inferior vena cava. However, proper preprocedural planning is of paramount importance.
- A transhepatic approach could be used for cardiac interventions in patients with interrupted inferior vena cava.
- Steerable sheaths facilitate precise transseptal puncture in patients with challenging cardiac anatomy.
Medical) as well as an SR0 Sheath (St. Jude Medical, Saint Paul, MN), which was likely secondary to the transhepatic approach forcing the sheaths to point too posteriorly and away from the fossa ovalis. We finally resorted to an Agilis NxT Steerable Introducer (Abbott, Lake County, IL), which helped obtain satisfactory positioning, and a mid-mid trans-septal puncture was successfully performed (Figure 3B). The needle was removed and exchanged for a ProTrack Pigtail Wire (Baylis Medical), which was advanced into the left atrium. Finally, the 14F double-curve access system was advanced into the left atrium and a 24 mm LAAC device was positioned, confirmed with PASS criteria and deployed in the standard fashion (Figure 3C–F). The 14F access system was removed and exchanged for a short 14F sheath. A SURGIFOAM Absorbable Gelatin Sponge (Ethicon, Somerville, MA) mixed with saline was placed in the hepatic vein as the sheath was being pulled out for hemostasis. There were no periprocedural complications and the patient was discharged on warfarin as per protocol. At 45-day follow-up, transesophageal echocardiogram demonstrated a well-seated device without thrombus or peri-device leak and the patient’s warfarin was replaced with clopidogrel.

**Discussion**

Percutaneous hepatic venous access has been previously used for catheter ablation in patients with complex anatomy such as dextrocardia and interrupted IVC. However, these cases involved ablation in the right atrium and did not require transseptal puncture. Additionally, although there have been prior reports of LAAC device implantation using transhepatic access, to our best knowledge this is the first case report where LAAC device implantation was performed overcoming the challenges of interrupted IVC and dextrocardia simultaneously. A number of conditions such as venous thrombus, webs, stenosis, and congenital

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**Figure 1** Radiographic images. A: Chest radiograph (posterior-anterior) showing dextrocardia. B: Computed tomography (axial image) confirming dextrocardia with situs inversus totalis. C: Computed tomography (axial image) showing interrupted inferior vena cava with no connection to the hepatic vein or right atrium (gray arrow), along with direct hepatic venous drainage into the right atrium (yellow arrow).

**Figure 2** Three-dimensional printed model. Left atrial model reconstructed using a 3D printer and mirror image that was used to plan for the best approach.
anatomical anomalies can limit atrial access through the femoral vein and IVC, necessitating use of alternate access sites. However, these alternate sites can pose significant challenges, such as small caliber of the vessel, which might not allow for standard sheath placement; difficulty in obtaining transseptal puncture using available catheters; and maneuverability of the system for proper positioning of the device.

Furthermore, the concomitant presence of dextrocardia and SIT also poses additional problems, as catheter manipulation has to be opposite to the usual to account for mirror-image anatomy. A multidisciplinary approach and adequate preprocedure planning are, therefore, very crucial to the success of such procedures. In our case, a multidisciplinary team consisting of an interventional cardiologist, an interventional radiologist, an electrophysiologist, and a cardiologist with periprocedural imaging expertise was involved in planning the procedure. Furthermore, the implanting interventional cardiologist and electrophysiologist used a 3D rendered model of the heart to practice catheter manipulation simulating dextrocardia. The use of hepatic vein for access allows for a large-sized sheath and good hemostasis post procedure, as it has good compressibility.

This approach has been associated with a <5% complication rate in invasive cardiac interventions in the pediatric population.11

For better maneuverability, we used a steerable sheath (Agilis NxT Steerable Introducer, Abbott) in an effort to obtain satisfactory positioning on the interatrial septum and perform an accurate and safe transseptal puncture. Although we do not use this routinely in our practice, it proved to be extremely helpful in this patient with a very challenging anatomy, and we would advocate its use in difficult cases. Additionally, we practiced with a 3D printed model of the left atrium preoperatively, which aided in our understanding of the anatomy and choice of appropriate tools.

**Conclusion**

Percutaneous transhepatic catheterization is a viable alternative in performing invasive cardiac procedures when venous access is inadequate. We report the first successful case of using transhepatic access in LAAC device implantation in a patient with an interrupted IVC associated with dextrocardia and SIT.
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