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CASE REPORT

CLINICAL CASE

Transhepatic Access for Percutaneous Mitral Balloon Commissurotomy With Dextrocardia and Inferior Vena Cava Interruption

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ABSTRACT

We report a successful percutaneous mitral balloon commissurotomy via left transhepatic venous access in a 42-year-old female patient with dextrocardia, situs inversus totalis, and inferior vena cava interruption. fWe also discuss the revisions required for optimal trans-septal approach from the left transhepatic vein. (J Am Coll Cardiol Case Rep 2024;29:102310) © 2024 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/).

HISTORY OF PRESENTATION

The transfemoral venous approach is the conventional approach to the left atrium (LA) via the inferior vena cava (IVC) and trans-septal puncture.[1,2] Nonetheless, in some clinical scenarios, femoral venous access may not be feasible owing to venous occlusions or congenital IVC interruption, often associated with congenital heart diseases.[1] For such conditions, alternative routes like the superior vena cava (SVC) or retrograde aortic approaches might be considered,[2] albeit with technical challenges.[3]

Percutaneous transhepatic venous access offers direct and shorter access, rendering superior equipment stability during the insertion of devices towards the interatrial septum.[2] Several studies have reported promising results of percutaneous transhepatic access in adults, requiring catheter ablation procedures.[1,2,4,5] This case report describes a successful percutaneous mitral balloon commissurotomy

LEARNING OBJECTIVES

- Consider transhepatic venous access in adult patients with inferior vena cava (IVC) interruption to facilitate stable performance of percutaneous catheterization procedures.
- Select the transhepatic approach for patients with IVC interruption who require percutaneous mitral balloon commissurotomy.
- Perform the required procedural modifications in patients with IVC interruption to achieve the ideal trans-septal puncture.

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ABBREVIATIONS AND ACRONYMS

CT = computed tomography

HV = hepatic vein

IVC = inferior vena cava

LA = left atrium

LV = left ventricle

MV = mitral valve

SVC = superior vena cava

TEE = transesophageal echocardiography

using the percutaneous left transhepatic approach in a patient with dextrocardia, situs inversus totalis and severe rheumatic mitral stenosis.

A 42-year-old woman with dextrocardia and situs inversus totalis presented with a 2-month history of dyspnea on exertion and NYHA functional class III. The 3-dimensional transesophageal echocardiogram (TEE) and spiral computed tomography (CT) scan confirmed the presence of dextrocardia and revealed inversus abdominal and atrial situs, L-loop ventricles, and interrupted IVC with azygos continuity to the left SVC with persistent right SVC, draining to the right-sided coronary sinus. The right ventricular systolic function was mildly reduced. Transthoracic echocardiography confirmed severe LA enlargement (LA volume of 90 cm^3/m^2), and a mitral valve (MV) area of 1 cm^2 (measured by 3-dimensional planimetry), Wilkins score of 8, and mean MV gradient of 10 mm Hg. There was also moderate aortic and tricuspid regurgitation and mild-moderate mitral regurgitation.

PAST MEDICAL HISTORY

The patient was otherwise healthy with no remarkable past medical history.

DIFFERENTIAL DIAGNOSIS

Not applicable.

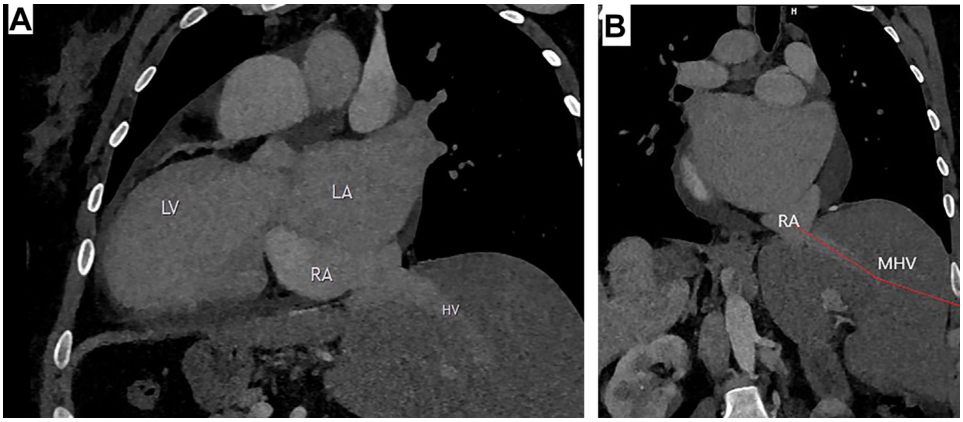
INVESTIGATIONS

Before the procedure, electrocardiogram-gated CT angiography was performed to investigate the optimal approach to trans-septal puncture from the middle hepatic vein (HV) and access to the LA and left ventricle (LV) (Figure 1).

MANAGEMENT

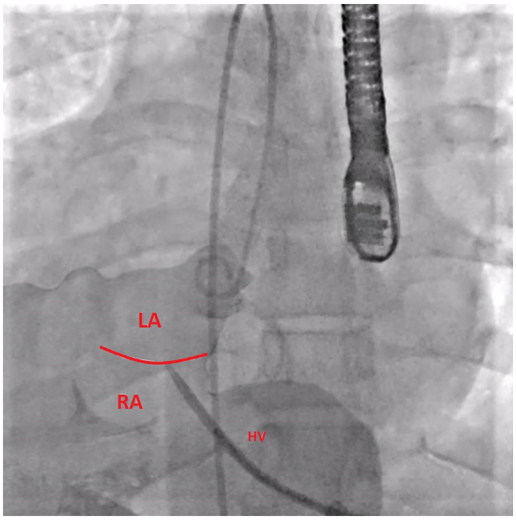
Under general anesthesia, the procedure was performed under ultrasound and fluoroscopic guidance. An 18G Chiba needle was inserted through the liver parenchyma to the mid portion of the middle HV under the left ninth rib ridge between the midclavicular and anterior axillary lines. The introduction of the needle to the HV was confirmed by contrast injection. An angled-tip 0.035 hydrophilic guidewire was placed into the right atrium, over which an 11-cm 6F sheath was secured in the HV. The hydrophilic wire was changed for a standard Amplatz guidewire, and the 6F sheath was replaced by a 28-cm 14F introducer sheath after serial dilatations of the access site. Finally, a steerable sheath was positioned in the 14F sheath. We also placed a pigtail catheter in

FIGURE 1 CTA



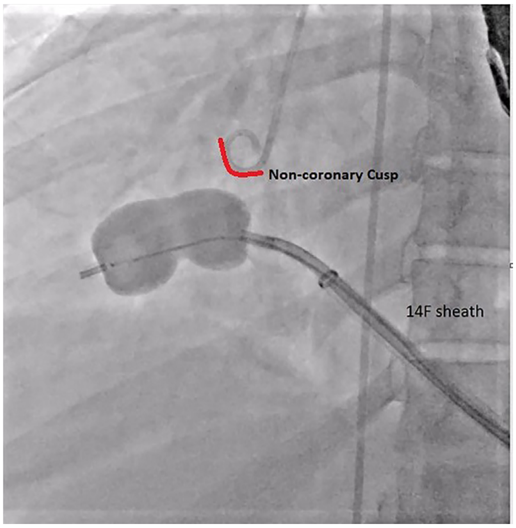
(A) CTA in coronal view, assessed to find the best route of interatrial septostomy from the middle HV and access to the LV. (B) The red line presents the trajectory of percutaneous middle HV access to RA for interatrial septostomy below the ninth rib on the left side.
CTA = computed tomography angiography; HV = hepatic vein; LA = left atrium; LV = left ventricle; MHV = middle hepatic vein; RA = right atrium.

FIGURE 2 Fluoroscopy Image



Overlay of fluoroscopy image of interatrial septostomy in anteroposterior view under transesophageal echocardiography guidance with an image of CTA in Figure 1 for better demonstration of septostomy position. Pigtail catheter in aortic root with a 14F sheath, a steerable introducer, and a trans-septal needle. Abbreviations as in Figure 1.

FIGURE 3 Inoue Balloon Insertion



Inflation of a 26-mm Inoue balloon through the MV in the left anterior oblique view, applied through a 14-F sheath from the left HV. The red curved line delineates the noncoronary aortic cusp. MV = mitral valve; other abbreviations as in Figure 1.

the non-coronary cusp of the aortic valve as another landmark. Using a 71-cm, 18G needle, targeting the 6 and 7 o'clock positions, a trans-septal puncture was performed under TEE guidance (Figure 2); heparin was administered subsequently.

The invasive measurement recorded a mean MV gradient of 10mmHg at a heart rate of 80 bpm. Next, a 0.025-inch stainless steel Inoue guidewire was introduced through the trans-septal catheter into the LA. A 26-mm Inoue balloon was then advanced through the 14F sheath into the LA. The Inoue balloon was advanced to the LV by clockwise rotation. We inflated the Inoue balloon with 2 sequential dilatations to a maximum balloon size of 24 and 26 mm, respectively (Figure 3). Ultimately, the postprocedural mean MV gradient was decrease to 3 mm Hg at a heart rate of 75 bpm with residual moderate mitral regurgitation. TEE confirmed an MV area of 1.7 cm^2 by planimetry (Figures 4 and 5, Videos 1 to 7). A schematic depiction of the patient's anatomical features and the procedures are presented in Figures 6 and 7. The footage of the procedure with a detailed description is provided in Supplemental Video 8.

After the procedure, protamine was administered, followed by the deployment of 2 embolization coils, 10 cm × 8 mm, and 10 cm × 10 mm in the parenchymal tract between the HV and the liver capsule to secure and achieve immediate hemostasis via a multipurpose catheter (Figure 8A). No complication was encountered during the procedure.

DISCUSSION

Although uncommon, congenital IVC interruption has been described frequently in the literature. The prevalence of IVC interruption or stenosis has been reported as 0.15% of the general population, but with an increased incidence of 1.3% in patients with congenital heart disease.[6] The most common anatomical variation of the IVC is its absence between the hepatic and renal veins, resulting in direct drainage of the HV into the right atrium or indirect drainage via the azygos vein.[3] IVC interruption is also commonly observed in patients with heterotaxy syndrome, characterized by dextrocardia or situs inversus.[1]

Percutaneous transhepatic venous access is feasible in such clinical scenarios,[1,5] particularly when transcatheter access to either atrium is required.[7] This approach has been used in various cardiovascular procedures, including diagnostic, interventional cardiac catheterization, and electrophysiology.[2,7] Considering the large diameter of the HV (6-14 mm), large-bore access via the HV is a feasible alternative.[3,8]

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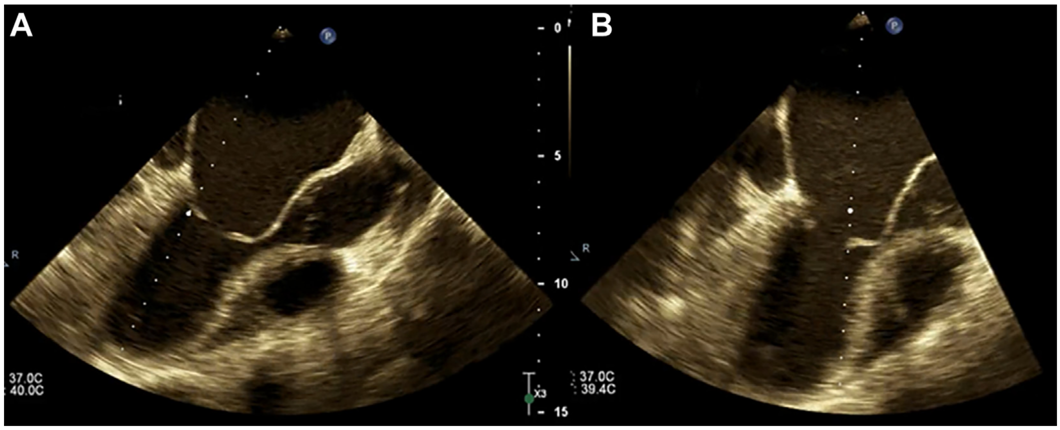
FIGURE 4 Two-Dimensional Transesophageal Echocardiography

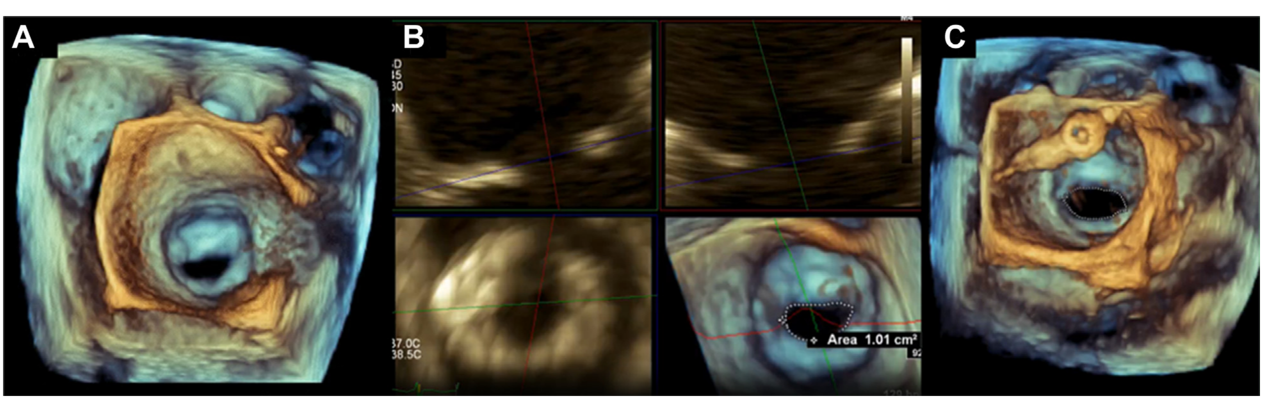


Two-dimensional transesophageal echocardiography long axis view. (A) Before PMBC. (B) After PMBC. PMBC = percutaneous mitral balloon commissurotomy.

Notably, the left HV approach requires minor modification of the standard trans-septal needle and Inoue balloon navigation. The position of the trans-septal puncture on the fossa ovalis is similar to standard percutaneous mitral balloon commissurotomy; however, navigating the trans-septal needle requires minor revisions. The clockwise rotation of the needle translates to anterior movement, and counterclockwise translates to posterior movement to fossa ovalis. Moreover, the needle should aim at 6 to 7 o'clock to be perpendicular to the interatrial septum. Navigation of the Inoue balloon from the LA to the LV requires clockwise rotation. The left anterior oblique view is consistent with the long axis of the LV for fluoroscopy during balloon inflation. Preplanning the procedure by the cardiac CT scan decreases the potential complications and simplifies the required procedural modifications.

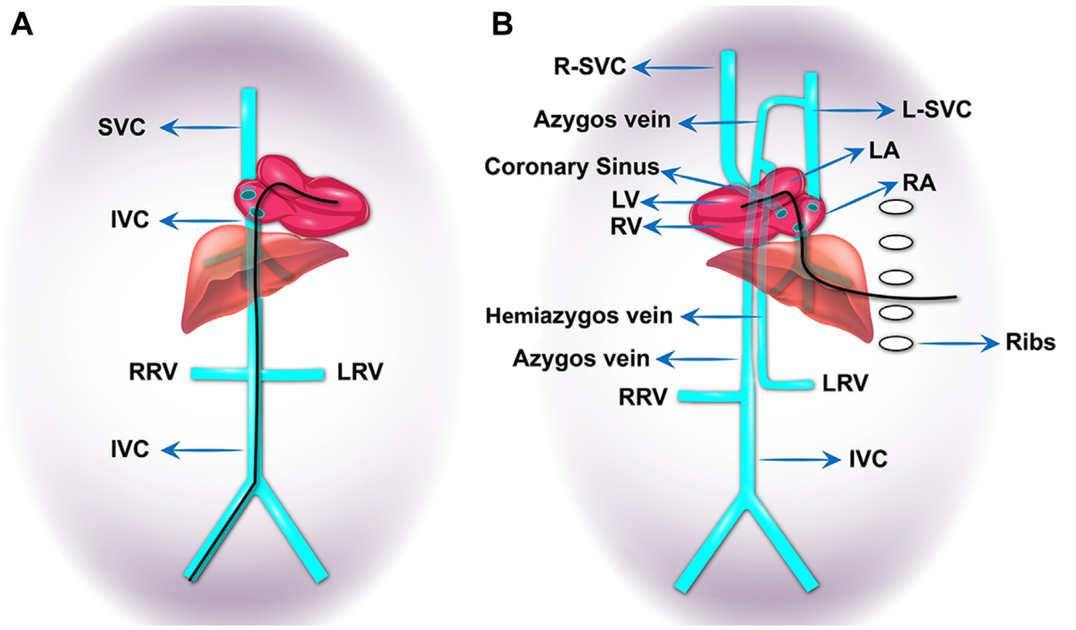
Percutaneous transhepatic venous access has been previously employed in catheter ablation for cardiac arrhythmias, in patients with and without dextrocardia or heterotaxy syndrome,[1-4] LA appendage

FIGURE 5 Three-Dimensional Transesophageal Echocardiography



(A) Surgical view before PMBC. (B) MV area measurement before PMBC using multiplanar reconstruction. (C) Surgical view after PMBC. Abbreviation as in Figure 4.

FIGURE 6 PMBC Pathways



Schematic image of (A) the usual pathway for PMBC with femoral vein access through the IVC compared with (B) percutaneous transhepatic access to the middle hepatic vein to the RA in our case with situs inversus totalis and interrupted IVC. IVC = inferior vena cava; LRV = left renal vein; RRV = right renal vein; R-SVC = right superior vena cava; RV = right ventricle; SVC = superior vena cava; other abbreviations as in Figure 1.

closure in patients with atrial fibrillation,[5,9] and MV repair.[7] To our knowledge, this is the first report of a patient with dextrocardia, IVC interruption, rheumatic mitral stenosis, and a left HV approach.[10]

FIGURE 7 2-Dimensional Transthoracic Echocardiography

Subcostal view, demonstrating situs inversus, dilated hepatic veins with multiple branches with no visible IVC suggestive of interrupted IVC. Abbreviation as in Figure 6.

FOLLOW-UP

A 24-hour postprocedural CT scan revealed proper hemostasis and no bleeding events or extravasation (Figure 5B). Full anticoagulation by warfarin and intravenous heparin resumed afterward.

CONCLUSIONS

This case report suggests the feasibility and safety of percutaneous transhepatic venous access to the LA in patients with interrupted IVC. Preplanning the alternative access site and understanding the required modifications are invaluable for procedural safety through an alternative venous access site.

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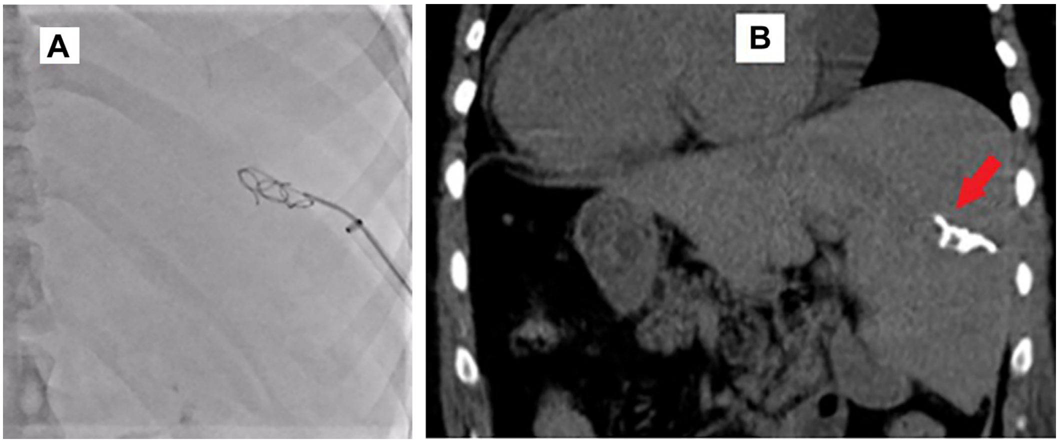
FIGURE 8 Placement of Embolization Coils



(A) Placement of 2 embolization coils (0.035-inch × 10 cm × 8 mm and 0.035-inch × 10 cm × 10 mm) in the parenchymal tract between the HV and the liver capsule via a multipurpose catheter. (B) Computed tomography image after procedure shows coils in the liver parenchymal with no hematoma formation.

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KEY WORDS commissurotomy, dextrocardia, mitral valve stenosis, inferior vena cava

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