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Case Report

Streamlined One-Stop Surgical Management for an Older Patient with Dextrocardia and Atrial Fibrillation: A Case Report

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Abstract

Co-occurrence of dextrocardia, a rare congenital heart defect, and atrial fibrillation (AF) is unusual. With the advancements in AF-related guidelines, anticoagulation therapy has become increasingly important. Lifelong oral anticoagulants remain imperative after successful AF ablation. Percutaneous left atrial appendage occlusion (LAAO) is an efficacious and secure strategy for preventing AF-related thromboembolic incidents, thereby confirming the progressive suitability of the one-stop approach of AF ablation + LAAO. Cryoablation, which is preferred for its short procedural duration and enhanced tolerability, is particularly advantageous for older patients with AF, facilitating a streamlined procedure under local anaesthesia. However, the presence of abnormal anatomical structures presents challenges to this technique. This study describes a case of successful cryoablation + LAAO performed under intracardiac echocardiography guidance in an older patient with dextrocardia and AF, providing a reference for the treatment of AF in patients with ectopic anatomy.

Keywords

dextrocardia; atrial fibrillation; cryoablation; streamlined left atrial appendage occlusion; intracardiac echocardiography; case report

Introduction

Dextrocardia, a congenital disease (1 in 10,000–12,000), and atrial fibrillation (AF) (1%–2%) are two rare conditions, and the co-occurrence of these two conditions is extremely rare [1]. Pulmonary vein isolation (PVI) serves as the cornerstone of AF ablation therapy, whereas percutaneous left atrial appendage occlusion (LAAO) is a preventative measure against AF-related thromboembolic events [2]. Conventional LAAO requires general anaesthesia and trans-oesophageal echocardiography (TEE) guidance, with cardiac surgery and extracorporeal circulation as a backup in emergency situations. Nonetheless, the accumulation of experience and advancements in medical device technologies have reduced the surgical risks associated with LAAO. Consequently, practices such as general anaesthesia and TEE, in some cases, may elevate patient risk and increase the time and cost of surgery and recovery. Evidence derived from clinical trials has demonstrated the safety and efficacy of LAAO under X-ray guidance, with a subset of clinicians accumulating extensive experience globally in streamlined LAAO approaches. However, the adoption of one-stop surgery in patients with dextrocardia has not been extensively documented. The presence of abnormal anatomical structures poses additional challenges to this technique, potentially increasing the risk of complications during transseptal puncture, PVI and LAAO.

Fig. 1. Lung digital radiography indicating the presence of dextrocardia.

Case Report

Patient information: A woman aged 88 years.

Diagnoses: Newly diagnosed AF; dextrocardia (Fig. 1); coronary atherosclerotic heart disease; heart function, New York Heart Association Class II; stage 3 hyper-

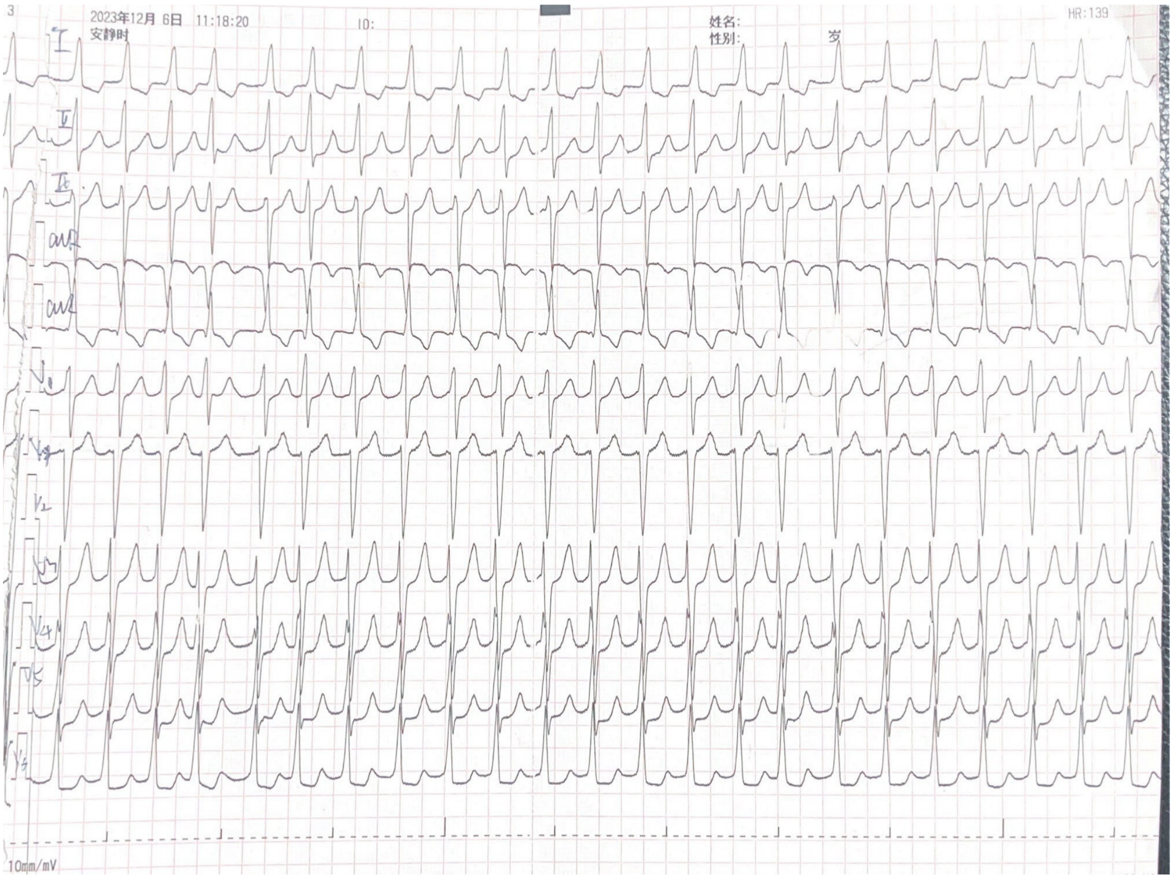


Fig. 2. Mirror-image electrocardiogram showing an atrial fibrillation rhythm with an average ventricular rate of 139 beats per minute, extensive anterior wall leading to ST segment (the interval between the S wave and the Twave is called the ST segment) depression and aVR leading (Augmented Unipolar Limb Lead aVR: Right arm as positive pole, left arm and left leg as negative pole) to ST segment elevation.

tension indicating very high risk; renal and hepatic dysfunction; history of colon cancer and history of gastrointestinal bleeding.

Chief complaint: Chest discomfort for half a day.

Post-admission electrocardiogram revealed AF (Fig. 2) with a rapid ventricular rate but normal troponin I levels. Echocardiography showed a left atrial diameter of 48 mm, left ventricular ejection fraction of 52%, calcification of the mitral valve posterior leaflet ring with mild mitral regurgitation and mild tricuspid and aortic regurgitation.

AF CHA_2DS_2VASc score (Table 1): congestive heart failure, 1 point; hypertension, 1 point; age, 2 points; vascular disease, 1 point; and female sex, 1 point, totalling 5 points, which indicated the need for anticoagulation intervention. HAS-BLED score (Table 2): renal and hepatic function abnormalities, 1 point each; history of bleeding, 1 point; age, 1 point; and aspirin use, 1 point, totalling 5 points, which indicated a high bleeding risk. Low-molecular-weight heparin was administered for anticoagulation.

Table 1. The CHA_2DS_2VASc score.

CHA_2DS_2VASc	Risk factors	Score
C	Chronic heart failure/Left ventricular dysfunction	1
H	Hypertensive	1
A	Age ≥75 years	2
D	Diabetes	
S	History of stroke/TIA/thromboembolism	
V	Vascular disease	1
A	Age ≥65 years	
Sc	Sex (Female)	1
Total	Maximum integral score	6

TIA, transient ischemia attack.

Coronary angiography revealed dextrocardia and a right-dominant circulation. Left anterior descending artery (LAD) (Figs. 3,4): proximal stenosis 95%; left circumflex artery: mid-segment stenosis 30%; and right carotid artery (Fig. 5): irregular wall, proximal stenosis 30%. A 2.5 × 19 mm Firebird2 drug-eluting stent was implanted in the proximal segment of the LAD (Figs. 3,4).

Table 2. Atrial fibrillation bleeding score: The HAS-BLED score.

HAS-BLED	Risk factors	Score
H	Hypertensive (SBP >160 mmHg)	
A	Abnormal liver function (3-fold increase in liver enzyme levels, >2-fold increase in bilirubin levels)	1
	Abnormal renal function (creatinine level ≥200 μmol/L)	1
S	History of stroke	
B	Bleeding history (including previous bleeding, bleeding constitution and anaemia)	1
L	Unstable INR (60% too high, unstable or substandard)	
E	Age ≥65 years	1
D	Medications (combination antiplatelet agents, nonsteroidal anti-inflammatory agents)	1
	Intemperance	
Total	Maximum integral score	5

INR, international normalized ratio; SBP, systolic blood pressure.

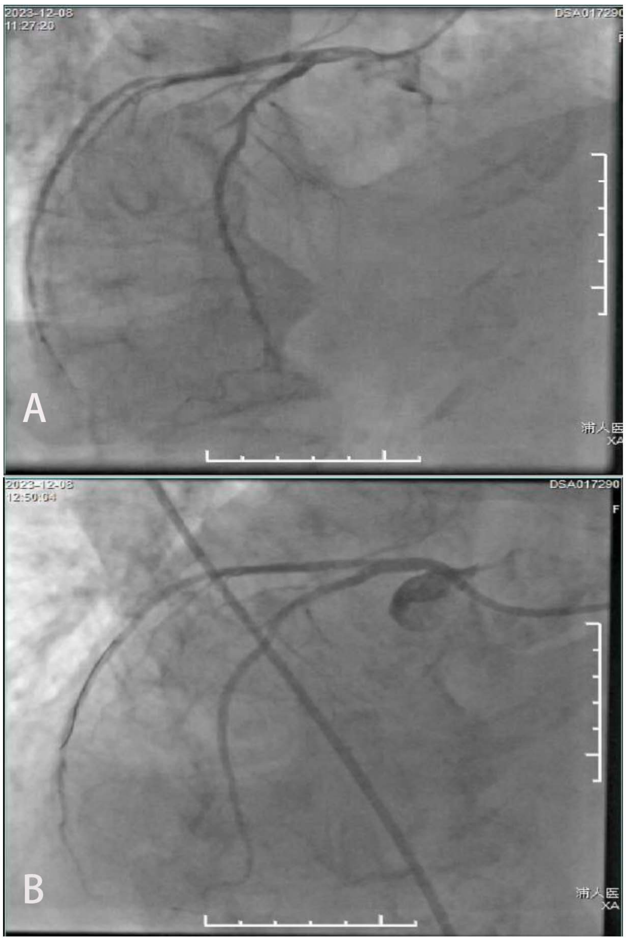


Fig. 3. Comparison of severe stenosis in the proximal and mid-segments of the left anterior descending artery before (A) and after (B) percutaneous coronary intervention from a mirror-image liver position.

Following the percutaneous coronary intervention, the patient presented with episodes of rapid ventricular rate AF accompanied by chest discomfort. Considering the patient's high HAS-BLED score, which indicated a significant bleeding risk from oral anticoagulation, advanced age and renal insufficiency, a decision was made to proceed with intracardiac echocardiography (ICE) to rule out left atrial appendage thrombosis, followed by AF cryoablation + LAAO under ICE guidance.

The patient, exhibiting dextrocardia and situs inversus totalis, underwent an X ray for procedural access via the right femoral vein for the insertion of 9F and 14F sheaths to facilitate the placement of the ICE catheter, cryo-sheath and LAAO delivery system. The 6F and 7F sheaths were inserted into the left femoral vein for the quadripolar and decapolar electrodes, respectively.

Preoperative pericardium images were obtained under ICE for comparison with postoperative pericardium images (Fig. 6).

ICE was used to exclude left atrial appendage and left atrial thrombus before operation (Fig. 7).

The digital subtraction angiography (DSA) system was set to mirror mode. Under DSA and ICE guidance, a successful transseptal puncture was performed at an angle of 45° on the left side of the DSA images (Fig. 8).

Owing to the patient's unique anatomical considerations arising from dextrocardia, a Johnson & Johnson (JNJ.US) adjustable bend coronary sinus electrode, which was designed for typical cardiac geometries, could not be navigated into the patient's coronary sinus. Consequently, it was positioned in the conventional right atrium (the patient's actual left atrium) for atrial potential monitoring.

Right Superior Pulmonary Vein Ablation

The right superior pulmonary vein exhibited a flat anterior course (Fig. 9). The Achieve catheter was advanced to the opening of the branch. Contrast injection performed via balloon inflation revealed retention of the contrast agent at the pulmonary vein orifice. The Achieve catheter was then retracted into the balloon and re-advanced to form a loop at the pulmonary vein orifice. As the sheath was not anchored to the balloon and the axis was acceptable, cryoablation was performed (Video 1).

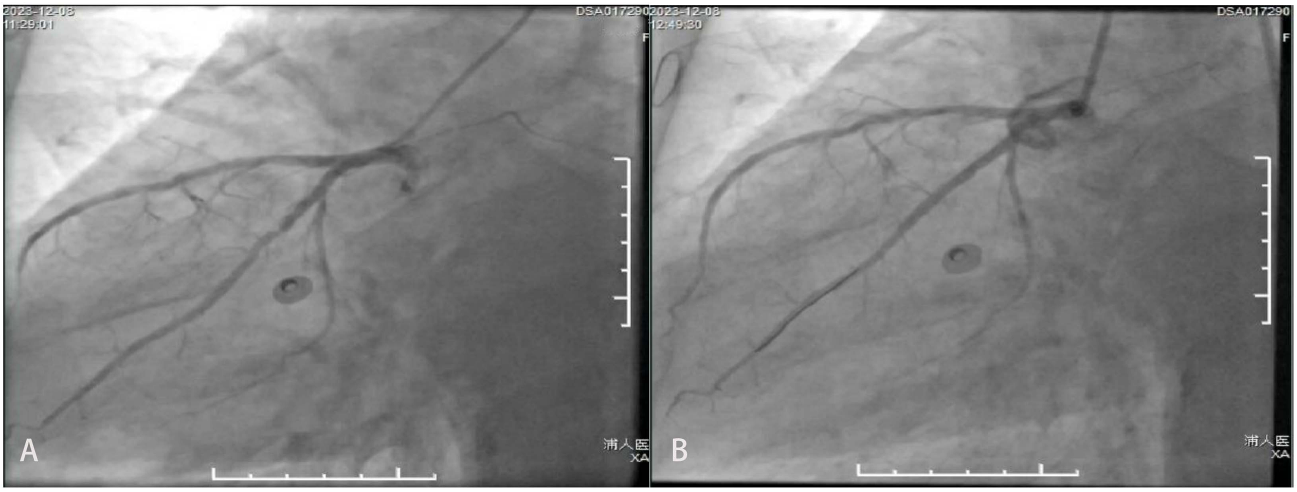


Fig. 4. Comparison of severe stenosis in the proximal and mid-segments of the left anterior descending artery before (A) and after (B) percutaneous coronary intervention from a mirror-image right shoulder position.

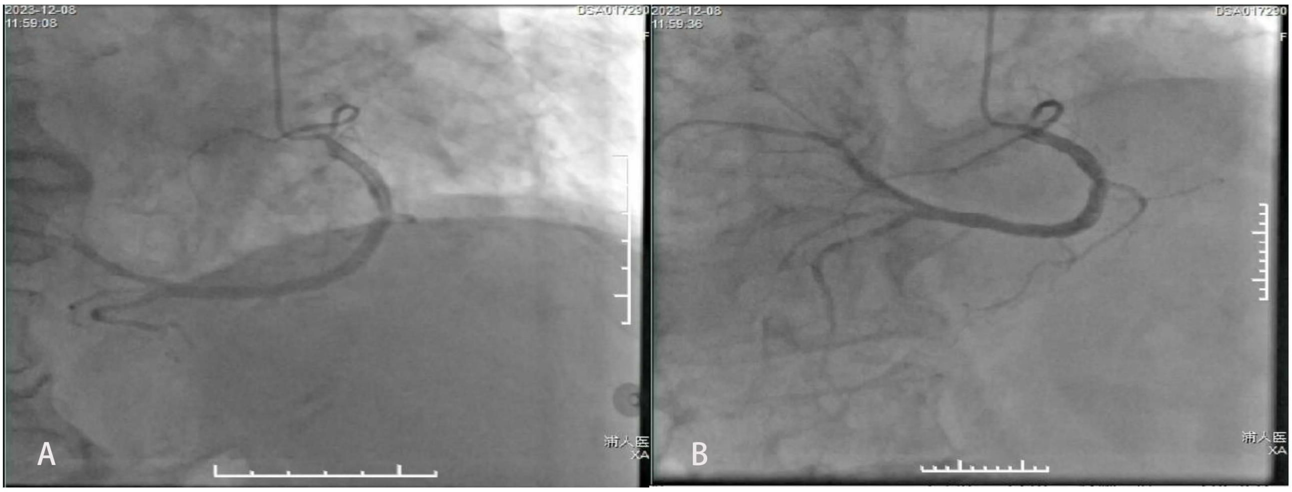


Fig. 5. No significant stenosis of the right coronary artery was visible in the mirror-image left anterior oblique (A) and head views (B).

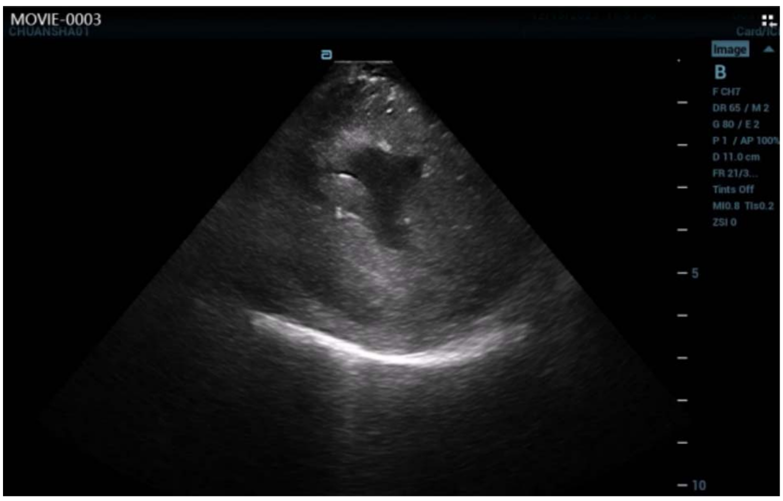


Fig. 6. Preoperative intracardiac echocardiography revealing the absence of pericardial effusion.

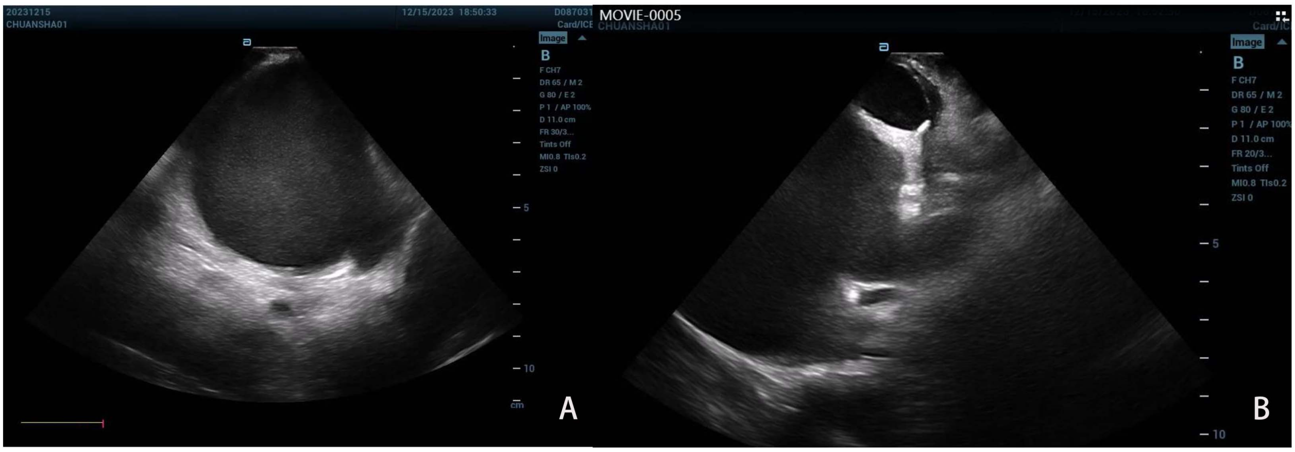


Fig. 7. Intracardiac ultrasound was used to detect left atrial and left atrial appendage thrombus. (A) Intracardiac echocardiography (ICE) exploration of the right atrial septum, verifying the absence of a thrombus in the left atrial appendage orifice. (B) ICE exploration of the right ventricular outflow tract, verifying the absence of a thrombus within the left atrial appendage body.

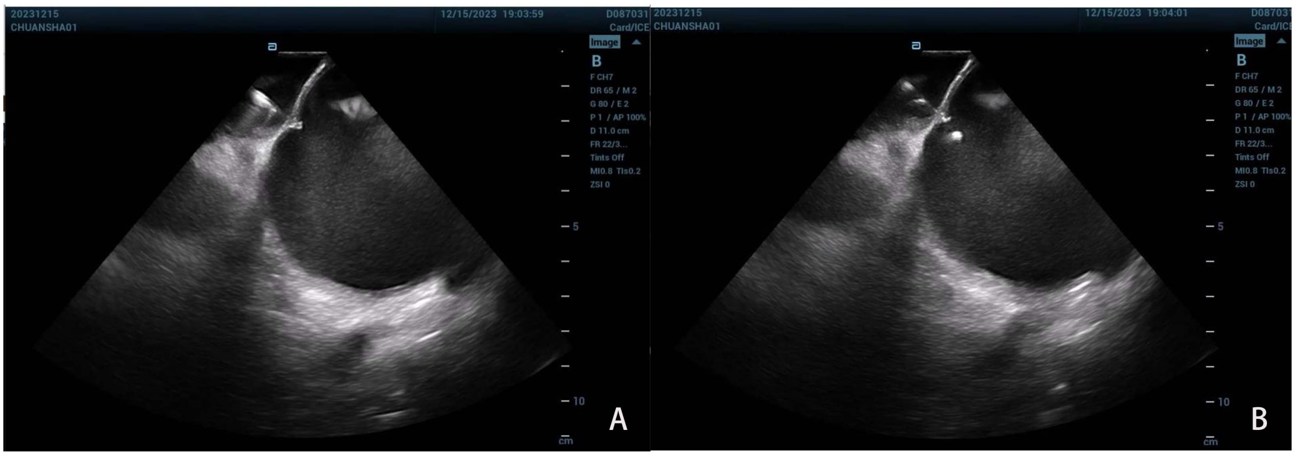


Fig. 8. Images obtained during intracardiac echocardiography-guided transseptal puncture. (A) Septal tenting caused by the needle tip. (B) Image of the needle tip penetrating through the septum into the left atrium.

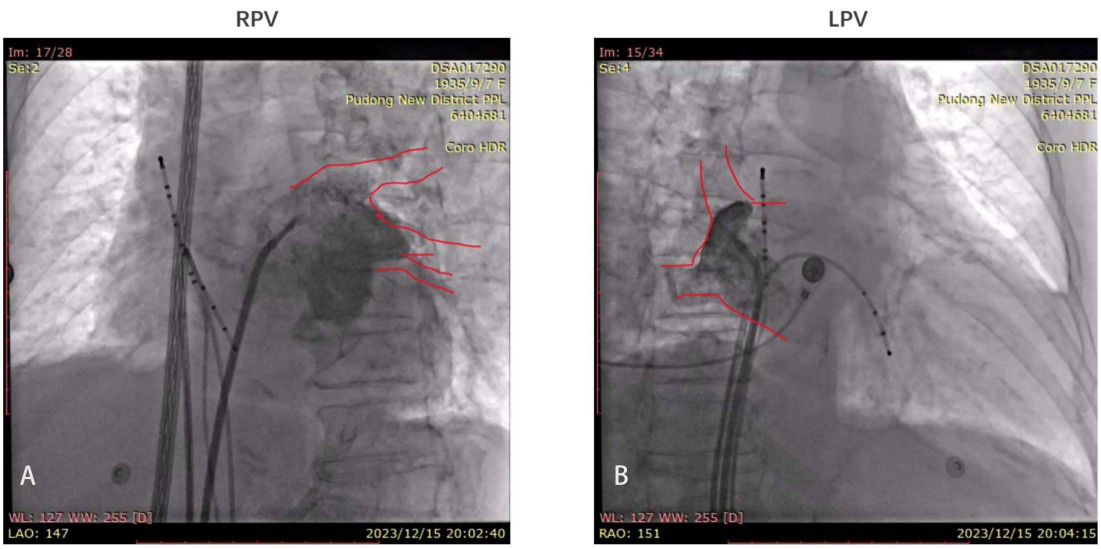
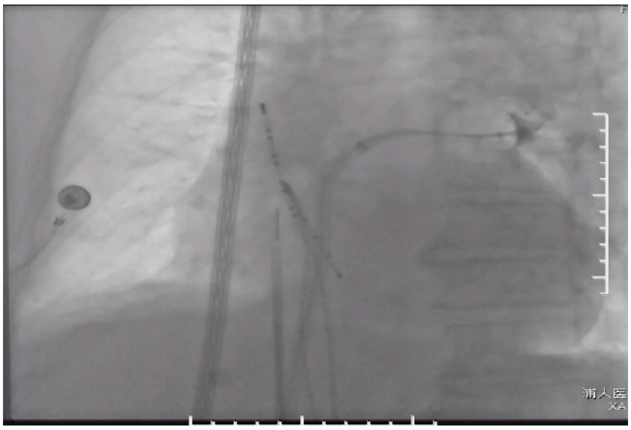
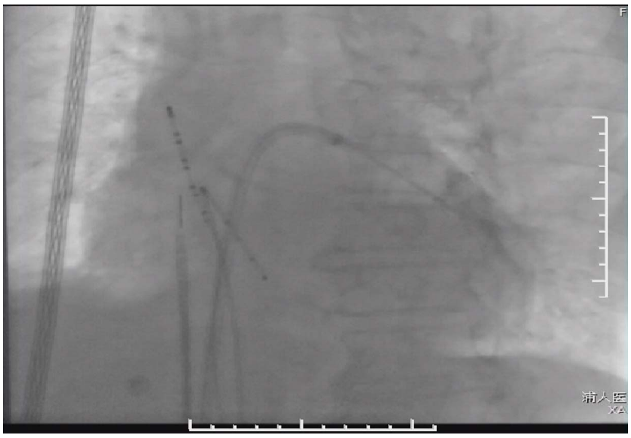


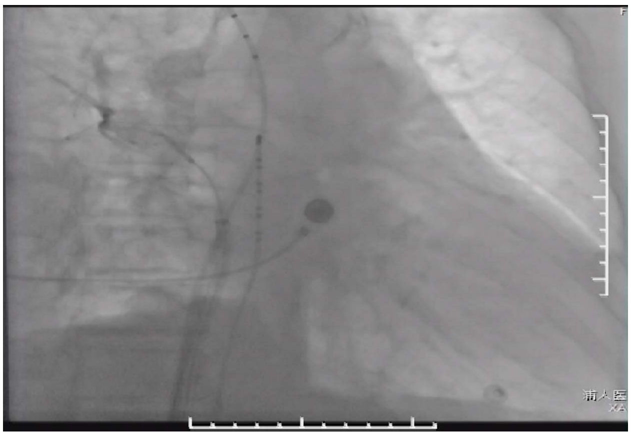
Fig. 9. Pulmonary venography. (A) Right pulmonary vein angiography. (B) Left pulmonary vein angiography.



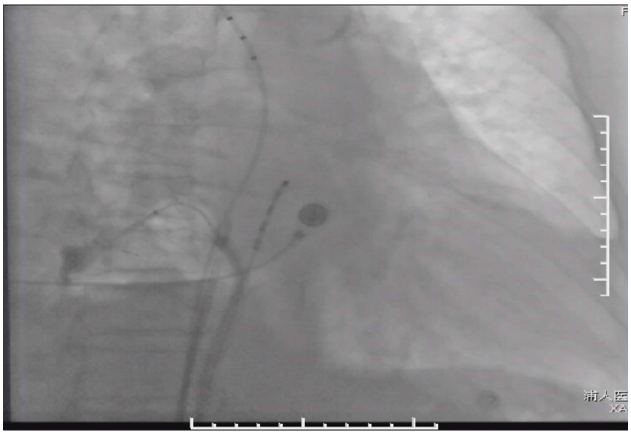
Video 1. Occlusion of the right superior pulmonary vein. Video associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8103.



Video 2. Occlusion of the right inferior pulmonary vein. Video associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8103.



Video 3. Occlusion of the left superior pulmonary vein. Video associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8103.



Video 4. Occlusion of the left inferior pulmonary vein. Video associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8103.

A single 180-s ablation strategy was implemented after observing a time to isolation (TTI) of 32 s and a temperature drop to –43 °C within 60 s, along with a satisfactory cooling curve (Fig. 10).

Right Inferior Pulmonary Vein Ablation

The Achieve catheter was advanced to the lower branch of the right inferior pulmonary vein, and the sheath was bent to align with the inferior branch. Following balloon inflation, the sheath was advanced to form a hockey stick shape, ensuring coaxial alignment. A cContrast injection showed significant retention of the contrast agent in the superior and inferior branches. The Achieve catheter was slightly retracted to visualise the PVP. Cryoablation was performed because the sheath was not anchored to the balloon (Video 2).

A single 180-s ablation strategy was adopted after observing a TTI of 18 s and a temperature drop to –43 °C within 60 s, along with a satisfactory cooling curve (Fig. 11).

Left Superior Pulmonary Vein Ablation

The left superior pulmonary vein exhibited an upwards course (Fig. 9). The Achieve catheter was advanced into the upper branch, followed by balloon inflation. Subsequently, the sheath was slightly bent and the entire system was advanced forward. The contrast agent was retained at the pulmonary vein orifice and branches, as demonstrated by contrast injection. The potential of the PVP was identified upon slight retraction of the Achieve catheter. Optimal alignment along the axis was attained based on the linear indication formed by the distal mark of the sheath. Thus, cryoablation was performed (Video 3).

Zero degree time (S)	30S temperature (℃)	60S temperature (℃)	120S temperature (℃)	Total time (S)	Minimum temperature (℃)	TTI (S)
14	-35	-43	-47	180	-48	32

Fig. 10. Disappearance of potential in the right superior pulmonary vein. TTI, time to isolation.

Zero degree time (S)	30S temperature (℃)	60S temperature (℃)	120S temperature (℃)	Total time (S)	Minimum temperature (℃)	TTI (S)
11	-37	-47	-50	180	-52	18

Fig. 11. Disappearance of potential in the right inferior pulmonary vein.

Zero degree time (S)	30S temperature (℃)	60S temperature (℃)	120S temperature (℃)	Total time (S)	Minimum temperature (℃)	TTI (S)
15	-33	-45	-51	180	-52	37

Fig. 12. Disappearance of potential in the left superior pulmonary vein.

Zero degree time (S)	30S temperature (℃)	60S temperature (℃)	120S temperature (℃)	Total time (S)	Minimum temperature (℃)	TTI (S)
12	-29	-41	-44	180	-46	-

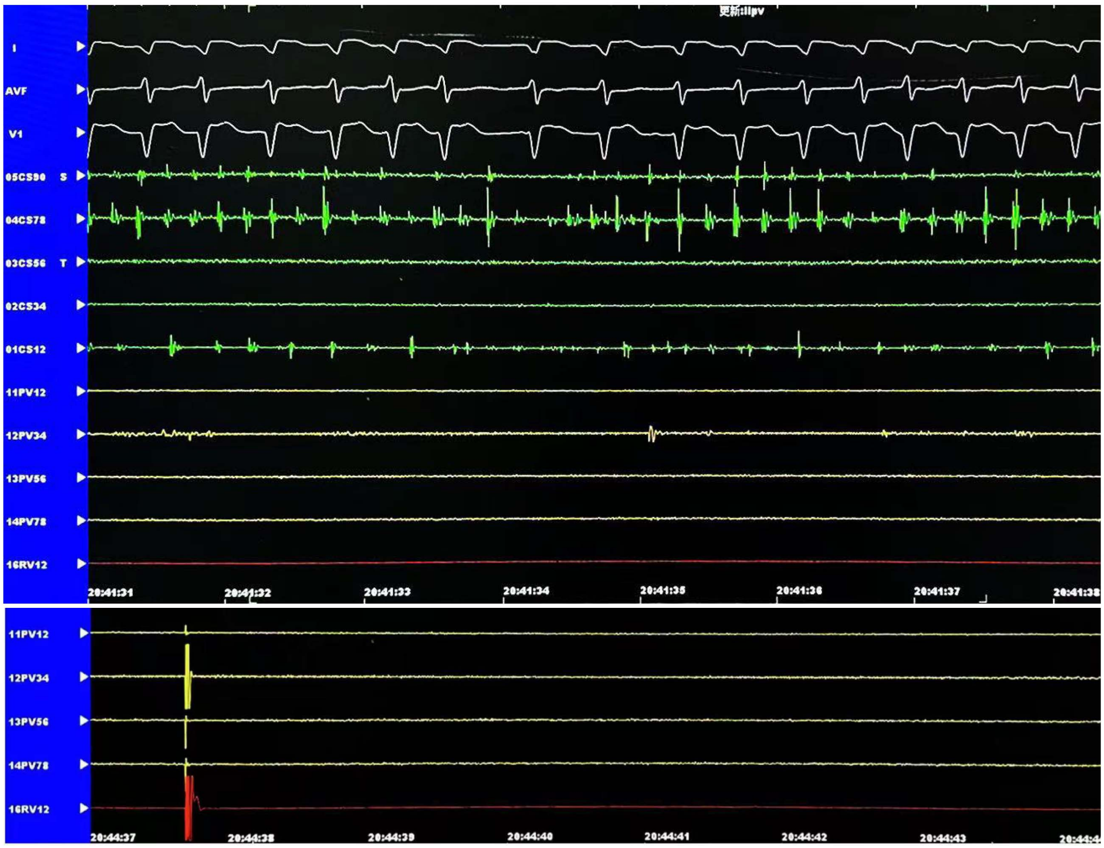


Fig. 13. Limination of electrical activity within the left inferior pulmonary vein.

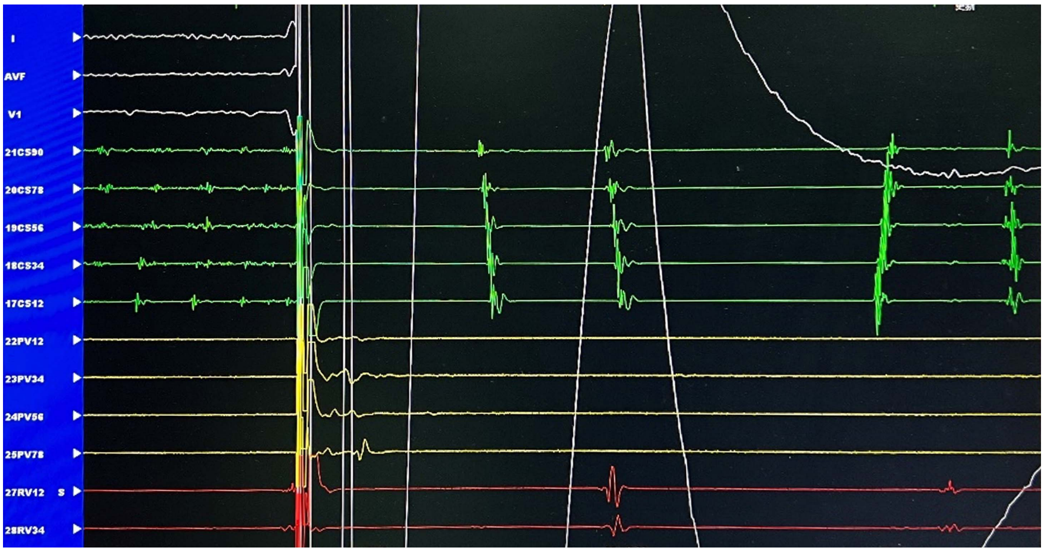


Fig. 14. Restoration to sinus rhythm after cardioversion.

Fig. 15. Angiography of the left atrial appendage at the left 30°/head 20° position.

Fig. 16. Angiography of the left atrial appendage at the left 30°/foot 20° position.

A single 180-s ablation strategy was adopted after observing a TTI of 37 s and a temperature drop to –45 °C within 60 s, along with a satisfactory cooling curve (Fig. 12).

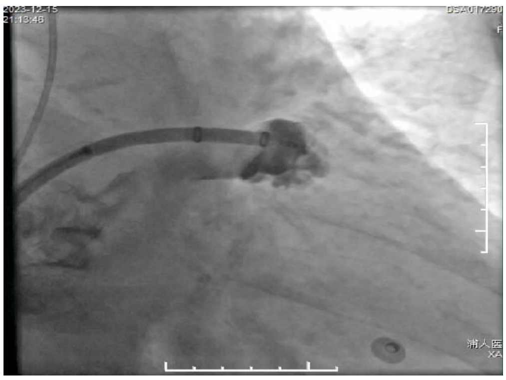


Fig. 17. Angiography of the left atrial appendage at the left 30°/foot 20° position shows the correct placement of the occluder disc.

Left Inferior Pulmonary Vein Ablation

The Achieve catheter was advanced to the opening of the lower branch of the left inferior pulmonary vein. The balloon was retracted below the sheath's bending point, and the sheath was fully angled to align with the lower branch. The sheath was withdrawn while advancing the balloon, and tension on the Achieve catheter was controlled to prevent the balloon from being ejected. After inflation, the sheath was retracted to occlude the branch. Contrast in-

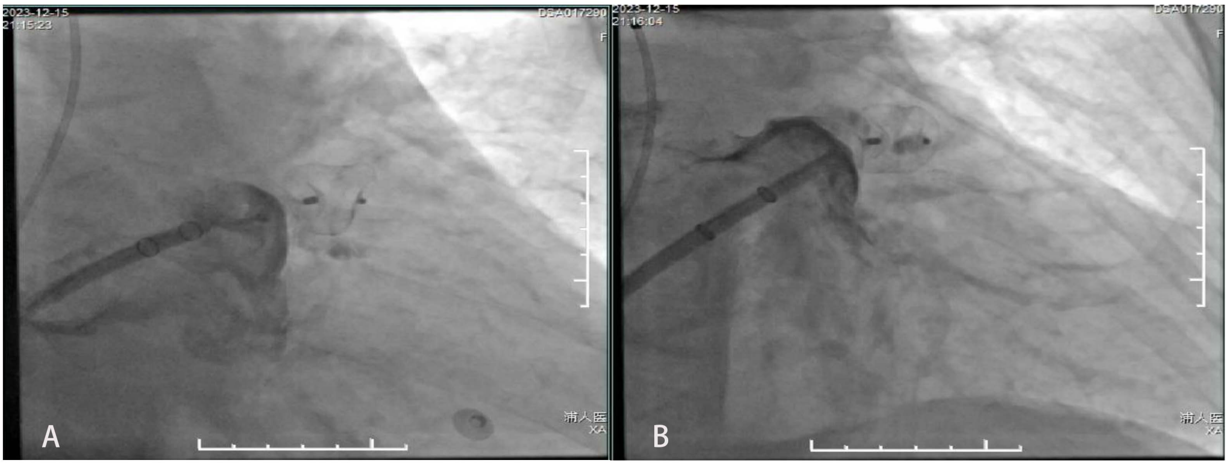


Fig. 18. Effective occlusion by the occluder disc at the left 30°/foot 20° position (A) and the left 30°/head 20° position (B), based on the position, anchor, seal, and size principle.

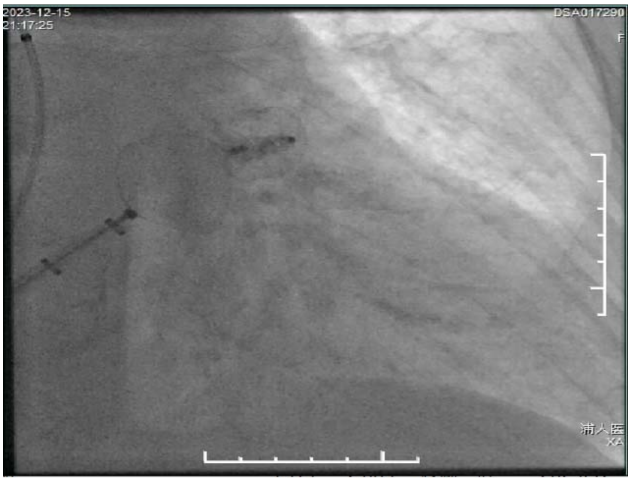


Fig. 19. Tug test assessing the stability of the occluder disc.

Fig. 20. Intracardiac echocardiography revealing good positions of the occluder and outer discs.

jection revealed contrast agent retention within the branch. No PVP potentials were detected. The sheath was rotated

Fig. 21. A final ICE exploration following the procedure indicating no pericardial effusion.

clockwise towards the posterior wall to form a loop with the distal mark, indicating optimal alignment. Thus, cryoablation was performed (Video 4). A single 180-s ablation strategy was adopted after observing a temperature drop to –41 °C within 60 s, along with a satisfactory cooling curve (Fig. 13). Following ablation, the Achieve catheter was retracted to the orifice without performing PVP detection.

Electrical cardioversion was performed with an electrical defibrillator after operation (Fig. 14).

Experience: In patients with dextrocardia undergoing cryoablation, setting DSA imaging to mirror mode, facilitates the alignment of pulmonary vein configuration images with that observed in patients with levocardia. Although the process of manipulating the sheath for elevation and angulation in patients with dextrocardia mirrors that in patients with levocardia, the approach for anterior and posterior axial movements is inverted. The left side of DSA images actually shows the right pulmonary vein; turning the X clockwise moves it forward, whereas turning it anti-

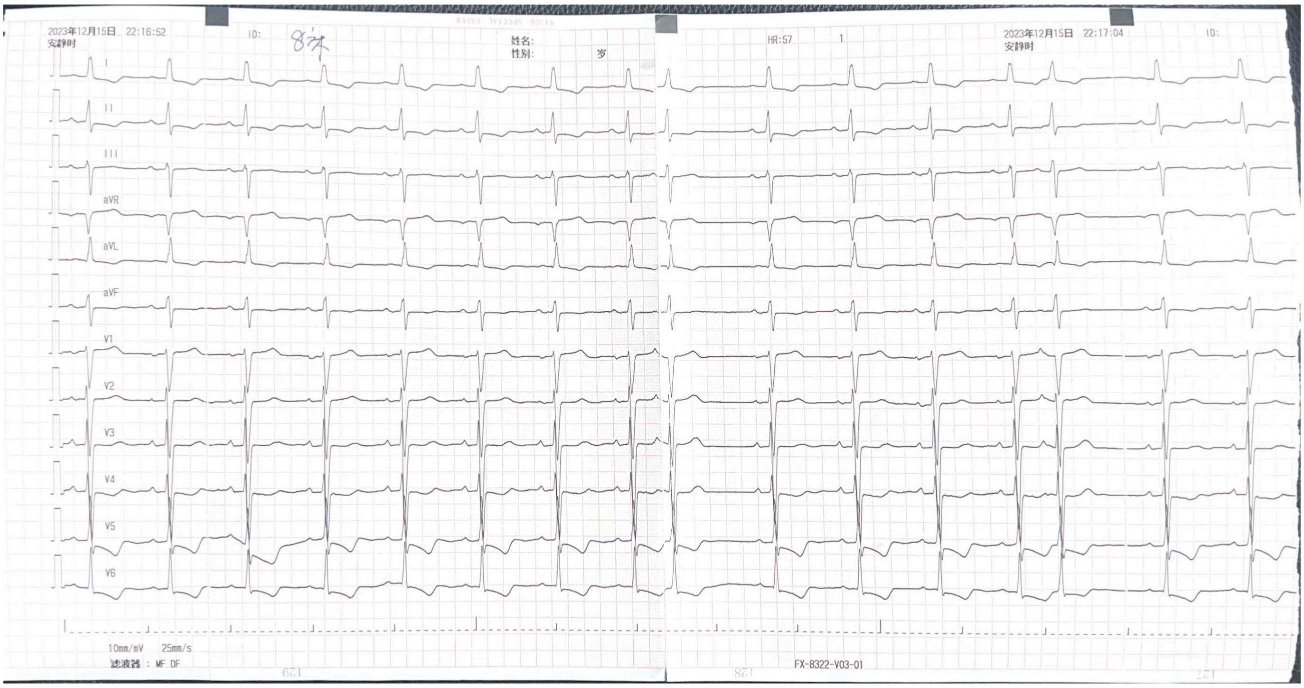


Fig. 22. Postoperative electrocardiography check-up indicating sinus rhythm.

clockwise moves it backward. Similarly, the right side of DSA images actually shows the left pulmonary vein; turning the X clockwise moves it backward, whereas turning it anticlockwise moves it forward.

Left Atrial Appendage Occlusion (LAAO)

Angiography and measurements of the left atrial appendage were performed at the left 30°/head 20° (Fig. 15) and left 30°/foot 20° (Fig. 16) positions.

The mirror position was used as the working position to release the left atrial appendage occlude (Fig. 17).

Angiography of the left atrial appendage at both left 30°/head 20° and left 30°/foot 20° positions confirmed effective occlusion by the left atrial appendage occluder (Fig. 18).

Tugging on the occluder disc tail performed to test the stability of the occluder (Fig. 19).

Considering the patient's distinctive cardiac anatomy and associated risks, ICE was not performed to traverse the septum for left atrial exploration. Instead, it was used to determine the occlusion status of the left atrial appendage occluder at the right atrial septum, which was found to be satisfactory (Fig. 20).

Postoperative routine ICE exploration of the pericardium indicated no pericardial effusion (Fig. 21).

Postoperative electrocardiography check-up: The sinus rhythm was well maintained (Fig. 22).

Discussion

Dextrocardia is rare in the general population [3] and may often lead to significant extracardiac anomalies [4–6]. In general, the incidence of AF in individuals with dextrocardia is similar to that in the general population. However, the modified cardiac structure in patients with dextrocardia can pose challenges for cardiologists during cardiac interventional procedures. Although PVI cryoablation [7,8] and LAAO [1,9] have been reported in patients with dextrocardia and AF, reports on a one-stop surgical approach for this population are scarce.

This study describes the case of an older woman with AF and concurrent coronary artery disease. She experienced significant myocardial ischaemia and chest discomfort during episodes of rapid ventricular rate AF, indicating an urgent need for AF cardioversion. Considering the patient's high HAS-BLED score, which indicates an increased bleeding risk, the use of oral anticoagulants was restricted, indicating an urgent need for LAAO. Catheter ablation has been proven effective in AF treatment, with PVI serving as the foundational technique. Cryoballoon ablation has recently emerged as a novel ablation method and has become one of the standard techniques for achieving PVI. The PROTECT AF and PREVAIL studies have provided evidence for the protective role of LAAO in preventing thromboembolic events in patients with AF, particularly in those with elevated CHA_2DS_2VASc and HAS-BLED scores. This indicates considerable risks associated with long-term oral anticoagulation, which ultimately makes LAAO the preferred treatment option [2,10]. Accumulating operator experience in percutaneous transcatheter LAAO has significantly increased the procedural success rate up to 98% [11,12]. Conventional LAAO necessitates general anaesthesia and TEE guidance, with backup cardiac surgery and extracorporeal circulation for handling emergency situations. Nonetheless, the accumulation of experience and advancements in medical device technologies have reduced the surgical risks associated with LAAO. Consequently, practices such as general anaesthesia and TEE may increase patient risk in certain contexts, prolonging the duration and increasing the cost associated with surgery and recovery. Evidence from clinical trials has demonstrated the safety and efficacy of LAAO under X-ray guidance. Currently, experienced centres routinely implement a streamlined LAAO procedure. In the present case, the patient successfully underwent a streamlined percutaneous cryoablation and LAAO procedure under ICE guidance. This case demonstrates the feasibility and safety of performing streamlined PVI cryoablation and LAAO for patients with dextrocardia and AF under continuous ICE guidance. The use of ICE facilitated a safe transseptal puncture process and the determination of the optimal puncture location. The direction of rotation for the manipulation of dextrocardia via intracardiac ultrasound is completely opposite to that for the manipulation of conventional surgery. Accurate anatomical positioning of the anomalous pulmonary vein ostia and left atrial appendage was achieved through DSA. The mirror mode of DSA visually aligned the anatomy of the pulmonary vein and left atrial appendage with that of a normal heart, albeit with completely reversed operational directions and DSA gantry angles. However, the decapolar electrode, designed solely to conform to the shape of the coronary sinus of a normal heart, could not be inserted into the coronary sinus. Instead, it was placed within the atrial system of the venous system to record atrial points. Fortunately, the reliance on coronary sinus potentials for PVI cryoablation is minimal. Thus, atrial potentials could be used to substitute coronary sinus potentials for monitoring the correlation between the pulmonary vein and atrial potentials during the procedure. Owing to the hospital's lack of experience in ICE-guided transseptal puncture into the arterial system atrium via the right atrial septum, the patient's advanced age and multiple comorbidities, the occlusion performance of the left atrial appendage occluder was not evaluated using routine ICE at four angles after implantation. Instead, DSA and venous system septal ultrasound were jointly performed to evaluate occlusion performance according to the Position、Anchor、Seal、Tyre (PAST) principle. The procedure yielded favourable results, with the patient maintaining sinus rhythm after cardioversion. Furthermore, AF recurrence in the early postoperative myocardial oedema phase was effectively maintained via the administration of half a tablet of sotalol daily for 3 months. Following conversion to sinus rhythm, the patient's arrhythmogenic cardiomyopathy was sufficiently controlled, cardiac function was markedly improved, and exercise tolerance was significantly enhanced compared with baseline. A follow-up TEE or pulmonary vein CTA at 45 days postoperatively confirmed the complete endothelialisation of the left atrial appendage occluder. Thus, oral anticoagulants were discontinued, and treatment was switched to oral dual antiplatelet therapy for 6 months, followed by long-term aspirin therapy, thereby substantially reducing the risk of bleeding.

Conclusion

In conclusion, intraoperative real-time ultrasound guidance is pivotal for successful transseptal puncture. Adapting to the reverse operation procedures via the image inversion function of the DSA system is crucial for the successful treatment of dextrocardia via cryoablation and LAAO. These insights have also been emphasised in other percutaneous cardiac interventions for dextrocardia, including catheter ablation for paroxysmal focal AF [13–15]. Therefore, a broader spectrum of cardiac diseases with concurrent anomalous anatomies can be effectively treated under real-time ultrasound guidance.

Availability of Data and Materials

All data and materials were authentically available.

Author Contributions

ZC contributions to the design of the work; SH contributions to the conception of the work; YX contributions to the acquisition of data for the work. All authors have participated sufficiently in the work. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study was conducted in accordance with the guidelines of the Helsinki Declaration. As this was a retrospective study about a case report, the Ethics Committee of the Pudong New Area People's Hospital in Shanghai waived the requirement for ethical approval and informed consent. All clinical data were collected at the Pudong New Area People's Hospital in Shanghai, and the study was also conducted at this hospital.

Acknowledgment

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This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.59958/hsf.8103.

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