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Navigating the Challenges of Refractory Heart Failure with atrioventricular and biventricular dyssynchrony: Clinical Reflections and Lessons Learned

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Case Report

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Abstract

Introduction

Heart failure (HF), a complex clinical syndrome arising from structural or functional cardiac impairment, carries substantial morbidity with 30% early readmission rates within three months post-discharge and strong mortality associations [(1)]. The pathophysiological interplay between atrial fibrillation (AF) and HF presents particular clinical challenges, as their concomitant presence portends worse prognoses than either condition in isolation[(2)]. Moreover, biventricular dyssynchrony emerges as a critical pathophysiological determinant of impaired ventricular filling and reduced cardiac output [(3)]. The tripartite convergence of these conditions creates a high-risk clinical scenario requiring sophisticated therapeutic strategies.

Here we present a therapeutic paradigm employed sequential interventions, highlighting clinical reflections and lessons learned from a staged interventional approach.

Methods

A therapeutic paradigm employed sequential interventions: initial atrioventricular node ablation (AVNA) with BiV-CRTD implantation, followed by delayed AF radiofrequency ablation 18 months later.

Results

The patient experienced relief from dyspnea, accompanied by enhanced performance on the 6MWT. The postoperative ECG demonstrated narrowed QRS complex duration,alongside improvements in LVEF and cardiac chamber dimensions. Near 100% biventricular pacing capture was achieved, with progressively optimized left ventricular lead parameters, dynamically decreasing pro-BNP levels and the maintenance of sinus rhythm one year after the AF ablation, collectively confirming the therapeutic benefits.

Conclusion

Correcting AV, interventricular, and intraventricular dyssynchrony is crucial. The efficacy of CRT varies individually due to myocardial viability, target vessel anatomy, and patterns of delayed cardiac activation. Reducing RV lead output to minimize pacemaker battery consumption in pacemaker-dependent patients with suboptimal LV lead parameters carries substantial risks. Although AVNA can achieve near-complete biV pacing in patients with persistent atrial fibrillation, this approach should be exercised with caution. For future management, Bachmann's bundle pacing may be considered, while left bundle branch area pacing represents a viable alternative when LV lead parameters remain unsatisfactory.

Key clinical message

The combined approach of AVNA plus BiV-CRT followed by AF radiofrequency ablation for patients with atrioventricular and biventricular desynchronization can improve quality of life and decrease the

readmission rate. Future investigations should prioritize three crucial areas: 1) intervention timing optimization, 2) procedural sequencing protocols, and 3) precision patient selection for combined therapy strategies.

Case history

A 64-year-old female patient with a 3-year history of essential hypertension (EH), exhibiting peak blood pressure recordings of 180/110 mmHg, was admitted to our department on three occasions within a six-month period. The patient reported a five-year progression of exertional dyspnea accompanied by gradually diminishing exercise tolerance, with intermittent lower extremity edema developing over the preceding six months. Although antihypertensive therapy had been initiated, the patient reported intermittent use of unspecified antihypertensive medications without regular blood pressure monitoring and denied any history of dizziness, headache, fatigue, or chest pain before initial admission.

Examination

Physical examination revealed clinical signs consistent with biventricular heart failure (detailed in Table 1). Diagnostic workup confirmed atrial fibrillation (AF) with a CHA2DS2-VASc score of 5 and complete left bundle branch block (CLBBB) on electrocardiogram (Fig. 1). Comprehensive cardiac evaluation via echocardiography and coronary angiography findings from the initial admission are presented in Fig. 2. Continuous cardiac monitoring demonstrated persistent AF rhythm.

Table 1
The physical examination on admission

Physical examination on admission		
Basic information Self-employed		
Vital signs	Temperature	36.6 degree
	Pulse frequency	60 x/minute
	Heart rate	83 x/minute
	Respiration rate	22 x/minute
	Blood pressure	142/86mmHg
Other signs	**Height** 1.56m, **Weight** 60Kg, **BMI** 24.7Kg/m2. Jugular vein distension, positive hepatojugular reflux. Lung moist rale. Cardiac signs of atrial fibrillation. Systolic murmurs (3/6) in the mitral valve area. Symmetric edema of lower limbs.	

Treatment and follow-up

The first admission (July 28th ,2023): The physician in charge first gave the diagnosis of dilated cardiomyopathy (DCM) and the standard treatments were given according to the guidelines(5). Those included intravenous diuresis and oral medication such as Furosemide 20mg QD and Spironolactone 20mg QD to reduce volume load, Rivaroxaban 20mg QD for anti-coagulation, Atorvastatin 20mg QN for stabilizing plaques, Sacubitril valsartan 25mg BID, Metoprolol sustained release tablets 23.75mg QD, Viricigua 2.5mg QD, Daglizin 10mg QD to improve cardiac remodeling. The patient's symptoms were relieved and the six-minute walk test (6MWT) increased from 100m to 420m before and after the first admission.

The second admission (Sept.27th ,2023): There was no clear cause for the worsening of HF and the vital signs and ECG manifestation were similar to the first one. The general treatment strategies were not significantly adjusted due to BP intolerance. Based on intravenous diuresis, the patient’s symptoms were relieved and discharged again.

The third admission (Nov.9th ,2023): Considering the unsatisfied efficacy of drug therapy, meanwhile the enlargement of left atrium as well as the fine tremors on ECG implied the high recurrence of AF after the radiofrequency ablation.[6] We performed the AVNA combined with BiV-CRTD (Fig. 3).

Follow up (**Nov. 2023 to Mar. 2025**): Her symptoms improved significantly and wasn't admitted to the hospital again for HF. The 6MWT also increased from the initial 100meters to 580 meters one year after the procedure.

The fourth admission (Mar. 26th, 2025): After excluding the left atrial thrombus, we performed the AF radiofrequency ablation. The major consumables (Table 2), the postoperative ECGs (Fig. 4), the parameters of CRT-D (Table 3), the left atrial substrate and ablation route map (Fig. 5), the parameters of UCGs and Pro-BNP (Table 4) are shown below respectively. The substrate of left atrium was poor as predicted before, with more low-voltage zones. In addition to pulmonary vein isolation (PVI), we also did posterior wall isolation, and the patient was converted to sinus rhythm with biventricular pacing after 100J synchronous electrocardioversion.

Table 2
Related materials and corresponding models

Serial Number	Device Name	Model
1	TC Ablation Catheter	NI75TCDH
2	Implantable cardiac resynchronization defibrillator (CRT-D)	Intica 5 HF-T QP
3	Implantable defibrillation electrode lead	Plexa ProMRI S 65
4	Implantable left ventricular pacing lead	Sentus ProMRI OTW QP L-85/49
5	Coronary sinus electrode lead delivery system and accessories	Selectra BIO2-45
6	Thermal dilution floating catheter	TD2704ND
7	SF Ablation Catheter	D134721IL
8	Pentary mapping Electrode Catheter	D128211
9	CARTO VIZIGO Bi-Directional Guiding Sheath	D138501

No.	Date	CRTD parameters															
		RV						LV					Pacing RV/CRT (%)	Mode	Basic frequency (bpm)	VT1/VT2/VF (bpm)	battery voltage (V)
		Sensing (mv)	capture (V)	Pulse amplitude (V)	Pulse Width (ms)	Pacing impedance (Ω)	Defibrillation impedance (Ω)	Sensing (mv)	capture (V)	Pulse amplitude (V)	Pulse Width (ms)	Pacing impedance (Ω)					
1	22/11/2023	24.2	1.5	1.75	0.4	625	84	24.4	5.5	6.5	0.4	1146	100/100	VVIR/BiV	80	171/OFF/207	3.15
2	15/12/2023	24	1.5	1.75	0.4	630	90	23.2	6	6.5	0.4	1156	100/100	VVIR/BiV	80	171/OFF/207	3.15
3	01/03/2024	23	0.4	1.5	0.4	654	94	22.5	6.5	7.5	1.5	1493	100/99	VVIR/BiV	65	171/OFF/207	3.15
4	19/04/2024	17.5	0.4	1.5	0.4	625	85	18.8	6.5	7.5	1.5	1392	100/99	VVIR/BiV	65	171/OFF/207	3.1
5	12/7/2024	20.1	0.4	1	0.4	639	88	16.0	5.5	7.5	1.5	1589	100/100	VVIR/BiV	65	171/OFF/207	3.02
6	24/3/2025	20	0.5	1	0.4	654	90	18.4	5.5	7.5	0.75	1594	100/100	VVIR/BiV	65	171/OFF/207	2.97
7	12/09/2025	20	0.5	1	0.4	654	90	17	4.0	5.0	0.75	1493	100/100	VVIR/BiV	65	171/OFF/207	2.96
8	06/03/2026	20	0.4	1	0.4	639	88	17.5	4.4	5	0.75	1377	100/100	VVIR/BiV	65	171/OFF/207	2.96

Table 3. The parameters of CRT-D

NO.	Date	Echocardiography							QRS duration(ms)	Pro-BNP (pg/ml)
		LA(mm)	LV(mm)	RA(mm)	RV(mm)	IVS(mm)	LVPW(mm)	LVEF (%)		
1	26/07/2023	48	53	51	21	11	11	34	152	3259
2	30/09/2023	53	64	48	18	11	11	29	154	8047
3	01/03/2024	53	55	48	20	11	11	34	125	1341
4	12/07/2024	50	52	47	21	11	11	42	124	1300
5	21/02/2025	51	53	47	20	9	9	45	124	1500
6	21/03/2025	51	52	50	20	10	10	48	138	980
7	06/03/2026	48	49	50	18	10	10	59	126	296

Table 4. The parameters of UCGs, ECGS and Pro-BNP

Discussion

HF combined with AF and cardiac dyssynchrony is a common high-risk clinical phenotype associated with progressive ventricular remodeling, reduced exercise tolerance and poor long-term prognosis. AF markedly impairs CRT efficacy, mainly due to irregular atrioventricular conduction and unstable biventricular pacing capture, which frequently leads to suboptimal CRT response[(4)].

In this case, we adopted a staged sequential strategy: initial AVNA plus BiV-CRTD implantation, followed by delayed AF radiofrequency ablation 18 months later. This approach yielded favorable clinical and structural improvements, including alleviated dyspnea, enhanced 6-minute walk performance, narrowed QRS duration, elevated LVEF and reduced pro-BNP, with nearly 100% biventricular pacing and stable sinus rhythm during follow-up. But as a single case report without a control group, the generalizability of this strategy is limited. Long-term outcomes beyond 1-year follow-up remain unclear, and the optimal timing of delayed AF ablation, require further large-scale validation.

In this case, we performed a staged sequential intervention strategy, including initial AVNA combined with BiV-CRTD implantation, followed by delayed AF radiofrequency ablation 18 months later. This strategy achieved satisfactory clinical and structural improvements, including relieved dyspnea, improved 6-minute walk capacity, narrowed QRS duration, increased LVEF and decreased pro-BNP levels. Near 100% biventricular pacing capture was maintained, and stable sinus rhythm was sustained during long-term follow-up. As a single case report, the present study lacks a large patient cohort and comparative control group, so the generalizability of the staged sequential intervention strategy remains to be verified in larger prospective studies. Long-term follow-up data beyond one year after AF ablation are not available to confirm the sustained durability of sinus rhythm and long-term CRT response. In addition, we did not compare the clinical outcomes of left bundle branch pacing versus conventional biventricular pacing in this patient, and the optimal timing of delayed AF ablation after AVNA and CRTD implantation needs further exploration in real-world populations.

Several key clinical lessons can be drawn from this case in the context of current evidence. First, high and stable biventricular pacing percentage is essential for successful CRT in persistent AF patients. AVNA effectively eliminates irregular native conduction and guarantees continuous ventricular resynchronization, which supports reverse cardiac remodeling in arrhythmia-mediated dyssynchrony HF. Emerging evidence indicates that LBBP provides a more physiological alternative to conventional biventricular pacing. By restoring native His-Purkinje conduction, LBBP yields narrower paced QRS complexes and superior reverse remodeling outcomes, especially in patients with unfavorable venous anatomy or suboptimal[5, 6].

Second, the clinical value of atrial lead implantation should be individually determined according to underlying rhythm status[7]. For patients with persistent AF and complete AV block after AVNA, atrial mechanical function is ineffective, and an atrial lead contributes minimally to atrioventricular synchrony. In contrast, atrial leads remain indispensable for patients with intermittent sinus rhythm to maintain coordinated multi-level ventricular synchrony.

Third, pulsed-field ablation (PFA) has become an innovative non-thermal technique for AF rhythm control in recent years. A randomized controlled trial demonstrated comparable efficacy between PFA and conventional radiofrequency ablation for paroxysmal AF, with reduced thermal injury to adjacent structures[8]. A large international multicenter registry further validated the overall safety profile of PFA in routine clinical practice[9]. Comprehensive state-of-the-art reviews highlight that intraoperative device monitoring is mandatory during PFA procedures in patients with pre-existing implantable devices such as CRTD systems to avoid electromagnetic interference[10]. Nevertheless, close intraoperative device monitoring is required during PFA in patients with implanted CRTD systems to prevent electromagnetic interference.

Fourth, this case highlights an important device programming consideration in clinical practice. For pacing-dependent patients with unsatisfactory LV lead performance, blind reduction of RV output solely to preserve battery life may compromise biventricular pacing stability and long-term resynchronization

efficacy. Therapeutic response should always take priority over battery conservation. Persistent suboptimal pacing parameters after repeated optimization warrant early consideration of conduction system pacing upgrade[6].

The staged intervention strategy applied in this study safely separates mechanical resynchronization and electrical rhythm control, reducing perioperative risk and allowing sufficient time for myocardial functional recovery. In conclusion, individualized selection of resynchronization modalities, rational evaluation of atrial lead necessity, application of modern ablation techniques, and standardized long-term device optimization are critical for improving clinical outcomes in complex HF patients with AF and cardiac dyssynchrony. Further prospective studies are needed to confirm the optimal timing and long-term efficacy of sequential intervention strategies.

Abbreviations

HF
Heart failure
AF
Atrial fibrillation
AVNA
Atrioventricular node ablation
CLBBB
Complete left bundle branch block
DCM
Dilated cardiomyopathy
6MWT
six-minute walk test
BiV-CRT
Biventricular cardiac resynchronization therapy
PVI
Pulmonary vein isolation
LVEF
Left ventricular ejection fraction

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the People's Hospital of LeShan Institutional Ethics Committee (Approval No.: LYLL [2026] KY005. Written informed consent for study participation was not required, as this work is a retrospective analysis using de-identified clinical data.

Consent for publication

Written informed consent for publication of the de-identified clinical details and relevant clinical images was obtained from the patient. A copy of the signed consent form is available to the editorial office.

Competing Interests

The authors declare that there are no competing interests.

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Author Contribution

Contributions: (I) Conception and design: Linling Li; (II) Administrative support: Yongquan Luo; Provision of study materials or patients: Linling Li; (IV) Collection and assembly of data: Yuanyuan Yang; (V) Data analysis and interpretation: Chengdong Peng; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors

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Availability of data and materials

All de-identified raw data supporting this work can be found in this manuscript.

References

1. Wideqvist M, Cui X, Magnusson C, Schaufelberger M, Fu M. Hospital readmissions of patients with heart failure from real world: timing and associated risk factors. ESC Heart Fail. 2021;8(2):1388–97.
2. Chyou JY, Tay WT, Tromp J, Ouwerkerk W, Yiu KH, Cleland JGF, et al. Prognostic Implications and Global Perspectives of Atrial Fibrillation in Patients Hospitalized for Heart Failure. JACC Heart Fail. 2025;13(3):453–64.
3. Kristensen SL, Castagno D, Shen L, Jhund PS, Docherty KF, Rørth R, et al. Prevalence and incidence of intra-ventricular conduction delays and outcomes in patients with heart failure and reduced ejection fraction: insights from PARADIGM-HF and ATMOSPHERE. Eur J Heart Fail. 2020;22(12):2370–9.

4. Hindricks G, Potpara T, Dagres N, et al. 2024 ESC Guidelines for the management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J. 2024;45(45):3314–414.
5. Zheng Z, Jiang L, Gao Y, et al. Left bundle branch area pacing vs. biventricular pacing significantly improves clinical outcomes and cardiac remodeling in cardiac resynchronization therapy: a systematic review and meta-analysis. Front Cardiovasc Med. 2025;12:1644033.
6. Zimerman A, et al. Conduction System vs Biventricular Pacing in Heart Failure: The PhysioSync-HF Randomized Clinical Trial. JAMA Cardiol. 2026;11(4):360–8.
7. Brignole M, Auricchio A, Baron-Esquivias G, et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur Heart J. 2021;42(35):3427–520.
8. Reddy VY, Dukkipati SR, Neuzil P, et al. Pulsed field or conventional thermal ablation for paroxysmal atrial fibrillation. N Engl J Med. 2023;389(18):1660–71.
9. Ekanem E, Neuzil P, Reichlin T, et al. Safety of pulsed field ablation in more than 17,000 patients with atrial fibrillation in the MANIFEST–17K study. Nat Med. 2024;30(9):2020–9.
10. Chun KRJ, Miklavčič D, Vlachos K, et al. State-of-the-art pulsed field ablation for cardiac arrhythmias: ongoing evolution and future perspective. Europace. 2024;26(12):euae134.

Figures

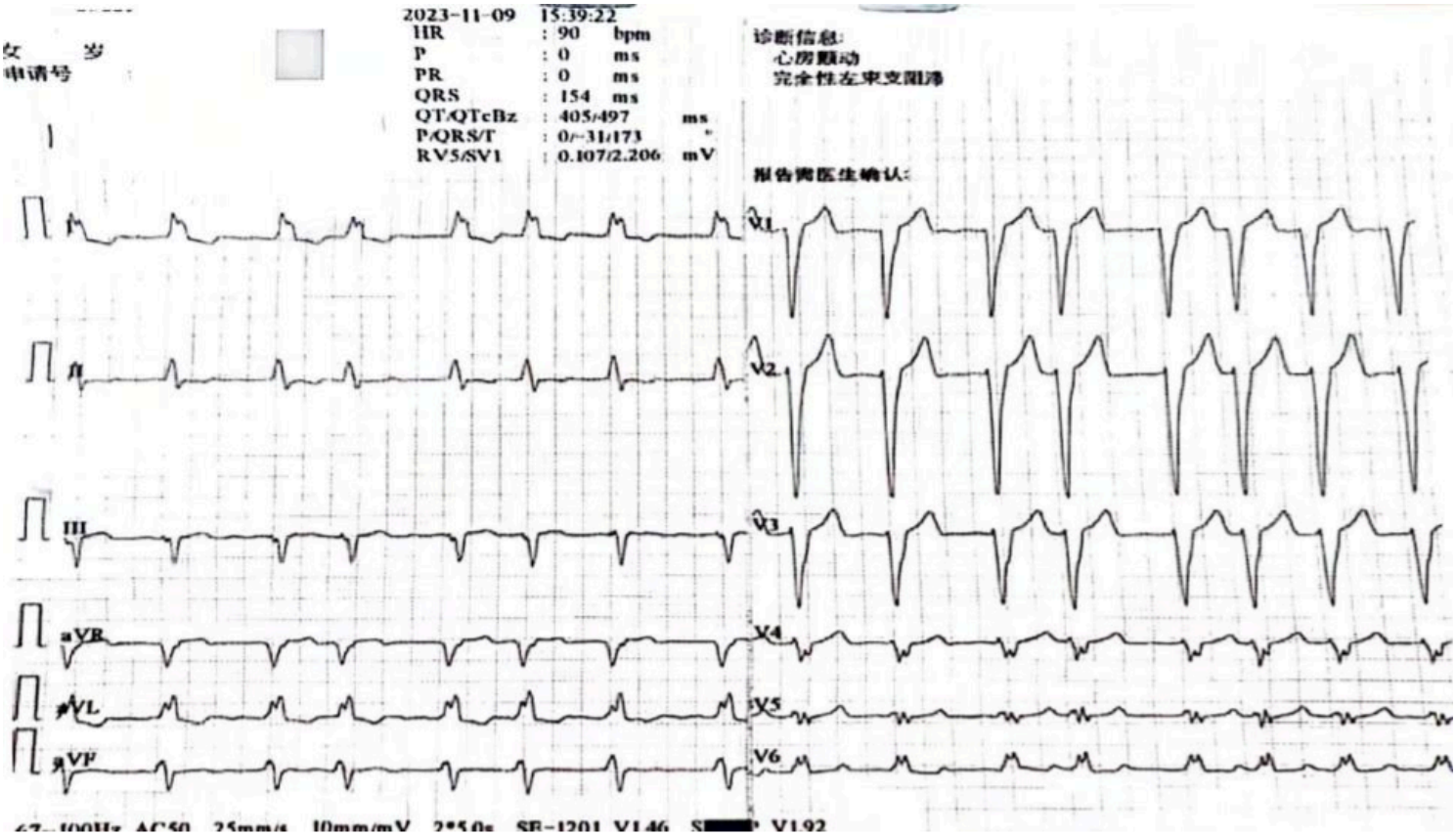


Figure 1

AF with CLBBB on admission (the QRS duration was 154ms)

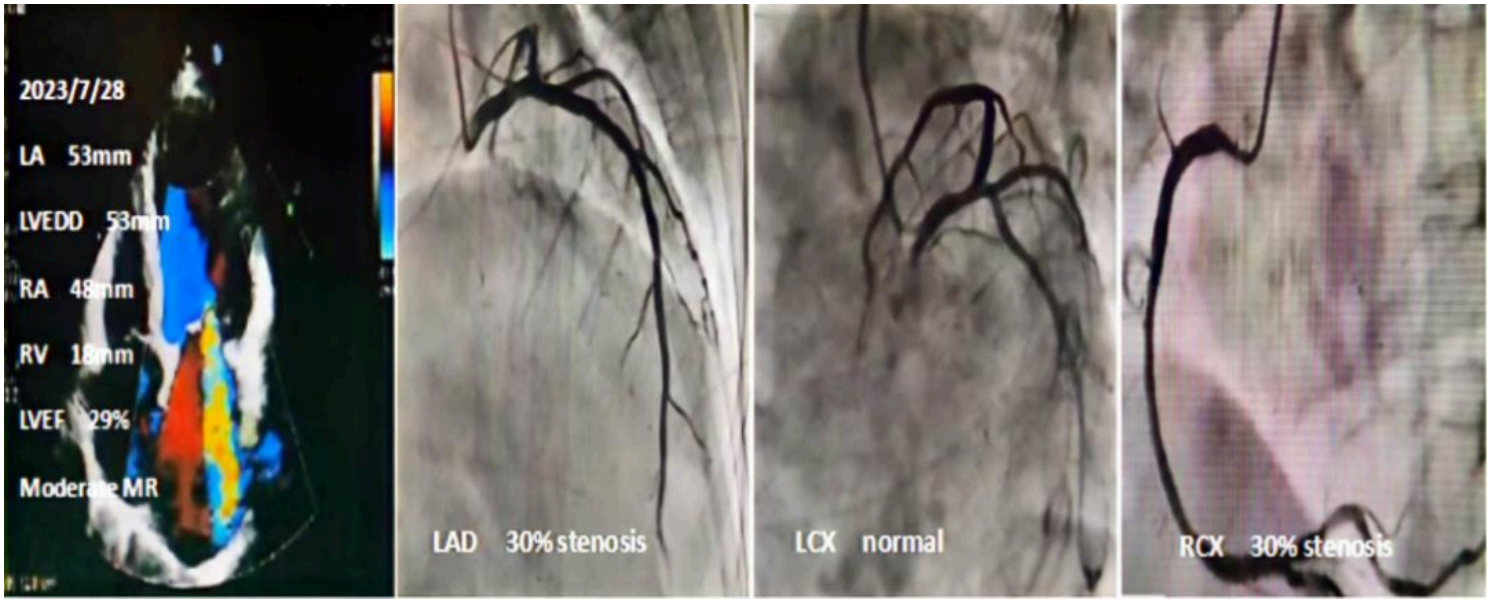


Figure 2

The UCG and CAG on first admission

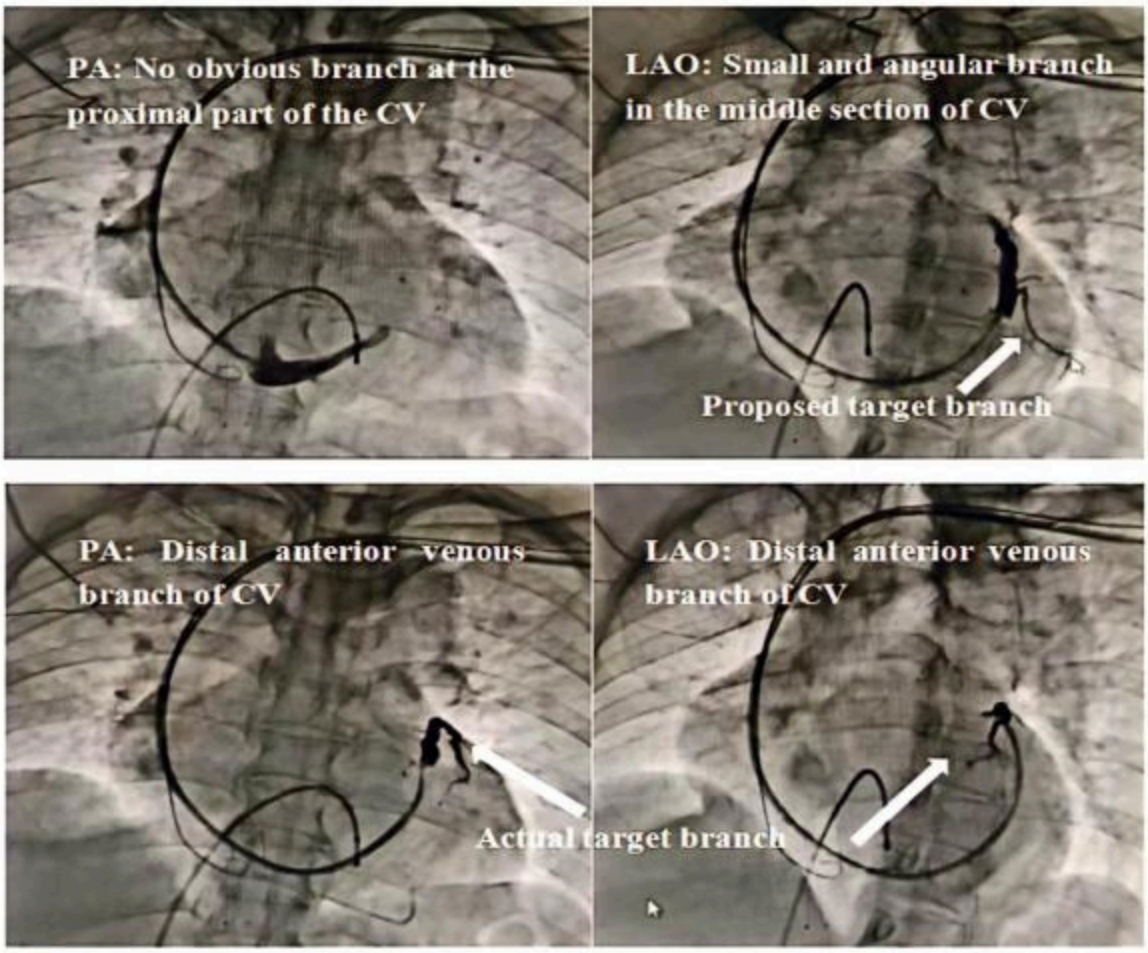


Figure 3

Coronary sinus angiography

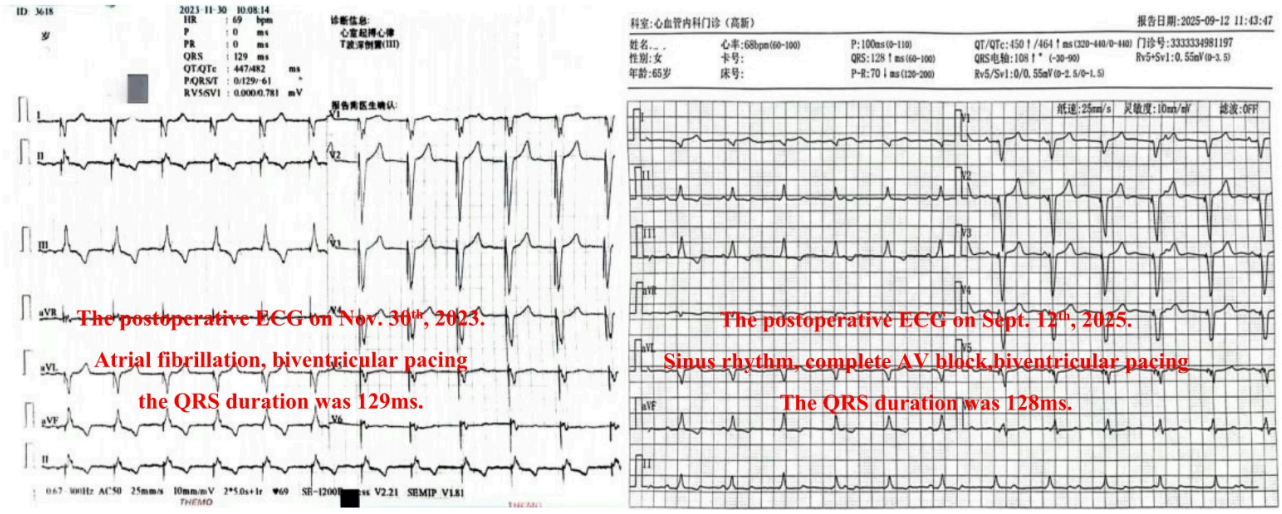


Figure 4

The postoperative ECGs on Nov. 30th, 2023 and Sept. 12th, 2025

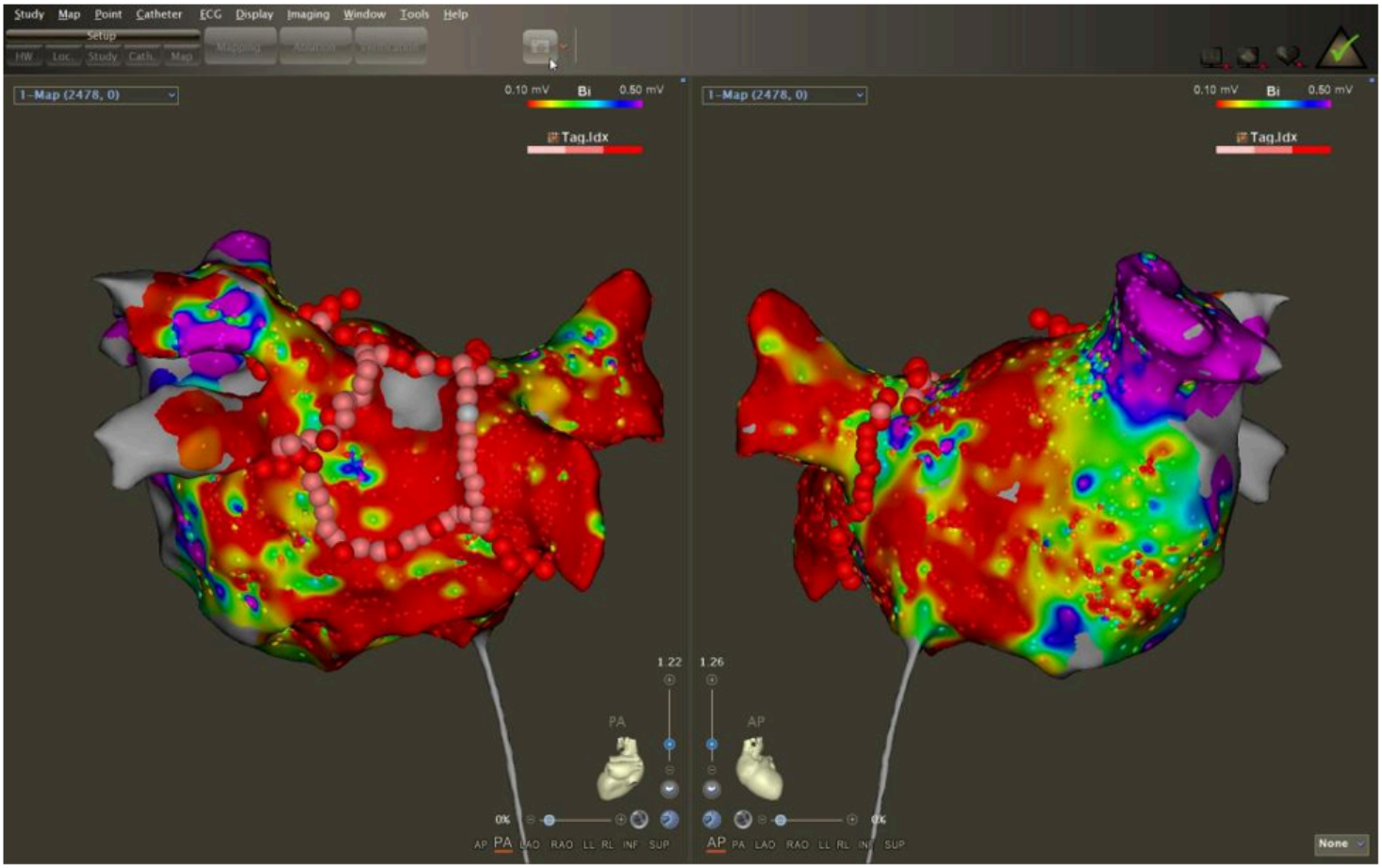


Figure 5

The left atrial substrate and ablation route map

Supplementary Files

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