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Case Report

Tachycardia-induced cardiomyopathy reversal and spontaneous closure of iatrogenic atrial septal defect following AF ablation: A case report

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ABSTRACT

Atrial fibrillation (AF) is associated with significant morbidity and mortality, particularly due to its relationship with left ventricular dysfunction. This case report describes a 73-year-old female patient with AF and heart failure with reduced ejection fraction, who demonstrated significant left ventricular function recovery following cryoballoon ablation. This case report also underscores the vital role of catheter ablation in managing AF-induced heart failure (HF) and illustrates the benign course of small iatrogenic atrial septal defects post-procedure. By recognizing tachycardia-induced cardiomyopathy, clinicians can prioritize appropriate interventions for patients with new-onset HF and AF, leading to substantial improvements in cardiac function and overall outcomes.

Keywords: Catheter ablation, iatrogenic atrial septal defect, pulmonary vein isolation, tachycardia-induced cardiomyopathy.

Atrial fibrillation (AF) is a prevalent arrhythmia associated with significant morbidity and mortality, particularly due to its relationship with heart failure (HF) and left ventricular dysfunction. Catheter ablation has emerged as an effective intervention for restoring sinus rhythm in AF patients, often leading to improvements in left ventricular ejection fraction (LVEF).[1] Studies indicate that approximately 82% of patients experience significant LVEF improvement post-ablation, especially those diagnosed with tachycardia-induced cardiomyopathy (TIC). Predictors of such improvement include a suspected diagnosis of TIC, shorter QRS duration, and smaller left ventricular size.[2] Cryoballoon ablation is a widely used method for pulmonary vein isolation (PVI), offering a shorter procedural time and comparable efficacy to radiofrequency ablation.

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Transseptal puncture during AF ablation can result in iatrogenic atrial septal defects (iASDs). While many iASDs close spontaneously within three to six months, persistent defects have been observed in a subset of patients. Factors such as a larger sheath diameter and the use of multiple sheaths through a single puncture may increase the likelihood of persistent iASDs.[1]

This case report presents a female patient with AF and reduced LVEF, who demonstrated significant recovery of ventricular function following cryoballoon ablation. Additionally, the patient developed an iASD post-ablation, which spontaneously resolved within five months. This real-world example underscores the importance of considering TIC in the differential diagnosis of HF and highlights the efficacy of interventional AF treatments.

CASE REPORT

A 73-year-old female patient with a medical history of hypertension, diabetes mellitus, and hyperlipidemia presented with a two-month history of progressive fatigue and palpitations. Her medications included ramipril/hydrochlorothiazide 5/25 mg daily, metformin 1000 mg twice daily, atorvastatin

10 mg daily, and aspirin 100 mg daily. She had a history of supraventricular tachycardia, for which she was on propafenone 150 mg twice daily and diltiazem 120 mg twice daily. Despite regular yoga practice, her symptoms had recently worsened.

The patient was a chronic smoker, and her 10-year coronary heart disease risk, calculated using the SCORE-TR system, was 22%. Given this elevated risk, an ischemic etiology for her HF was initially considered. However, coronary angiography revealed no significant stenosis, leading to the consideration of tachycardia-induced cardiomyopathy.

At presentation, her heart rate was irregular, and electrocardiography confirmed low-rate AF. Transthoracic echocardiography showed a LVEF of 28% and a left atrial diameter of 4.1 cm. Given the symptomatic AF and reduced LVEF, the patient underwent PVI using cryoballoon ablation.

Twenty-four hours post-ablation, her LVEF improved to 40%. At three months, it increased to 50%, and by five months, it reached 60%, with a global longitudinal strain of -19.7%. Post-procedural imaging detected a 3 mm iASD with left-to-right shunting, which had completely closed by the five-month follow-up. Throughout a one-year follow-up, the patient remained free of AF recurrence and was asymptomatic. A written informed consent was obtained from the patient.

DISCUSSION

For many years, we have known that rapid atrial impulses can lead to left ventricular dysfunction and dilation.[3] Rapid, irregular atrial rates and the resulting high ventricular response cause electrical and structural remodeling of the left ventricle. At the same time, AF is also observed as a complication in the course of chronic HF. Recent studies report TIC in one out of 20 HF patients and one out of eight heart failure with reduced ejection fraction (HFrEF) patients.[4] Some studies indicate that in patients with LVEF <40%, the prevalence exceeds 50%.[5] Given the high prevalence and favorable prognosis of TIC, clinicians must be alert in diagnosing TIC and consider referring patients for interventional treatments such as PVI to restore sinus rhythm, which is of critical importance.

Relatively younger age (<79 years), new-onset HF, resting heart rate >112 bpm, or relatively low N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels should prompt suspicion of AF-induced TIC.[5] Arrhythmia-induced cardiomyopathy (AIC) is now considered an umbrella entity in which TIC represents one of the most common phenotypes, particularly in AF, where the cumulative tachyarrhythmia burden and ventricular irregularity may matter more than a single resting heart-rate snapshot. In our patient, the 'low-rate AF' documented at admission likely reflected recent high-dose propafenone and diltiazem use, while her report of daily palpitations with breakthrough tachycardia episodes supports a clinically relevant arrhythmia burden, consistent with reversible AIC/TIC as evidenced by the rapid LVEF recovery after ablation. However, the effectiveness of echocardiographic parameters in differentiating AF-induced TIC from HFrEF patients with AF remains controversial. For example, an left ventricular end-diastolic diameter (LVEDD) of ≤61 mm was able to distinguish TIC from dilated cardiomyopathy with a sensitivity of 100% and specificity of 71% in one study, whereas other studies found no significant difference.[6]

The RACE (Lenient versus Strict Rate Control in Patients with Atrial Fibrillation) and AFFIRM (The Atrial Fibrillation Follow-up Investigation of Rhythm Management) trials have strongly demonstrated that in AF patients, there is no difference in adverse outcomes between a resting heart rate of >110 bpm and <80 bpm. Accordingly, The European Society of Cardiology (ESC) guidelines recommend a more flexible approach to heart rate control in these patients. However, TIC patients are an exception. Early rhythm and heart rate control are crucial for restoring left ventricular function and reducing HFrEF-associated adverse outcomes. Therefore, catheter ablation is strongly recommended in both the 2021 ESC and 2023 American College of Cardiology (ACC)/American Heart Association (AHA) HF guidelines.[7,8]

The timeline for left ventricular function recovery after sinus rhythm restoration varies between 48 h and several months.[9] Acute LVEF improvement is linked to adaptive changes, while long-term recovery (weeks to months after rhythm restoration) is associated with left ventricular remodeling and improved contractile function.

Although most iASDs resolve spontaneously, larger defects or those with significant left-to-right shunting may persist and require closure. In some cases, percutaneous closure with a septal occluder device may be necessary.[10] Since post-ablation follow-up is not always conducted at the center where the procedure was performed, encountering an iASD with significant left-to-right shunting on follow-up echocardiography can be concerning for clinicians.

For these reasons, we believe this case report is important, as it provides imaging evidence of both the striking improvement in left ventricular function and the complete resolution of an iASD.

We present this case to provide a visual and clinical example of the significant recovery potential in TIC and the natural course of iASDs post-ablation. Such real-world cases are invaluable for educating clinicians, particularly in centers where interventional AF treatments are not routinely performed. Awareness of TIC as a reversible cause of HF is crucial, as timely referral for catheter ablation can lead to marked improvements in cardiac function. Additionally, understanding the benign nature and typical resolution timeline of iASDs can alleviate concerns when these defects are encountered during follow-up.

In conclusion, this case underscores the importance of considering TIC in patients with HF and AF, especially when ischemic causes have been excluded. Catheter ablation offers a viable treatment option, leading to significant improvements in left ventricular function. Furthermore, iASDs resulting from the procedure often resolve spontaneously within months, as demonstrated in this patient. Clinicians should be aware of these outcomes to provide optimal care and counseling for patients undergoing AF ablation.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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