

Atrial pacing and administration of nifekalant hydrochloride for unstable atrial fibrillation: a case report

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Received 26 September 2019; first decision 21 December 2019; accepted 1 April 2020; online publish-ahead-of-print 14 May 2020

Background

Atrial fibrillation (AF) is a common arrhythmia in patients with hypertrophic cardiomyopathy (HCM) and can deteriorate haemodynamic status.

Case summary

We report a case of a 77-year-old woman with cardiogenic shock due to paroxysmal AF, complicated with HCM and aortic stenosis. Atrial fibrillation was successfully managed with temporary atrial pacing and administration of nifekalant hydrochloride without invasive mechanical circulatory support until surgery. Septal myectomy, aortic valve replacement, and pulmonary vein isolation were performed.

Discussion

This case suggests that atrial pacing and nifekalant may be safe and effective for rhythm control.

Keywords

Case report • Hypertrophic cardiomyopathy • Aortic stenosis • Atrial fibrillation • Nifekalant hydrochloride • Cardiac pacing

Learning points

- Paroxysmal atrial fibrillation (AF) can deteriorate haemodynamics in patients with hypertrophic cardiomyopathy and aortic stenosis.
- Hybrid therapy of atrial pacing and administration of nifekalant is effective to suppress unstable and incessant AF.

Introduction

Atrial fibrillation (AF) is common in patients with hypertrophic cardiomyopathy (HCM)¹ and is related to poor prognosis.² Even in the acute setting, AF can deteriorate heart failure or result in cardiogenic shock in patients with HCM, due to loss of atrial

contraction and worsening of left ventricular outflow tract (LVOT) obstruction. We present a case with successful rhythm management using atrial pacing and nifekalant hydrochloride (NIF) administration to suppress rapid and incessant AF in a patient with HCM and aortic stenosis (AS).

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Handling Editor: Timothy C. Tan

Peer-reviewers: Philipp Sommer and Habib Khan

Compliance Editor: Stefan Simovic

Supplementary Material Editor: Peysh A. Patel

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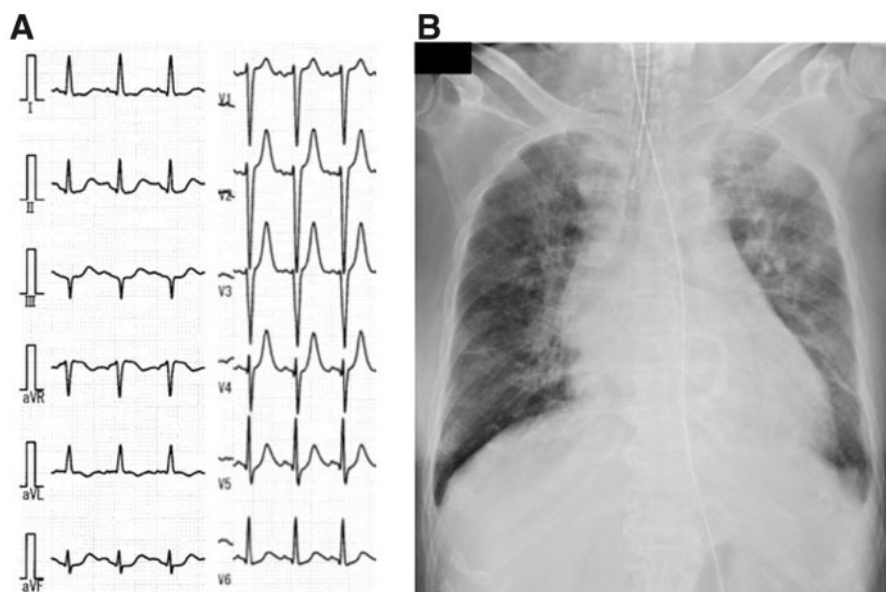


Figure 1 (A) Electrocardiogram and (B) chest radiograph at admission.

Timeline

Day 0	The patient was diagnosed with hypertrophic cardiomyopathy, aortic stenosis, and paroxysmal atrial fibrillation (AF)
Day 1	She presented with general fatigue at the emergency department. Electrocardiography showed sinus bradycardia, and she was treated with isoproterenol (ISP). ISP induced AF and caused cardiogenic shock. She was referred to our hospital
Day 2	ISP was stopped and temporary atrial pacing was started
Day 3	Paroxysmal AF incessantly recurred and caused shock status. Atrial pacing and administration of nifekalant successfully suppressed recurrence of AF
Day 11	Surgery was performed
After surgery	Echocardiography revealed decreased pressure gradient of the left ventricular outlet tract and no valve dysfunction

Case presentation

The patient was a 77-year-old woman with HCM, AS, and paroxysmal AF diagnosed 2 years ago. She was taking oral β -blocker, cibenzoline, and anticoagulants. She had experienced palpitation, which became more frequent. Aortic stenosis was considered moderate with annual echocardiography and treated with medication. One day

prior to admission, she experienced general fatigue and visited the hospital. Electrocardiography showed sinus bradycardia, which recovered after hydration and isoproterenol (ISP) administration; however, ISP induced rapid AF, and she developed cardiogenic shock [systolic blood pressure (BP) declined to <60 mmHg]. Sinus rhythm was restored after emergent electric cardioversion. She was referred to our hospital for mechanical circulatory support and emergent intervention for HCM.

Her vital signs on arrival were as follows: BP, 141/60 mmHg; heart rate, 121 b.p.m. (sinus tachycardia); oxygen saturation, 100% (intubated, 5 L/min of oxygen). She had neither jugular venous distension nor pretibial oedema. Systolic murmur was audible at the fourth left sternal border. Coarse crackles were audible bilaterally. Blood tests showed no abnormalities except for a serum brain natriuretic peptide of 622.9 pg/mL. The blood concentration of cibenzoline was normal. Electrocardiography showed sinus tachycardia (Figure 1A). Chest radiography showed cardiomegaly (the cardiothoracic ratio was 61% with bilateral lung congestion) (Figure 1B). With respect to echocardiographic parameters (Figure 2A), the left ventricular ejection fraction was 73.7% and the diameter of the left ventricle (LV) was 30 mm in diastole and 18 mm in systole. The diameter of the ventricular septum was 22 mm, and the posterior wall was 14 mm. The left atrium diameter was 42 mm. The pressure gradient (PG) at the LVOT was 122.8 mmHg, and the peak flow velocity was 5.5 m/s. The aortic valve area (AVA) index was $0.74 \text{ cm}^2/\text{m}^2$ with tracing. Transoesophageal echocardiography showed no thrombus in the left atrium or tricuspid aortic valve and $0.59 \text{ cm}^2/\text{m}^2$ of AVA index with tracing. Computed tomography (CT) also showed hypertrophic septum and calcified aortic valve (Figure 3).

Soon after arrival, rapid AF and cardiogenic shock recurred, and electrical cardioversion was required. We attempted to taper ISP because it could deteriorate LVOT obstruction and induce AF.

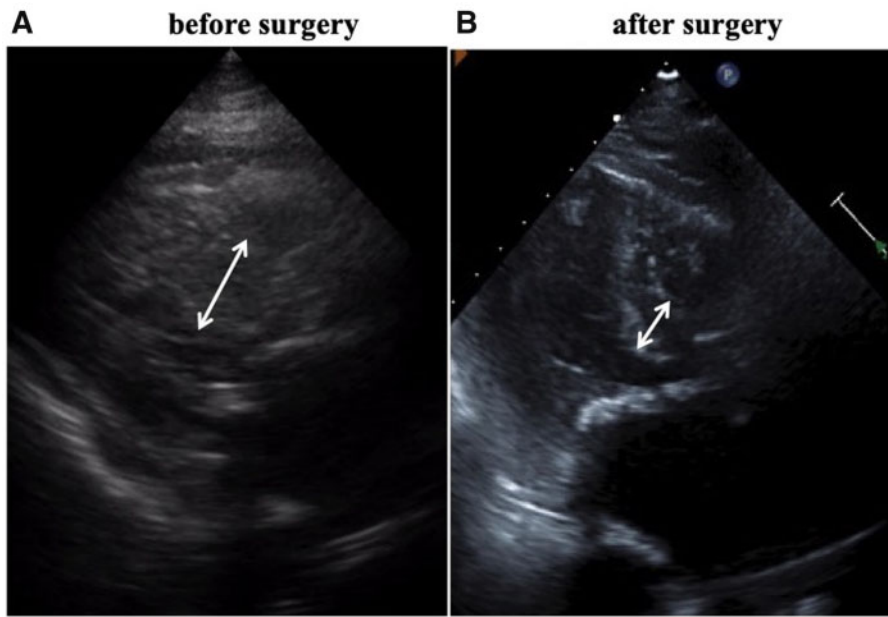


Figure 2 Echocardiography (A) before and (B) after surgery. These images show a parasternal long-axis view in systole. The diameter of the inter-ventricular septum decreased from 22 to 15 mm after surgery (arrows).



Figure 3 Computed tomography scan. These images show the hypertrophic septal myocardium and calcified aortic valve in systole (left) and in diastole (right).

However, sinus bradycardia and junctional rhythm resulted in low BP with the decrement of ISP. Thus, the pacer was temporarily introduced at the catheterization laboratory. Coronary angiography revealed no stenosis. Right heart catheterization under sinus rhythm

revealed that the mean pulmonary artery wedge pressure was 25 mmHg, and the cardiac index was 3.41 L/min/m². The PG was remarkably higher between the aorta and LV apex (the peak-to-peak pressure was 109 mmHg) and mid-LV (118 mmHg) but lower at the

subaortic valve (19 mmHg). Multipolar electrode catheters were placed in the coronary sinus (CS) and right ventricle. Measurement of the PG between the aorta and LV under several pacing modes revealed that PG was lowest in AAI pacing (Figure 4). Finally, the patient was managed under AAI pacing of 70 pulses per minute (ppm) (the pacing site was at the proximal CS). Then, ISP was discontinued and landiolol was initiated to improve LVOT obstruction. However, rapid AF and cardiogenic shock recurred the following day. Even with high-dose landiolol and intravenous administration of amiodarone,

AF reinitiated soon after multiple electrical cardioversion (Figure 5). Following NIF administration (0.2 mg/kg bolus infusion with 0.2–0.3 mg/kg/h continuous infusion) and atrial pacing at 90 ppm, AF was completely suppressed and her haemodynamic state stabilized (systolic BP was >100 mmHg). This strategy was effective and enabled the treatment of decompensated heart failure with careful use of diuretics. Cardiac surgery was performed on Day 11. Excessive muscles on the ventricular septum and around the papillary muscles were excised via trans-aortic and trans-apical approaches. From the finding of low PG between the aorta and subaortic valve, AS was considered not severe. However, aortic valve replacement was also performed because (i) the AVA index met the criteria for severe AS, (ii) calcified aortic valve was found on CT, and (iii) AS could be treated simultaneously during cardiac surgery. Pulmonary vein isolation and left atrial appendage resection were performed. No LVOT obstruction and valve dysfunction were observed in the echocardiogram after surgery (Figure 2B). She had been free from symptoms related to AF recurrence and been visiting the outpatient clinic for 6 months.

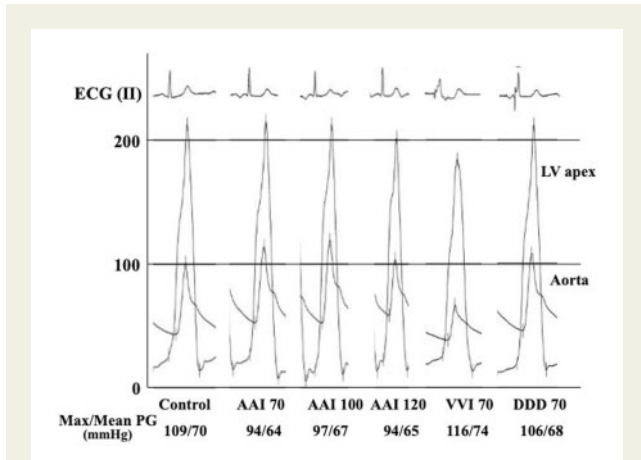


Figure 4 Measurements of pressure gradient between the left ventricle and aorta in each pacing mode. ECG, electrocardiography; LV, left ventricle; PG, pressure gradient.

Discussion

We presented a rare case of unstable incessant AF in a patient with HCM and AS, which was successfully controlled prior to surgery by the hybrid therapy of atrial pacing and NIF. This case demonstrates that ISP is contraindicated to HCM due to deterioration of LVOT obstruction and AF induction. Moreover, this case is novel as it presents successful rhythm management without invasive mechanical circulatory devices.³

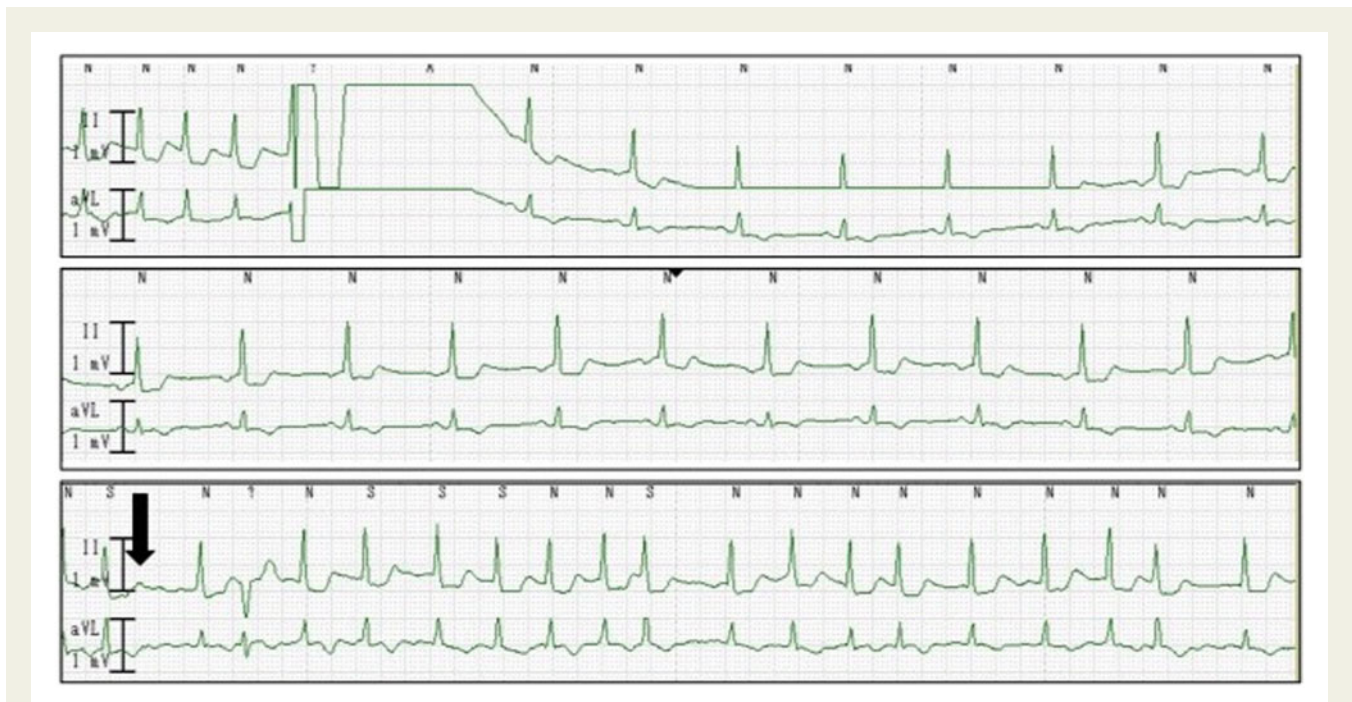


Figure 5 Electrocardiographic tracing. Atrial fibrillation recurred soon after electrical cardioversion and caused persistent cardiogenic shock. Arrow shows the timing of atrial fibrillation recurrence.

Atrial pacing has several mechanisms to control AF: suppression of the atrial premature beats, which can be triggers of AF, and avoidance of the dispersion of atrial effective refractory period.⁴ Pacing from Bachmann's bundle and ostial CS reduces atrial conduction time and prevents AF.^{5,6} Therefore, CS is the preferred pacing site in the setting of temporary use. In contrast, PG between the aorta and LV was higher even in DDD pacing in this case. The therapeutic effect of DDD pacing for LVOT obstruction is controversial⁷; therefore, it seems reasonable to manage AF with atrial pacing in this case.

Landiolol is effective for AF complicated with heart failure and is considered the first choice for treatment, especially in critical states.⁸ Landiolol is primarily effective for AF; however, it is ineffective for other atrial tachyarrhythmias, such as atrial flutter and atrial tachycardia.⁹ On the contrary, NIF is a pure rapid-delayed rectifier potassium current (IKr) blockade and can prolong the action potential duration and effective refractory period of the myocardium.¹⁰ Although NIF is generally used for treatment of ventricular tachyarrhythmia, it is effective for AF and other atrial tachycardia.¹¹ Moreover, NIF is short-acting ($T_{1/2} = 1.53 \pm 0.23$ h) and can be safely used in patients with impaired cardiac function and ischaemic heart disease.^{12,13} Electrocardiography should be monitored to avoid QT prolongation and torsade de pointes. NIF is available only in Japan. In other countries, dofetilide may have a similar effect as the selective IKr blocker; however, it is difficult to use in an acute setting because it is an oral drug.¹⁴ Vernakalant is an alternative antiarrhythmic drug and can be used for patients with mild heart failure including stable ischaemic heart disease; however, it is contraindicated in cases of hypotension and severe AS.¹⁵ To the best of our knowledge, no clinical trials have reported the efficacy of atrial pacing and NIF for AF. Further clinical research is required to clarify the efficacy of this strategy.

Conclusion

Hybrid therapy consisting of atrial pacing and NIF may be safe and effective for unstable AF, even in patients with HCM and AS.

Lead author biography



Daisuke Yakabe graduated from Kyushu University in 2010. He was an intern in Teine Keijinkai Hospital from 2010 to 2012 and a resident in the Department of Cardiology from 2012 to 2016. He was a member of the medical staff at Kyushu University Hospital from 2016 to 2018. Since 2018, he has specialized in clinical electrophysiology in National Hospital Organization Kyushu Medical Center.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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