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CASE REPORT
Structural intervention

A case report of percutaneous intramyocardial septal radiofrequency ablation in an adult with re-obstruction after Morrow procedure

Huiyi Wang, Changhui Lei, and Liwen Liu *

Xijing Hypertrophic Cardiomyopathy Center, Department of Ultrasound, Xijing Hospital, Airforce Military Medical University, Xi'an, Shannxi 710032, China

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Background Some patients with hypertrophic cardiomyopathy (HCM) re-occur with drug-refractory symptoms but are not eligible for re-operation after the Morrow procedure. Traditional treatment options are limited. We present the first case of the use of ultrasound-guided percutaneous intramyocardial septal radiofrequency ablation (PIMSRA) for the treatment of a patient with HCM combined with congenital anatomically corrected malposition of the great arteries (MGA) after Morrow procedure.

Case summary A 61-year-old male patient with congenital MGA, who had been treated with the Morrow procedure for HCM, had worsening symptoms in recent years that were difficult to control medically. He was diagnosed with occult obstructive HCM by stress echocardiography. After multi-disciplinary discussion, this patient was treated with PIMSRA. The post-operative clinical outcome was remarkable, with a significant decrease in septal thickness and disappearance of the left anterior branch conduction block.

Conclusion Percutaneous intramyocardial septal radiofrequency ablation is feasible and can be one of the options for the treatment of patients with HCM, especially those who cannot choose Morrow procedure. However, it still needs a large sample of clinical trials to validate its clinical effectiveness.

Keywords Hypertrophic cardiomyopathy • PIMSRA • Interventional procedure • Morrow procedure • Case report

ESC curriculum 2.2 Echocardiography • 6.5 Cardiomyopathy • 7.4 Percutaneous cardiovascular post-procedure

Learning points

1. Special patient situation

This case represents a class of people who have received less clinical attention: patients with hypertrophic cardiomyopathy with recurrent obstruction after Morrow procedure. At the same time, congenital anatomically corrected malposition of the great arteries was a more unusual treatment background for this patient, so we were very careful in choosing the treatment methods.

2. Unique and innovative procedure

After considering the patient's status and wishes, we finally chose percutaneous intramyocardial septal radiofrequency ablation, a unique radiofrequency ablation procedure for hypertrophic cardiomyopathy in our centre. This new procedure is less invasive and has cardioprotective advantages for patients with conduction block. This is the first attempt in patients with hypertrophic cardiomyopathy with recurrent obstruction combined with congenital anatomically corrected malposition of the great arteries.

* Corresponding author. Tel: +86 29 84775443, fax: +86 29 83244121, Email: liuliwen@fmmu.edu.cn

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Introduction

Hypertrophic cardiomyopathy (HCM) is an inherited cardiomyopathy characterized by left ventricular hypertrophy.[1] Currently, there are two methods of treatment for HCM: pharmacologic and invasive. The Morrow procedure is the gold standard for the invasive treatment of HCM, which can improve the symptoms and prognosis of patients by reducing the septal thickness.[2] However, there are some patients who have re-emerged symptoms after treatment that are difficult to control with medication and ineligible for re-operation. The treatment of these patients is limited. We present the first case of an innovative procedure, ultrasound-guided percutaneous intramyocardial septal radiofrequency ablation (PIMSRA), applied to one patient with congenital anatomically corrected malposition of the great arteries (MGA) combined with HCM after Morrow procedure.

Summary figure

Infancy	The patient had congenital anatomically corrected MGA.
Age 38	The patient was diagnosed with obstructive HCM by TTE in 2000.
Age 45	Because of the obvious symptoms of chest tightness and shortness of breath after activity, the patient underwent Morrow procedure to resect the sub-aortic valve and the surrounding hypertrophic myocardium in 2007, and his symptoms were under control for a short period of time after the procedure.
Age 53	The patient began to experience paroxysmal atrial fibrillation.
Age 58	The patient came to Hypertrophic Cardiomyopathy Diagnostic and Treatment Center with worsening chest pain and chest tightness; metoprolol succinate was poorly effective. Stress echocardiography suggested occult obstructive HCM. After combined consideration, we chose PIMSRA as a treatment plan.
Age 59	The patient underwent a PIMSRA procedure.
Age 61	The patient recovered well after the surgery, with satisfactory therapeutic results and a significant improvement in the quality of life.

KEY DIAGNOSTICS: occult obstructive hypertrophic cardiomyopathy.

Case presentation

The patient, male, 61 years old, with MGA, was diagnosed with HCM by echocardiography in 2000, and he underwent the Morrow procedure to resect the sub-aortic valve and the surrounding hypertrophic myocardium in 2007. In September 2020, he visited our centre due to worsening symptoms of chest tightness and shortness of breath and reported a 5-year history of paroxysmal atrial fibrillation and a history of pre-syncope during postural changes. The patient's regular use of metoprolol succinate (47.5 mg daily) was ineffective. Our ultrasound examination suggested congenital MGA (*Figure 1A*) and post-operative changes after sub-aortic myocardial resection (*Figure 1C*), the patient's maximum septal thickness was 26 mm (anterior septal base) (*Figure 1B*), the left ventricular outflow tract pressure gradient (LVOT-PG) was 12 mmHg at rest, the stress echocardiography suggested the LVOT-PG increased from 27 to 77 mmHg during the experiment, which proved he had occult obstructive HCM. Electrocardiography suggested the presence of second-degree type I atrioventricular block, complete right bundle branch block, and left anterior branch block. New York Heart Function Class III. Cardiovascular magnetic resonance suggested that the LVOT was narrowed, and the thickened myocardium around it had an uneven signal, which was considered as partial myocardial fibrosis (*Figure 2A*).

After multi-disciplinary discussion, the risk of damage to the conduction bundles was higher with Morrow procedure or alcohol ablation, and the patient was eligible for ultrasound-guided PIMSRA. The cool-tip RF™ radiofrequency ablation system was chosen to perform the PIMSRA treatment.

Procedure

The patient was in the left lateral position after general anaesthesia with endotracheal intubation, continuous electrocardiogram, blood pressure, and oxygen saturation monitoring were performed. Under the real-time guidance of transthoracic echocardiography (TTE), the radiofrequency electrode needle (ACT1520) was inserted percutaneously through the myocardium into the hypertrophied interventricular septum (*Figure 3A and B*). Intra-operative colour Doppler TTE guidance was used to avoid vascular injury at the point of needle placement. If persistent heart block or tachyarrhythmia occurred, the ablation procedure would be suspended until normal rhythm was restored spontaneously or after lidocaine treatment. The entire ablation procedure lasted 1 h and 40 min, with a total of six ablations of the more hypertrophic locations of the septum. The radiofrequency energy was started from 50 W and increased slowly to avoid arrhythmias. The maximum energy for ablation was 130 W (*Figure 3C and D*).

The patient had no serious adverse events during the operation and 1 month after the operation. The patient was maintained on routine metoprolol succinate (47.5 mg daily). At 6 months after the operation, the patient's symptoms improved significantly compared with the pre-operative period, atrial fibrillation had no more episodes, and the quality of life was significantly improved; echocardiography showed that the patient's maximal septal thickness was 18 mm (middle of the anterior septum), and the LVOT-PG was 9 mmHg at rest and 21 mmHg after exercise load without LVOT obstruction (*Figure 4E and F*). Electrocardiography suggested a complete right bundle branch block. The left bundle branch block disappeared when compared with the pre-operative period (*Figure 4G*). New York Heart Function was upgraded to Class I. Myocardial three-dimensional strain suggested that there was no decrease in the global longitudinal strain (GLS) (*Figure 4H*). Echocardiography at 1 year post-operatively suggested that the patient had a maximum septal thickness of 11 mm (posterior septal base) (*Figure 4J*); myocardial three-dimensional strain suggested improvement in GLS compared with 6-month follow-up. The improvement was more noticeable in the basal of the left ventricle.

Discussion

This case explores a new path for PIMSRA treatment of patients with HCM who re-appear symptomatic after Morrow procedure and who are poorly controlled by medications and lack other effective therapeutic modalities. This case demonstrates that PIMSRA is feasible and can be one of the options for the treatment of this group of patients.

Hypertrophic cardiomyopathy is the most common autosomal dominant cardiomyopathy.[3] The Morrow procedure is the gold standard for the treatment of HCM.[4] However, there exist some patients who have undergone poor post-operative outcome or even re-obstruction of LVOT because of insufficient resection extent, papillary muscle abnormalities, or a combination of other diseases that lead to myocardial hypertrophy. Such patients often require re-operation.[5] Alcohol ablation is also a commonly used invasive treatment modality for patients with HCM. The possibility of conduction block and inadequate ablation is higher, especially for patients with existing bundle branch conduction block.[6] Therefore, after comprehensive evaluation by a multi-disciplinary team, PIMSRA, which is less invasive and equipped with electrocardiographic

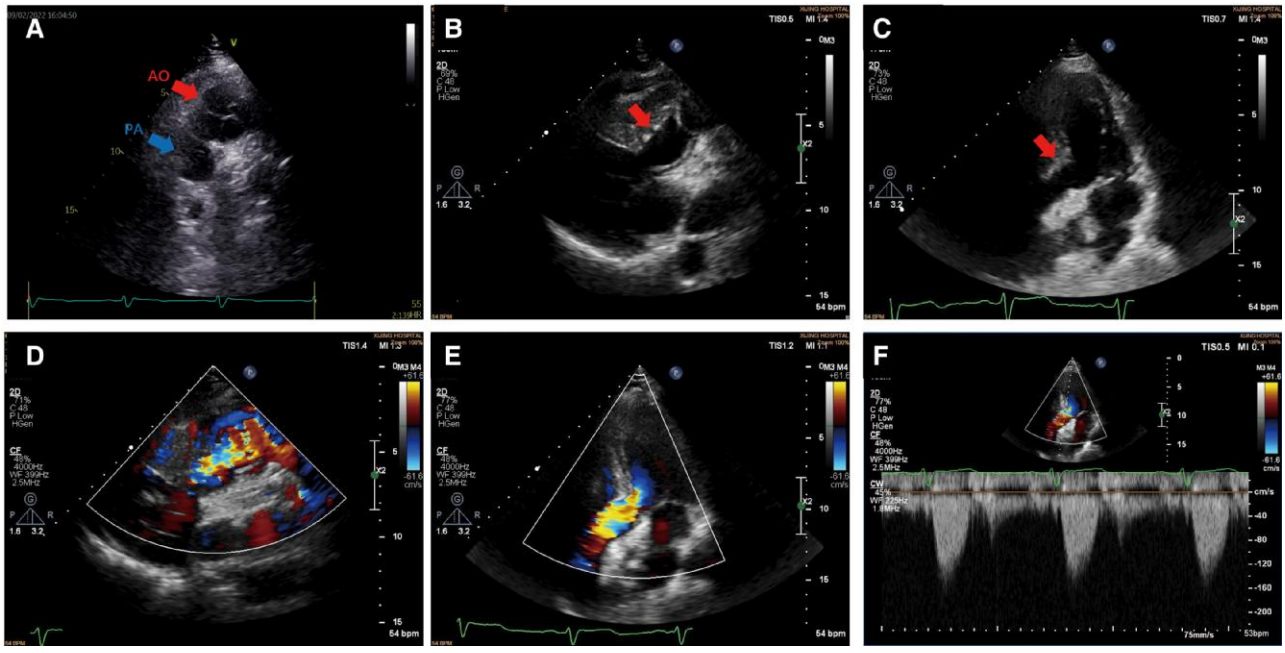

Figure 1 Pre-operative echocardiography. The aorta and pulmonary artery (*A*), septal hypertrophy (*B*), the left ventricular outflow tract (*C*), Doppler flow imaging (*D*, *E*), and the gradient at rest of left ventricular outflow tract (*F*). AO, aorta; PA, pulmonary artery.

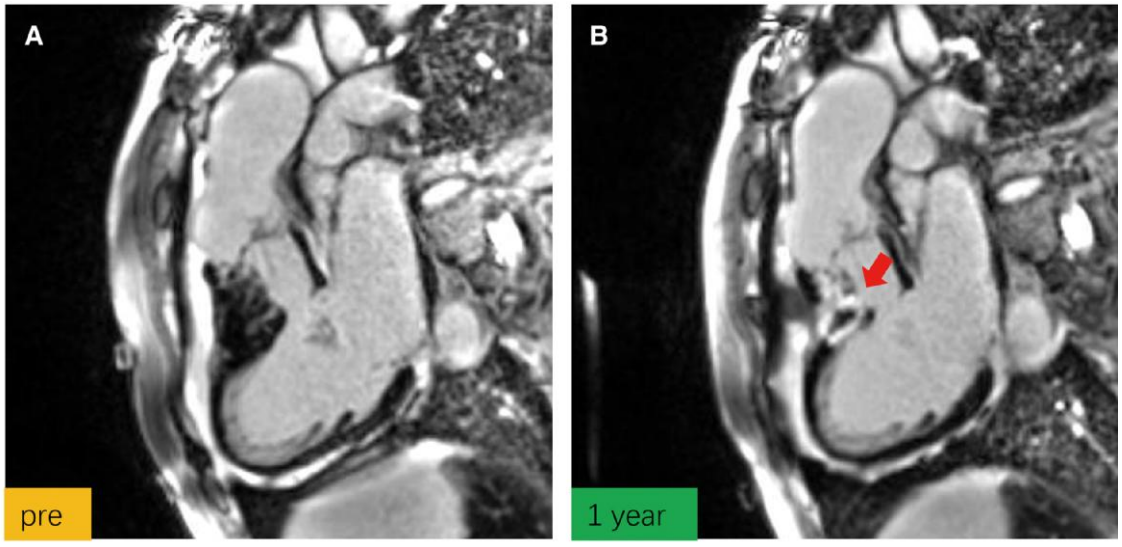

Figure 2 Pre-operative and post-operative cardiovascular magnetic resonance. Pre-operative cardiovascular magnetic resonance (*A*) and 1-year post-operative cardiovascular magnetic resonance (*B*). The arrow shows the ablation area.

protection, was chosen. This was also the first patient with congenital MGA combined with HCM to be treated with PIMSRA after Morrow procedure. The ablation area and cardiac structure were well visualized by TTE; therefore, we did not use intra-cardiac echocardiography or transoesophageal echocardiography during the procedure.

Intra-operative and 1-year post-operative follow-up of this patient showed that the procedure is clinically effective, with significant improvement in clinical symptoms. Notably, electrocardiography suggested no increased probability of arrhythmia and the disappearance of the left anterior branch block. During the entire PIMSRA procedure, professional personnel are equipped to monitor the electrocardiography, so that the conduction bundles affected by the ablation process will be immediately detected and early warning will be given to stop the ablation and make corresponding adjustments. Previous retrospective studies

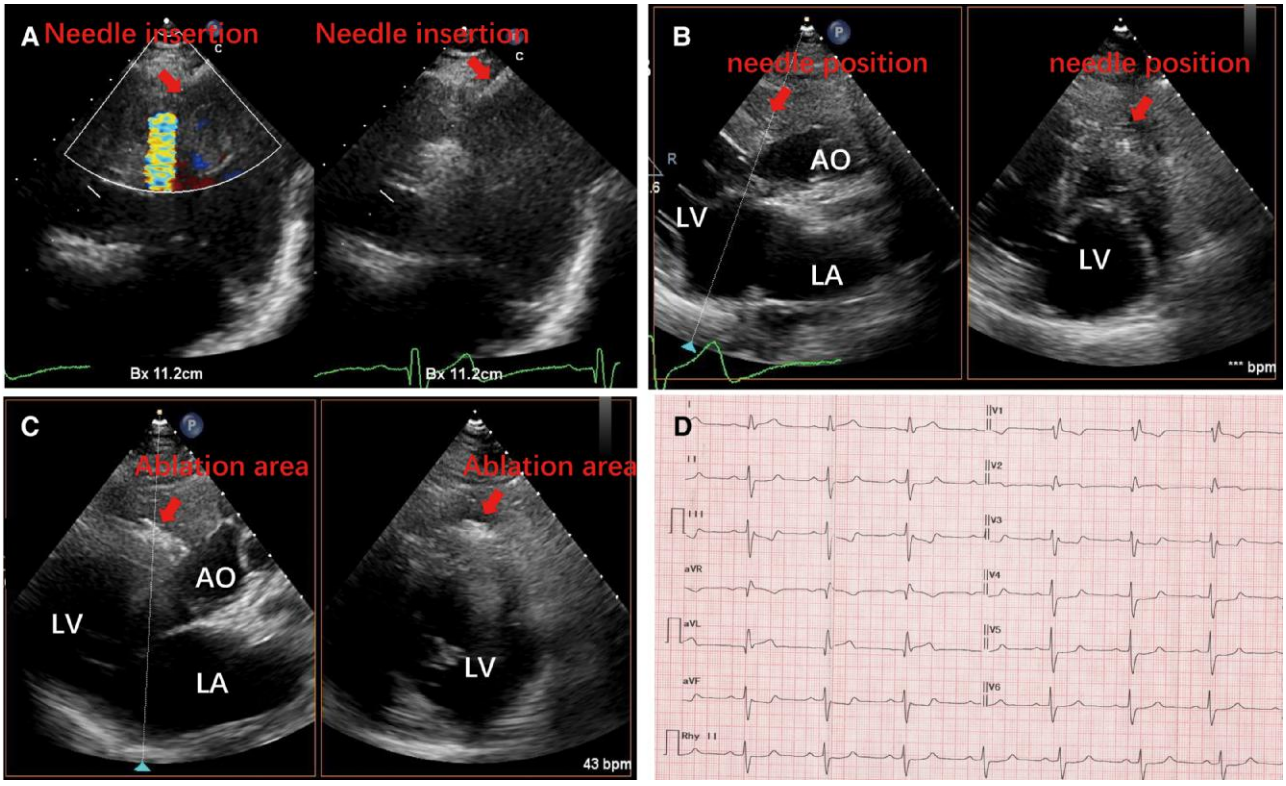

Figure 3 Intra-operative monitoring. Intra-operative echocardiogram (*A–C*) and intra-operative electrocardiography (*D*). AO, aorta; LA, left atrium; LV, left ventricle.

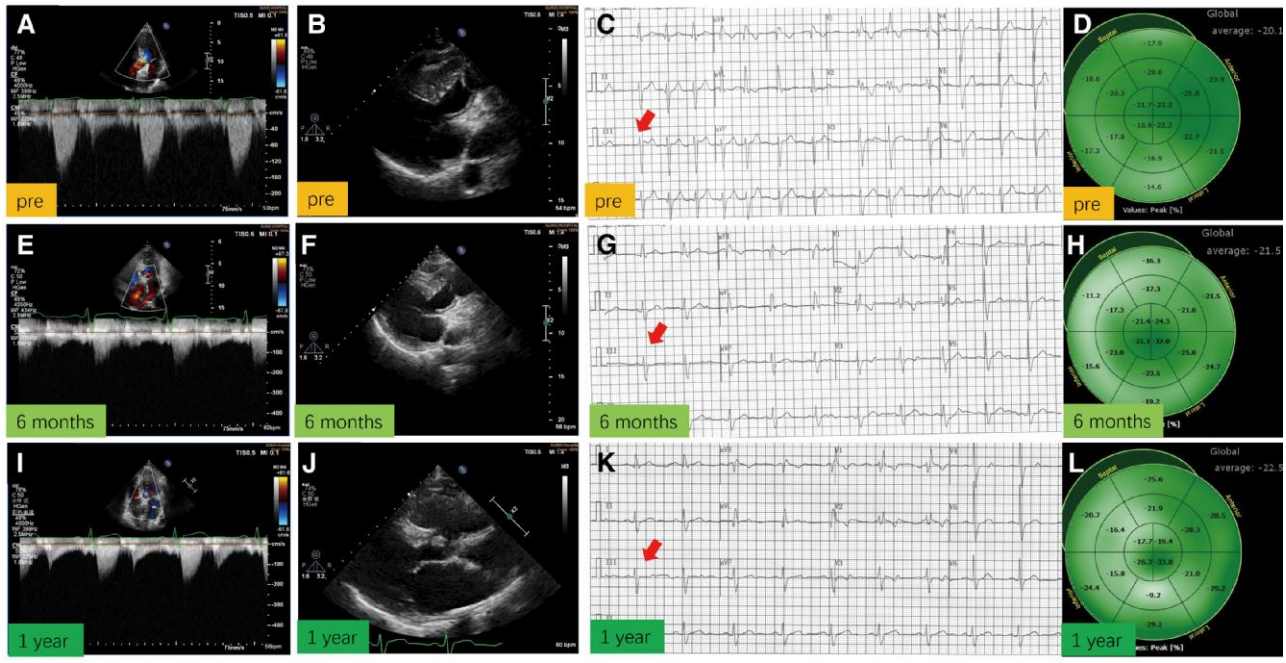

Figure 4 Pre-operative and post-operative echocardiographic and electrocardiographic features. Pre-operative echocardiography (*A, B*), pre-operative electrocardiogram (*C*), pre-operative global longitudinal strain (*D*), 6-month post-operative echocardiography (*E, F*), 6-month post-operative electrocardiogram (*G*), 6-month post-operative global longitudinal strain (*H*), 1-year post-operative echocardiography (*I, J*), 1-year post-operative electrocardiogram (*K*), and 1-year post-operative global longitudinal strain (*L*).

have confirmed that PIMSRA does not increase the risk of arrhythmia in patients through complete electrocardiographic protection measures.[7] Meanwhile, after ablation of the hypertrophied myocardium, the myocardial blood supply was improved, and the burden of the hypertrophied myocardium on normal tissues was lifted, which may be the reason for the disappearance of the left anterior branch block in this case. From this case, it can be seen that the electrocardiographic protection characteristics of PIMSRA may be advantageous.

Noteworthy, in addition to HCM, there are other causes of LVOT obstruction. For example, LVOT obstruction may occur after transcatheter mitral valve implantation (TMVI) because of the prosthesis pushing the anterior mitral leaflet towards the septum.[8] To prevent post-operative LVOT obstruction after TMVI, alcohol septal ablation has been proposed. Percutaneous intramyocardial septal radiofrequency ablation, as an original therapeutic modality, can be effective in relieving LVOT obstruction in patients with HCM by thinning the interventricular septum.[7] Therefore, we will explore the possibility of PIMSRA application to prevent LVOT obstruction after TMVI.

Despite the good results obtained from this treatment, due to the lack of evidence from a large sample of clinical trials, it is now not yet the first choice of invasive treatment for post-Morrow patients, and a comprehensive assessment and individualized selection of treatment modalities through a multi-disciplinary team are still needed to achieve the expected clinical outcomes.

Lead author biography

Huiyi Wang, currently enrolled in the Department of Ultrasound Medicine at the Xijing Hospital of the Airforce Medical University, received her bachelor's degree in Clinical Medicine from the Airforce Medical University and is now a post-graduate student in ultrasound medicine.

Consent: The authors confirm that consent was obtained from the patient prior to submission and publication, including all figures and information contained in this report in line with the Committee on Publication Ethics (COPE) guidelines.

Conflict of interest: None declared.

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Data availability

The data of this case report are available from the corresponding author upon reasonable request.

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