

Percutaneous Intramyocardial Septal Radiofrequency Ablation for Hypertrophic Obstructive Cardiomyopathy



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ABSTRACT

BACKGROUND In patients with disabling symptoms caused by hypertrophic obstructive cardiomyopathy (HOCM), echocardiography-guided percutaneous intramyocardial septal radiofrequency ablation (PIMSRA) could be a less invasive treatment option.

OBJECTIVES This study aimed to investigate the safety and efficacy of the PIMSRA for left ventricular outflow tract (LVOT) gradient reduction in HOCM.

METHODS The study enrolled 15 patients with HOCM. These patients underwent electrocardiography, imaging, and blood biochemistry examination over 6 months of follow-up.

RESULTS At 6 months of follow-up, patients showed significant reductions in peak LVOT gradients (resting gradient: from 88.00 [66.00] mm Hg to 11.00 [6.00] mm Hg; $p = 0.001$; stress-induced gradient: from 117.00 [81.00] mm Hg to 25.00 [20.00] mm Hg; $p = 0.005$) and interventricular septum (IVS) thickness (anterior IVS: from 25.00 [21.00] mm to 14.00 [12.00] mm; $p = 0.001$; posterior IVS: from 24.00 [21.00] mm to 14.00 [11.50] mm; $p = 0.001$). The reductions in IVS thickness and LVOT gradients were associated with improvement in New York Heart Association functional classification (from 3.00 [2.00] to 1.00 [1.00]; $p < 0.001$), total exercise time (from 6.00 [5.50] min to 9.00 [8.00] min; $p = 0.007$), and pro B-type natriuretic peptide levels (from 924.00 [370.45] pg/ml to 137.45 [75.73] pg/ml; $p = 0.028$). No patient had bundle branch block or complete heart block.

CONCLUSIONS PIMSRA is a safe and effective treatment approach for severe, symptomatic HOCM and results in sustained improvement in exercise capacity, persistent reduction in LVOT gradient, and sustained improvement in cardiac function. (J Am Coll Cardiol 2018;72:1898–909) © 2018 the American College of Cardiology Foundation. Published by Elsevier. All rights reserved.



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Resting or provocative left ventricular outflow tract (LVOT) obstruction has been reported to occur in nearly 70% of patients with hypertrophic cardiomyopathy and can lead to dyspnea, chest pain, atrial fibrillation, heart failure, and even sudden cardiac death (1-4). The removal of LVOT obstruction has been shown to alleviate symptoms and improve prognosis. Two invasive methods, namely, surgical myectomy and alcohol septal ablation (ASA), are used to relieve LVOT obstruction in drug-refractory patients. Although both procedures can clearly improve clinical symptoms and reduce the LVOT gradient, it is important to consider that sternotomy and extracorporeal circulation are required in myectomy, ethanol might be incorrectly injected, and the anatomic variability of the vascularized hypertrophic septum might cause issues in ASA (5-9).

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We developed a novel minimally invasive treatment, transthoracic echocardiography (TTE)-guided percutaneous intramyocardial septal radiofrequency ablation (PIMSRA) of the hypertrophic interventricular septum (IVS). This procedure provides a new approach (percutaneous intramyocardial approach) for treating hypertrophic obstructive cardiomyopathy (HOCM) by using radiofrequency ablation to relieve LVOT obstruction. Our study aimed to evaluate the safety and efficacy of PIMSRA in patients with HOCM.

METHODS

PATIENTS. The study included 15 patients (mean age, 40.73 ± 16.66 years; 2 female patients) who underwent PIMSRA with typical HOCM and severe symptoms (New York Heart Association functional class II or III) despite adequate medications. All patients were part of the study group registered at clinicaltrials.gov (NCT02888132) and provided informed consent to proceed with PIMSRA. All patients underwent clinical examination, standard 12-lead electrocardiography (ECG), TTE at rest and during dynamic bicycle exercise, contrast echocardiographic examination, computed tomography angiography (CTA), cardiac magnetic resonance (CMR) imaging, and blood biochemical examination before the PIMSRA.

All TTE studies were performed with the EPIQ 7C Ultrasound System (Philips Medical Systems, Bothell, Washington) with a 1.0- to 5.0-MHz transducer. Patients were told to lie in the left lateral recumbent position. ECG was performed simultaneously. Patients then underwent a routine echocardiographic

study with an S5-1 probe. Subsequently, both left ventricular (LV) end-diastolic mass and LV ejection fraction were calculated using the formula recommended by the American Society of Echocardiography. The LV end-diastolic mass was indexed to the body surface area and was expressed as the LV mass index. Furthermore, LVOT gradients were assessed under resting conditions before the PIMSRA. Stress echocardiography was performed with a bicycle exercise according to a standard protocol (10) for assessment of the provoked LVOT gradient.

CMR studies were then performed with a 1.5-T magnetic resonance scanner (MAGNETOM Aera, Siemens AG, Erlangen, Germany). By using an ECG-gated, breath-holding, steady-state, free-precession pulse sequence, we acquired 3 standard LV cine long-axis slices (4-, 2-, and 3-chamber views) and a stack of contiguous short-axis slices from the atrioventricular ring to the apex (full LV coverage and slice thickness of 8 mm, with no overlap and no gap). The imaging parameters were as follows: 16 temporal phases per slice, 3.0 ms repetition time, 1.5 ms echo time, 50° flip angle, 32 to 36 cm × 32 to 36 cm field of view, 0.75 rectangular field of view, and 192 × 256 matrix. We acquired late gadolinium-enhanced sequences 10 min after intravenous administration of 0.2 mmol/kg gadolinium-diethylenetriamine penta-acetic acid (Magnevist, Schering, Berlin, Germany) using breath-holding, 2-dimensional, phase-sensitive inversion recovery. Furthermore, the Turbo FLASH (fast low-angle shot) sequence was obtained in the same orientation as the cine images. The inversion time ranged from 240 to 300 ms and was chosen to null normal myocardial signals (inversion time optimized by the T1 scout sequence).

PIMSRA PROCEDURE. The study protocol was approved by the institutional ethics committee of Xijing Hospital (KY20162042-1) and was performed in accordance with the ethical standards of the Declaration of Helsinki. The study was registered at clinicaltrials.gov (NCT02888132).

The patients were placed in the left lateral decubitus position after general anesthesia was introduced. Heart electrical activity, blood pressure, and blood oxygen levels were monitored simultaneously throughout the procedure. A temporary pacing wire was inserted with the tip at the apex of the right ventricle by using a 6F sheath through the right internal jugular vein. The procedure of TTE-guided

ABBREVIATIONS AND ACRONYMS

- ASA** = alcohol septal ablation
- CMR** = cardiac magnetic resonance
- CTA** = computed tomography angiography
- ECG** = electrocardiography
- HOCM** = hypertrophic obstructive cardiomyopathy
- IVS** = interventricular septum
- LAD** = left anterior descending coronary artery
- LV** = left ventricular
- LVOT** = left ventricular outflow tract
- PIMSRA** = percutaneous intramyocardial septal radiofrequency ablation
- T1** = inversion time
- TTE** = transthoracic echocardiography

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