Percutaneous transluminal septal myocardial ablation markedly reduces energy loss in hypertrophic obstructive cardiomyopathy: a four-dimensional flow magnetic resonance imaging study

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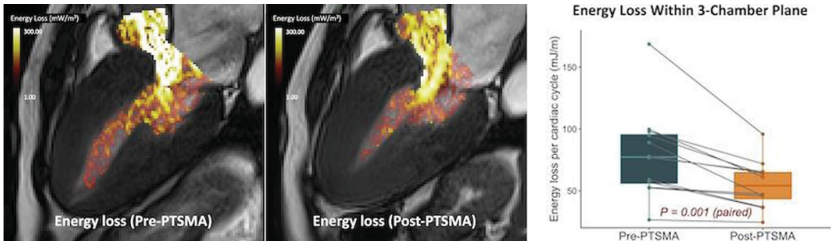
Background: Functional follow-up modalities of hypertrophic obstructive cardiomyopathy (HOCM) subjected to percutaneous transluminal septal myocardial ablation (PTSMA) are limited mainly to echocardiography and catheterization. Recent advancements in four-dimensional (4D) flow magnetic resonance imaging (MRI) have enabled us to assess patients from the perspective of fluid dynamics by visualising blood flow and calculating quantitative parameters such as wall shear stress and energy loss within cardiac chambers or blood vessels. Several reports have demonstrated that the intra-cardiac energy loss decreased along with improvement of cardiac function achieved by treatment of cardiac diseases. Whether changes in energy loss occur along with PTSMA in HOCM patients and the underlying mechanism remain unknown.

Purpose: This study sought to investigate the influence of PTSMA in patients with HOCM on energy loss in the left ventricle (LV) and aortic root measured by 4D flow MRI.

Methods: We retrospectively recruited HOCM patients who underwent PTSMA at a referral centre from May to November 2019. Patients who underwent 4D flow MRI both before and after PTSMA were included. We collected demographic and clinical data from electronic health records. MRI scans implemented two-dimensional phase-contrast imaging of the three-chamber plane with three-directional velocity, using a 1.5 T scanner. Furthermore, 4D blood flow analysis was performed on off-line saved data, using iTFlow version 1.9. We assessed energy loss in one cardiac cycle within the three-chamber plane of the LV and aortic root (area surrounded by the LV endocardium, sinotubular junction, and mitral annulus).

Results: This study finally included 12 patients, whose mean age was 66±12 years, and 5 (42%) of whom were men. The pressure gradient between the LV apex and ascending aorta was 81±32 mmHg before and 20±22 mmHg immediately after PTSMA ($P<0.005$, paired). Before PTSMA, 6 patients were in New York Heart Association functional class III and the other 6 in class II. However, after PTSMA, 10 patients improved to class I and 2 to class II. PTSMA reduced energy loss in one cardiac cycle within the three-chamber plane of the LV and aortic root, from 79±36 mJ/m to 55±19 mJ/m (P=0.001, paired).

Conclusions: PTSMA in patients with HOCM reduced energy loss within the LV and aortic root, indicating significant decrease with cardiac workload. Four-dimensional flow MRI of the three-chamber plane to assess energy loss within the LV and aortic root is a time-efficient and reproducible quantitative method to evaluate the effects of PTSMA. Given its non-invasive nature, it also enables to sequentially follow-up HOCM patients who underwent PTSMA.



Periprocedural changes of energy loss