Is it Aortic Stenosis or LV Outflow Tract Obstruction? The complementary role of 4D flow cardiac MRI.

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Summary

Trans-thoracic echocardiography (TTE) is the primary imaging modality for diagnosing any left ventricular outflow tract obstruction (LVOTO), estimating hemodynamic severity and timing of surgical intervention[1]. Multi-parametric cardiac magnetic resonance imaging (CMR) provides additional details on tissue characterisation and cardiac haemodynamics. We present a case of a 74-year-old gentleman with a history of hypertrophic cardiomyopathy (HCM), where four-dimensional flow identified the mechanism of obstruction in the outflow tract when Doppler methods proved challenging.

Case description

A 74-year-old gentleman with a history of hypertrophic cardiomyopathy (HCM) presented with non-specific abdominal pain. His angiogram and Fabry's screening were negative. Echocardiography demonstrated left ventricular (LV) hypertrophy with preserved ejection fraction. There was early diastolic dysfunction. Systolic anterior mitral valve leaflet (AMVL) motion causing possible LV outflow tract (LVOT) obstruction was observed on colour-Doppler. Due to the aliasing of the mitral regurgitation (MR) jet, measurement of the direct LVOT gradient proved challenging.

A cardiovascular magnetic resonance (CMR) assessment with four-dimensional flow (4D flow) was performed. There was asymmetrical LVH (septum: 16.7mm) with mid-wall myocardial fibrosis on late gadolinium enhancement, confirmed on T1 mapping. On cines and 4D flow, three-dimensional velocity-mapping, systolic anterior motion (SAM) of the AMVL was seen. The AMVL drift resulted in mild MR, which was directly quantified by the 4D flow. Furthermore,

SAM caused LVOTO with a peak resting gradient of 64mmHg (Figure 1; Supplementary Video 1-3).

Two-dimensional phase-contrast (2DPC) assessment is routinely used in CMR for flow assessment. However, it can miss recognising the true peak velocity plane, and also it can significantly underestimate the true peak velocity, as it captures only the through-plane velocities and not velocities in all directions[2]. Previous studies have shown how 4D flow can be used for LVOTO pressure gradient assessment[3].

This specific case not only emphasises the significance of quantifying peak velocity in the LVOTO using 4D flow but also showcases its visualisation capabilities, which offer precise identification of flow acceleration where routine Doppler or 2DPC techniques are challenging. 4D flow three-dimensional velocity assessment allowed us to distinctly demonstrate the mechanism of obstruction in the outflow tract and accurately quantify LVOT gradient in a patient with HCM. Hence, this case highlights that 4D flow can complement routine multi-parametric CMR.

Statement of Consent: The authors confirm that written consent for submission and publication of this case report, including images and associated text, has been obtained from the patient in line with COPE guidance.

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Figures

Figure 1. Echocardiographic and multi-parametric cardiovascular magnetic resonance imaging assessment of aortic stenosis.

Panel a, b and c: Apical 4-chamber long-axis view demonstrating the systolic anterior motion of the anterior mitral leaflet towards the outflow tract and possible flow acceleration on Colour Doppler. The peak velocity on continuous wave Doppler was 4.25m/sec. However, due to the mitral regurgitation jet superimposing the outflow tract flow, it was not clear if this was indeed in the outflow tract. Importantly, as this was not Pulse Wave Doppler, it was difficult to determine the spatial location of the peak velocity.

Panel d: Steady-state free precession short-axis cine images showing asymmetrical septal hypertrophy (16.74mm at end-diastole).

Panel e: Late gadolinium enhancement imaging with a predefined signal threshold of 3 standard deviation, demonstrating mid-wall myocardial fibrosis.

Panel f and g: Native and post-contrast T1 mapping demonstrating fibrotic changes in the anterior wall and septum, consistent with the diagnosis of hypertrophic cardiomyopathy.

Panel h, i and j: 4D flow three-dimensional velocity visualisation of flow and its speed demonstrate that the flow acceleration is happening in the LV outflow tract with a peak velocity of 4.07m/sec. The SAM can be seen in panel h clearly with resultant mitral regurgitation.

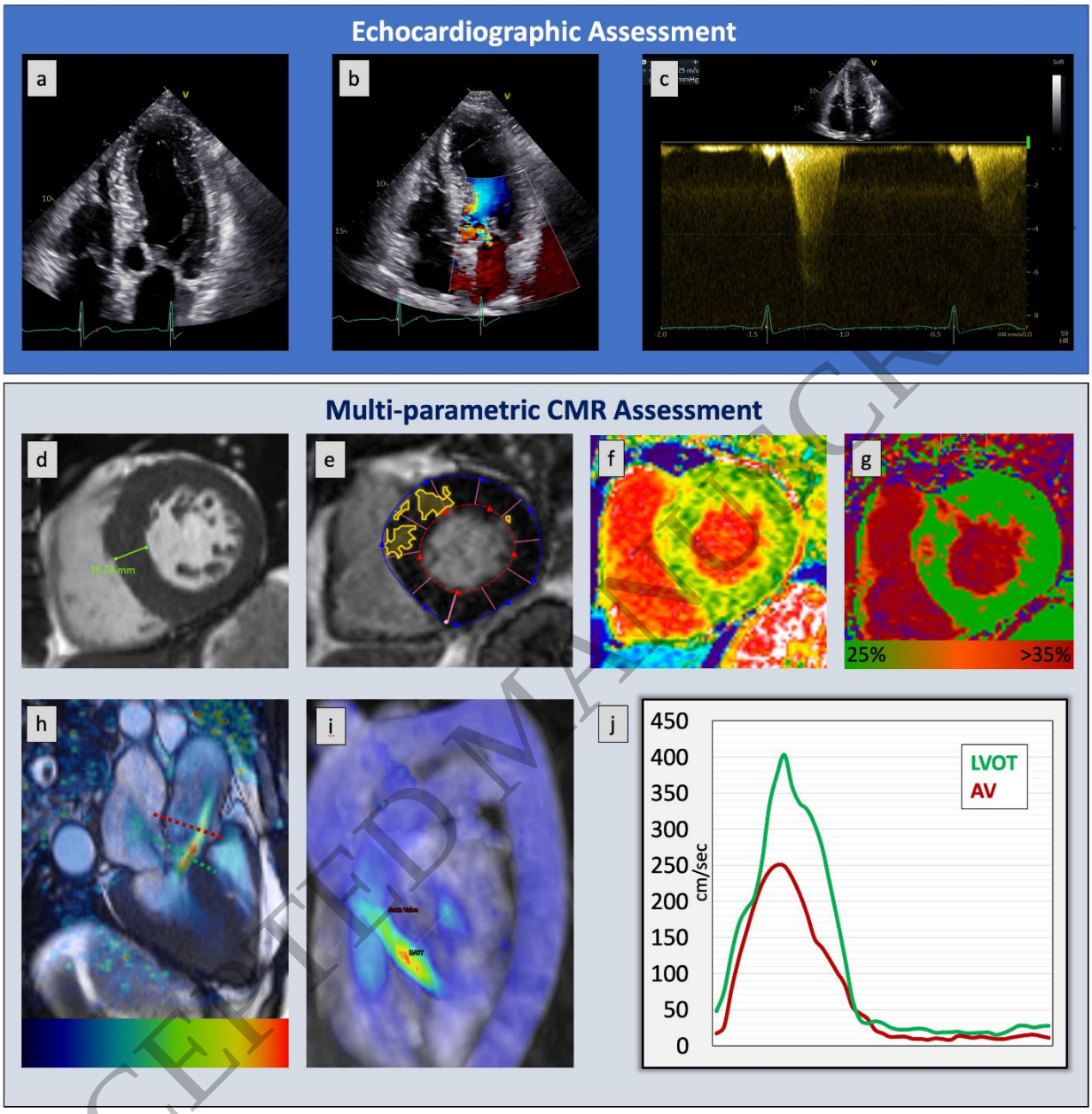

Figure 1
165x169 mm (x DPI)