

# Left heart matters in Ebstein's anomaly: the importance of a closer follow up—a case report

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## Background

Ebstein's anomaly (EA) is mainly thought of as a right heart condition, however, congenital left-sided lesions can co-exist. Therefore, it is paramount to include the left side of the heart as part of a routine investigation in these patients. We present a 57-year-old symptomatic patient with EA and progressive tricuspid regurgitation (TR) associated with acquired left ventricular outflow obstruction (LVOTO).

## Case summary

A 57-year-old woman, known to have severe EA presented with shortness of breath and chest pain on exertion secondary to progression of the tricuspid valve regurgitation and right ventricle dilatation leading to a dynamic compression of the left outflow tract requiring surgical intervention.

## Discussion

Left ventricular obstruction secondary to severe TR and dilation of the right ventricle can present and remain silent at rest but becoming significant on exertion. Therefore, we recommend that all patients with EA and significant TR undergo exercise echocardiography at regular intervals to specifically look for acquired dynamic LVOTO.

## Keywords

Ebstein's anomaly • Tricuspid regurgitation • Left ventricular outflow obstruction (LVOTO) • Case report

## Learning points

- Ebstein's anomaly should not be regarded as a disease confined only to the right side of the heart.
- Left side lesions can be present as well. Left ventricular outflow obstruction (LVOTO) can be acquired and dynamic, secondary to a leftward displacement of the interventricular septum due to severe right ventricular dilation ± severe tricuspid regurgitation or fixed. Dysfunction of the left ventricle can be present due to an abnormal ventricular–ventricle interaction or non-compaction.
- Dynamic LVOTO has to be thought of as a potential complication despite the absence of a significant gradient on echo at rest.
- A thorough investigation of the heart both at rest and on exertion has to be performed when following up this subset of patients with the aim to reveal underlying LVOTO.

## Introduction

Ebstein's anomaly (EA) is predominantly considered a right heart condition but it is well recognized that congenital left-sided

lesions can co-exist and be the leading cause of clinical deterioration. The incidence is approximately 1 per 200 000 live births and it accounts for <1% of all cases of congenital heart disease with no gender preponderance. In its most severe form, the

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diagnosis may be established *in utero* or infancy, requiring early surgery but can be diagnosed later in childhood and not uncommonly in adulthood. Therefore, it is paramount to always investigate the heart in its entirety. We present a 57-year-old symptomatic patient with EA and progressive tricuspid regurgitation (TR) associated with acquired left ventricular outflow obstruction (LVOTO).

## Timeline

Nine months prior to presentation	Medical history of Ebstein's anomaly and hypertension. Asymptomatic. Transthoracic echocardiogram: moderate tricuspid regurgitation (TR). Patient was on bendroflumethazide and recently, started on losartan.
Upon presentation to peripheral clinic	Became symptomatic: progressive dyspnoea and chest pain. No signs of heart failure. Transthoracic echocardiogram: severe TR. Left ventricular outflow obstruction. Chest pain was provoked by vasodilator medication (losartan). Medication was discontinued and chest pain disappeared.
One month later	Progression of shortness of breath. Cardio-pulmonary test: $VO_2$ max decreased. Coronary tomography: normal coronaries. Surgical referral.
Six months later	Cardiac magnetic resonance: severe TR. Preserved right ventricular ejection fraction.
A year after presentation	Transoesophageal echocardiogram: increased velocity to left ventricular outflow (LVOT) tract. Stress echocardiogram: significant increase in LVOT velocity on exercise. Surgical decision was made.

## Case presentation

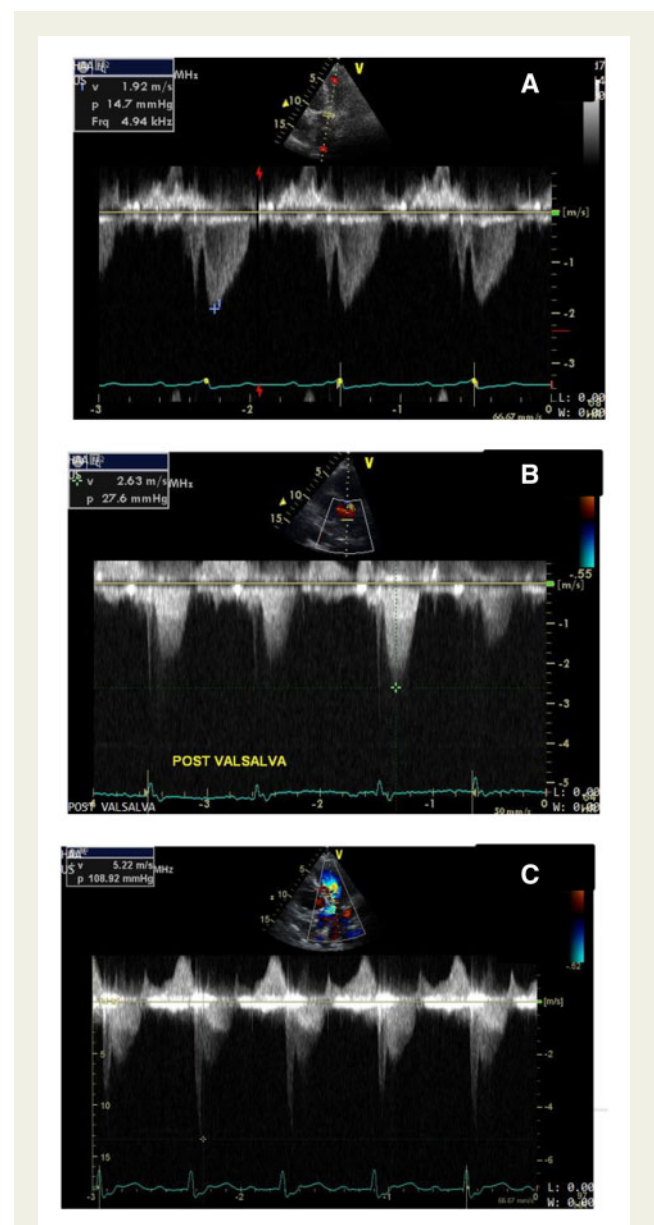
A 57-year-old woman with a known history of EA with moderate TR and systemic hypertension became symptomatic with progressive dyspnoea and angina-like chest pain, occurring primarily on exertion or after meals. The patient denied syncope and dizziness but had occasional palpitations on exertion.

The patient was taking bendroflumethazide only for hypertension, having found her chest pain worsened on losartan.

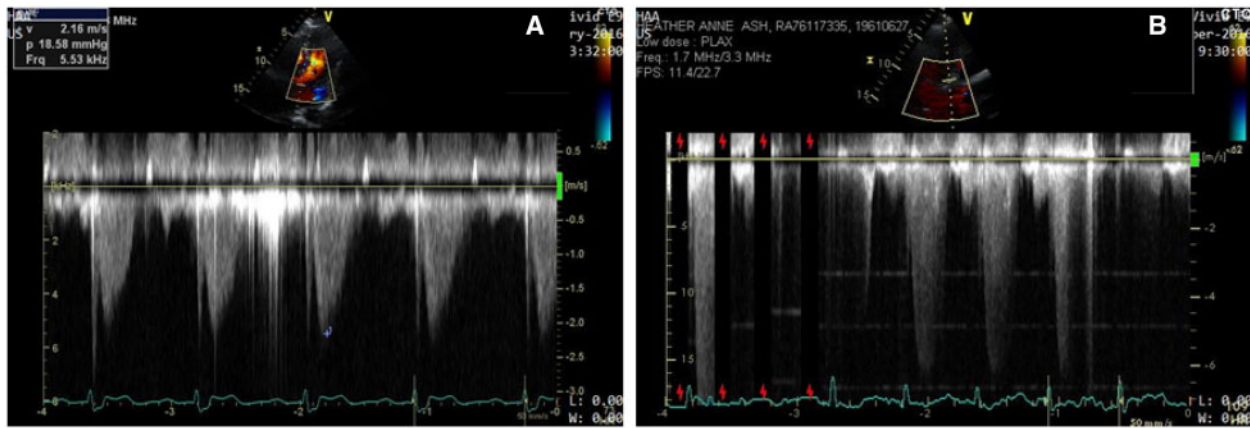
On examination, height was 163 cm, weight 57 kg, blood pressure was 157/74 mmHg, heart rate 75 b.p.m., and oxygen saturations were 98%. Her jugular venous pressure was not elevated, chest was clear and there was no peripheral oedema. There was a grade 2/6 pansystolic murmur at the left sternal edge.

Electrocardiogram (ECG) showed normal sinus rhythm with a prolonged PR interval (220 ms) and right bundle branch block (QRS duration 160 ms) (Figure 1). A 24 h Holter monitoring showed sinus rhythm with first degree heart block throughout, 54–104 b.p.m., with occasional runs of ventricular bigeminy and premature ventricular complexes. Full blood count, renal and liver function tests were normal.

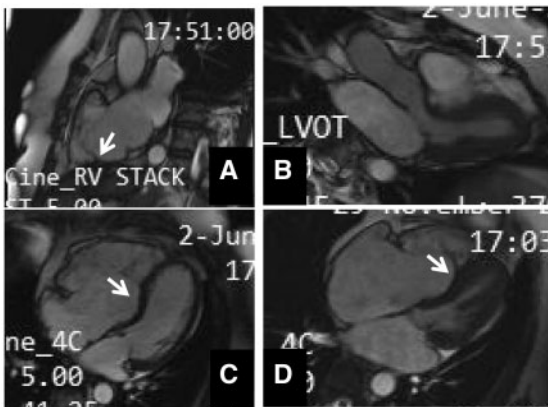
Transthoracic echocardiography performed in 2014 showed a small, non-hypertrophied left ventricle with normal function. The commissure of the posterior and septal leaflets of the tricuspid valve was significantly apically displaced (42 mm), resulting in a large atrialized component of the right ventricle. The anterior leaflet was large



**Figure 1** Dopplers of peak forward flow velocity across the left ventricular outflow tract on transthoracic echocardiography. (A) At rest: peak velocity 1.92 m/s. (B) Post-Valsalva manoeuvre: peak velocity 2.63 m/s. (C) With leg raising: peak velocity 5.22 m/s.



**Figure 2** Dopplers of peak forward flow velocity across the left ventricular outflow tract on stress echocardiography. (A) At rest: peak velocity 2.16 m/s. (B) At peak exercise 6.3 m/s.



**Figure 3** Cardiac magnetic resonance imaging. (A) Contrast-enhanced two-chamber view showing apical displacement of the septal leaflet of the tricuspid valve (arrow). (B) Three-chamber view showing narrowing of the left ventricular outflow tract at end-systole. No systolic anterior motion of the mitral valve was found (SAM). (C) Four-chamber end-diastole view. Leftward displacement of the septum during diastole (arrow) due to the protrusion of the atrialized right ventricle. (D) Four-chamber end-systole view. Persistence of the leftward displacement of the interventricular septum during systole (arrow).

and redundant. There was severe TR. Aortic and mitral valve morphology was normal. There was no systolic anterior motion of the mitral valve. The aortic annulus was small and there was turbulent flow through the left ventricular outflow (LVOT) due to the abnormal motion of the atrialized portion of the right ventricle in systole, resulting in a peak velocity through the LVOT of 2.6 m/s at rest, increasing to 3.5 m/s post-Valsalva (peak gradient 27 mmHg at rest and 48 mmHg post-Valsalva) (Supplementary material online, Video S1).

Given the patient's cardiovascular risk profile, computed tomography of the coronary arteries was undertaken, which was normal.

Symptoms persisted and worsened with an objective deterioration in functional capacity over a 5-month period, based on cardiopulmonary exercise testing done ( $\text{VO}_2\text{max}$ : 24.3 mL/kg/min—METS 6.9 in July vs.  $\text{VO}_2\text{max}$ : 18.7 mL/kg/min—METS 5.3 in December with a reduced oxygen pulse).

A year later a cardiac magnetic resonance imaging showed an increase in the right ventricular end-diastolic volume over a 12-month period, from 123 mL/m<sup>2</sup> (ejection fraction 64%) to 146 mL/m<sup>2</sup> (ejection fraction 57%). The tricuspid regurgitant fraction increased from 32% to 52%.

Transoesophageal echocardiography (TOE) was performed to explore the LVOT anatomy in 2015. Post-TOE, transthoracic echocardiography demonstrated a resting peak velocity of 1.9 m/s across the LVOT, which increased to 5.2 m/s (incomplete Doppler envelope) with leg raising (Figure 2). No atrial septal defects were identified. In the same year, an exercise stress echocardiography showed a significant increase in peak gradient to 157 mmHg and a peak flow velocity through the LVOT from 2.1 m/s (mean gradient 12 mmHg) at rest to 6.3 m/s (mean gradient 95 mmHg) at peak stress at very low workload (25 W) (Figure 3).

Losartan was switched to verapamil 80 mg three times daily due to the chest pain being worse on losartan. The mechanism for this was felt to be myocardial ischaemia due to exacerbation of the LVOTO secondary to reduction of the systemic vascular resistance and therefore reduction in coronary blood flow. We felt that verapamil might reduce any dynamic LVOTO in a manner similar to that in hypertrophic obstructive cardiomyopathy. She was also prescribed indapamide 2.5 mg once a day instead of bendroflumethazide with good blood pressure control.

The patient's case was reviewed at the multidisciplinary meeting and the decision was made to proceed to cardiac surgery for tricuspid valve repair or replacement in the hope that this would reduce the LVOTO and some LVOTO resection if possible.

Due to the rarity of the condition, the patient has chosen not to have surgery and is currently seeking several opinions worldwide.

## Discussion

Ebstein's anomaly is rare. Although the condition exhibits typical characteristics, each affected patient has different morphological and haemodynamic features, resulting in different natural histories.<sup>1</sup> Age of presentation and symptomatology depend on the anatomic and functional severity of the tricuspid valve abnormality as well as the presence of associated anomalies such as septal defects, and the arrhythmia burden.<sup>2</sup> The combination of EA and an atrial septal defect or patent foramen ovale is found in 60–70% of cases.<sup>1–3</sup> Wolff–Parkinson–White syndrome occurs in 10–29% cases, and results in supraventricular tachycardia in at least 15% of these.<sup>1</sup>

Ebstein's anomaly was originally described as a lesion affecting the right side of the heart.<sup>4</sup> Along with the cardinal tricuspid valve anomaly, pulmonary stenosis, atresia, and hypoplastic pulmonary arteries have been described. However, left-sided lesions are increasingly being recognised, largely due to improvements in cardiac imaging, and are thought to be present in 39% of cases. These include non-compaction of the left ventricle and muscular left ventricular bands, as well as abnormalities of the mitral valve, such as mitral valve prolapse and accessory mitral valve tissue. Atretic or bicuspid valves have also been described, as has coarctation of the aorta and subaortic stenosis.<sup>4</sup>

Left ventricular outflow obstruction associated with EA is very rare. Isobe et al.<sup>5</sup> reported a case of EA and LVOTO due to abnormal accessory tissue of the mitral valve but others have described dynamic LVOTO due to severe TR.<sup>6</sup> Li et al.<sup>1</sup> reported a large series of 245 patients who underwent tricuspid valve surgery. Six were found to have LVOTO at the time of surgery, none of whom had signs of it pre-operatively. The severe LVOTO could be treated with reoperation of the atrialized right ventricle. In a large review of patients with EA from the Mayo clinic, only two patients out of 106 had LVOTO mimicking hypertrophic obstructive cardiomyopathy and requiring myectomy.<sup>4</sup>

Hirata reported the case of a 59-year-old woman with similar features, where a 20 mm displacement of the posterior and septal leaflets' commissure resulted in abnormal motion of the basal septum causing LVOTO.<sup>7</sup> In this case, the ECG and transthoracic echo both showed signs of left ventricular hypertrophy (LVH), both of which would have prompted looking for significant LVOTO. Furthermore, this patient had severe LVOTO at rest and this was unlikely to be missed on routine echocardiography. Moreover, the patient also had systolic anterior motion of the mitral valve as a result of the LVOTO and consequent severe mitral regurgitation.

In this case, we describe dynamic severe LVOTO in EA due to worsening and severe TR into an atrialization right ventricle with consequent abnormal motion of the basal interventricular septum. The haemodynamics were subtle at rest and exacerbated by exercise provoking angina secondary to severe LVOTO. This case adds to the current literature base on EA as the LVOTO was not present at rest and there was no LVH. Moreover, unusually, the patient complained of angina in the presence of normal coronary arteries, hinting at the underlying pathophysiology. This illustrates the importance of always searching for potential LVOTO despite the absence of a significant gradient at rest or LVH, particularly if the patient complains of classical angina with no coronary disease.

A multicentre registry would help to understand the mechanisms that lead to the development of acquired LVOTO in EA

thereby potentially improve outcomes with earlier surgery in this subset of patients.

## Conclusions

Ebstein's anomaly is mainly a right-sided heart condition. However, in addition to the co-existence of congenital left-sided lesions, worsening of the TR and consequently dilation of the right ventricle can result in progressive acquired dynamic LVOTO that may require correction at the time of surgical repair of the tricuspid valve.

In this case, the full diagnosis was not made initially as the patient had minimal LVOTO at rest and no LVH. We therefore advise congenital cardiologists that EA can rarely be complicated by acquired LVOTO secondary to progressive TR and right ventricular dilatation. We recommend that all patients with EA and significant TR undergo exercise echocardiography at regular intervals to specifically look for acquired dynamic LVOTO.

## Lead author biography



Dr Maria Victoria Ordoñez, adult cardiologist specialist in adult congenital heart disease trained in Buenos Aires, Argentina, and Montreal, Canada. Currently, working as a research and clinical ACHD fellow at the Bristol Heart Institute, Bristol University, Bristol, UK.

## 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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