

Enhanced Echocardiography Imaging in Reoperation for Complex Congenital Heart Disease in a Child



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INTRODUCTION

In children, careful evaluation of mitral valve (MV) disease is essential for repair. Early identification of findings requiring modification of the repair may prevent the need for a reoperation later and may decrease morbidity, mortality, and overall hospital costs over the long term.¹ Two-dimensional (2D) and three-dimensional (3D) transesophageal echocardiography (TEE) are the gold standard for presurgical planning.¹⁻⁵ Recent progress in echocardiography for both acquisition and postprocessing techniques has led to improvement in diagnosis accuracy.⁶

We report a case where new software provided images of MV that were even closer to reality, enabling the surgeon to choose the optimal surgical techniques for repair.

CASE PRESENTATION

A 13-year-old patient was referred to surgery for recurrent significant left ventricular outflow tract (LVOT) obstruction and severe mitral regurgitation (MR). The child had a history of congenital subvalvular aortic stenosis obstruction with fibromuscular ridge extended from the septum to the anterior leaflet of the MV. The fibromuscular ridge was extensively resected, and a limited myectomy of the subaortic region was carried out. In the process of resecting the shelf, a small perforation was inadvertently made in the anterior leaflet of the MV. Perforation was closed using a pledgeted primo suture, and an additional partial posterior annuloplasty was made using a flexible ring from a thin-walled 3.5-mm Gore-Tex Vascular graft (Newark, DE).

After the initial surgery, the peak velocity through the LVOT was 1.9 m/sec. The child was subsequently followed up in an outreach clinic where the LVOT gradient was reported as gradually increasing, and 6 years later, the child was referred back for severe LVOT obstruction and moderate MR (Figure 1).

Prebypass 2D TEE showed reoccurrence of complex LVOT obstruction and severe MR due to restriction of the posterior leaflet and prolapse of the anterior leaflet. Additional echo-bright tissue was seen above the mitral orifice (Figures 2 and 3, Videos 1 and 2). Three-dimensional TEE with additional imaging modality revealed a

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VIDEO HIGHLIGHTS

Video 1: Prebypass 2D TEE in the midesophageal long-axis view showing additional echo-bright tissue posteriorly located from the annulus and appearing to be independent from the valve and the left ventricular fibromuscular obstruction.

Video 2: Prebypass 2D TEE in the midesophageal long-axis view with color Doppler showing severe MR with gap of coaptation between the prolapsing anterior MV leaflet and restricted posterior leaflet and the accessory attachment of the muscle band to the anterior leaflet of the MV and fibromuscular narrowing of the LVOT obstruction.

Video 3: Prebypass 3D TEE in the left atrial view showing the detached posterior annuloplasty ring from the annulus and its dislodgment anteriorly and above the mitral orifice with remaining attachment to the annulus at the commissural levels. Posterior MV leaflet seems to be short and not coapting with the anterior MV leaflet.

Video 4: Prebypass 3D TEE in the left atrial view, with FlexiLight. Light is shining from the left atrium, to enhance the in-depth perception showing the detached posterior annuloplasty ring from the annulus and its dislodgment anteriorly and above the mitral orifice with remaining attachment to the annulus at the commissural levels. Posterior MV leaflet seems to be short and not coapting with the anterior MV leaflet.

Video 5: Prebypass 3D TEE in the left atrial view FlexiLight and HD color Doppler flow mapping showing the dehiscent annuloplasty ring, with in-depth visualization of the relationship among the annulus, the leaflets, and the ring, and the severe MR, with posterior origin of the regurgitant jet.

Video 6: Postbypass 2D TEE in the midesophageal long-axis view with color Doppler showing mild MR and the relief of the LVOT obstruction with septal myectomy up to the midcavity level and division of accessory attachment of the anterior MV to the anterolateral papillary muscle (*arrow*).

Video 7: Postbypass 3D TEE in the left atrial view showing the repaired MV with the well-seated partial posterior annuloplasty graft.

Video 8: Postbypass 3D TEE in the left atrial view, with Flexilight. The light is shining from the left atrial view, right behind the MV annulus to enhance depth perception.

View the video content online at www.cvcasejournal.com.

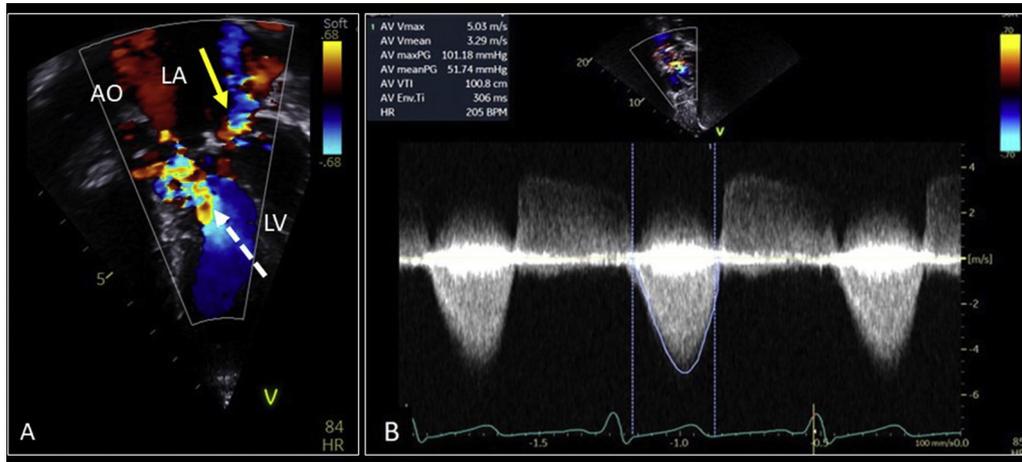


Figure 1 Transthoracic echocardiography, 2D and color Doppler flow mapping in the apical five-chamber view in anatomical projection (A) and spectral continuous-wave Doppler (B) across the LVOT documenting significant obstruction (dotted arrow) and mild aortic regurgitation and moderate MR (arrow). Ao, Aortic valve; LA, left atrium; LV, left ventricle.

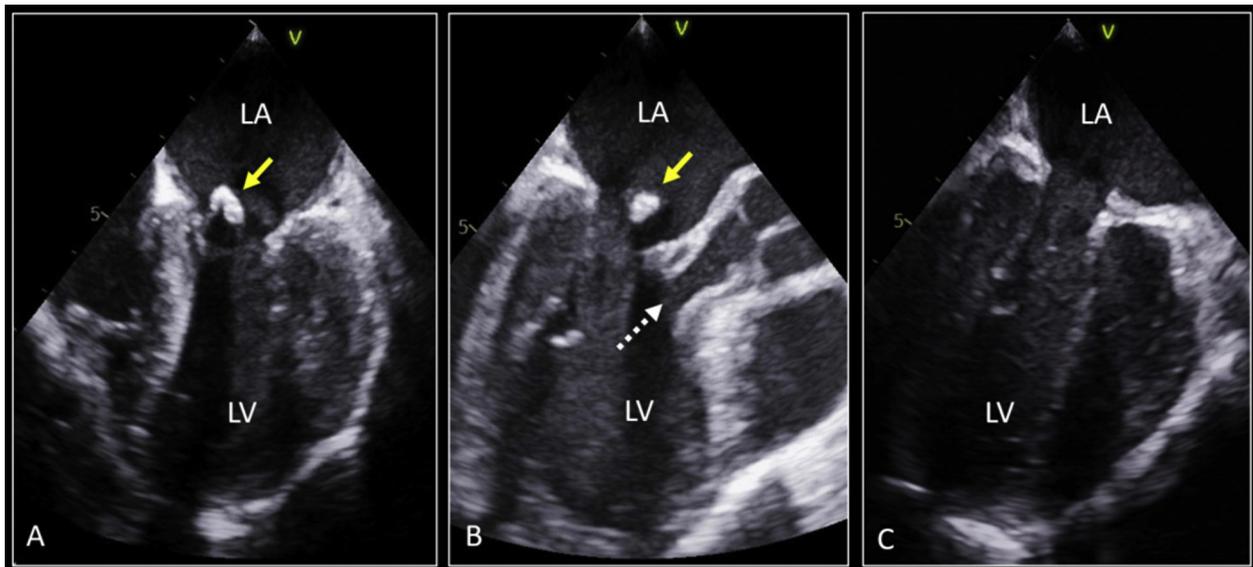


Figure 2 Prebypass 2D TEE 3 standard MV views: midesophageal four-chamber view (A), long-axis view (B), and two-chamber view (C) showing additional echo-bright tissue above the mitral orifice (arrow) and the LVOT obstruction (dotted arrow). LA, Left atrium; LV, left ventricle.

detached annuloplasty ring from the posterior annulus and its dislodgment anteriorly and above the mitral orifice, with remaining attachment to the annulus at the commissural levels. Additional high-definition color Doppler flow mapping (HD color) identified an MR jet with high-velocity flow originating from the posterior aspect of the annuloplasty ring (Figure 4, Video 3).

Real-time photo-realistic rendering and lighting source technology (FlexiLight [General Electric, Boston, MA]), by shining the light from inside the left atrium, helped us to improve our comprehension of the spatial relationship of the mitral leaflets, annulus, and dislodged prosthetic annuloplasty graft (Videos 4 and 5)

All these enhanced echocardiography techniques enabled the surgeon to have a more complete view of the problem, matching well his surgical finding and enabling him to choose the best repair technique.

After exposing the MV through a transeptal approach, the bridging Gore-Tex graft was removed, the posterior leaflet was released from

the annulus, and the incision was extended beyond the commissures on either side. Posterior leaflet augmentation was performed using a Matrix patch (Auto Tissue Berlin, Berlin Germany), with 6-0 prolene continuous suture. Septal myectomy was done up to the midcavity level, and accessory attachment of the anterior MV to the anterolateral papillary muscle was divided.

The result was very satisfactory, with only mild subvalvular flow acceleration and an LVOT Vmax of less than 2 m/sec, and MR was mild with mild mitral stenosis and a mean gradient of 5 mm Hg (Figures 5 and 6, Videos 6, 7 and 8)

DISCUSSION

As previously described, 2D and 3D TEE are the gold standard to identify the mechanism of MV disease prior to MV surgery.¹⁻⁵ A similar case of annuloplasty ring dehiscence diagnosed by 3D TEE

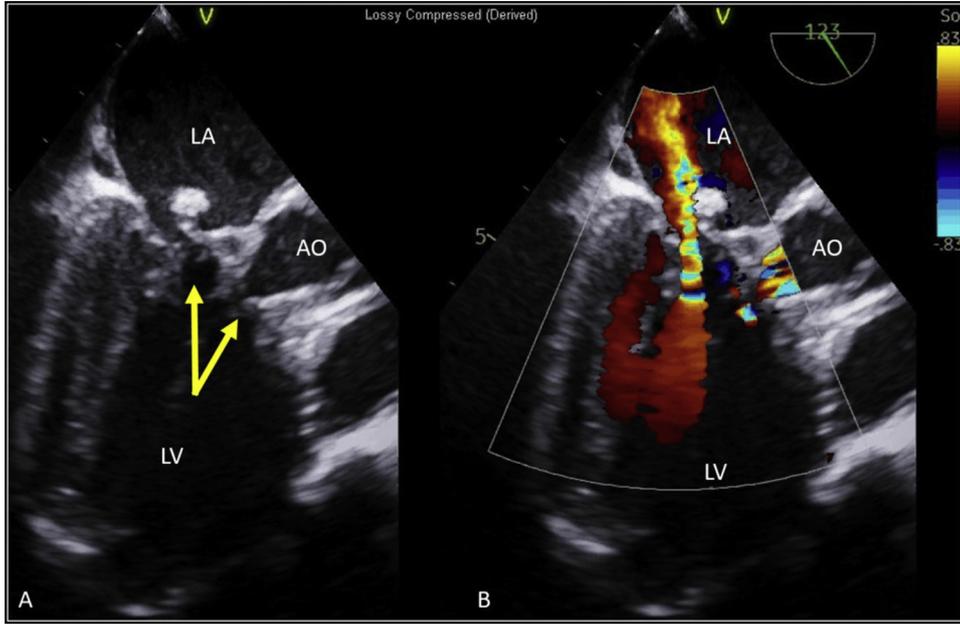


Figure 3 Prebypass 2D TEE midesophageal long-axis view **(A)** and color Doppler flow mapping **(B)** showing severe MR with gap of coaptation between the prolapsing anterior MV leaflet and restricted posterior leaflet (*arrow*) and the accessory attachment of the muscle band to the anterior leaflet of the MV and a fibromuscular narrowing of the LVOT obstruction causing the preoperative gradient (*arrow*). Ao, Aortic valve; LA, left atrium; LV, left ventricle.

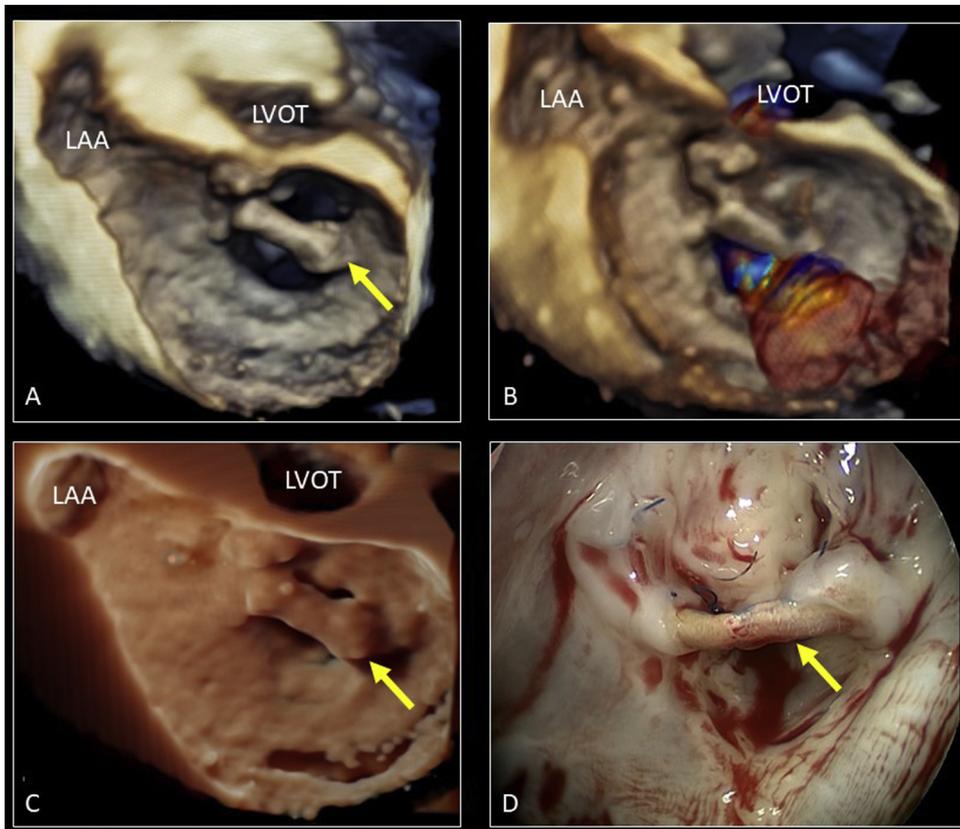


Figure 4 Prebypass 3D TEE in the left atrial view **(A)** and HD color Doppler flow mapping **(B)**, FlexiLight **(C)**, and direct surgical view **(D)** showing the detached posterior annuloplasty ring (*arrow*) from the posterior annulus and its dislodgment anteriorly and above the mitral orifice with remaining attachment to the annulus at the commissural levels and the severe MR with posterior origin of the regurgitant jet. LAA, Left atrial appendage.

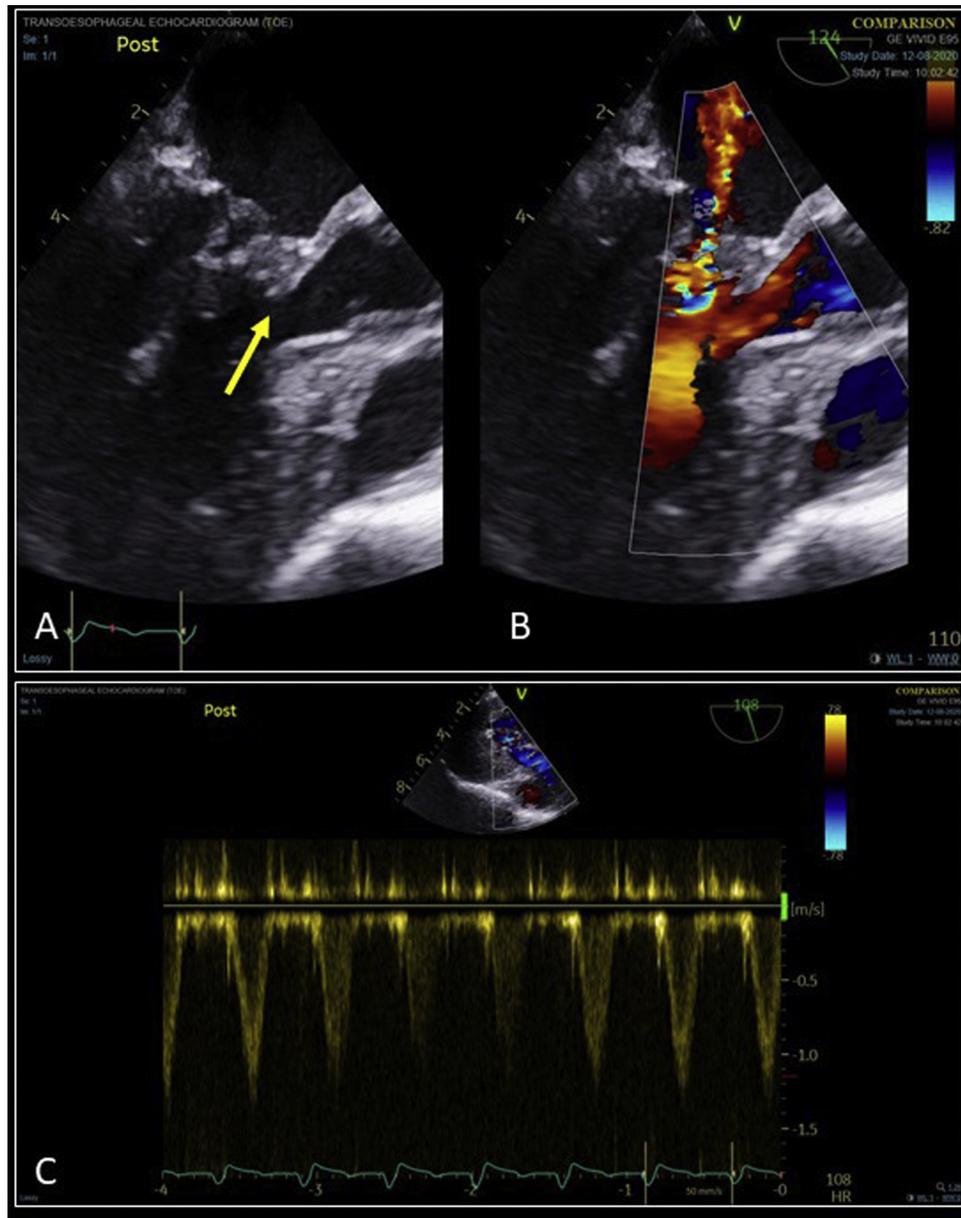


Figure 5 Postbypass 2D TEE mid-esophageal long-axis view (**A**), color Doppler flow mapping (**B**), and spectral Doppler (**C**) showing mild MR and relief of the LVOT fibromuscular obstruction with the divided accessory chordal attachment (*arrow*).

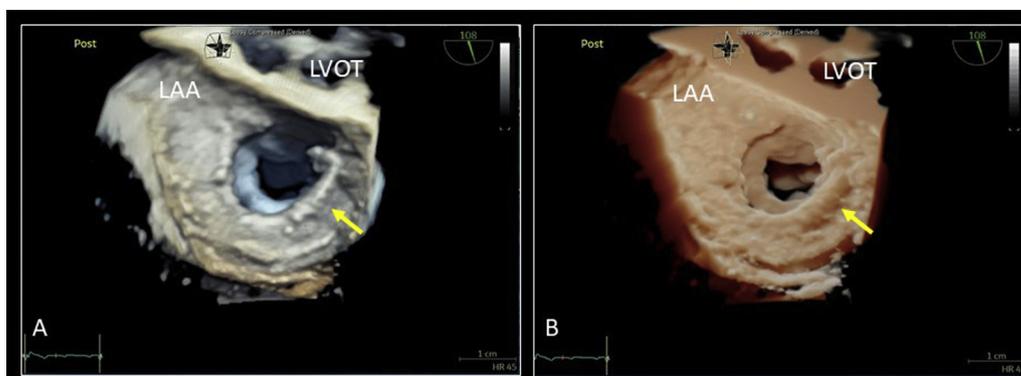


Figure 6 Postbypass 3D TEE in the left atrial view (**A**) and FlexiLight (**B**) showing the well-seated partial posterior annuloplasty graft above the mitral orifice (*arrow*). LAA, Left atrial appendage.

has been reported in an adult patient.⁷ Our case demonstrated the benefit of enhanced echocardiography imaging in a complex case of congenital heart disease in a child, to help the surgeon choose the best strategy for MV repair. Indeed, the 3D TEE, as well as real-time photo-realistic rendering and lighting source technology (FlexiLight), allowed us, by changing the lighting conditions, to improve contrast and in-depth perception of the mitral leaflets, annulus, and dislodged prosthetic annuloplasty ring.

Furthermore, the use of 3D color Doppler flow mapping is important to detect the origin and number of regurgitant jets, but its use is limited in children. Indeed, in children, the addition of color Doppler flow mapping reduces the temporal resolution, and the achievable frame rate may be too low for fast-moving structures such as atrioventricular valves.² In our case, the HD color Doppler flow mapping helped us to identify the origin of the MR jet. The high-velocity flow created a more coherent color signal that allowed looking through the color to better assess the jet dimensions and origin, which is typically obscured by surrounding low-flow color speckles.

CONCLUSION

In summary, enhanced echocardiography imaging provides the clinician with all the information needed to choose the optimal surgical valve repair technique in a child born with complex congenital left ventricular obstruction associated with MV abnormality.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.11.002>.

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