

Distortion of Aortic Valve from Mechanical Traction Imposed by the Mitral Valve Prosthesis: The Three-dimensional Transesophageal Echocardiographic Perception

Abstract

Iatrogenic injury to the aortic valve is a rare but frequently reported complication during mitral valve surgeries. Intraoperative 2-dimensional transesophageal echocardiography (2D TEE) has a major impact in diagnosing these injuries, so that timely intervention is possible. However, 2D TEE has lot of limitations during the perioperative period, which can be overcome by the three dimensional echocardiography (3D-TEE). We report a case where 3D TEE has undoubtedly delineated the cause for distortion of aortic sinus after mitral valve replacement and helped in the successful outcome.

Keywords: *Iatrogenic aortic valve injury, mitral valve replacement, three-dimensional echocardiography*

Introduction

Intraoperative transesophageal echocardiographic (TEE) assessment of a surgically placed prosthetic valve not only involves the assessment of valve function or regurgitant leaks but also the iatrogenic injury to the adjacent cardiac structures. Aortic valve (AV) and left circumflex artery are reported to be more liable to injury following mitral valve (MV) surgeries.^[1,2] Intraoperative two-dimensional TEE (2D-TEE) has its own limitations due to inadequate imaging planes and poor spatial orientation. This can be overcome by the recent advances in three-dimensional TEE (3D-TEE) where exact mechanism of the lesion can be understood in a more comprehensive manner.^[3] We report a case, in which 3D-TEE has evidently demarcated the distortion of AV following an accidental suture in the left coronary sinus (LCS) during MV replacement.

Case Report

A 47-year-old male, a known case of rheumatic heart disease since childhood, presented with symptoms of congestive cardiac failure. On examination, he was in atrial fibrillation with controlled ventricular rate and a Grade 4 pansystolic murmur was heard at the apex. His preoperative transthoracic echocardiography (TTE) revealed a severely stenotic rheumatic MV

with mild-to-moderate regurgitation, moderate tricuspid regurgitation, severe pulmonary hypertension, dilated left atrium, and good biventricular function. Surgery was planned to replace the diseased MV. He was receiving oral digoxin and diuretics once daily which were discontinued on the day of surgery.

In the operating room (OR), standard anesthesia monitoring was established. General anesthesia was induced with 500 µg of fentanyl, 3 mg of midazolam, and 60 mg of propofol. Muscle relaxation was attained with 6 mg of pancuronium. After intubating the trachea, a real-time-3D TEE (RT-3D-TEE) probe was placed in the esophagus, and the heart was examined with an ultrasound machine (iE 33; Philips Medical Systems, Bothell, WA, USA). The pre-cardiopulmonary bypass (CPB) TEE confirmed the preoperative TTE findings. After adequate systemic heparinization, CPB was instituted, and a 31 mm Medtronic–Hall tilting disc valve was implanted in the mitral position. Post-CPB TEE examination showed a well-seated, normally functioning MV prosthesis. However, mid-esophageal AV short axis view revealed the distortion of trileaflet AV to a clover shape with mild-to-moderate eccentric regurgitation [Figure 1a]. An electrocardiographic-gated left ventricular full volume loop was

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acquired over 4 beats with briefly held respiration at a frame rate of 20–25 Hz. The displayed 3D image was rotated and cropped to view the MV in surgeon’s orientation (en-face view). It showed impingement of the prosthesis sewing ring over the LCS causing restriction of left coronary cusp [Figure 1b and Video 1]. Surgeon was informed about the unusual finding, and he realized that an inadvertent suture might have been placed through the LCS leading to its distortion and eccentric aortic regurgitation (AR). Extracorporeal circulation was reinstated, and the tethered suture at the junction of sewing ring and left coronary cusp was removed. The patient was weaned off from CPB with inotropic support of dobutamine 2.5 µg/kg/min and noradrenaline 0.05 µg/kg/min. Post-CPB 2D and RT-3D-TEE examination showed the restoration of the trileaflet AV appearance and normal movement of the left coronary cusp without any injury [Figure 2a, b and Video 2]. The removal of tethered sutures did not produce any paravalvular leak of the MV prosthesis [Figure 3 and Video 3]. Heparin was reversed with protamine, and sternal closure was done after achieving hemostasis. Postoperative period remained uneventful, and he was discharged from the hospital on the 8th postoperative day.

Discussion

AV being in central location at the base of cardiac skeleton is more vulnerable to iatrogenic injury during cardiac valve surgeries. Reports of AR due to inadvertent perforation of the AV cusps following MV surgeries have been published in the literature.^[4] To the best of our knowledge, the role of intraoperative 3D-TEE imaging delineating the mechanism of these iatrogenic injuries has not been reported so far.

The intraoperative TEE is highly recommended for open heart valve surgeries.^[5] Although 2D TEE is influential in diagnosing accidental injury to adjacent cardiac structures during valve surgeries, there are several limitations to its use in the intraoperative period. The artifacts created by prosthetic valves interfere with the identification of exact mechanism responsible for the iatrogenic injury. Moreover, specific spatial relationship of prosthesis with the adjacent structures is difficult to acknowledge with 2D TEE following valve replacement surgeries.^[6] These drawbacks can be overcome by the 3D-TEE where a myriad of information can be envisaged by obtaining a 3D full-volume loop of heart base and cropping on a desired plane to focus on the region of interest. Color flow Doppler evaluation in 3D imaging enables to identify the exact location of regurgitation in a more precise manner than 2D echocardiography.^[3]

In our case, an inadvertent suture had been placed in the LCS while suturing the sewing ring of the prosthetic valve to the anterior aortomitral curtain. It resulted in the distortion of the aortic sinus due to the impingement of the prosthetic valve, and movement of left coronary cusp

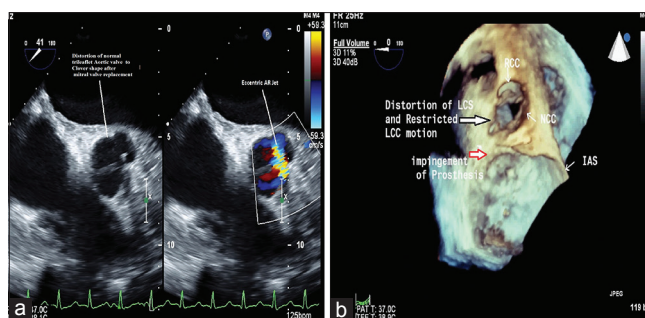


Figure 1: (a) Two-dimensional mid-esophageal aortic valve short axis view showing distortion of normal aortic valve to clover shape with mild-to-moderate eccentric aortic regurgitation (b) Three-dimensional mitral valve en face view showing impingement of mitral prosthesis over the left coronary sinus with restriction of left coronary cusp

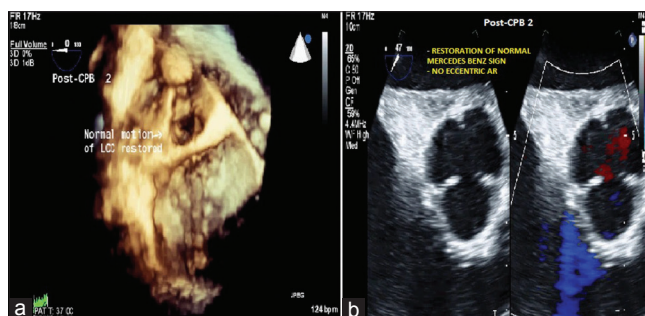


Figure 2: (a) Postcardiopulmonary bypass three-dimensional mitral valve en face view showing restoration of normal left coronary sinus and leaflet motion (b) two-dimensional mid-esophageal aortic valve short axis view showing restoration of normal shape of aortic valve with no regurgitation



Figure 3: Postcardiopulmonary bypass three-dimensional color Doppler examination of mitral valve prosthesis (31 mm Medtronic–Hall tilting disc prosthesis) showing normal valve function with no paravalvular leak

got restricted. The exact mechanism was better understood with 3D imaging of en face MV view as compared to 2D-TEE,^[7] convincing the surgeon to reinstitute the CPB for correction of pathology.

The anatomic relationship between AV and MV in the cardiac skeleton may alter the geometry of each other during their replacement.^[8] The location of the left and noncoronary cusp near the anterior mitral annulus is

more prone to injury during the suture placement for sewing ring.^[9] The surgical untethering done by releasing two sutures on the mitral sewing ring had restored the normal contour of the aortic sinus in our case. Post-CPB TEE examination revealed the absence of aortic leaflet perforation deferring the need for AV replacement.

In summary, 3D-TEE has added advantage to 2D-TEE in the intraoperative period to delineate the anatomy and exact mechanism of inadvertent injury following MV replacement. It is a useful imaging modality and has a definite role in making important surgical decisions.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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