Case Report

Use of real-time three-dimensional transesophageal echocardiography in type A aortic dissections: Advantages of 3D TEE illustrated in three cases

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ABSTRACT

Stanford type A aortic dissections often present to the hospital requiring emergent surgical intervention. Initial diagnosis is usually made by computed tomography; however transesophageal echocardiography (TEE) can further characterize aortic dissections with specific advantages: It may be performed on an unstable patient, it can be used intra-operatively, and it has the ability to provide continuous real-time information. Three-dimensional (3D) TEE has become more accessible over recent years allowing it to serve as an additional tool in the operating room. We present a case series of three patients presenting with type A aortic dissections and the advantages of intra-operative 3D TEE to diagnose the extent of dissection in each case. Prior case reports have demonstrated the use of 3D TEE in type A aortic dissections to characterize the extent of dissection and involvement of neighboring structures. In our three cases described, 3D TEE provided additional understanding of spatial relationships between the dissection flap and neighboring structures such as the aortic valve and coronary orifices that were not fully appreciated with two-dimensional TEE, which affected surgical decisions in the operating room. This case series demonstrates the utility and benefit of real-time 3D TEE during intra-operative management of a type A aortic dissection.

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INTRODUCTION

Aortic dissections affect about 3–4 per 100,000 people every year.[1] Stanford type A aortic dissections often present acutely to the hospital requiring emergent surgical intervention. There are three main diagnostic modalities that have all shown to have sensitivity and specificity of over 95%: Computed tomography angiography, magnetic resonance imaging, and transesophageal echocardiography (TEE).[2] TEE has the ability to characterize aortic dissections and the aortic valve with specific advantages over these other modalities: It may be performed on an unstable patient, it can be used intra-operatively, and it has the ability to provide continuous real-time information. In addition to traditional two-dimensional (2D) TEE, three-dimensional (3D) TEE has become more accessible over recent years allowing it to serve as an additional tool in the operating room. Several case reports have already demonstrated the utility of real-time 3D echocardiography in further defining and illustrating the extent of an aortic dissection and aortic valve function.[3-6] A study of 51 patients with acute type A aortic dissections used 3D TEE to evaluate coronary involvement showing that 3D TEE increased diagnostic certainty of coronary involvement over 2D TEE.[7] Another study of 67 patients with aortic aneurysms with or without dissection demonstrated that 3D TEE had specific advantages that included increasing diagnostic certainty of aortic dissections versus aneurysms and providing

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the ability to measure aortic rupture areas via en face views. In our case series of three patients presenting with type A aortic dissection, we discuss the utility and potential advantages of using real-time 3D TEE intra-operatively to accurately diagnose the extent of dissection in each case.

CASE REPORTS

Case 1

A 60-year-old female with a history of diabetes, hypertension, and asthma presented with substernal chest pain radiating to the back and abdomen. Computed tomography (CT) scan demonstrated a type A aortic dissection extending through the aortic arch involving the brachiocephalic, left carotid, and left subclavian arteries and continued to the iliac arteries bilaterally. The patient was transferred to our institution for acute surgical repair of her aortic dissection. Intra-operatively, 2D TEE confirmed a type A dissection originating from above the right coronary artery (RCA) take-off and extending through the descending aorta with severe aortic regurgitation. 3D TEE also demonstrated severe aortic regurgitation with better visualization of the underlying pathology. 3D TEE revealed that the aortic regurgitation was caused by a tear in the intimal flap that prolapsed into the aortic valve preventing full closure of the valve despite normal leaflet morphology [Figure 1]. These findings were discussed with the surgeon who opted to resuspend the aortic valve as opposed to replacing it, in addition to replacing the ascending aorta and the hemiarch. The patient had an uneventful postoperative course and was discharged 1-week after surgery.

Case 2

A 59-year-old female with a history of uncontrolled hypertension, hyperlipidemia, diabetes mellitus, schizophrenia, and gout presented to an outside hospital with acute chest pain radiating to the back and upper abdomen. CT scan revealed a type A aortic dissection from the aortic valve extending to the renal arteries. Upon the transfer to our institution, the patient was noted to have uncontrolled hypertension and ST elevations in inferior leads correlating with the distribution of the RCA. Intra-operative 2D TEE demonstrated a dissection flap that was likely originating just above the RCA. Mild right and left ventricular systolic dysfunction was noted with hypokinetic movement in the mid and basal inferior walls. The aortic valve leaflet and annulus were noted to be normal with moderate aortic regurgitation. Blood flow was appreciated by Doppler in the left main coronary artery. 3D TEE demonstrated an intact RCA orifice that was not involved in the dissection, however, further visualization of the dissection flap showed the flap covering and occluding the RCA orifice during diastole [Figure 2]. The surgeon noted perforation of the aortic root just at the level of the RCA. A Bentall procedure was performed with a biologic aortic prosthesis along with a hemiarch replacement. The patient was extubated 5 days later and discharged 2 weeks after surgery.

Case 3

A 51-year-old male with a history of uncontrolled hypertension, morbid obesity, and sleep apnea presented initially to an outside hospital with findings of an acute myocardial infarction from a thrombus in the RCA requiring emergent percutaneous catheterization intervention with a drug-eluting stent (DES). The following day, CT scan revealed a type A aortic dissection with the dissection flap extending infrarenally. This prompted immediate admission to our institution for further management. As the patient was on prasugrel for the DES and was hemodynamically stable, surgical intervention was delayed to allow for platelet function

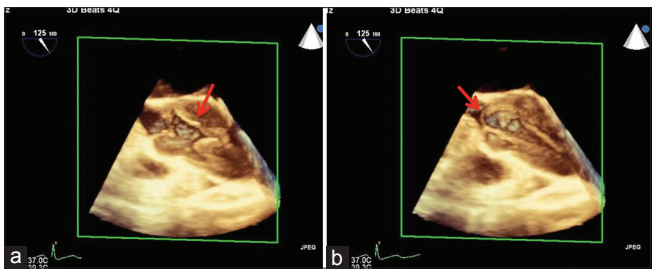

Figure 1: (a) Three-dimensional transesophageal echocardiography (3D TEE) showing dissection flap (red arrow) in ascending aorta during systole. (b) 3D TEE showing dissection flap (red arrow) prolapsing into aortic valve during diastole causing severe aortic regurgitation

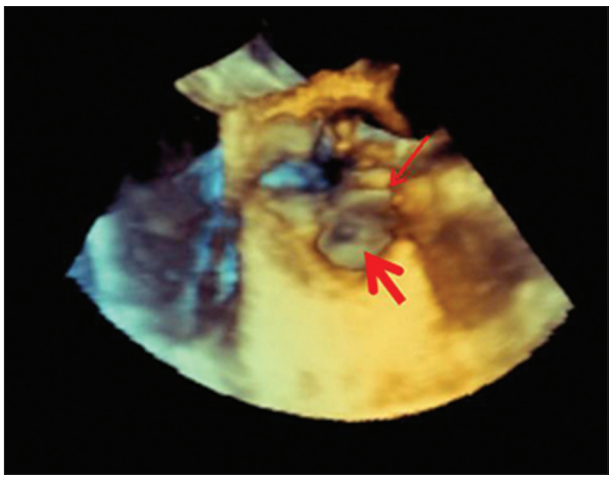

Figure 2: Dissection flap (thin red arrow) originating just around the right coronary artery (RCA) orifice (thick red arrow). Flap intermittently occluding RCA flow but not involving the orifice

recovery. Six days after admission, the patient was brought to the operating room for repair of his type A aortic dissection. Intra-operative 2D TEE was consistent with RCA obstruction and demonstrated mild right ventricular dysfunction, moderate left ventricular systolic dysfunction, and an akinetic inferior wall. 3D TEE provided dynamic visualization of the dissection flap protruding onto the non and right coronary cusps and into the aortic valve causing aortic regurgitation with normal aortic valve leaflets. In addition, the right coronary orifice was clearly visualized to be within the false lumen [Figure 3].

Surgical exploration confirmed 3D TEE findings of the false lumen extending to the aortic valve annulus with complete avulsion of the origin of the RCA. A Yacoub valve sparing root replacement was performed along with partial replacement of the aortic arch using an ascending aortic arch graft, including an innominate and left carotid bifurcation graft. The patient also required coronary artery bypass of the RCA with removal of the RCA stent. A mitral valve annuloplasty ring was also placed to repair significant mitral regurgitation. Post repair, worsening right ventricular function required implantation of a right ventricular assist device (RVAD). The patient remained on an RVAD with an oxygenator after surgery with successful weaning and removal of the RVAD about 1-week later. After a long hospital course, the patient was discharged to a rehabilitation center with good recovery at follow-up several months later.

DISCUSSION

Three-dimensional TEE has become more prevalent and readily accessible in many operating rooms throughout the years. While costly, many of the newer TEE devices have 3D capability and will have an increased presence as institutions are required to periodically upgrade their diagnostic devices. Real-time 3D TEE does not require additional processing that is time consuming and can be easily incorporated into the routine intra-operative TEE examination to provide direct visualization and understanding of dynamic anatomy such as that seen in acute type A aortic dissections. It may also be the first diagnostic modality in patients who present to the hospital in unstable condition and require emergent surgery. This case series further supports the utility and benefit of using real-time 3D TEE in the operating room during repair of type A aortic dissections. In our three cases described above, 3D TEE provided additional understanding of spatial relationships between the aortic dissection flap and neighboring structures such as the aortic valve and coronary orifices that were not fully appreciated with 2D TEE. In two of these cases, real-time 3D TEE demonstrated the mechanism of aortic regurgitation caused by prolapse of the dissection flap into the aortic valve sparing these two patients from undergoing valve replacement. Coronary artery involvement was also clearly differentiated in two of our cases: In one case the RCA orifice was identified in the true lumen while in another case the RCA orifice was identified to be in the false lumen. Additional understanding and appreciation of the extent of the dissection flap was obtained in all three of these cases using real-time 3D TEE. 3D TEE does have a few disadvantages: It requires additional training and familiarity by the operator, it is also prone to artifacts, and it adds additional time to the overall TEE exam. In many cases, 2D TEE is likely sufficient to identify fully and characterize the extent of an aortic dissection. However, regular incorporation of some real-time 3D TEE in each intra-operative examination will allow operators to become more adept at 3D TEE and may allow them to uncover additional information about the case. The routine used of real-time 3D TEE illustrated in the above three cases enhanced the understanding of the type A aortic dissections that assisted with intra-operative management and surgical repair.

Figure 3: Right coronary artery orifice (white arrow) within the false lumen

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