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Case Report

The Impact of 3-D Transesophageal Echocardiography during Transcatheter Closure of Paravalvular Leak following Prosthetic Mitral Valve Replacement.

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Abstract

Paravalvular leak, though uncommon, can develop in both prosthetic and bioprosthetic prostheses. Two-dimensional transesophageal echocardiographic (TEE) evaluation is often insufficient to determine the origin of paravalvular leak that occurs after mitral valve replacement. Three-dimensional TEE enables the visualization of cross-sectional images of the mitral valve and the origin of paravalvular leaks, which is not possible with two-dimensional TEE. Consequently, the size, number, and location of the defects, which are the key guides in the treatment plan of paravalvular leak, can be measured. We describe the impact and role of real-time three-dimensional TEE in the detection and closure of paravalvular leaks in a patient who had undergone prosthetic mitral valve replacement.

Key Words: paravalvular leak; transcatheter closure; 3-d transesophageal echocardiography

Introduction

Paravalvular leak (PVL), although uncommon, can develop in both prosthetic and bioprosthetic prostheses. [1] The most common cause of PVL is infection, followed by annular calcification. Following prosthetic mitral valve replacement (MVR), destruction may develop in the valve ring due to infective endocarditis or postoperative endocarditis, resulting in dehiscence in tissue and paravalvular regurgitation and leak in the suture line.[2] Debulking of the calcified valve and reduced tissue stability due to disrupted sutures in the calcified foci may lead to tissue destruction in the suture line. Minor PVLs are not clinically significant, whereas major leaks may require intervention due to symptomatic heart failure and severe hemolytic anemia. Treatment of PVL may

be in the form of surgical closure (using a running monofilament suture technique), or percutaneous or transcatheter closure, which has recently gained popularity. [3] The mortality rate of prosthetic mitral valve reoperations is 6.2% under elective conditions and up to 13.3% under emergency conditions, making transcatheter closure increasingly more popular.[4]

Two-dimensional (2D) transesophageal echocardiography (TEE) is significantly superior to 2D transthoracic echocardiography in terms of accurate estimation of regurgitation, distinguishing between central/paravalvular leaks, and determining the degree and causes of the regurgitation.[2] Differential diagnosis of pathologies responsible for paravalvular regurgitation including, separation of sutures, fistulas, perivalvular abscess, and dehiscence, is possible by 2D TEE. For the detailed assessment of the PVL origin and the length of the defect, real-time three-dimensional (RT-3D) TEE has been used recently. [5] Herein, we describe a patient who, on preoperative echocardiography, was diagnosed to have two PVLs following MVR. During transcatheter closure, RT-3D TEE demonstrated three PVLs instead of two described in preoperative TEE.

Case Report

A 52-year-old man, who had undergone MVR with a mechanical prosthesis (33 mm ON-X® Mitral Valve) six years ago, was admitted with progressive dyspnea (New York Heart Association class III) for three months. On auscultation, a PHV click was heard at the 5th intercostal space in the mid-clavicular line, along with a late systolic murmur grade II. Blood investigations revealed hemolytic anemia, increased reticulocyte count, and unconjugated bilirubinemia. TEE demonstrated a bileaflet prosthetic heart

valve at the mitral position with normal leaflet movements, trivial valvular mitral regurgitation, and a mean transvalvular pressure gradient of 4 (Figure 1A, 1B). There were two jets of severe PVL, one at the 2 o'clock position and another at the 7 o'clock position, when viewed from the left atrial (LA) side. The 'Heart Team' offered

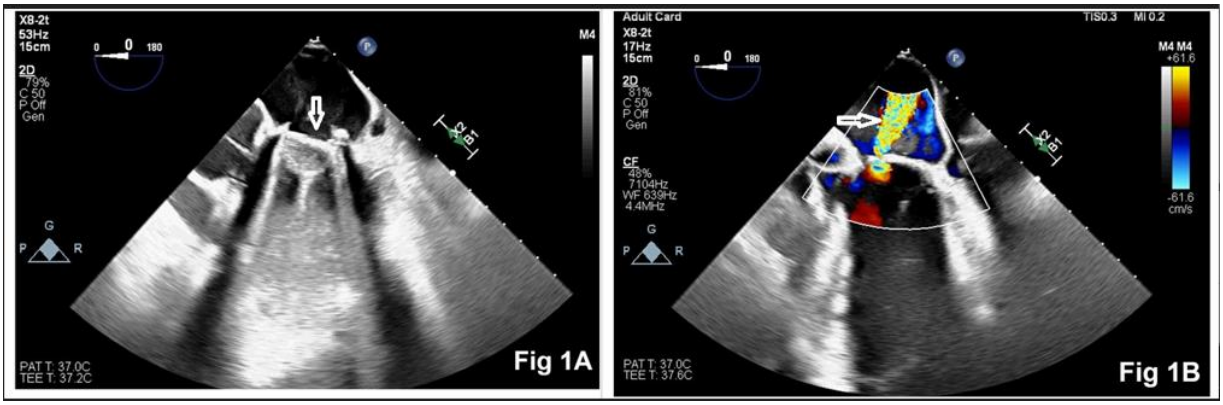

Figure 1: Two-dimensional echocardiography showing prosthetic valve at mitral position (**Figure 1A**) with paravalvular leak at the medial commissure (**Figure 1B**).

transcatheter closure of the PVLs to the patient and, informed consent was obtained. Considering the complexity and duration of the procedure, along with the requirement of intraoperative TEE, the procedure was performed under general anaesthesia in a hybrid operating room. En-face view of the mitral valve showed severe PVLs through 3 defects: two at the 2 o'clock position and one at the 7 o'clock position (Figure 2A, 2B). Antegrade trans-septal approach via the femoral vein was chosen for PVL closure (Fig 3A). A telescoping coaxial system was introduced into the LA, including a trans-septal LA sheath. An 8.5 F Agilis NXT Steerable introducer, a 6 F coronary guide (multipurpose catheter), and a 5 Fr multipurpose diagnostic catheter were used during the procedure (Figure 3B). Fluoroscopy with RT-3D TEE was used for the successful insertion of the guide wire through the defects. All three PVLs were closed successfully with AmplatzerTM Vascular Plug II devices in a stepwise manner (Figure 4A, 4B, 4C). At the end of the procedure, there was no residual PVL (Fig 4D). The patient made an uneventful recovery.

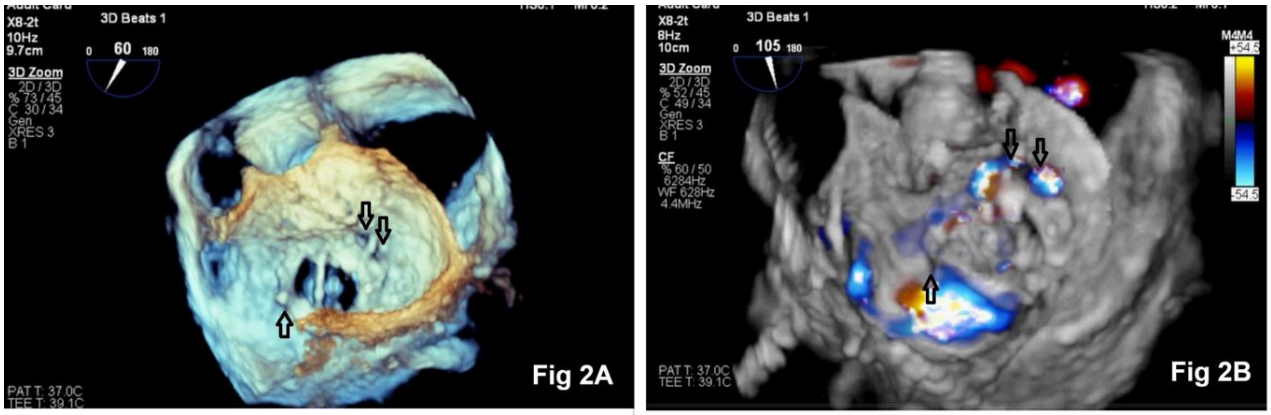

Figure 2: Three-dimensional (3D) en-face view of the mitral valve demonstrating two paravalvular leaks at the 2 o'clock position and one at the 7 o'clock position (**Figure 2A**). 3D en-face view with color Doppler (**Figure 2B**)

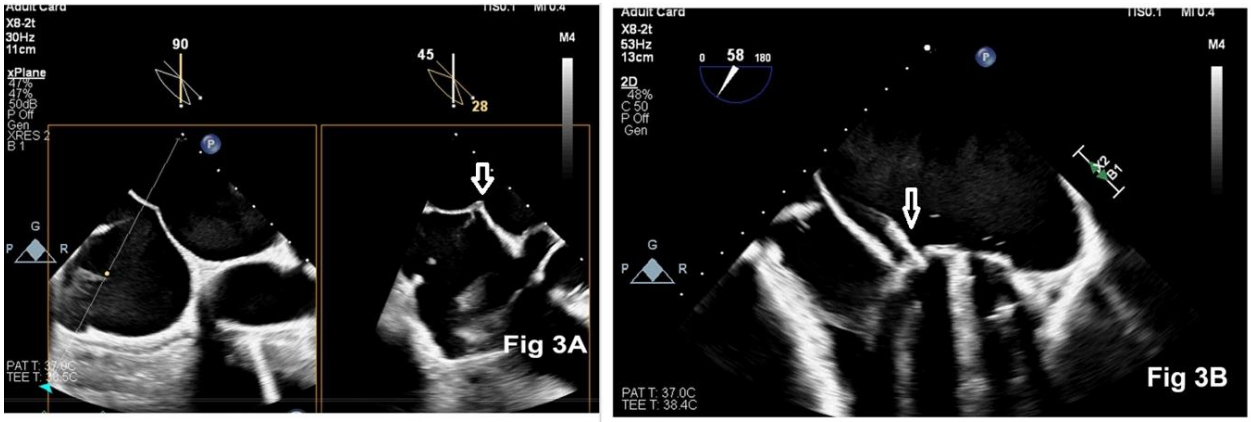

Figure 3: Two-dimensional echocardiography showing trans-septal puncture (**Fig 3A**) and a steerable introducer sheath positioned at the paravalvular leak (**Fig 3B**)

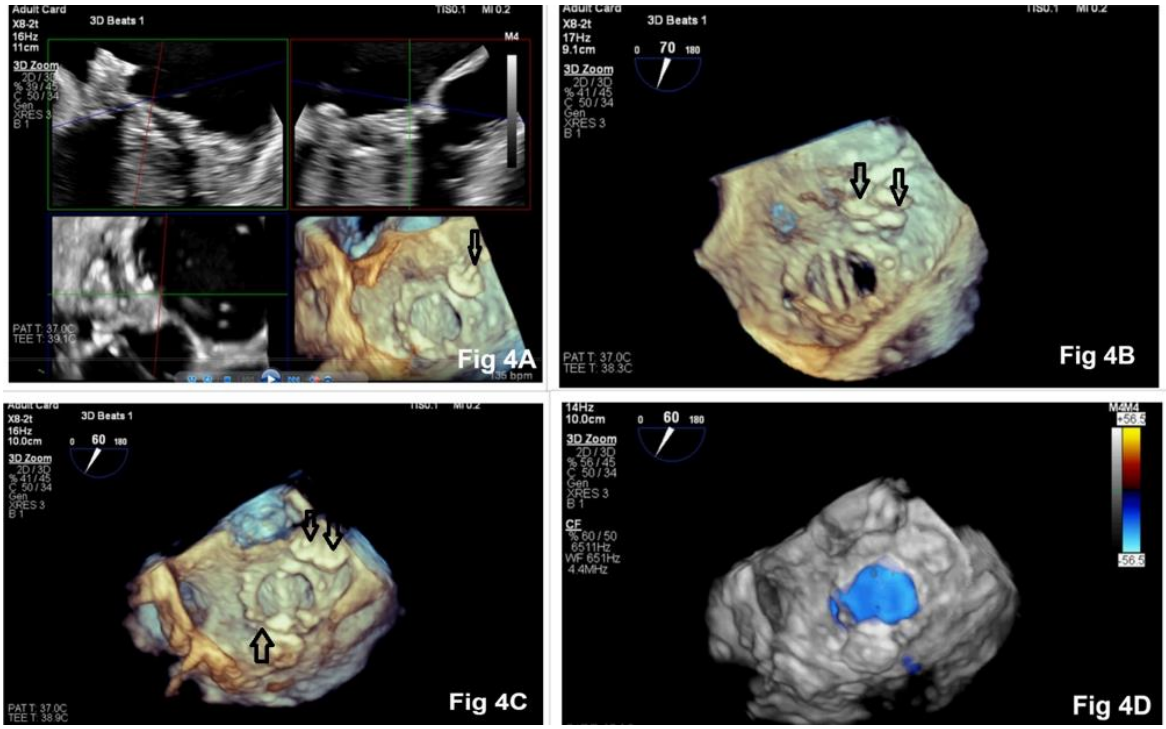

Figure 4: 3D en face view of the mitral valve showing placement of the first, second, and third Amplatzer™ vascular plug devices (Fig 4A, 4B, 4C). There was no paravalvular leak at the end of the procedure (Fig 4D).

Discussion

Paravalvular leak (PVL) occurs due to the dehiscence of the annular tissue around the prosthetic/bioprosthetic valve, resulting in regurgitation of blood retrogradely. The incidence of PVL is about 7% to 17% for the mitral valve and 5% to 10% for the aortic valve. [1,6] Symptomology can vary from asymptomatic patients with mild PVL to disabling symptoms pertaining to heart failure and hemolysis. Risk-factors associated with mitral PVL include the use of continuous and pledgeted sutures. Surgical closure has been the traditional approach to patients with PVL; however, studies have shown that surgical repair has been associated with 30-day/in-hospital mortality of 8.5 to 11.5%.[7] Percutaneous catheter-based technique has been suggested as a suitable, minimally invasive option for even high-risk patients. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines for the management of valvular heart disease recommend transcatheter closure as a class IIa indication for patients with intractable hemolysis or NYHA class III or IV heart failure, who have suitable anatomy for transcatheter closure and who are high-risk candidates for surgical closure.[8] However, percutaneous closure should not be performed in patients with active endocarditis, intracardiac thrombi, or large regurgitant jets (more than 1/3rd of the circumference of the prosthetic annulus).

2D TEE allows direct scanning of the entire sewing ring diameter of the prosthetic valve and other anatomical structures without the need for geometrical assumptions. On the other hand, 3D TEE en face view can give anatomical localization of the PVL associated with prosthetic or bioprosthetic valves. RT-3D TEE plays a key role in the procedural guidance during PVL closure. 3D TEE can give crucial information about the number, size, shape, and circumference of the defects. Galrinho et al have shown that percutaneous PVL closure has a reasonable success rate, a low complication rate, and results comparable to surgical treatment in high-risk patients.[9] During the procedure, TEE can assist in the confirmation of the position of the guidewire through the defect and not through the prosthetic valve.[10] It also enables the confirmation of the correct position of the vascular plug device. RT-3D TEE, when combined with fluoroscopy, can help in real-time guidance of the passage of the guidewire and transcatheter device to the desired position. The RT-3D TEE transducer will be beneficial for establishing percutaneous or surgical treatment strategies for complications due to paravalvular mitral regurgitation related to prosthetic mitral valves, since it provides excellent spatial delineation of prosthetic decomposition and related structures. The limitations of RT-3D TEE include the inability to see fast-moving structures such as vegetations, the prolongation of the duration of assessment, and the inability to measure planimetric areas of PVL. However, the origin and degree of leakage can be determined by the full volume method.

To conclude, percutaneous device closure is a useful approach in patients with moderate to severe PVL presenting with disabling symptoms. The transcatheter technique is less invasive than reoperative surgery and especially useful in high-risk patients who are not suitable candidates for surgical repair. RT-3D TEE is superior to 2D TEE in localizing and measuring the size of PVLs that develop following prosthetic MVR.

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