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Stuck Leaflets in Prosthetic Heart Valves with Different Etiology and Treatments

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Abstract

A stuck leaflet in the prosthetic heart valve is a rare but severe mechanical valve replacement complication requiring prompt diagnosis and treatment. Multimodality cardiac imaging is essential in diagnosis. 2D-3D echocardiography, fluoroscopy, and cardiac computed tomography scan are important for the definition of etiopathogenesis and differential diagnosis. The treatment might vary from medical follow-up to emergency surgery, depending on the etiological cause and the patient's clinical manifestation. In this review, we shared our four cases and discussed different etiologies and treatments for stuck leaflets.

Keywords: Prosthetic heart valve, stuck and restricted leaflet, prosthetic heart valve dysfunctions

Introduction

Valve replacement with bioprosthetic or mechanical valves is widely used for the surgical treatment of valve regurgitation and stenosis. A stuck leaflet in the prosthetic heart valve (PHV) is a possible and uncommon complication after surgery, particularly during the long-term follow-up[1,2]. Although stuck leaflet is mainly known as a complication of mechanical prosthetic valves, it has also been reported in bioprosthetic heart valves[3,4]. Although cases of stuck leaflets are generally reported during surgery and the early follow-up period, the number of cases of stuck leaflets in PHVs in the late period is limited[3,4]. Echocardiography, cardiac computed tomography (CT), and fluoroscopy are used to diagnose the stuck leaflet in the PHVs. Especially fluoroscopy and 2D-3D transesophageal echocardiography (TEE) are essential for rapid and high-sensitivity diagnosis. This report presents a case series of stuck leaflets treated

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differently due to different etiologies. Even though ethics committee approval is not required for case reports and review in our country, the Declaration of Helsinki was followed, and informed consent was obtained from the patient and relatives to publish this report.

Case Reports and Literature Review

Case 1

A 65-year-old female patient was admitted to our hospital with a complaint of shortness of breath. In her past medical history, she had undergone minimally invasive robotic cardiac surgery due to rheumatic mitral valve disease, and mitral valve replacement preserving the posterior leaflet (Medtronic Open-Pivot 27 mm mechanical valve) was performed in 2019 (Figure 1). Transthoracic echocardiography (TTE) showed an increased gradient in the mechanical mitral prosthesis. TEE was performed and revealed that mechanical prosthesis leaflet movements close to the posterior annulus were restricted and a pressure gradient of 29/16 mmHg through the mitral prosthetic valve (Figure 2). Even though the increase in tissue echogenicity on the mitral valve, no thrombus, vegetation, or any mass could be observed, fluoroscopy revealed that one of the mitral leaflets was stuck, and its movements were restricted. The international normalized ratio (INR) values were within the normal range over the last 6 months. The patient was recommended to re-operate. During the operation, it was observed that the atrial surface of the mitral prosthesis had tissue overgrowth, and the posterior leaflet was stuck. However, no entrapment of the sub-valvular tissue was detected, and no additional pathology was observed on the ventricular surface of the mitral prosthesis. The mitral mechanical prosthetic valve was replaced with a Medtronic Hancock II 27 mm mitral bioprosthetic valve (Figure 2).

Case 2

A 74-year-old female patient was admitted to our clinic with a complaint of dyspnea and decreased effort capacity in 2018. Her past medical history, she had a mechanical aortic prosthesis (21-mm bi-leaflet aortic valve, St Jude Medical, Inc, St Paul, Minn.) and mitral prosthesis (29-mm bi-leaflet mitral valve St Jude Medical, Inc, St Paul, Minn.) due to a rheumatic heart valve disease in 1999. TTE showed a pressure gradient of 88/55 mmHg through the aortic prosthetic valve. We performed TEE; no thrombus was observed in the aortic and mitral valves. However,

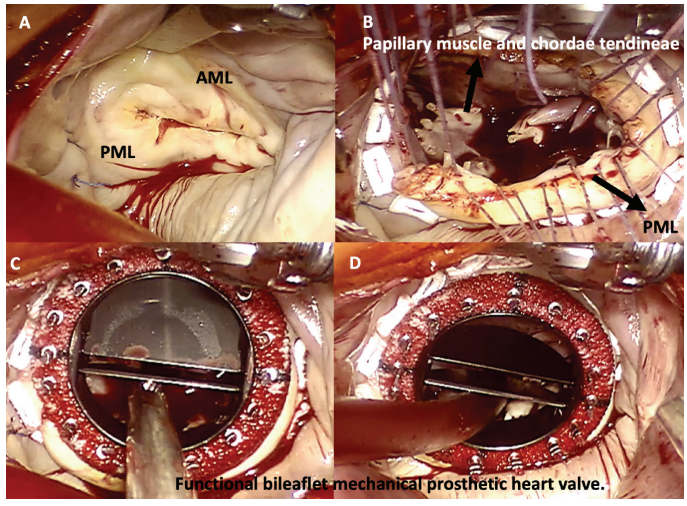

Figure 1. A-D; Images of robotic mitral valve replacement in 2019 and normal mitral valve function

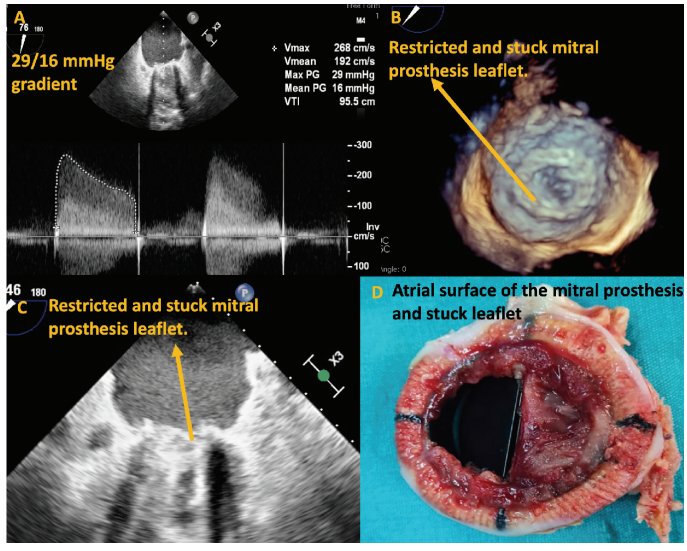

Figure 2. A-C; 2D and 3D transesophageal echocardiography images of increased mitral prosthetic heart valve gradient and restricted leaflet movements. D: Resected mitral prosthetic heart valve atrial surface images showed tissue overgrowth and stuck leaflets

it was determined that the valve tissue was thickened, particularly in the aortic prosthesis, and the mitral valve was normal. INR value was within the normal therapeutic range. During fluoroscopy, one of the aortic valve leaflets was stuck (Video 1). We diagnosed the patient with a stuck aortic prosthesis due to pannus overgrowth and recommended a re-operation, but she refused the surgery. INR values were closely monitored and kept between 3.0-3.5 to resolve the microthrombus that we could not detect in the echocardiographic examination, and acetylsalicylic acid was added.

At follow-up, the aortic gradient decreased to 57/34 mmHg in 3 years. Echocardiography and fluoroscopy revealed that bi-leaflet aortic prosthetic valve movements were nearly normal and unstuck (Figure 3, Video 1). We performed cardiac CT for the definite diagnosis of valve pathology, confirming the normal leaflet movements and pannus overgrowth (Figure 3). We believe that the primary pathophysiological mechanism is pannus overgrowth plus microclots, which are resolved with efficient anticoagulation.

Case 3

A 67-year-old male patient was admitted to the emergency unit with decompensated heart failure and low cardiac output. From his past medical history, we learned that he underwent mitral bi-leaflet metal prosthesis surgery due to rheumatic heart disease in 1999 and that he was re-operated in 2014 for pannus overgrowth. TTE revealed a pressure gradient of 39/24 mmHg through the mitral valve prosthesis, severe tricuspid regurgitation, systolic pulmonary artery pressure of 90 mmHg, right ventricular dilatation, and dysfunction (Figure 4). In the TEE, one of the leaflet movements of the mitral prosthetic valve was restricted and stuck, and a 40/21 mmHg gradient was observed (Figure 4). No thrombus

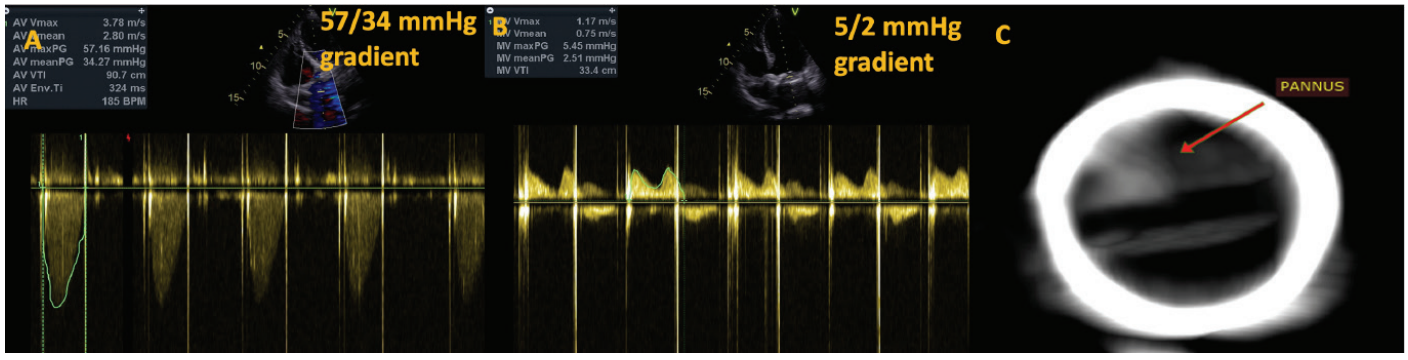

Figure 3. A-B; Transthoracic echocardiographic images of aortic and mitral valve gradient. C; Cardiac computed tomography confirmation of normal leaflet movements and pannus overgrowth

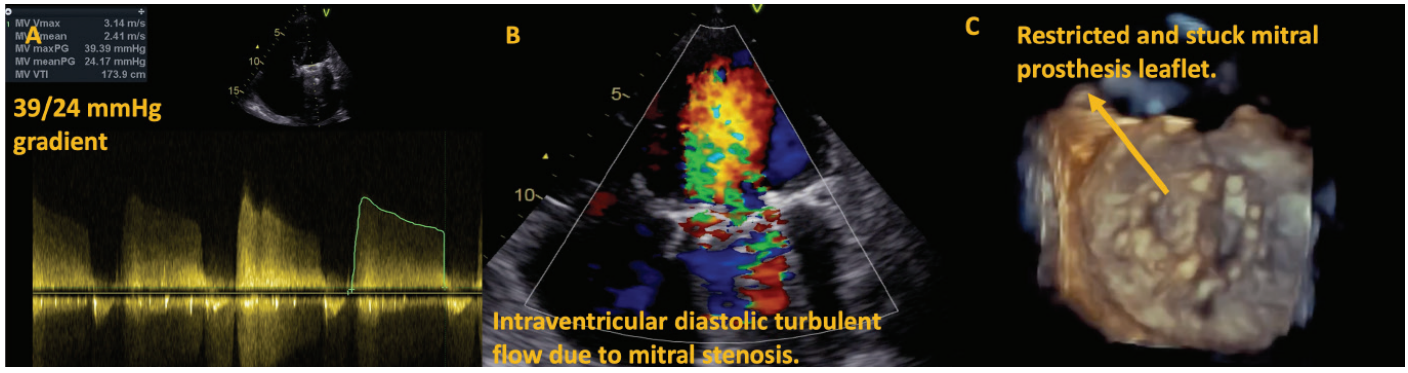

Figure 4. A-C; In 2D and 3D transesophageal echocardiography images of increased mitral prosthetic heart valves gradient, Intraventricular diastolic turbulent flow due to mitral stenosis, and restricted leaflet movements

was observed in the valve, but valve thickness increased due to pannus overgrowth, which caused stuck leaflets (Figure 4). Finally, fluoroscopy showed that one leaflet of the mitral prosthesis valve did not move and stuck (Video 2). INR values were within the normal range in the last 6 months. The primary pathophysiological mechanism was pannus overgrowth; thus, emergency surgery was planned. However, the patient's hemodynamic status could not be stabilized, and he died.

Case 4

A 57-year-old female patient presented with increased dyspnea for the last three months. to her past medical history, she had operated on a mitral valve replacement nine years ago. TTE showed an increased gradient through the mitral valve prosthesis. TEE revealed that the movements of the anterior leaflet of the bi-leaflet mitral metal prosthesis were restricted and stuck, and a gradient of 29/12 mmHg was detected (Video 3). It was observed the valve thickness increased because of pannus overgrowth, but thrombus and vegetation were not detected. Fluoroscopy confirmed that one of the mitral metal prosthesis leaflets was restricted and stuck (Video 3). INR values were within the normal range in the last 6 months. As a result, it was thought that the primary pathophysiological mechanism was pannus overgrowth, and surgery was recommended.

Discussion

In these reports, four different patients who developed stuck leaflets in mechanical PHV were discussed. The etiologies and treatments of these four patients were different. Based on these differences, stuck leaflet diagnosis and management were reviewed and discussed. PHV dysfunction is a rare but often severe complication that is caused mainly through valve thrombosis, pannus formation, vegetation, or sub-valvular tissue entrapment[5]. A detailed evaluation of mechanical PHV obstruction and stuck leaflets to understand the underlying etiology is pivotal because all they all have different management strategies.

PHV thrombosis is one of a major causes of primary valve obstruction and stuck leaflets. The PHV thrombosis incidence was reported to be 0.03% in bioprosthetic valves, 0.5-8% in mechanical valves[6]. Different therapeutic modalities for valve thrombosis include anticoagulation with heparin or warfarin, thrombolytic therapy, and surgery, and the decision is primarily influenced by a valvular obstruction, valve location, and clinical features. The management of mechanical heart valve thrombosis in non-critically ill patients depends mainly on the occurrence of a thromboembolic event and the size of the thrombus. Firstly, the optimization of the oral anticoagulation drug dosage and IV heparin administration can be considered[7,8]. After that, fibrinolytic therapy can be considered and indicated for patients with a small clot, no contraindication to fibrinolysis, first-time episode of valve thrombosis, and New York Heart Association functional classes I to II[7,8]. However, surgery should be recommended in critically ill patients with large clots and patients with recurrent valve thrombosis[7,8].

Another common cause of mechanical valve obstruction and stuck leaflets is pannus overgrowth, particularly in the late period of the disease. Pannus is a non-immune inflammatory reaction of the body to the valve prosthesis, a proliferation of fibroelastic tissue and collagen, with a starting point in the suture[9]. It usually proliferates on the ventricular side of the prostheses. It is associated with certain risk factors such as operative technique, small valve ring, prosthesis characteristics, young age, female sex, low cardiac output, turbulent flow, infection, and inadequate anticoagulation[9]. Surgery or palliative care are treatment options for patients with clinical and imaging features consistent with PHV pannus overgrowth with moderate to severely symptomatic obstruction. It is essential to distinguish between thrombus and pannus as the leading causes of PHV obstruction. Some clinical and imaging features favor pannus. In echocardiographic imaging, dense, non-mobile, and often not visualized mass by TTE and TEE favors the pannus[10]. In a patient with new

mechanical valve obstruction, if a leaflet motion is well visualized and normal by TEE, then pannus is likely[10]. In cardiac CT, high attenuation mass, which is greater than the interventricular septum and HU ≥145 units as considered pannus[11]. Fluoroscopy provides the most reliable assessment of mechanical leaflet motion but does not enable the assessment and differentiation of soft tissue associated with the valve. Surgery is the primary treatment for pannus overgrowth, but palliative follow-up can be performed in patients who are prohibited at high risk of surgery due to advanced age and additional comorbidities or refused surgery.

Infective endocarditis is a rare cause of PHV obstruction. PHV endocarditis is usually seen with valve dehiscence, paravalvular abscess, and regurgitation. PHV obstruction and stuck leaflets are extremely rare and are mainly the result of large vegetation that limits valve movements[12]. Surgery is recommended for PHV endocarditis complicated by a heart block, annular or aortic abscess, dehiscence, or obstruction[12].

Entrapment of the sub-valvular tissue is another important reason for PHV obstruction and dysfunction[13]. The preservation of sub-valvular tissue, especially the posterior leaflet, has become the recommended surgical method in mitral valve replacement. This procedure has advantages such as preserving left ventricular geometry and function and improving early and long-term survival[14]. Nevertheless, preservation of the sub-valvular apparatus also has potential complications. One is left ventricular outflow tract obstruction caused by the anterior leaflet[15,16]. Additionally, intermittent PHV obstructions due to entrapment of chordal tissue between the disk of the valve and housing have been reported [16]. To avoid these complications and to maintain left ventricular performance and geometry, preserving the posterior leaflet, resection of the unsupported portion of the anterior leaflet, or chordal transfer have been recommended[14,15].

No case of stuck leaflets due to tissue hyperproliferation on the atrial surface of the valves has been reported, particularly in the early period after surgery. Pannus overgrowth develops more frequently in the late period after surgery because of fibroelastic tissue and collagen hyperproliferation on the ventricular surface with the effect of flow dynamics. We do not think that the development of tissue hyperproliferation on the atrial surface in case 1 in the early period can be explained by the dynamics and pathophysiology of pannus formation. We think that this is the result of other inflammatory reactions. Inflammation at least occurs at every heart valve implantation site[17]. Removing the native valves damage tissues. After that, the implantation of a PHV leads to trauma and the presence of new foreign material, leading to thrombosis and inflammatory cell exudation[17].

For diagnosis, multimodality imaging is essential. TTE is recommended as an initial test to suspect the diagnosis. A 2D or 3D TEE is a commonly used imaging modality to identify the cause of PHV malfunction[10,18]. Fluoroscopy is an essential imaging technique for assessing mechanical PHV movements and identifying the type of implanted prosthesis and its function[19]. Additionally, it can evaluate valve leaflet mobility and valvular ring motion. At cine fluoroscopy, the normal-opening angle is usually less than 30° typically less than 20°, and the closing angle is usually greater than 120°-130°. With a stuck leaflet, there is a limited range or absence of motion of the PHV leaflet[18,20]. Cardiac CT is another crucial imaging modality that can provide additional information on valvular mobility, thrombus and pannus distinction, as well as valvular and paravalvular pathologies[11]. A specific opening and closing angle for each valve are provided by the manufacturer, which also varies with the position (ie, mitral vs aortic). At CT, the normal-opening angle is 73°-90° for bi-leaflet valves and 60°-80° for mono-leaflet valves[20].

Conclusion

The stuck leaflet is a rare but potentially severe complication of PHV. TEE, fluoroscopy, and cardiac CT

are feasible and highly effective imaging modalities that can detect and make the differential diagnosis of etiology. Furthermore, the treatment might vary from medical follow-up to emergency surgery, depending on the etiological cause and the patient's clinical manifestation.

Ethics

Informed Consent: Informed consent was obtained from the patient and relatives to publish this case report.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Kadan M, Bolcal C, Concept: Asil S, Design: Asil S, Data Collection and/or Processing: Çelik M, Analysis and/or Interpretation: Çelik M, Yüksel UÇ, Bolcal C, Barçın C, Literature Search: Asil S, Yüksel UÇ, Writing: Asil S, Barçın C.

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Video 1. Stuck leaflet image on fluoroscopy and resumption of leaflet movements with medical treatment three years later

http://glns.co/3bq2e

Video 2. Fluoroscopy images of stuck and restricted mitral leaflet movements

http://glns.co/if9v6

Video 3. In 2D and 3D transesophageal echocardiography and fluoroscopy, images of mitral prosthetic valve restricted leaflet movements and stuck leaflets

http://glns.co/hiqag

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