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A Rare Case of Left Ventricular Outflow Tract Obstruction 18 Years after a Mechanical Mitral Valve Replacement

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Authors' contributions

This work was carried out in collaboration among all authors. Author FMZ performed echocardiography and wrote the first draft manuscript. Author SB managed clinically the patient and revised with critically the manuscript. Author AF reviewed the echocardiography and checked the interpretation and quality of images. Author AB managed literature research. Author MBH revised the manuscript. Author BR managed the patient in the ICU, aided to literature management and revised the manuscript. Author SO revised the manuscript in depth with critical and suggested valuable modifications. Author MSM made the final revision of the manuscript. All authors read and approved the final manuscript.

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Case Report

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ABSTRACT

Background: Left ventricular outflow tract (LVOT) obstruction is a serious complication that can occur after various mitral-valves, surgical or percutaneous, interventions.
It was rarely described in mechanical mitral valve replacements.
Aim: to describe a rare case of late LVOT obstruction after a mitral valve replacement by a low-profile mechanical prosthesis.
Case Presentation: A 48-year woman, with a history of rheumatic mitral valve disease and mechanical mitral replacement by a hemi-disc valve 18 years ago, presented for a recent dyspnea.

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Echocardiography showed a narrowing of the LVOT, with anterior position of the mitral prosthesis, aorto-mitral annular angulation, septal thickening and remnant native sub-valvular tissue attached to the septum in the LVOT region. This resulted in LVOT obstruction with a peak gradient of 75 mmHg. The heart team opted for a redo surgery, but the surgical decision was refused by the patient.

Discussion: This is a rare case of late LVOT obstruction after mitral valve replacement by mechanical low-profile prosthesis. Preserved native mitral valve tissue, which is the main described cause of LVOT obstruction after mechanical mitral valve replacements was not the unique cause of obstruction in this patient who had also a septal thickening and anterior prosthetic position. Aorto-mitral annular angulation that was identified as a risk factor of LVOT obstruction after trans-catheter mitral valve replacements, should be, probably, also took into account and assessed pre-operatively in patients undergoing surgical mitral replacements.

Conclusion: LVOT obstruction can occur after mechanical mitral replacements event with low profile prosthesis. In patients with identified risk factors of LVOT obstruction, preservation mitral anterior leaflet should be avoided, and preservation of other native mitral tissue should be discussed.

Keywords: Heart valve prosthesis; left ventricular outflow obstruction; post-operative complication; cardiac surgery.

ABBREVIATIONS

LV : Left ventricle/left ventricular;
LVOT : Left ventricular outflow tract;
TAVR : Transcatheter aortic valve replacement;
TMVR : Transcatheter mitral valve replacement;
TTE : Transthoracic echocardiography;
TOE : Transesophageal echocardiography;
SAM : Systolic anterior motion of the mitral valve;

1. INTRODUCTION

Left ventricular outflow tract (LVOT) obstruction is currently a serious complication of valvular interventions. It has been largely described after mitral valve repair [1,2] and it had recently a renewed interest, with the advent of trans-catheter aortic (TAVR) and mitral (TMVR) valve replacements [3,4]. LVOT was also well studied in surgical bioprosthetic mitral valve replacements, but it was only rarely reported after mechanical mitral valve replacements.

Left ventricular outflow obstruction after a mechanical mitral valve replacement has yields prognostic and therapeutic concerns. It can have multiple concomitant mechanisms. Their identification by a comprehensive echocardiographic study is very important to guide therapy.

The aim of this study was to describe a case of late LVOT obstruction after a mitral valve replacement by a hemi-disc mechanical prosthesis and particularly to highlight on its multiple mechanisms that could be identified by echocardiography imaging.

2. CASE PRESENTATION

A 48 years-old-woman, with a history of rheumatic heart valve disease, had a mechanical mitral valve replacement 18 years ago with a 29 mm- Sorin Bicarbon prosthesis with preservation of native leaflets and chordae tendineae. The post-operative course was initially favorable, the patient was asymptomatic. She gave birth to two children after surgery. She was in sinus rhythm and only received oral anticoagulation without any other medication. Socio-demographic data are summarized in Table 1.

Table 1. Socio-demographic data of the patient

Age	48 years
Sex	female
Civility	Married; 2 children
Origin	urban
Educational level	primary
Profession	None

Recently, she complained of dyspnea on exertion and nocturnal cough. On physical examination, she had a blood pressure of 110/70 mmHg, a regular heart rate of 80 bpm, normal mitral prosthesis sounds, with a systolic murmur maximal in the left parasternal region. There were no jugular distension nor peripheral edema. Breath rate was 16 cpm, oxygen saturation was 97% and pulmonary crackles in bilateral lung bases were noticed.

Transthoracic echocardiography (TTE) revealed an acceleration of LVOT flow (4.3 m/s) with a

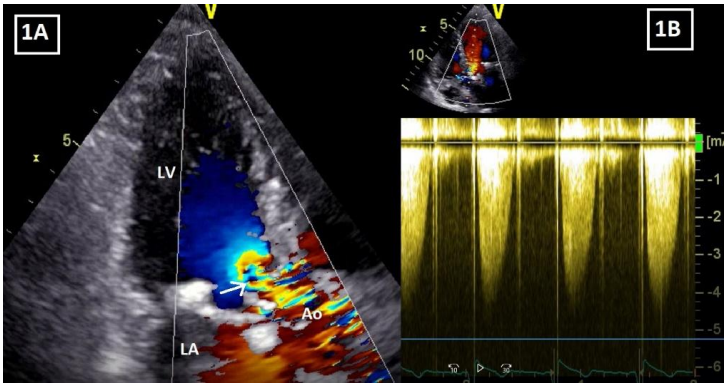

Fig. 1. 1A: Apical 3 chamber view with color flow Doppler showing accelerated flow in the left ventricle outflow tract (arrow); 1B: Accelerated aortic continuous wave Doppler
Ao: aorta; LA: left atrium; LV: left ventricle

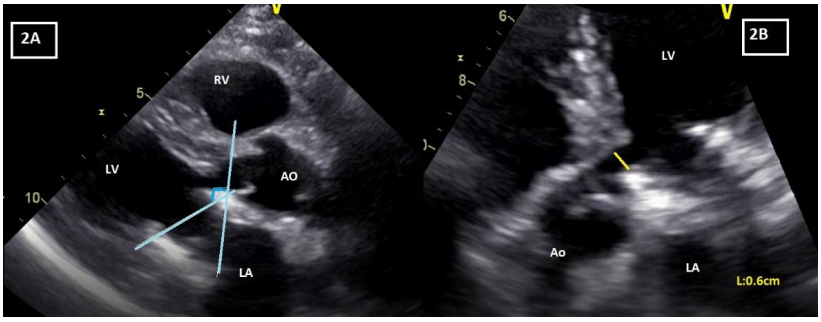

Fig. 2. 2A: parasternal long axis view showing the narrowing of the left ventricular outflow tract, the anterior position of the mitral prosthesis and the aorto-mitral annular angulation (blue lines). 2B apical 5 chamber view focused on the left ventricle outflow tract region showing its narrowing
Ao: aorta; LA: left atrium; LV: left ventricle; RV: right ventricle

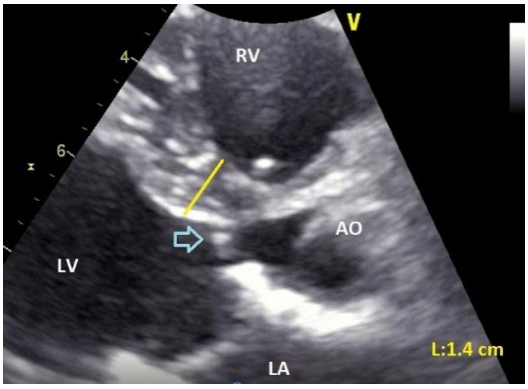

Fig. 3. Parasternal long axis view focused on the left ventricular outflow tract region showing the thickening of the septum (yellow line) and the presence of remnant mitral tissue attached to the septum and contributing to left ventricle outflow tract obstruction
Ao: aorta; LA: left atrium; LV: left ventricle; RV: right ventricle

maximal gradient of 75 mmHg. (Fig. 1), aortic valve opening was normal. LVOT was narrowed by the anterior position of the mitral prosthesis and aorto-mitral annular angulation (Fig. 2), a localized thickening of the inter-ventricular septum (14 mm) and the presence of a remnant

of sub-valvular native tissue attached to the septum in the LVOT region (Fig. 3).

The diastolic trans-mitral flow was normal with a maximal velocity of 2 m/s. Left ventricular (LV) ejection fraction was 66%. Pulmonary artery systolic pressure was 45 mmHg. Transesophageal echocardiography (TOE) allowed planimetry of aortic valve area (1,6 cm²) and confirmed TTE findings.

The medical team opted for a redo surgery for mitral valve tissue resection and septal myectomy. The surgical decision was refused by the patient who continued to have a medical follow-up and kept stable under a low dose of loop diuretic treatment.

3. DISCUSSION

A very rare case of late LVOT obstruction, 18 years after a mitral valve replacement by a low-profile mechanical prosthesis was described.

LVOT obstruction is a major element, widely studied in hypertrophic cardiomyopathy, where it was linked to systolic anterior motion of valve leaflets (SAM) by venturi effect and was associated with heart failure and of death when gradient at rest was greater than 30 mmHg [5].

As a complication of mitral valve interventions, LVOT obstruction is an old, new problem.

In 1986, Jett GK el al. [6] aimed to compare the effect of *surgical mitral replacement* with different mechanical and bioprosthetic valves on LVOT gradient in small LVs. They implanted 25 mm-bovine pericardial, porcine aortic, 60-degree tilting disc and hemi disc valves and 2M, 28mm caged-ball valves in 5 animals for each type of valve. After mitral valve replacements, only caged-ball valves produced a significant LVOT gradient (32±23 mmHg). During isoproterenol infusion, substantial gradients were produced by bio prosthetic valves that reached 47±4 mm Hg for bovine pericardial valves and the gradient reached 65±30 mm Hg for caged-ball valves. Low profile mechanical valves still did not produce any significant gradient.

These findings were confirmed in humans and many cases of LVOT obstruction after bio prosthetic mitral valve replacement were reported Lee et al. [7] Tewari et al. [8]. Pericardial bovine prostheses are thicker and taller than porcine prostheses, thus they are more prone to induce a LVOT obstruction.

In mitral valve repair, LVOT obstruction was mainly due to systolic anterior motion of the mitral valve (SAM) that occurred in patients with degenerative mitral disease, large redundant posterior leaflet and not enlarged LVs [9,10]. Anterior displacement of leaflet coaptation with a small coaptation point to septum distance was associated to LVOT occurrence [10]. According to Mihaileanu et al. [2], that reported a series of 307 mitral valve repairs, LVOT due to SAM incidence reached 14% in patients with identified risk factors. On the contrary, LVOT obstruction did not occur in rheumatic valve disease in this study. Additive surgical techniques, like chordal, mid posterior to mid anterior leaflet, transposition demonstrated efficacy to prevent this complication [1].

Significant LVOT obstruction with hemodynamic compromise had an incidence of 9.3% in the multicenter registry of trans-catheter mitral valve replacements (TMVR) in native mitral valves with severe annular calcifications reported by Guerrero et al. [11]. Bapat et al. [12] led an interesting comprehensive study of risk factors of LVOT obstruction after valve in valve and valve in ring procedures, they found that the type of surgical heart valve (pericardial versus porcine), the design of the ring (flexible versus semi-rigid) and the depth of the SAPIEN XT® valve influenced LVOT obstruction. Aorto-mitral annular angle was inversely proportional to the degree of LVOT obstruction. Pre-procedural LVOT neo-surface area prediction could be achieved by computer-aided design and three-dimensional-printed heart models for more precise and personalized procedures [13].

LVOT obstruction was rarely reported after mechanical mitral valve replacement by low profile prostheses. In the Table 2; 3 cases reported in the literature [14-16] and the case reported in this study are compared. This comparison allowed to highlight that the main identified cause after mechanical valve replacement was an obstruction by preserved native valve. Preservation of posterior leaflet and sub valvular tissue is largely used for better post-operative LV function and surgical results. The preservation of the anterior leaflet carries a risk of LVOT obstruction that should be assessed before surgery. However, beside native valve preservation, other risk factors, like aorto-mitral annular angulation, that were studied in TMVR

could also represent predisposing factors in surgical mechanical valve replacement. Thickened septum could contribute to obstruction and it was either reactive or pre-existing. Surgery led to favorable outcome in the 3 described cases.

The management *of LVOT* obstruction can be medical when it is moderate. For severe symptomatic LVOT obstructions redo surgery or alcohol septal ablation [17] could be performed depending on the mechanism of obstruction and achieved good results.

Table 2. Summary of literature cases of left ventricular outflow tract obstruction following mechanical mitral valve replacements by low profile protheses

Author (year)	Patient's age	Mechanical mitral prosthesis type; size	Delay after surgery	Echocardiography findings and identified mechanisms (M) of LVOT obstruction	Management
Okamoto (2006)	79 years	St. Jude Medical; 25mm	16 years	LVOT jt velocity 6.1 m/s M: SAM of the preserved anterior mitral leaflet	Surgical: resection of the redundant anterior mitral leaflet with preservation of mitral apparatus
Wu (2008)	57 years	ATS; 27mm	10 years	M: anterior displacement of the prosthesis and thickening of the interventricular septum at the opposing part (13 mm)	Surgical: replacement of the prothesis (part of the ring which has been sutured to a remnant mitral anterior leaflet was sutured to the natural mitral annulus), septal myectomy and aortic mechanical valve replacement (for moderate aortic stenosis)
Smedira (2017)	69 years	Not reported	5 years	Septum=15mm Peak gradient= 155 MmHg M: retained valve and subvalvular apparatus, with chordal attachments extending into the LVOT.	Surgical: resection of remnant anterior mitral valve, removal of hypertrophied papillary heads, septal myectomy and cryoMaze (for atrial fibrillation treatment)
Our case	48 years	Sorin Bicarbon; 29mm	18 years	Normal LV size Peak gradient 75 MmHg M: Anterior position of the prosthesis Aorto-mitral annular angulation Remnant sub valvular tissue attached to the septum Localized thickening of the septum (14 mm)	Surgical indication refused by the patient. Medical treatment

LVOT: left ventricular outflow tract obstruction, M: mechanism

4. CONCLUSION

LVOT obstruction after mitral valve intervention is a rare but serious complication that can occur after mechanical or bio-prosthetic, surgical or percutaneous replacements and after mitral valve repair.

Mechanical valve replacements for rheumatic valve disease are still frequent in developing countries. The pre-operative assessment for this type of surgery should predict the occurrence of post-operative left ventricular outflow tract obstruction by taking into account the left ventricular cavity size, the outflow tract size, the septal thickness and the mitral valve position. If risk factors are identified the preservation of native valve should be discussed and the preservation of the anterior valve particularly evicted.

The follow-up of these patients should be led regularly at the short and long-term periods to depict this complication.

When a LVOT obstruction is identified on Doppler examination, a comprehensive echocardiography should determine its mechanisms that can be multiple.

Surgical or alcohol septal ablation can successfully overcome this problem and improve patients' outcome, but the prevention of this problem through a comprehensive pre-operative echocardiographic assessment is a key to avoid this serious complication.

CONSENT

The patient gave a written consent for this publication

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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