ECRONICON OPEN ACCESS
EC CARDIOLOGY
Research Article

The Contribution of Echocardiography in the Dysfunctions of Mechanical Prosthesis: Report of 11 Cases

Saloua Oummou*, Abir Abardazzou, Salwa Karimi, Dounia Benzeroual and Mustapha Elhattaoui

CHU Med VI, Cardiology Department of Marrakesh, Morocco

***Corresponding Author:** Saloua Oummou, CHU Med VI, Cardiology Department of Marrakesh, Morocco.

Received: November 21, 2016; **Published:** April 21, 2017

Abstract

Introduction: The echocardiography has an essential place in the surveillance of prostheses.

Aim: The aim of our study was to describe the echocardiographic aspects of dysfunction of valvular prostheses.

Materials and Methods: This is a retrospective study, which collected all patients admitted for dysfunction of mechanical prosthesis bileaflet in the cardiology department of Marrakech during a period of 2 years.

Results: We included 11 patients. The mean age was 43 years. Seven cases were carrying a mitral prosthesis, 3 patients with aortic prosthesis and one case a double valve. The average age of prostheses was 3.7years. All prosthesis was an ON-X type. The prosthesis dysfunction was revealed by an infectious syndrome (27%), acute heart failure (18%), ischemic stroke (18%), while 36% were asymptomatic. The transthoracic echocardiography (TTE) was pathological in 10 cases: a reduction in the functional surface prostheses with increased transprosthetic gradient (54%) significant paraprosthetic leak (45%), a thrombus in one case, an anomaly of the movements of leaflet (18%). The echo-transesophageal (TEE) made in 8 patients, objectified images of thrombi (3 cases), paraprosthetic leaks (6 patients), abnormal of the movements of leaflet (4 cases).

Conclusion: Echocardiography is the gold standard for the diagnosis of prosthetic dysfunction with superiority of TEE over TTE.

Keywords: *Dysfunction; Mechanical Prosthesis Bileaflet; Echocardiography*

Abbreviation

DVI: Doppler Velocity Index; EOA: Effective Orifice Area; EROA: Effective Regurgitant Orifice Area; LV: Left Ventricular; LVOT: Left Ventricular Outflow Tract; MPG: Mean Pressure Gradient; PHT: Pression Half Time; PHV: Prosthetic Heart Valves; R vol: Regurgitant Volume; TEE: Transesophageal Echocardiography; TTE: Transthoracic Echocardiography; TVI: Time Velocity Integral; VC: Venna Contracta

Introduction

Prosthetic heart valves (PHV) are increasingly implanted in the world to replace diseased native valves. The dysfunction of the prosthetic valve remains a very serious complication with high mortality and morbidity. In clinical practice, transthoracic echocardiography and transesophageal echocardiography are the routine imaging modalities to evaluate the function of PHV.

Aim

The aim of our study was to describe the echocardiographic aspects of dysfunction of valvular prostheses.

Materials and Methods

This is a retrospective study, which collected all patients admitted for dysfunction of mechanical prosthesis bileaflet in the cardiology department of Marrakech during a period of 2 years.

Transthoracic studies included M-mode, two-dimensional, Doppler color flow imaging as well as pulsed and continuous wave Doppler modalities, performed with a 2.5-MHz transducer from standard echo windows.

Color Doppler was used for screening and evaluating the degree of intra- and/or paraprosthetic regurgitation.

Doppler-derived parameters of PHV function included peak velocity, mean pressure gradient (MPG), and velocity-time integral of the jet by continuous-wave Doppler performed from apical. Prosthetic effective orifice area (EOA) was derived from the continuity equation. A Doppler velocity index (DVI) was also calculated as the ratio between the proximal velocity-time integral in the LVOT and the velocity-time integral through the prosthesis valve.

For TEE, monoplane 3.5 and 5.0 MHz phased-array transducers mounted at the tip of a modified gastroscope were used. All TEE was performed after administration of a local pharyngeal anesthetic without additional premeditation. Patients fasted for 4 hours and were examined in a right lateral decubitus position without complications. All TEE was performed primarily for diagnostic reasons. Informed consent was obtained from all patients before the examination.

Echocardiographic criteria allow dysfunction diagnosis are summarized in Table 1, 2 and 3 [1].

	Possible Stenosis		**Significant Stenosis**	
	Aortic	**Mitral**	**Aortic**	**Mitral**
Valve structure and motion	Often Abnormal	Often Abnormal	Abnormal	Abnormal
Peak velocity m/s	3 - 4	1.9 - 2.5	> 4	> 2.5
Mean gradient (mmHg)	20 - 35	6 - 10	> 35	> 10
Doppler velocity index	0.25 - 0.29	2.2 - 2.5	< 0.25	> 2.5
Effective orifice area (cm^2)	0.8 - 1.2	1 - 2	< 0.8	< 1
Pressure half time (ms)	-	130 - 200	-	> 200

Table 1: *Doppler echocardiography criteria for detection and quantification of valve stenosis.*

	Mild	**Moderate**	**Severe**
LV size	Normal	Normal or Dilated	Dilated
Valve structure and motion	Normal	Abnormal	Abnormal
Color flow jet area	< $4cm^2$	variable	> $8cm^2$
VC (cm)	< 0.3	0.3 -0.59	> 0.6
R vol (ml/beat)	< 30	30 -59	> 60
EROA (cm^2)	< 0.20	0.20 -0.49	> 50
Pulmonary venous flow	Systolic dominance	Systolic blunting	Systolic

Table 2: *Echocardiographic and doppler criteria for severity of prosthesis mitral regurgitation*

EROA: Effective Regurgitant Orifice Area, R vol: Regurgitant Volume, VC: Vena Contracta.

	Mild	Moderate	Severe
LV size	Normal	Normal or dilated	Dilated
Valve structure and motion	Normal	Abnormal	Abnormal
VC (cm)	< 0.3	0.3 - 0.59	> 0.6
R vol (ml/beat)	< 30	30 - 59	> 60
PHT (ms)	> 500	200 - 500	< 200
Diastolic flow reversal in the ascending aorta	< 10	10 - 20	> 20

Table 3: *Echocardiographic and doppler criteria for severity of prosthesis aortic regurgitation.*

Results

We included 11 patients, six were women. The mean age was 43 years (20 - 55 years). Seven cases were carrying a mitral prosthesis, 3 patients with aortic prosthesis and one case a double valve. The average age of prostheses was 3.7years. All prosthesis was an ON-X type. The prosthesis dysfunction was revealed by a chronic fever (27%), acute heart failure (18%), ischemic stroke (18%), while 36% were asymptomatic. The transthoracic echocardiography (TTE) was pathological in 10 cases: a reduction in the functional surface prostheses with increased transprosthetic gradient (54%) significant paraprosthetic leak (45%) (Figure 1), a thrombus in one case (Figure 2), an anomaly of the movements of leaflet (18%). The echo-transesophageal (TEE) made in 8 patients, objectified images of thrombi (3 cases), paraprosthetic leaks (6 patients), abnormal of the movements of leaflet (4 cases) (Table 4).

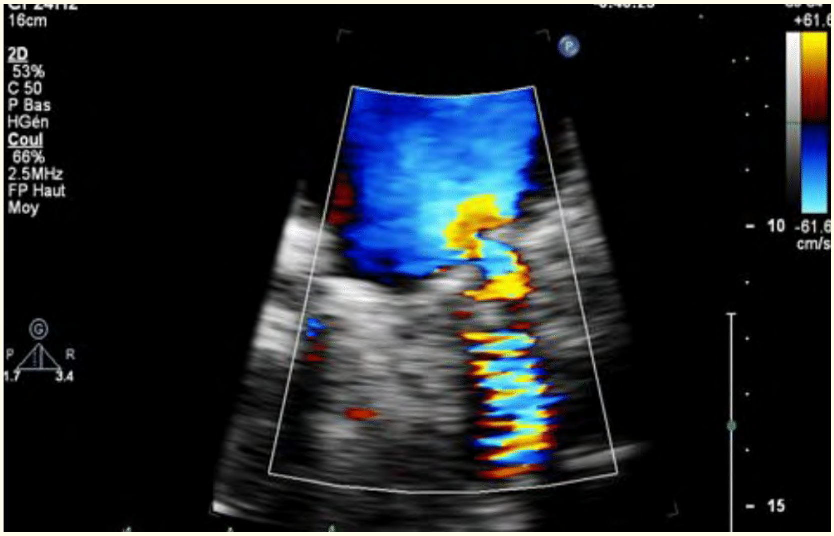

Figure 1: *Colour Doppler images of mitral para-prosthesis regurgitation.*

Figure 2: *Thrombus image on the mitral prosthesis.*

	TTE (N = 11)			TEE (N = 8)
Mitral prosthesis N = 6 cases	Anomaly of the movements of leaflet	2 cases		2 cases
	Increased gradient	3 cases	14+/-2mmHg	
	Paraprosthetic leak	3 cases		3 cases
	Decreased EOA	3cases	1.2+/-0.3 mm^2	
	PHT decreased	5 cases	190+/-15 ms	
	Thrombus	1 case		2 cases
	Vegetation	0		3 cases
Aortic prosthesis N = 6 cases	Anomaly of the movements of leaflet	0		2 cases
	Increased gradient	3cases	32+/-2mmHg	
	Paraprosthetic leak	2 cases		3 cases
	Decreased EOA	3 cases	0.8 +/-0.15mm^2	
	DVI decreased	3 cases	0.24+/-0.03	
	Thrombus	0		1 case

Table 4: *Echocardiographic data of patients.*

Discussion

Prosthetic valve dysfunction is one of the most serious complications after mechanical valve replacement. In literature, the incidence was 0.1 - 6% per patient year and the mean interval between the initial valve replacement and reoperation was 10 - 16 years [2].

Owing to its versatile, non-invasive, radiation-free, and low cost nature, Doppler echocardiography is undoubtedly the method of choice to evaluate prosthetic valve function. This evaluation follows the same principles used for the evaluation of native valves, with some important specifics. A complete echocardiography includes two-dimensional imaging of the prosthetic valve, evaluation of valve leaflet/occluder morphology and mobility, presence of thrombus or vegetation, measurement of the transprosthetic gradients and EOA, estimation of the degree of regurgitation.

Leaflet morphology, mobility and etiology of PHV dysfunction

Prosthetic valve stenosis is generally associated with abnormal valve morphology and/or mobility. TTE imaging of the valve occlude is often difficult to obtain because of reverberations and shadowing caused by the prosthetic valve components. TEE can provide improved image quality and thereby improved detection of the etiology of PHV dysfunction: leaflet calcification and thickening, vegetation, thrombus or pannus [3].

Quantitative parameters

Quantitative parameters of prosthetic valve function include transprosthetic flow velocity and pressure gradients, valve EOA, and DVI.

Transprosthetic velocity and gradient

The high velocity or gradient alone is not proof of intrinsic prosthetic obstruction and may be secondary to prosthesise patient mismatch, high flow conditions, prosthetic valve regurgitation, or localised high central jet velocity in bileaflet mechanical valves.

Effective orifice area

The EOA of prosthetic aortic valves is calculated with the continuity equation, based on the left ventricular outflow tract (LVOT) diameter, the time velocity integral (TVI) obtained by pulsed wave Doppler in the LVOT, and TVI obtained by continuous wave Doppler through the valve prosthesis. The EOA is reduced in case of obstruction of the prosthesis.

Doppler velocity index

The DVI is a dimensionless ratio of the proximal flow velocity in the LVOT to the flow velocity through the aortic prosthesis. TVI may also be used in place of peak velocities to calculate DVI. These parameters can be helpful to screen for valve obstruction, particularly when the cross-sectional area of the LVOT cannot be obtained.

Detection and quantification of prosthetic valve regurgitation

It is important to separate physiologic from pathologic prosthesis regurgitation. Mechanical prostheses have a normal regurgitant volume known as leakage backflow. As opposed to the pathologic regurgitant jets, the normal leakage backflow jets are characterized by being short in duration, narrow, and symmetrical. In the case of pathologic regurgitation, it is also important to distinguish paravalvular from transvalvular regurgitation.

TOE is more sensitive in detecting the origin of the regurgitant jets, the mechanism of regurgitation and the associated complications such as presence of pannus, thrombus, vegetation or masses interacting with occlude closure, abscess formation, or prosthesis dehiscence [4].

Indeed, TEE, especially 3-dimensional TEE, is the best diagnostic tool, which can define the causes better and helps in guiding therapy, risk stratification and monitoring follow-up outcomes. This improved visualization by TEE can be explained by the following: the unobstructed view provided by close approximation of the esophagus to the heart; the ability to use higher frequency transducers, enabling the visualization of even small masses or masses with low echogenicity; and the ability to evaluate the atrial surface of devices in the mitral position [5].

Conclusion

Echocardiography is the gold standard for the diagnosis of prosthetic dysfunction with superiority of TEE over TTE. Hence, TEE should be systematically performed when there is a clinical or TTE suspicion of PHV dysfunction.

Bibliography

1. Zoghbi., *et al*. "Guidelines and Standards: Recommendations for Evaluation of Prosthetic Valves with Echocardiography and Doppler Ultrasound". *Journal of the American Society of Echocardiography* 22.9 (2009): 975-1014.

2. Wei-Guo Ma., *et al*. "Dysfunction of mechanical heart valve prosthesis: experience with surgical management in 48 patients". *Journal of Thoracic Disease* 7.12 (2015): 2321-2329.

3. Werner G., *et al*. "Comparison of Transthoracic and Transesophageal Echocardiography for Detection of Abnormalities of Prosthetic and Bioprosthetic Valves in the Mitral and Aortic Positions". *The American Journal of Cardiology* 71.2 (1993): 210-215.

4. Daniel LB., *et al*. «Comparison of transthoracic and transesophageal assessment of prosthetic valve dysfunction". *Echocardiography* 7.2 (1990): 83-95.

5. Bach DS. "Transesophageal echocardiographic (TEE) evaluation of prosthetic valves". *Cardiology Clinics* 18.4 (2000): 751-771.

Volume 2 Issue 6 April 2017