Case report

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The importance of being "three-dimensional": how to save a mitral valve. Case report.

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Abstract

In a 72-year-old male patient an acute coronary syndrome (ACS) was complicated by left ventricular aneurysm and severe mitral regurgitation. Two-dimensional echocardiography failed in detecting mechanism of mitral regurgitation. Transthoracic three dimensional echocardiography allowed us to obtain a better visualization of the relationship between papillary muscles, ventricular walls and mitral leaflets and dynamic systolic displacement of the posterior papillary muscle associated with restriction of both leaflets with greater apical tethering of anterior leaflet (A3-A2 scallops). Echocardiography performed after cardiac surgery revealed that ventricular reshaping after posterior papillary muscle realignment allowed the mitral regurgitation resolution.

Keywords: Mitral regurgitation; echocardiography; myocardial infarction.

Introduction

Three-dimensional imaging of mitral regurgitation provides additional informations in detecting ischemic mechanisms; this tecnique is a powerful tool and could become a unique instrument for the cardiothoracic surgeon.

Case report

A 72-year-old male patient with a history of hypertension, coronary artery disease (previous inferior myocardial infarction), and chronic encephalopathy was admitted to the Emergency Department due to syncopal episode without neurological deficits. Biochemical tests showed increased cardiac enzyme (creatine kinase, creatine kinase MB isoenzyme, and troponin I) levels. ECG showed a sinus rhythm 80/min with Q waves in leads II, III, and aVF and inverted T waves in leads V4, V5, V6. The patient was diagnosed as having a Non-ST-Elevation-Myocardial-Infarction.

On physical examination, his blood pressure was 110/60 mmHg and a holosystolic murmur of Levine 3/6 was heard at the mitral area. Chest X-ray showed enlarged cardiac silhouette with moderately increased cardiothoracic index and pulmonary congestion. CT brain was negative for acute hemorragic or ischemic lesions.

Transthoracic two-dimensional echocardiography showed a large and partially thrombosed aneurysm of the inferior wall with involvement of the basal segment of the posterior interventricular septum. A severe mitral valve regurgitation was detected by color Doppler but mitral leaflet apposition and coaptation were normal (fig 1).

A real-time 3D echocardiography system (Sonos 7500, Philips Medical Systems, Andover, MA, USA) with a 2–4 MHz 3000 element MATRIX transthoracic transducer was used to acquire 3D full-volume and color Doppler images [1-2].

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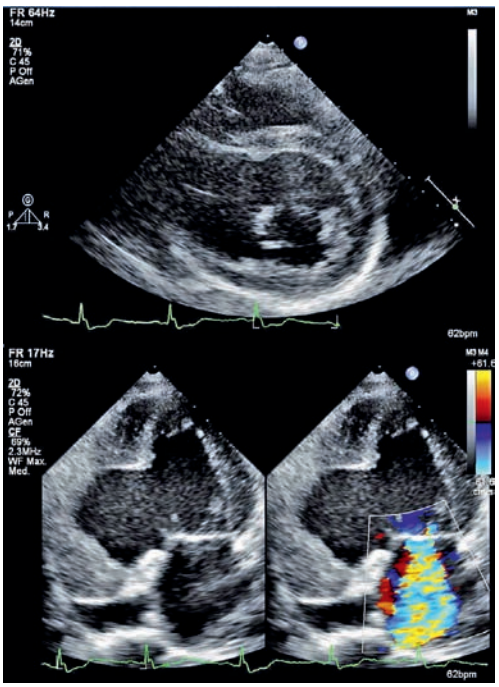


Fig 1. Up: Transthoracic two-dimensional short axis of left ventricle at mitral level (systolic frame): boundary between aneurysm and normal left ventricle is well detected. The wall of the aneurysm is not recognizable because of the poor lateral definition of two-dimensional imaging. Down: Transthoracic two-dimensional two-chamber apical view (systolic frame): on the left aneurysm of the inferior wall partially thrombosed; on the right mitral regurgitation at the Color Doppler.

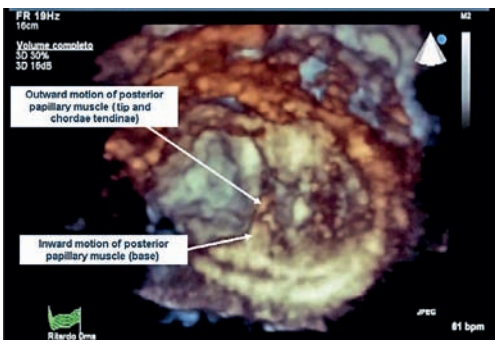


Fig 2. Transthoracic three-dimensional reconstruction. Ventricular view: the left ventricle is cropped at the basal of the papillary muscles. The basal of the postero-medial papillary muscle shows an inward movement while the tip has an outward movement. Both leaflets are tethered.

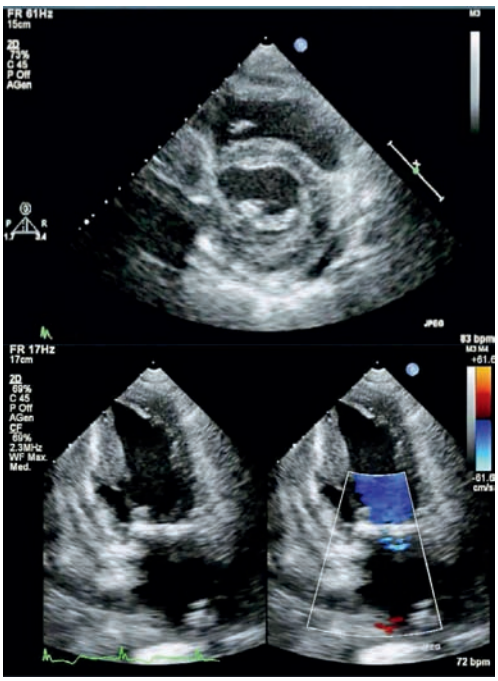


Fig 3. Up: Postoperative Transthoracic two-dimensional short axis of left ventricle at mitral level: the posterior aneurysm is not recognizable. Down: Postoperative Transthoracic two-dimensional two-chamber apical view (systolic frame): on the left the inferior wall is quite normal and on the right mitral regurgitation is disappeared.

Images for three-dimensional data-set were obtained in the wide-angle mode from the apical views and particular care was taken to include the entire left ventricle and mitral valve apparatus in the full-volume dataset [3-6].

The real time three-dimensional (3DE) data set was then cropped to visualize the entire left ventricle using multi-plane slices. A free-hand plane was used to obtain a better visualization of the relationship between papillary muscles, ventricular walls and mitral leaflets. In systole the base of the postero-medial papillary muscle showed an inward motion toward the center of the left ventricle while the tip had an abnormal outward motion. Dynamic systolic displacement of the posterior papillary muscle was associated with restriction of both leaflets with greater apical tethering on the anterior leaflet (A3-A2 scallops). The anomalous motion of the posterior papillary muscle and anterior leaflet was better detected when the single-slice plane was finally adjusted to display the border zone of the aneurysm (fig 2).

Critical stenosis of the left main coronary artery and total occlusion of the right coronary artery were detected at coronary angiography.

We established on the basis of 3DE imaging that simple aneurysmectomy and posterior annuloplasty could eliminate mitral regurgitation.

The patient underwent surgical intervention: triple coronary artery bypass grafting (Left Internal Thoracic Artery on Left Anterior Descending artery, Great Saphenous Vein on Obtuse Marginal artery and on Right Posterolateral artery), left ventricle remodeling by excising the aneurysm of the postero-inferior wall and sewing up the scarred and infarcted regions and mitral valvuloplasty by a rigid ring were performed.

There were no complications in the postoperative course.

Echocardiography performed after cardiac surgery revealed that ventricular reshaping allowed posterior papillary muscle realignment and mitral regurgitation resolution (fig 3).

Discussion

Echocardiography is the first-line modality for the assessment of the etiology and severity of mitral regurgitation. Traditionally, two-dimensional transthoracic echocardiography has greatly contributed to the clinical diagnosis of mitral regurgitation (MR) and it is the main modality for this evaluation.

Now, a more detailed assessment of pathology is possible thanks to 3DE. This technique is playing an increasingly important role in the management of valvular heart disease because of developments in ultrasound and computer technologies, which have resulted in improved online 3D displays and sophisticated offline volumetric quantification of valves [7].

Three-dimensional echocardiography spatial reconstruction can identify more precisely the movement of papillary muscles and provide a dynamic view of the anatomy of the mitral valve and the physiopathology of the implied disease [8].

In patients with ischemic MR, left ventricular remodelling caused by abnormal wall motion results in irregular papillary displacement and asymmetric tethering associated with eccentric MR [9].

Watanabe et al in their work [4] demonstrate that quantification of geometric parameters such as tenting length and volume with localization of the variable peak-tenting site is not only feasible, but is also superior by 3DE. Quantifying differences in mitral geometry and MR jet characteristics between ischemic and dilated MR can provide mechanistic insights into these 2 distinct types of MR and accordingly can alter surgical interventions, as happened in our case.

In fact thanks to 3DE an intra-papillary dissinchrony was found and the surgical intervention was modified accordingly.

Three dimensional echocardiography plays an essential role in understanding the geometry of mitral valve complex and contributes greatly to decision making in surgical strategy in functional MR. This technique is a powerful tool when used by expert sonographers and it could become a useful and unique instrument for the cardiothoracic surgeon.

This emphasizes the importance of the heart-team in the contemporary art of medicine: only by working together and in harmony can we make the right and best choice for the patient. And so "*Bona Mente Debet Primus Chirurgus Operare Quam Armata Manu*" (*Before cutting, the surgeon has to think seriously about what the best thing to do is*).

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