DOI: 10.1111/echo.13617

CASE REPORT

WILEY Echocardiography

Three-dimensional echocardiography for predicting postoperative ventricular volumes after surgical ventricular reconstruction of left ventricular aneurysm: A case-based presentation

María Teresa Politi MD | Martín Federico Vivas MD | Eduardo Filipini MD | Iván Chillik MD | Laura Mariana Riznyk MD | Gustavo Avegliano MD | Ricardo Ronderos MD

Section of Echocardiography, Department of Cardiovascular Imaging, Instituto Cardiovascular de Buenos Aires, Buenos Aires, Argentina

Correspondence
María Teresa Politi, Section of Echocardiography, Department of Cardiovascular Imaging, Instituto Cardiovascular de Buenos Aires (ICBA), Buenos Aires, Argentina.
Email: teresapoliti@yahoo.com.ar

Three-dimensional transthoracic echocardiography (3DTTE) may have a role in predicting final left ventricular volumes and clinical response after the surgical ventricular reconstruction (SVR) of left ventricular aneurysms and pseudoaneurysms. Left ventricle final volumes can be calculated through "virtual aneurysmectomy." We present a patient with a huge ventricular dilation combined with myocardial dissection, localized wall rupture, and aneurysm of the left ventricular apex after acute myocardial infarction in which accurate predictions from 3DTTE suggest potential clinical value.

KEYWORDS
acute myocardial infarction, cardiac surgery, dissection, left ventricular aneurysm, live three-dimensional transthoracic echocardiography, myocardial rupture

Left ventricle volume assessment may have prognostic value in patients undergoing surgical ventricular reconstruction (SVR).[1,2] Three-dimensional transthoracic echocardiography (3DTTE) may accurately estimate final postoperative left ventricle volumes through "virtual aneurysmectomy," thus avoiding postoperative low cardiac output related to small ventricular volumes. Prospective human studies combine data from left ventricular volumes with the systolic dyssynchrony index (SDI) to predict clinical outcomes after SVR, which may be useful for identifying clinically responsive patients.[3,4] We report the case of a man with progressive dilation of the left ventricle with aneurysm formation combined with myocardial dissection and localized free wall rupture after acute myocardial infarction. Accurate predictions of final left ventricular volumes and ejection fraction (EF) after SVR using 3DTTE suggest potential clinical value.

A 44-year-old man admitted with the diagnosis of anterolateral myocardial infarction showed severe three-vessel disease with a patent main left coronary artery on coronary angiography. Although a coronary artery bypass grafting (CABG) surgery was planned, the patient refused to accept the procedure.Three weeks after the event, the patient once again developed severe chest pain and orthopnea. A 2DTTE performed at bedside showed a dilated left ventricle with an apical aneurysm and a severely deteriorated systolic function (ejection fraction 10%). A closer inspection revealed a distinct echogenic mass within the apical portion of the left ventricle cavity and color flux going through the left ventricle wall, suggesting myocardial dissection added to the left ventricular apical aneurysm. There were no pathologic findings regarding the right ventricle or the heart valves (Figure 1, Movies S1 and S2). We arrived at the diagnosis of ischemic cardiomyopathy with a left ventricle aneurysm and myocardial dissection, and probably an intracavitary thrombus.

Although this was clearly a surgical setting that would require excluding the myocardial dissection, the possibility of also performing a ventricular reconstructive surgery (VRS) aiming at reducing left ventricle dimensions was attractive and seemed worth taking into consideration. As real time three-dimensional echocardiography has been reported to be useful in assessing the location of left ventricle rupture and the orifice's dimensions and geometries, we performed a 3DTTE (EPIQ 7C, Philips Healthcare, Matrix 5 MHz probe) to guide surgical correction.[5] A 3DTTE revealed a myocardial tear dissecting the middle and distal portions of the anterior wall and the

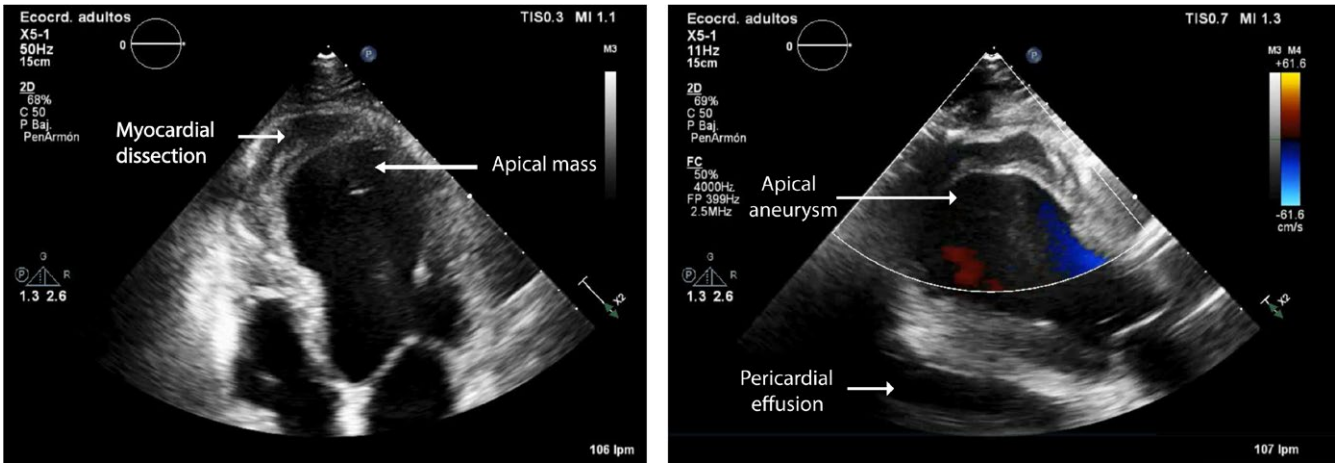

FIGURE 1 Two-dimensional transthoracic echocardiogram (2DTTE) and color Doppler showing a severely dilated left ventricle with an apical aneurysm and a severely deteriorated systolic function with moderate pericardial effusion. A closer inspection revealed an apical intracavitary echogenic mass and myocardial dissection

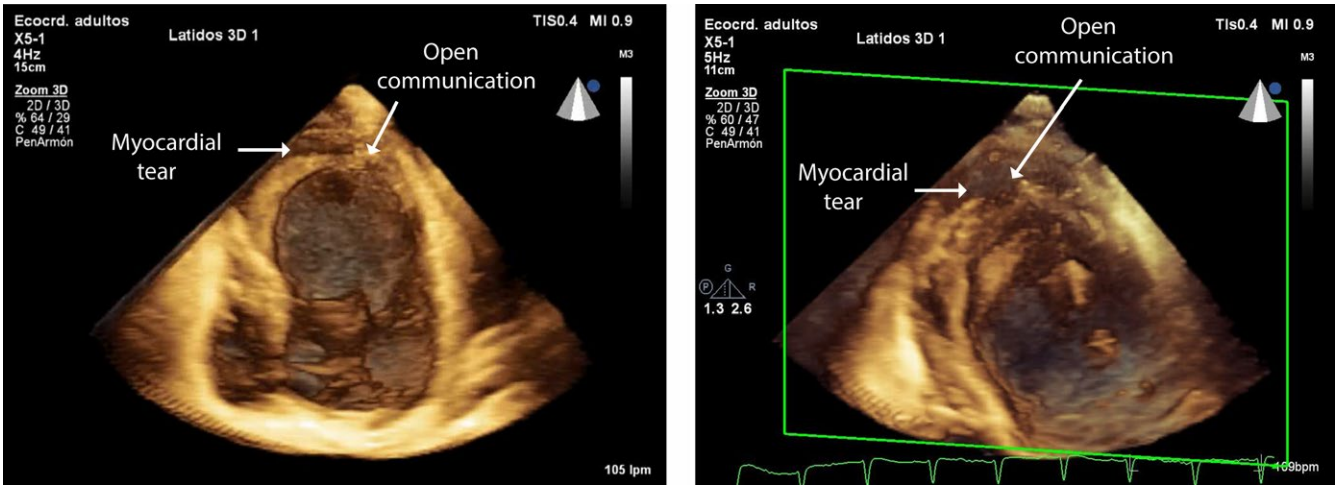

FIGURE 2 Three-dimensional transthoracic echocardiogram (3DTTE) showing myocardial tear dissecting the middle and distal portions of the anterior wall and the interventricular septum, with an open communication between the dissected portions and the pericardial cavity

interventricular septum, with a small open communication between the dissected portions and the pericardial cavity. The apical portion of the left ventricular cavity was covered with a low-echogenicity layer, which probably corresponded to mural thrombosis. The left ventricle was clearly dilated and dyskinetic in the apical anterior and apical septal regions. Left ventricle diastolic (LVDV) and systolic (LVSV) volumes were 209 and 192 mL, respectively, with a 10% ejection fraction and a SDI of 15% (Figure 2, Movie S3). Using the regular volumetric calculation software provided by QLAB 9.0 (Philips Healthcare, Andover, MA, USA), we performed a "virtual aneurysmectomy" of the left ventricle to predict postoperative ventricular volumes. As a reference to place the predicted apex, we considered the center of the plane that separates the transition between the normokinetic area and the dyskinetic area using two longitudinal planes on the multiplanar reconstruction mode (MPR). For making this decision, we also looked at changes in the thickness and brightness of the left ventricular wall. Predicted postoperative LVDV and LVSV were 138 and 78 mL, respectively, with a 44% ejection fraction (Figure 3, Movie S4). According to our estimations, the calculated percentage decrease in diastolic left ventricular volume would be around 33%, leaving final ventricular volumes above normal values. We therefore considered that performing a SVR using this resection plane was likely to be safe and effective. These values were also nearing the 60-mL limit of the minimum systolic volume to perform a Dor procedure, which also approximates the limit proposed to define low systolic volume.[6,7]

The patient promptly underwent combined CABG and VRS, requiring a postoperative intra-aortic balloon pump (IABP). Ten days after surgery, a 3DTTE reported LVDV and LVSV of 120 mL and 76 mL, respectively, with a 37% ejection fraction. In the mid-apical portion of the left ventricular cavity, a region of increased echogenicity indicated the site of the surgical patch closure.

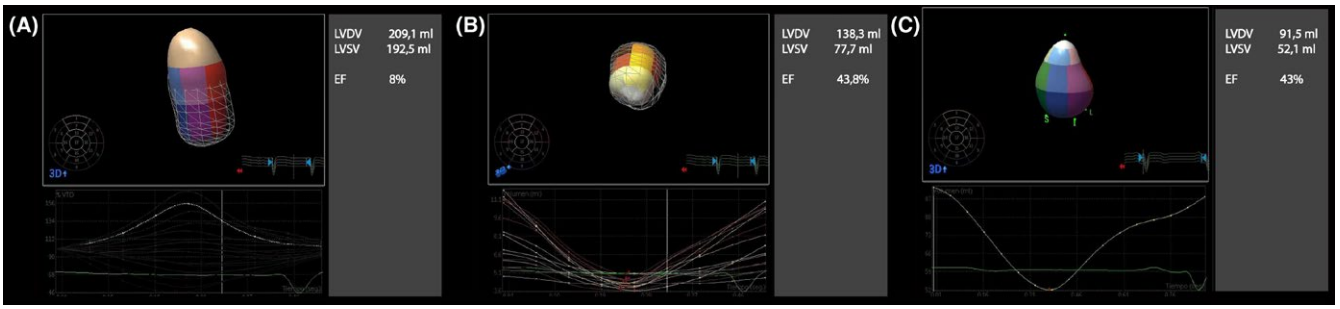

FIGURE 3 Preoperative measurements (A), "virtual aneurysmectomy" predictions (B), and 6-month postoperative measurements (C) of left ventricular diastolic and systolic volumes (VTD and VTS) using three-dimensional transthoracic echocardiogram (3DTTE)

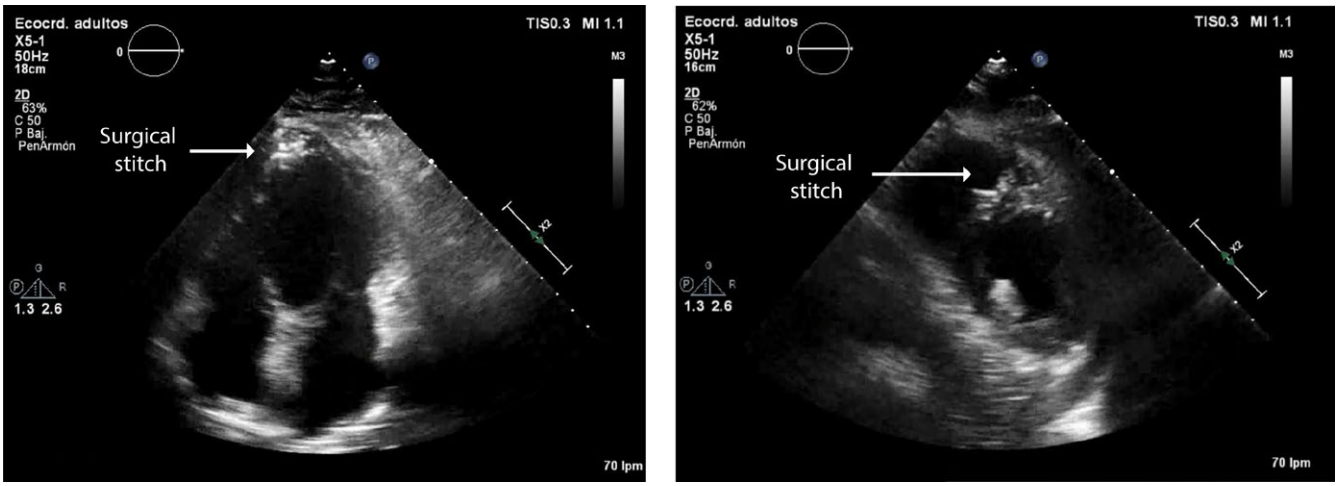

FIGURE 4 Six-month postoperative two-dimensional transthoracic echocardiogram (2DTTE) showing final left ventricle shape and dimensions

Six months after the reconstructive surgery, the patient was called back for a scheduled appointment. He had no clinical signs of heart failure and was asymptomatic. A control 3DTTE reported adequate surgical results with LVDV and LVSV of 92 and 52 mL, respectively, and with a 43% ejection fraction and a SDI of 2.8% (Figure 4, Movies S5, S6, and S7).

This case report suggests that a 3DTTE "virtual aneurysmectomy" may be useful in guiding the SVR of left ventricular aneurysms. Current experience with SVR indicates that early mortality is approximately 8% and is mainly due to low output syndrome and that over 15% of survivors require early reoperation.[8,9] The accurate estimation of postoperative left ventricular size remains one of the major challenges.

There have been attempts to estimate postoperative left ventricular volumes using different imaging approaches, mainly cardiac magnetic resonance.[1,5] 3DTTE "virtual aneurysmectomy" does not require special software and can be performed by any experienced 3DTTE operator with standard 3DTTE equipment. Although this case report suggests that 3DTTE "virtual aneurysmectomy" may effectively predict final ventricular volumes, large prospective studies with not only echocardiographic but also clinical outcomes are warranted.

REFERENCES

1. Yamazaki S, Doi K, Numata S, et al. Ventricular volume and myocardial viability, evaluated using cardiac magnetic resonance imaging, affect long-term results after surgical ventricular reconstruction. *Eur J Cardiothorac Surg*. 2016;50:704–712.
2. Hong Z, Yuming M, Chunmei W, et al. The value of myocardial torsion and aneurysm volume for evaluating cardiac function in rabbit with left ventricular aneurysm. *PLoS ONE*. 2015;10:e0121876.
3. Huang XS, Gu CX, Yang JF, et al. A pilot study of systolic dyssynchrony index by real-time three-dimensional echocardiography predicting clinical outcomes to surgical ventricular reconstruction in patients with left ventricular aneurysm. *Interact Cardiovasc Thorac Surg*. 2014;19:938–945.
4. Hartyánszky I, Tóth A, Berta B, et al. Personalized surgical repair of left ventricular aneurysm with computer-assisted ventricular engineering. *Interact Cardiovasc Thorac Surg*. 2014;19:801–806.
5. Avsar S, Keskin M, Velibey Y, et al. Incremental utility of real time three-dimensional transthoracic echocardiography for the assessment of left ventricular free wall rupture location, orifice geometry, and complex intracardiac flow. *Echocardiography*. 2015;32:1738–1741.
6. Dor V, Saab M, Coste P, et al. Left ventricular aneurysm: a new surgical approach. *Thorac Cardiovasc Surg*. 1989;37:11–19.
7. Pibarot P, Clavel MA. Left ventricular outflow tract geometry and dynamics in aortic stenosis: implications for the echocardiographic assessment of aortic valve area. *J Am Soc Echocardiogr*. 2015;28:1267–1269.

8. Sartipy U, Albage A, Lindblom D. The Dor procedure for left ventricular reconstruction. Ten-year clinical experience. *Eur J Cardiothorac Surg*. 2005;27:1005–1010.
9. Castelvecchio S, Menicanti L, Ranucci M. Development and validation of a risk score for predicting operative mortality in heart failure patients undergoing surgical ventricular reconstruction. *Eur J Cardiothorac Surg*. 2015;47:e199–e205.

SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

Movie S1. Two-dimensional transthoracic echocardiogram (2DTTE) showing left ventricular apical aneurysm and myocardial dissection from apical four-chamber view.
Movie S2. Color Doppler showing blood flow entering dissection from parasternal long axis view.
Movie S3. Three-dimensional transthoracic echocardiogram (3DTTE) showing myocardial tear and mural thrombosis from apical four-chamber view.
Movie S4. "Virtual aneurysmectomy" predictions of left ventricular diastolic and systolic volumes (VTD and VTS) and ejection fraction (EF) using three-dimensional transthoracic echocardiogram (3DTTE).
Movies S5 and S6. Six -month postoperative two-dimensional transthoracic echocardiogram (2DTTE) showing final left ventricle shape and dimensions from short axis view (Movie S5) and parasternal long axis view (Movie S6).
Movie S7. Six-month postoperative measurements of left ventricular diastolic and systolic volumes (VTD and VTS) using three-dimensional transthoracic echocardiogram (3DTTE).

How to cite this article: Politi MT, Vivas MF, Filipini E, et al. Three-dimensional echocardiography for predicting postoperative ventricular volumes after surgical ventricular reconstruction of left ventricular aneurysm: A case-based presentation. *Echocardiography*. 2017;00:1–4. https://doi.org/10.1111/echo.13617