

## Mitral Valve Three-dimensional Echocardiography: Friend or Foe?

LEOPOLDO PÉREZ DE ISLA<sup>1</sup>

Three-dimensional echocardiography has widely transformed the world of cardiac imaging over the last decade. One of the most outstanding changes is that cardiologists have stopped believing dogmatically in formulas which, based on linear parameters, are able to calculate the area of different cardiac structures assuming a regular and symmetrical morphology and a single plane spatial arrangement. Multiple scientific evidence has been published against this method, since calculations based on this type of formulas can be quite different from real measurements. (1) Calculation of the left ventricular outflow tract for the assessment of patients with severe aortic stenosis is currently the most controversial example. Many discrepancies between parameters disappear with the use of three-dimensional echocardiography. (2, 3)

The mitral valve annulus is a fibrous elliptically-shaped region which becomes more circular in diastole than in systole (4) and serves as attachment of the mitral leaflets. The annulus has a saddle-like contour and is not located in a single plane, but has portions called trigones which are closer to the ventricular apex, and middle parts of the anterior and posterior leaflets which are closer to the left atrial roof, the middle part of the anterior leaflet being slightly higher. Its normal average area is 7 cm<sup>2</sup> and is modified during the cardiac cycle, increasing at end-systole and reaching its maximal dimension at end-diastole, (5) with an average 25% change in mitral valve area. Area reduction starts with atrial contraction, and is minimal during mid-systole. It is also important to know that the mitral annulus is displaced towards the atrium in diastole and towards the ventricle in systole. Once the mitral annulus characteristics are known, it is easy to understand the limitations of calculating the mitral annulus area by measuring its diameter in a single plane, a method usually employed to estimate the blood volume passing through it for further quantification of mitral or aortic regurgitant volumes.

Three-dimensional echocardiography allows direct quantification of the area of any cardiac structure without using mathematical formulas. Therefore, we may say that the measurement is “more real” as it is not based on a geometrical approach. The technique is not free from limitations (1) and cannot replace two-dimensional echocardiography in all cases; yet, it af-

fords diagnostic tools to complement the information provided by other techniques, thus facilitating the management of most of our patients.

In this issue of the Argentine Journal of Cardiology, Lombardero et al. (6) publish an elegant study comparing the mitral annulus measured by two-dimensional transthoracic echocardiography versus three-dimensional transesophageal echocardiography and the differences in the estimation of stroke volume in left ventricular inflow and outflow tracts using these techniques. In addition, they tried to assess the real level at which the effective mitral valve orifice is located. Undoubtedly, the study is very imaginative in its design concept and denotes the authors' acquaintance and expertise with the methods employed

The results of the study are surprising. Before reading them, one would expect that three-dimensional echocardiography exhibited an overwhelming superiority over conventional methods. However, and quoting the exact phrase that opens the conclusions of the study: “The better the technique for measuring the mitral annulus, the farther we are from the effective mitral orifice”, we may state that the better technique is associated with worse results because the effective mitral orifice is the functional or useful orifice of the mitral valve. Their statement is based on the fact that the underestimation of the mitral annulus size by transthoracic two-dimensional echocardiography brings the estimation of mitral flow closer to that obtained using the ideal effective mitral orifice. Moreover, when they used three-dimensional transesophageal echocardiography to measure the mitral annulus, stroke volume through the left ventricular inflow tract was overestimated, and, thus, they do not recommend its use as a substitute of the traditional evaluation by two-dimensional echocardiography. And, as a final conclusion, they demonstrate that the mitral valve area measured at one centimeter of the highest point of the mitral annulus is closer to the effective mitral orifice. All these results should not divert us from reality: the fact that some methods are better than others does not imply that one of them is indeed very good, as indicated by the poor correlation results. Nevertheless, I think it is useful to criticize the criticism to three-dimensional echocardiography made in this study. From my point of view, I would like to ask the reader of this

editorial the following question: Wouldn't it be better to investigate where to measure the mitral valve area while using three-dimensional echocardiography rather than declaring that three-dimensional echocardiography should not be used? I expect this aspect to be studied and discussed in further investigations in order to shed light on this issue.

As every work, the study by Lombardero et al. (6) has its limitations, some of which are pointed out by the same authors. The small number of patients included is one limitation. Another one is the use of the application "MVQ (mitral valve quantification)", as the results obtained with this tool depend on the operator and require adequate training and experience, not available to all echocardiographers, in addition to being time-consuming.

The future is coming fast and surely the new technologies, particularly three-dimensional techniques, will have much to say over the next years, as it is currently occurring with several other technological advances. (7, 8) Probably other authors, as Lombardero et al. (6) who have deep knowledge about the anatomical, functional and clinical aspects of the heart and its diseases, will provide evaluation methods to improve our patients' management. And, of course, turn three-dimensional echocardiography into an even better friend than it is today.

#### Conflicts of interest

None declared

#### REFERENCES

1. Lang RM, Badano LP, Tsang W, Adams DH, Agricola E, Buck T, et al. EAE/ASE Recommendations for Image Acquisition and Display Using Three-Dimensional Echocardiography. *Eur Heart J Cardiovasc Imag* 2012;13:1-46. <http://doi.org/fz3zc8>
2. Pérez de Isla L, Zamorano J, Pérez de la Yglesia R, Cioccarelli S, Almería C, Rodrigo JL. Quantification of aortic valve area using three-dimensional echocardiography. *Rev Esp Cardiol* 2008;61:494-500.
3. González-Cánovas C, Muñoz-Esparza C, Oliva MJ, González-Carrillo J, López-Cuenca A, Saura D, et al. Severe aortic valve stenosis with low-gradient and preserved ejection fraction: a misclassification issue? *Rev Esp Cardiol* 2013;66:255-60. <http://doi.org/f2ffk9>
4. Flachskampf FA, Badano L, Daniel WG, Feneck RO, Fox KF, Fraser AG, et al. European Association of Echocardiography; Echo Committee of the European Association of Cardiothoracic Anaesthesiologists. Recommendations for transoesophageal echocardiography: update 2010. *Eur J Echocardiogr* 2010;11:557-76. Erratum in: *Eur J Echocardiogr* 2011;12:255. <http://doi.org/cfkt7g>
5. Lang RM, Badano LP, Tsang W, Adams DH, Agricola E, Buck T, et al. EAE/ASE recommendations for image acquisition and display using three-dimensional echocardiography. *J Am Soc Echocardiogr* 2012;25:3-46. <http://doi.org/dt5z3f>
6. Lombardero M, Perea G, Tinetti M. ¿Dónde está el orificio mitral efectivo? Where is the Effective Mitral Orifice? Divergencies between Mitral Inflow Volume and Left Ventricular Outflow Tract Volume by Echocardiography. *Rev Argent Cardiol* 2014;82:109-16.
7. de Agustín JA, Marcos-Alberca P, Fernández-Golfín C, Gonçalves A, Feltes G, Nuñez-Gil IJ, et al. Direct measurement of proximal isovelocity surface area by single-beat three-dimensional color Doppler echocardiography in mitral regurgitation: a validation study. *J Am Soc Echocardiogr* 2012;25:815-23. <http://doi.org/q2s>
8. de Agustín JA, Viliani D, Vieira C, Islas F, Marcos-Alberca P, Gómez de Diego JJ, et al. Proximal isovelocity surface area by single-beat three-dimensional color Doppler echocardiography applied for tricuspid regurgitation quantification. *J Am Soc Echocardiogr* 2013;26:1063-72. <http://doi.org/q2t>