CME

Where is the Effective Mitral Orifice? Echocardiographic Divergence Between Mitral Inflow Volume and Left ventricular Outflow Tract Volume

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ABSTRACT

Objectives
Two-dimensional transthoracic echocardiography (2DTTE) is not a reliable method for estimating regurgitatant volume in mitral insufficiency due to inadequate measurement of the mitral annulus (MA). Three-dimensional transesophageal echocardiography (3DTEE) offers better tools for measuring the MA.

Objectives
The aim of this study was to compare the MA area and the difference in mitral inflow (MI) volume and left ventricular outflow tract (LVOT) volume determined by 2DTTE and 3DTEE in normal hearts, and to evaluate at what level of the mitral valve apparatus the mitral effective orifice is actually located.

Methods
A total of 13 consecutive and prospective patients with indication of transesophageal echocardiography (9 to rule out cardioembolic source and 4 due to febrile syndrome) were included in the study. Their mean age was 42 (29-47) years and 7 were women. All the patients had normal 2DTTE, were in sinus rhythm and had normal blood pressure at the moment of the study. 2DTTE and 3DTEE were simultaneously performed. LVOT area and MA area were calculated by 2DTTE and 3DTEE. Mitral valve (MV) area distal to the MA was estimated by 3DTEE. Mitral inflow and LVOT volume were calculated as the product between the area and flow velocity time integral (VTI). The effective mitral valve area (EMVA) was hypothetically estimated by dividing the LVOT (3DTEE) volume by MI VTI.

Results
Correlation (rs), concordance and 95% CI between MA area by 2DTTE vs. 3DTEE were: 0.506, 1.97 (-0.40 to 4.34), EMVA vs. 3DTEE: 0.549, 2.41 (-4.03 to -0.79) and EMVA vs. MV at 11 mm (8-12) of the MA: 0.982, 0.079 (-0.26 to 0.42). The difference between MI volume and LVOT volume (ml) was: 2DTTE: 12.8 (7.5-19), 3DTEE: 32.8 (25.9-48) and 3DTEE (from the MV distal to the MA) 1.8 (1.25-3.6).

Conclusions
The better the technique for measuring the mitral annulus, the farther we are from the mitral effective orifice. The mitral valve area measured at one centimeter of the highest point of the mitral annulus is the best approximation to the effective mitral orifice.

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Abbreviations >

MA	Mitral annulus	3DTEE Mu Ar	Mitral orifice area [(sections distal to the mitral annulus) measured by planimetry and with the multi-slice feature of the QLAB plug-in]
EMVA	Theoretical and hypothetical effective mitral valve area		
TT LPLAV MA Ar	Mitral annulus area measured by transthoracic echocardiography (average of mitral annulus diameter measured at apical 2-chamber and left parasternal long axis views)	MVQ Ar	Mitral annulus area calculated by Mitral Valve Quantification [(QLAB plug-in) in projection plane]
		Avg3D LVOT Ar	Average of left ventricular outflow tract areas measured in systole by 3D transesophageal echocardiography (by direct planimetry)
2DTT MA Ar	Mitral annulus area measured by 2D transthoracic echocardiography (average of mitral annulus diameters measured at apical 2-chamber and 3-chamber views)	2DTT LVOT Ar	Left ventricular outflow tract area measured by 2D transthoracic echocardiography
		2DTEE	Two-dimensional transesophageal echocardiography
2D3D TEE Ar	Mitral annulus area measured by transesophageal echocardiography [as average of the diameters in 2-chamber and 3-chamber views (perpendicular planes) but from a full acquisition of the 3D software]	3DTEE	Three-dimensional transesophageal echocardiography
		2DTTE	Two-dimensional transthoracic echocardiography
		MI	Mitral inflow
		LVOT	Left ventricular outflow tract
		Vol	Volume
		VTI	Velocity time integral

INTRODUCTION

In patients with structurally normal hearts, left ventricular outflow tract (LVOT) volume has to be similar to mitral inflow (MI) volume. The difference of volume between both tracts in important to quantify mitral regurgitation by 2D transthoracic echocardiography (2DTTE) and is based on measuring the mitral annulus (MA) area and the LVOT area. (1) Yet, the result of this estimation is unreliable in daily practice. The MA is a non planar saddle-shaped structure defined as a hyperbolic paraboloid. (2) However, 2DTTE assumes that the geometry of the MA (and of the LVOT) is circular. Three-dimensional transesophageal echocardiography (3DTEE) does not make geometrical assumptions as 2DTTE and, therefore, should measure LVOT and MA areas and their respective volumes with greater accuracy. The goal of the present study was to investigate the origin of the divergence in volume between both tracts in structurally normal hearts in which the normal difference should be close to 0 ml. The following measurements were compared: MA measured by 2DTTE vs. 3DTEE and the difference between LVOT volume and MI volume measured by 2DTTE and 3DTEE. We also evaluated at what level of the mitral valve apparatus the effective mitral orifice determined by 3DTEE is actually located.

METHODS

A total of 13 consecutive and prospective patients (42 [29-47] years old; 7 were women) with indication of transesophageal echocardiography (in 9 patients to evaluate cardioembolic source and in 4 patients due to febrile syndrome) were included. All the patients had normal 2DTTE, were in sinus rhythm and had normal blood pressure at the moment of the study. Patients with arrhythmias that could affect the determinations of the parameters were excluded.

2D transthoracic echocardiography and 2D/3D transesophageal echocardiography

2DTTE, 2DTEE and 3DTEE were successively and simultaneously performed with a 3D echocardiographic imaging platform Philips IE33 (Philips Ultrasound USA), capable of acquiring 2D digital images, 3D real-time (live) images and full volume gated images. This complete 3D capture was transferred to a workstation and then analyzed using the QLAB 8.1 software (Philips Medical System). Firstly, 2DTTE was performed according to the usual protocol. Immediately after, an X7-2t multiplane transesophageal probe was introduced under sedation administered by an anesthesiologist and TEE was performed. Full volumes were acquired at 0, 45, 90, 120 and 180 degrees of 2DTEE. The best capture (without stitching artifacts) was chosen for the analysis of the mitral apparatus and LVOT. Two plug-ins from the 3DTEE QLAB software were used: the MVQ (Mitral Valve Quantification) analysis software and the Multiplanar Imaging. The MVQ software has been designed for a semi-automated evaluation of the mitral apparatus and the MA in multiple planes (9 planes were pre-established in this study) with manual tracing of 18 points around the mitral annulus border. Multiplanar imaging enables the simultaneous visualization of three 2DTEE (longitudinal (red) and transverse (green) planes and a third (blue) plane where a diameter or area of a structure of interest is measured).

Estimation of the left ventricular outflow tract area and mitral annulus area

2D transthoracic echocardiography

The LVOT area was estimated by the usual method (LVOT

diameter transformed in area according to the formula: Area $= (d / 2)2.\pi$ which we called 2DTT LVOT Ar. (3) To measure the MA area (in diastole), two combinations were obtained: average diameter of 3-chamber and apical 2-chamber views (anteroposterior diameter and intercommissural diameter) and average diameter measured at the left parasternal long axis view and apical 2-chamber view. Both averages were transformed in areas (according to the formula described): 2DTT MA Ar and TT LPLAV MA Ar, respectively.

2D/3D transesophageal echocardiography

LVOT area was estimated with Multiplanar Imaging (QLAB) as the average area in each systolic frame obtained by direct planimetry (Avg 3D LVOT Ar) with an average of 8 systolic frames per patient, and was predetermined as reference area. The MA measurement by 3DTEE was performed as follows: 1) MVQ (QLAB) was used to estimate the average MA area (in the projection plane) of each diastolic frame (an average of 7 diastolic frames per patient). This area was called MVQ Ar and was predetermined as reference area (Figure 1), and 2) MA longitudinal and transverse diameter were simultaneously determined using Multiplanar Imaging (QLAB) in the frame with the maximal opening in diastole. Then, the average between the intercommisural diameter (2-chamber view) and the anteroposterior diameter (3-chamber view) was obtained and transformed in area according to the formula described. This area was called 2D3D TEE Ar (Figure 2 A and B).

To obtain a MI measurement different from the MA, we evaluated the mitral orifice area with multiplanar/multislice processing (in 9 4-mm axial slices). We placed the first section in the highest plane of the MA (mitral-aortic intervalvular fibrosa) and the rest of the sections were placed in the direction of the ventricle. The average areas in diastole were measured by direct planimetry in the sections where valve border and opening were perfectly visible, and were called 3DTEE Mu Ar (Figure 2 C and D).

Estimation of the theoretical and hypothetical effective mitral orifice

In normal hearts, the volume (area .VTI) in both tracts has to be the same. Therefore, (and considering AVg 3D LVOT Vol as reference and the intra-TEE mitral VTI):

$$\text{3D LVOT area. intra-TEE LVOT VTI =}$$
$$\text{Effective mitral valve area . intra-TEE MI VTI}$$

As 3D LVOT area . intra-TEE LVOT VTI equals volume, the equation for the effective mitral valve area results as:

$$\text{EFFECTIVE MITRAL VALVE AREA =}$$
$$\text{3D LVOT vol / intra-TEE LVOT}$$

Then, the hypothetical effective mitral valve area (EMVA) would correspond to the "ideal" theoretical area that both methods evaluating MI area in this study should have to achieve a volume difference close to 0 between both tracts.

Left ventricular outflow tract and mitral inflow volumes

According to the validated formula for measuring volume in both tracts, the area (in cm^2) was multiplied by the velocity time integral, (VTI, in cm) measured on the spectral Doppler display of each tract using pulsed-wave Doppler. LVOT VTI and MI VTI were estimated in 2DTTE before performing TEE and in 2DTTE during TEE (under sedation), changing the TEE probe for the 2DTTE probe. In this way, the area and the VTI in each tract and with each method (2DTTE and 3DTEE) were obtained simultaneously and with the same hemodynamic variables. The VTI in each tract was estimated as the average of three measurements. Each LVOT and MI area obtained by 2D TTE (2DTT LVOT Ar, 2DTT MA Ar and TT LPLAV MA Ar) and by 3DTEE (3D LVOT Ar, 2D3DTEE Ar, MVQ Ar and 3DTEE Mu Ar) was multiplied by the VTI corresponding to each tract and to each method

Fig. 1. Mitral annulus area by MVQ (Mitral Valve Quantification) 3DTEE (3DTEE MVQ Ar). Upper Images:Final result of 18 points traced around the mitral annulus border in multiple planes. Left lower image: 2D mitral annulus reference plane. Right lower image: 3D reconstruction of the mitral annulus. Right margin: Mitral annulus areas and diameters. A2D corresponds to the mitral annulus area in the plane projection used in this study.
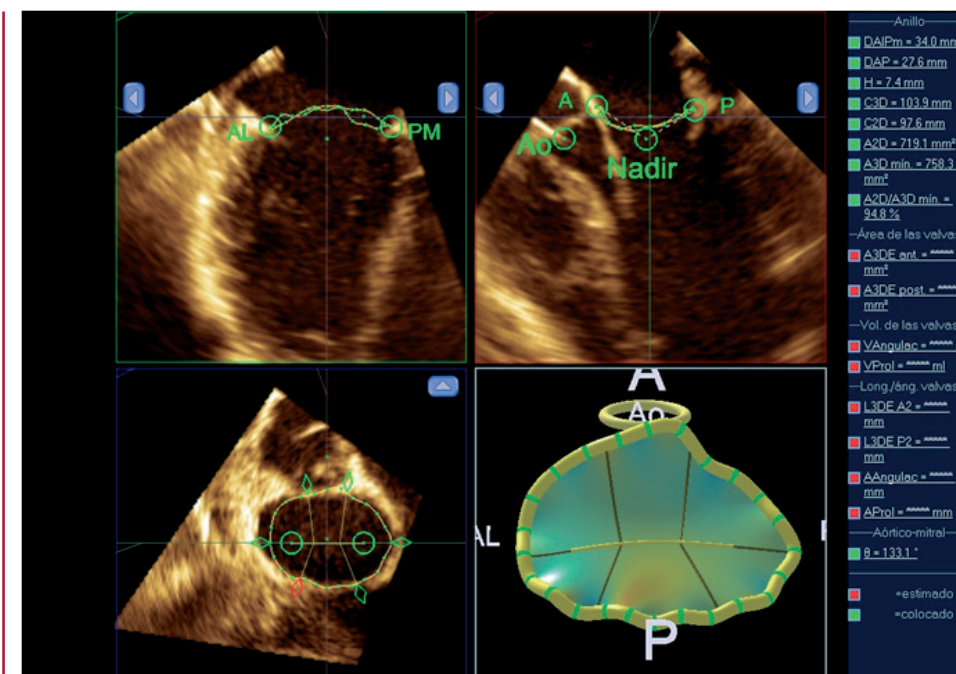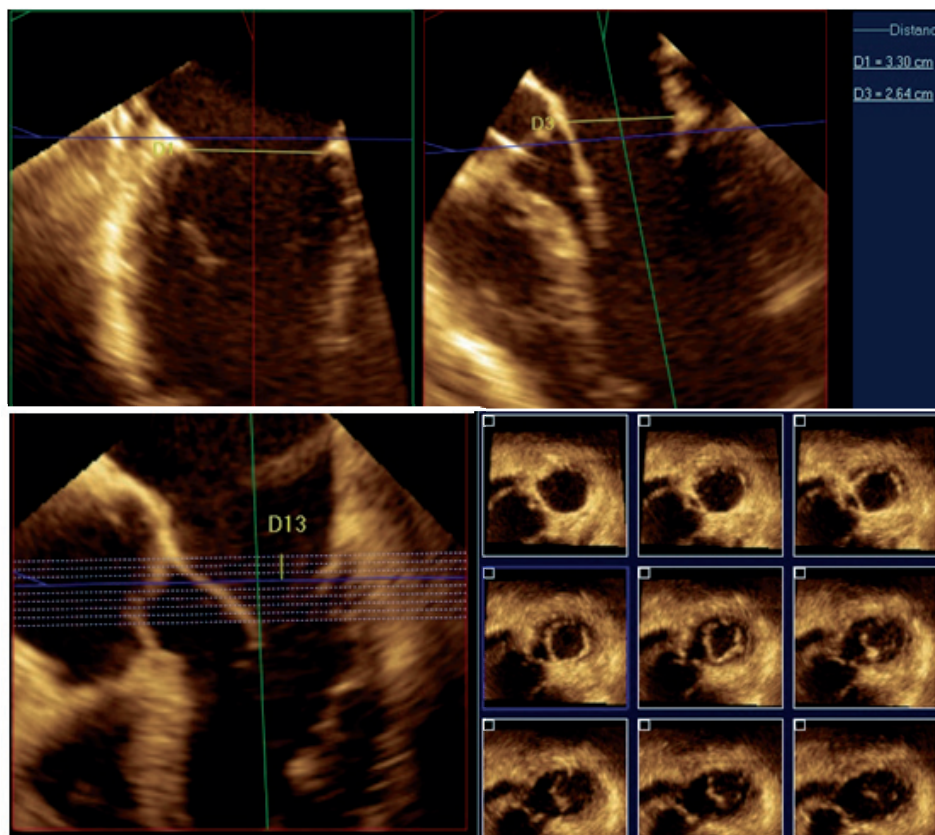
Fig. 2. Mitral inflow area obtained in diastole by 3DTEE Multiplanar Imaging. **A** and **B**.Mitral annulus area obtained from the intercommisural diameter in the 2-chamber view **(A)** and from the anteroposterior diameter in the 3-chamber view **(B)** (2D3D TEE Ar).**C** and **D**. Mitral orifice area distal to the mital annulus obtained with multislice processing (3DTEE Mu Ar). The transverse line shows the section level.

(2DTTE and 3DTEE). In this way, LVOT and MI volumes were obtained and were identified according to the way the area was estimated, in 2DTTE: 2DTT LVOT Vol, 2DTT MA Vol and TT LPLAV MA Vol; and in 3DTEE: 3D LVOT Vol, 2D3DTEE Vol, MVQ Vol and 3DTEE Mu Vol. The difference between LVOT volume and MI volume measured by 2DTTE and 3DTEE was then calculated.

Statistical analysis
Data are expressed as median (interquartile range) of the variables described. Spearman's (rs) correlation coefficient was used to analyze the correlation between variables according to the type of distribution. The Bland Altman plot method was used to estimate the concordance between compared variables.

RESULTS
Table 1 shows the medians of the variables obtained by 2DTTE and 3DTEE. A poor correlation was observed between the MA area by MVQ QLAB (MVQ Ar) versus the different ways of evaluating LVOT (2DTTE Ar, 2D3DTEE Ar and 3DTEE Mu Ar) (Table 2). The theoretical and hypothetical EMVA had the worst correlation with the MA area by MVQ (rs: 0.549, 95% CI -4.03 to 0.71). When the EMVA was compared with the other ways of measuring the LVOT (Table 3), an adequate correlation (rs: 0.982, 95% CI -0.26 to 0.42) was observed between the EMVA and the 3DTEE Mu Ar (as average in diastole) when it was estimated at 10.5 mm (8-12 mm) from the highest MA point.

Table 4 shows that the correlation between MI MVQ Vol (estimated from the most sophisticated measurement of the MA area) and the rest of the ways of measuring MI Vol (2DTT MA Vol, TT LPLAV MA Vol, 2D3DTEE Vol and 3DTEE Mu Vol) was very poor, particularly with any volume estimated by 2DTTE. The best correlation was obtained with the volume measured from the 2D3DTEE Ar (rs: 0.726, 95% CI -12.45 to 38.01).

The volumes found in each tract and according to each method (2DTTE and 3DTEE) is described in Table 1. The difference between MI volume and LVOT volume by 2DTTE was 12.8 ml (7.59-19.1) measured from the MA in apical 2-chamber and 3-chamber views and 15.7 ml (10.9-27.8) considering the LPLAV MA area. The difference between MI volume and LVOT volume by 3DTEE was 21.8 ml (14.5-27.8) from the 2D3D TEE Vol, 1.8 ml (1.25-3.6) from the 3DTEE Mu Vol and 32.8 ml (25.9-48) from the TEE MVQ Vol. The ideal difference, closest to 0 ml, was then found between the 2D3DTEE LVOT Vol and the 3DTEE Mu Vol (mitral orifice area at 10.5 mm distal to the annulus). And the difference farthest from 0 ml occurred when the LVOT volume was estimated considering the best measurement of the mitral annulus area, the MA MVQ Vol.

DISCUSSION
The estimation of regurgitant volume by 2DTTE is

Table 1. Variables estimated in 13 patients with structurally normal hearts

Variables obtained (2DTTEand 3DTEE)	Median	IQR (25-75)
2DTTE LVOT diameter, cm	2.02	1.86-2.05
pre-TEE 2DTTE LVOT VTI, cm	20	19.4-21.2
intra-TEE 2DTTE LVOT VTI, cm	20.4	18.8-21
2DTTE LVOT area, cm2	3.21	2.71-3.29
Average 3D LVOT area, cm2	3.29	2.84-3.48
2DTTE LVOT Vol, ml	62.4	57.8-65.3
3DTEE LVOT maximum systolic Vol, ml	72.6	65.7-75.2
Average 3DTEE LVOT systolic Vol, ml	61.3	56.2-67.8
2DTTE mitral VTI, cm	16.1	14.8-17.8
2DTTE apical 2-chamber view MA diameter, cm	2.6	2.12-2.74
2DTTE apical 3-chamber view MA diameter, cm	2.38	2.07-2.67
2DTTE LPLAV MA diameter, cm	2.7	2.51-2.92
2D3DTEE 2-chamber view MA diameter, cm	2.76	2.69-2.93
2D3DTEE 3-chamber view MA diameter, cm	2.65	2.48-2.76
2DTTE MA area, cm2	4.82	3.52-5.72
2DTTE LPLAV MA area, cm2	5.74	4.48-6.51
2D3DTEE MA area, cm2	5.86	5.38-6.44
Mitral area distal to MA (3DTEE Mu Ar in cm2)	4.05	3.61-4.94
Average diastolic MA MVQ area, cm2	6.72	6.44-7.07
Hypothetical effective mitral valve area, cm2	4.15	3.79-4.91
2DTTE apical 3 and 2-chamber view MI Vol, ml	72.7	67.3-80
2DTTE LPLAV MI Vol, ml	77.7	73-95.6
2D3DTEE MI Vol, ml	88.6	74.8-106.4
3DTEE MI Mu Vol, ml	59.6	53.1-68.5
Average diastolic MI MVQ Vol, ml	99.8	89.2-110.7

IQR: Interquartile range. For the rest of the abbreviations, please see the list at the beginning of the article.

Table 2. Correlation between the mitral annulus area by 3DTEE MVQ and the rest of the ways of quantifying the left ventricular outflow tract (2DTTE, 3DTEE and from the mitral orifice distal to the mitral annulus by multislice 3DTEE)

	Pearson's correlation coefficient (r)	Concordance Mean difference (Bland & Altman)	95% CI
MVQ Ar vs.2DTT MA Ar	0.506	1.973	-0.40 to 4.34
MVQ Ar vs.TT LPLAV MA Ar	0.439	1.392	-0.81 to 3.59
MVQ Ar vs.2D3DTEE Ar	0.573	0.847	-0.91 to 2.61
MVQ Ar vs.3DTEE Mu Ar	0.480	2.492	-4.26 to -0.71

CI: Confidence interval. For the rest of the abbreviations, please see the list at the beginning of the article.

Table 3. Correlation between the hypothetical effective mitral valve area and the rest of the ways of quantifyingmitral inflow (2DTTE, 3DTEE and fromthe mitral orifice distal to the mitral annulus by multislice 3DTEE)

	Pearson's correlation coefficient (r)	Concordance Mean difference (Bland & Altman)	95% CI
EMVA vs.MVQ Ar	0.549	2.413	-4.03 to -0.79
EMVA vs.2DTT MA Ar	0.688	0.44	-2.43 to 1.55
EMVA vs. TT LPLAV MA Ar	0.715	1.021	-2.67 to 0.63
EMVA vs.2D3DTEE Ar	0.692	1.566	-3.10 to -0.028
EMVA vs.3DTEE Mu Ar	0.982	0.079	-0.26 to 0.42

CI: Confidence interval. For the rest of the abbreviations, please see the list at the beginning of the article.

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MVQ Ar vs. 3DTEE Mu Ar	0.480	2.492	-4.26 to -0.71

Table 4. Correlation between mitral inflow volume based on mitral annulus area by 3DTEE MVQ vs.2DTTE Vol, 2D3DTEE Vol (based on the area estimated as average between the anteroposterior diameter and the intercommisural diameter) and 3DTEE Mu Vol (based on the mitral valve area distal to the mitral annulus)

CI: Confidence interval. For the rest of the abbreviations, please see the list at the beginning of the article.

a traditional and attractive way of evaluating mitral insufficiency, as the method quantifies regurgitation during the entire systole and does not use a single frame (as the methods based on proximal flow convergence: PISA and vena contracta). Recent studies have demonstrated that holosystolic mitral regurgitation is "more severe" and has worse outcome than when mitral regurgitation occurs in other moments of systole. (4) However, quantification of regurgitant volume by 2DTTE is not always predictable. Which are the weaknesses of 2DTTE that make the determination unreliable?

Apart from the traditional sources of error (as spectral waveform trace and improper probe position), the size of the MA and LVOT vary during the cycle and 2DTTE assumes that both tracts have a circular geometry. (5) Conversely, 3DTEE has demonstrated that LVOT morphology is variable and seldom circular. (6, 7)

Measuring the MA has been historically difficult independently of the method used due to its complex structure and morphology. It has been suggested that the mitral annulus is not a distinct entity and is described as an atrioventricular transitional area. (8) Assuming that the MA has a circular shape does not reflect the reality. (9) Should we use the area of this complex structure estimated by 2DTTE to measure MI volume?

To solve this issue, we included subjects with normal hearts in whom the volume difference between both tracts should be 0 ml and who simultaneously underwent 2DTTE and 3DTEE. 3DTEE is attractive as it does not make geometrical assumptions, does not have issues related with the acoustic window and has very sophisticated software (MVQ QLAB) to measure the MA, outlining up to 24 points around the border of the annulus. The MVQ software enables multiple calculations in the mitral valve apparatus. In our study, we used the area in projection plane (2DA) as MA reference area. Specifically, we obtained the average area of the MA in diastole and of the LVOT in systole. In this way, and as opposed to 2DTTE, we included all the changes in the area of each tract in each moment of the cycle. We also estimated the theoretical area the MI should have to achieve a difference of 0 ml between both tracts (EMVA), and we obtained it by simply dividing the LVOT volume predetermined as reference (3DTEE) by the intra-TEE mitral VTI.

As expected, the correlation between the MA area measured by the sophisticated 3DTEE MVQ method versus 2DTTE was very poor and it improved only slightly when it was compared versus the area measured by 2DTEE aligned from a 3D capture. Both calculations are based on diameters, assume circular-shaped annuli and measure diameters at different height of the annulus. Therefore, they do not reflect the MA geometry.

However, the analysis of this study shows two paradoxical responses. The first is that MI volume measured by the sophisticated method of estimating the MA area (MVQ (Vol) has the highest difference in ml (and the worst result) between both tracts. This finding suggests that the better the technique for measuring the mitral annulus, the greater the difference in volume between both tracts in normal hearts. This finding was confirmed by the fact that the MA area measured by 3D MVQ had the worst correlation with the ideal and hypothetical EMVA.

The average mitral orifice area measured in diastole at 10.5 mm (8-12 mm) from the highest point of the MA had an excellent correlation with the hypothetical EMVA, and the difference between the MI volume based on this area and the 3DTEE LVOT volume was very close to 0 ml. These findings suggest that the effective mitral orifice is not in the MA and that measurement of MI volume should not be based on the MA area.

The second paradoxical response was that, despite the MA area measured by 2DTTE was incorrect compared to 3DTEE, the difference in volume between both tracts measured by 2DTTE was not so imperfect. The better the technique for measuring the MA, the farther we are from the effective mitral orifice, and, conversely, we are closer to the effective mitral orifice as the measurement of the MA is less accurate. In the present study, 2DTTE underestimated MA area by 29% versus MVQ 3DTEE and, in turn, the area measured by MVQ 3DTEE overestimated the effective mitral orifice by 34%, an error that brings 2DTTE closer to the effective mitral orifice. Therefore, to consider the mitral annulus for calculating MI volume and to measure it inaccurately is a double error that is partially neutralized and may explain its current validity.

We have not found this type of study in the literature with normal hearts and 3DTEE. Measuring the MA for calculating MI volume has been questioned,

and a promising study using color 3DTEE for automated and simultaneous quantification of MI and LVOT volumes in a single beat has been recently published. (10) Also, some authors suggest replacing MA calculation for regurgitant volume by a hybrid 2D3DTTE (3D stroke volume minus 2DTTE LVOT Vol). (11, 12) This demonstrates that the attractive quantification of mitral regurgitation in the entire cycle and not in a single frame requires the development of new methods based on 3D echocardiography to measure MI volume in a more accurate and practical way.

Study limitations
When interpreting results, this study should be considered an initial attempt using sophisticated technology in a small number of patients. Mitral VTI was always taken at the level of the mitral annulus plane using 2DTTE in the 4-chamber view and could vary if it were measured at 1 cm of the MA highest distal point. The studies were performed by a single trained and experienced operator and, therefore, we cannot draw conclusions about inter-observer variability.

CONCLUSIONS
The better the technique for measuring the mitral annulus, the farther we are from the effective mitral orifice. Paradoxically, underestimating the MA size by 2DTTE reduces the difference versus the ideal EMVA. In turn, MA measurement by 3DTEE should not be used to calculate MI volume due to volume overestimation and, despite the paradoxical result, neither by 2DTTE due to methodological error. The mitral valve area measured at 1 cm of the highest point of the MA approximates the effective mitral orifice. These finding may explain the discrepancies and the lack of reliability of the volumetric method by 2DTTE to quantify the regurgitant volume in mitral insufficiency. Future research might determine the applicability of this concept to calculate the regurgitant volume in mitral insufficiency.

RESUMEN

¿Dónde está el orificio mitral efectivo? Divergencia entre el volumen del tracto de salida y el tracto de entrada del ventrículo izquierdo por ecocardiografía

Introducción
El cálculo del volumen regurgitante en la insuficiencia mitral por eco transtorácico 2D (ETT2D) es poco confiable y está relacionado con una medición inadecuada del anillo mitral (AM). El eco transesofágico 3D (ETE3D) posee mejores herramientas de medición del AM.

Objetivos
Comparar el área del AM y la diferencia de volumen del tracto de entrada y del tracto de salida del ventrículo izquierdo (TSVI y TEVI) por ETT2D y ETE3D en corazones normales. Evaluar en qué nivel del aparato mitral se encuentra el orificio mitral efectivo.

Material y métodos
Se incluyeron 13 pacientes consecutivos y prospectivos, de 42 (29-47) años, 7 de sexo femenino, con indicación de eco transesofágico (9 por búsqueda de fuente embolígena y 4 por síndrome febril), que tenían un ETT2D normal y se encontraban con ritmo sinusal y normotensos en el momento del estudio. Se les realizó simultáneamente ETT2D y ETE3D. El área del TSVI y del AM se midió por ETT2D y ETE3D. Se estimó por ETE3D el área de la válvula mitral (VM) distal al AM. El volumen de cada tracto se calculó como el producto del área por la integral velocidad-tiempo (VTI) del flujo. Se estableció una hipotética área mitral efectiva (AME) como el cociente entre el volumen del TSVI (ETE3D) y la VTI del TEVI.

Resultados
Correlación (rs), concordancia e IC 95% entre área del AM por ETT2D vs. ETE3D: 0,506, 1,97 (-0,40 a 4,34), AME vs. ETE3D 0,549, 2,41 (-4,03 a -0,79) y AME vs. VM a 11 mm (8-12) del AM: 0,982, 0,079 (-0,26 a 0,42). La diferencia de volumen (ml) entre ambos tractos fue: ETT2D 12,8 (7,5-19), ETE3D 32,8 (25,9-48) y ETE3D (desde VM distal al AM) 1,8 (1,25-3,6).

Conclusiones
Cuanto mejor medimos el anillo mitral, más lejos estamos del orificio mitral efectivo. El área mitral a 1 cm del punto más alto del anillo mitral es la que más se acerca al orificio mitral efectivo.

Palabras clave > Insuficiencia de válvula mitral
Ecocardiografía tridimensional

Conflicts of interest
None declared.

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