PISA is the best tool to define mitral regurgitation severity

David Messika-Zeitoun
1. Are quantitative methods > qualitative or semi-quantitative methods?

2. Among quantitative methods, which one is the best?
Semi-quantitative Measurements
Semi-quantitative assessment of MR severity

- Color flow Doppler
- Pulmonary venous flow
- Continuous wave Doppler of the mitral regurgitant jet
- Vena contracta
MR Quantification
Color Flow Doppler

4+: severe
3+: moderate to severe
2+: moderate
1+: mild
MR Quantification
Color Flow Doppler

- A gross estimation of MR degree
What is the degree of MR?
Color Flow Imaging Compared With Quantitative Doppler Assessment of Severity of Mitral Regurgitation: Influence of Eccentricity of Jet and Mechanism of Regurgitation

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Rochester, Minnesota

Objectives. To determine the influence of jet eccentricity and mechanism of mitral regurgitation, we examined 1) the relation between jet extent and severity of mitral regurgitation, and 2) the use of Doppler color flow imaging for quantitation of mitral regurgitation.

Background. Doppler color flow imaging is widely used to assess mitral regurgitation. However, whether, how and in which subgroups it can quantify regurgitation remain controversial.

Methods. In 80 patients with mitral regurgitation, results of color flow Doppler studies obtained in two orthogonal apical views were prospectively compared with quantitative Doppler measurement of the regurgitant volume and the regurgitant fraction. Comparisons were made according to the eccentricity of the jet (group 1 eccentric jets, n = 29; group 2 central jets, n = 51); group 2 was subdivided according to the mechanism of mitral regurgitation (group 2a organic, n = 27; group 2b ischemic or functional, n = 24).

Results. Globally, weak correlations were found between regurgitant volume and jet area (r = 0.57) and regurgitant fraction and jet area/left atrial area ratio (r = 0.65). Groups 1 and 2 showed a correlation between regurgitant volume and jet area (r = 0.68 and r = 0.65, respectively, p < 0.0001), but the slope was steeper in group 2 than in group 1 (0.22 vs. 0.06, p < 0.0001). The same jet area corresponded to more severe regurgitation in group 1 than in group 2 (jet ≥8 cm², regurgitant volume 113 ± 55 vs. 43 ± 21 ml, p < 0.0001). Similarly, for comparable regurgitant volumes (24 ± 22 vs. 29 ± 11 ml, p = NS), group 2a had a smaller jet area than did group 2b (5.3 ± 6 vs. 9.6 ± 6 cm², p < 0.02). Quantitation of regurgitation by Doppler color flow imaging was unreliable in group 1; in group 2b, the regression line between regurgitant fraction and jet area/left atrial area ratio was close to the identity line.

Conclusions. Mitral regurgitant jet eccentricity and mechanism influence jet extent. The same regurgitant volume produces smaller jet areas for eccentric compared with central jets and for central organic compared with ischemic or functional regurgitation. Quantitation of regurgitation using Doppler color flow imaging is possible in ischemic or functional regurgitation but inappropriate in eccentric jets, where quantitative Doppler study should be recommended.

(J Am Coll Cardiol 1993;21:1211-9)
Eccentric jets
Hemodynamic factors

Regurgitant Volume

Effective Regurgitant Orifice

Volume overload

Anatomic lesions
Determinants of regurgitant volume in mitral regurgitation: contrasting effect of similar effective regurgitant orifice area in functional and organic mitral regurgitation

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Background
Quantitative assessment of the severity of mitral regurgitation (MR) is based on the calculation of the effective regurgitant orifice (ERO), a measure of lesion severity, and of the regurgitant volume (RVol), a measure of left ventricular volume overload. We aimed at evaluating the determinants of RVol in both organic (OMR) and functional mitral regurgitation (FMR).

Methods and results
MR severity was quantitatively assessed using the proximal isovelocity surface area (PISA) method in 240 patients, 142 with OMR and 98 patients with FMR. By definition, ERO and RVol were strongly correlated both in patients with OMR and FMR (both R = 0.90, P < 0.0001) but the slopes of the regression lines were significantly different (P < 0.0001). This difference remained significant in patients with elevated systolic pulmonary artery pressure (SPAP > 40 mmHg, P < 0.0001) but not in patients with normal SPAP (≤40 mmHg, P = 0.09). In multivariate analysis, independent determinants of RVol were ERO (P < 0.0001), MR mechanism (FMR/OMR) (P = 0.0003) and SPAP (P = 0.03). In patients with elevated SPAP, ERO (P < 0.0001), left ventricular ejection fraction (LVEF) (P = 0.03), and MR mechanism (P = 0.03) were independently associated with RVol, whereas in patients with normal SPAP, ERO (P < 0.0001) was the only independent determinant of RVol.

Conclusion
In the present study, we evaluated the contrasting effect of similar lesion severity in OMR and FMR and showed that similar ERO were associated with lower RVol in FMR compared with OMR. The regurgitant volume is the result of complex interactions of anatomic lesions, LVEF, and SPAP and our results highlight the importance of taking into account these parameters when interpreting RVol values in clinical practice, especially in FMR.

Keywords
Mitral regurgitation • Echocardiography • Quantification • PISA
European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspid regurgitation (native valve disease)

The colour flow area of the regurgitant jet is not recommended to quantify the severity of MR. The colour flow imaging should only be used for diagnosing MR.
MR Quantification
Pulmonary Venous Flow

Highly specific but poorly sensitive
MR Quantification
Vena Contracta

Vena contracta
Regurgitant jet
Flow convergence

3 mm
Mild MR
Gray zone
Severe MR
7 mm

Gray zone
MR Quantification
Vena Contracta

- Not always easy
- Not always feasible
- Multiple jets
- Grey zone
We Need Quantitative Measurements
Quantitative Methods

1. PISA

2. Quantitative Doppler

3. Left ventricular volumes
# Grade of MR Severity

<table>
<thead>
<tr>
<th></th>
<th>Organic MR</th>
<th>Functional MR</th>
<th>AR</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regurgitant Volume, ml</strong></td>
<td>≥ 60</td>
<td>≥ 30</td>
<td>≥ 60</td>
<td>≥ 45</td>
</tr>
<tr>
<td><strong>Effective regurgitant orifice, cm²</strong></td>
<td>≥ 0.40</td>
<td>≥ 0.20</td>
<td>≥ 0.30</td>
<td>≥ 0.40</td>
</tr>
</tbody>
</table>
Quantitative Determinants of the Outcome of Asymptomatic Mitral Regurgitation

Maurice Enriquez-Sarano, M.D., Jean-François Avierinos, M.D., David Messika-Zeitoun, M.D., Delphine Detaint, M.D., Maryann Capps, R.D.C.S., Vuyisile Nkomo, M.D., Christopher Scott, M.S., Hartzell V. Schaff, M.D., and A. Jamil Tajik, M.D.

**Graph:**
- **Death from Cardiac Causes (%)** vs. **Rate of Cardiac Events (%)**
- **Years** from 0 to 5
- **ER0 ≥40 mm² (62±8%)**
- **ER0 20–39 mm² (40±7%)**
- **ER0 <20 mm² (15±4%)**
- **P<0.01**

In those with at least 40 mm² of regurgitation, prompt referral should be considered for cardiac surgery.
Regurgitant volume was less strongly predictive of survival after adjustment for age and the presence or absence of diabetes (P=0.04) and even less so after adjustment for age, sex, the presence or absence of diabetes and atrial fibrillation, and the ejection fraction (P=0.06). The qualitative grade of mitral regurgitation, jet area, and ratio of the jet to the left atrial area were predictive of survival on univariate analysis (all P≤0.05) but not on multivariate analysis (all P>0.30). Furthermore, nested models showed that quantitative classification based
Ischemic Mitral Regurgitation
Long-Term Outcome and Prognostic Implications With Quantitative Doppler Assessment

Galen et al. [23] found that the degree of mitral reflux was the best predictor of survival among the MR patients. In particular, the risk of death was increased in patients with moderate and severe MR, with the highest risk in those with severe MR (ER > 20 mmHg). The Kaplan-Meier survival curves indicated that patients with severe MR had a significantly lower survival rate compared to those with mild or moderate MR. This study highlights the importance of quantifying mitral regurgitation severity for risk stratification and clinical decision making in the chronic post-MI phase. (Circulation. 2001;103:1759-1764.)
Prognostic Importance of Exercise-Induced Changes in Mitral Regurgitation in Patients With Chronic Ischemic Left Ventricular Dysfunction

Patrizio Lancellotti, MD; Pierre Troisfontaines, MD; Anne-Christine Toussaint, MD; Luc A. Pierard, MD, FESC

Background—In the post-myocardial infarction phase, mortality risk is related to the severity of mitral regurgitation (MR), but the precise role of exercise-induced changes in MR remains uncertain. We aimed to evaluate the impact of exercise-induced changes in MR on mortality.

Multivariate Predictors of Mortality

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\chi^2$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERO difference $\geq 13 \text{ mm}^2$</td>
<td>8.1</td>
<td>0.0045</td>
</tr>
<tr>
<td>ERO $\geq 20 \text{ mm}^2$</td>
<td>6.0</td>
<td>0.01</td>
</tr>
<tr>
<td>Mitral deceleration time</td>
<td>3.9</td>
<td>0.044</td>
</tr>
</tbody>
</table>

Conclusions—In patients with ischemic MR and left ventricular dysfunction, quantitative assessment of exercise-induced changes in the degree of MR provides independent prognostic information. Significant exercise-induced increases in MR unmask patients at high risk of poor outcome. [(Circulation. 2003;108:1713-1717.)]
Quantitative measurements are superior to semi-quantitative measurements.
Which Quantitative Method?
Conservation of mass

Flow 2 = Flow 1

Flux 2 = ERO X Max MR velocity
**PISA**
Proximal Isovelocity Surface Area

\[
\text{ERO} = \frac{2\pi \times (R^2) \times Va}{\text{Peak velocity}}
\]

\[
\text{RVOL} = \text{ERO} \times \text{MR}_{TVI}
\]
Advantages of the PISA

- Relatively simple and fast
- Few parameters
- High feasibility
- Good reproducibility
- Not affected by other valve leak
Reproducibility of Proximal Isovelocity Surface Area, Vena Contracta, and Regurgitant Jet Area for Assessment of Mitral Regurgitation Severity

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Tel Aviv, Israel; and Los Angeles, California

OBJECTIVES The aim of this study was to evaluate the interobserver agreement of proximal isovelocity surface area (PISA) and vena contracta (VC) for differentiating severe from nonsevere mitral regurgitation (MR).

BACKGROUND Recommendation for MR evaluation stresses the importance of VC width and effective regurgitant orifice area by PISA measurements. Reliable and accurate assessment of MR is important for clinical decision making regarding corrective surgery. We hypothesize that color Doppler-based quantitative measurements for classifying MR as severe versus nonsevere may be particularly susceptible to interobserver agreement.

METHODS The PISA and VC measurements of 16 patients with MR were interpreted by 18 echocardiologists from 11 academic institutions. In addition, we obtained quantitative assessment of MR based on color flow Doppler jet area.

RESULTS The overall interobserver agreement for grading MR as severe or nonsevere using qualitative and quantitative parameters was similar and suboptimal: 0.32 (95% confidence interval [CI]: 0.1 to 0.52) for jet area–based MR grade, 0.28 (95% CI: 0.11 to 0.45) for VC measurements, and 0.37 (95% CI: 0.16 to 0.58) for PISA measurements. Significant univariate predictors of substantial interobserver agreement for: 1) jet area–based MR grade was functional etiology (p = 0.039); 2) VC was central MR (p = 0.013) and identifiable effective regurgitant orifice (p = 0.049); and 3) PISA was presence of a central MR jet (p = 0.003), fixed proximal flow convergence (p = 0.025), and functional etiology (p = 0.049). Significant multivariate predictors of raw interobserver agreement ≥80% included: 1) for VC, identifiable effective regurgitant orifice (p = 0.035); and 2) for PISA, central regurgitant jet (p = 0.02).

CONCLUSIONS The VC and PISA measurements for distinction of severe versus nonsevere MR are only modestly reliable and associated with suboptimal interobserver agreement. The presence of an identifiable effective regurgitant orifice improves reproducibility of VC and a central regurgitant jet predicts substantial agreement among multiple observers of PISA assessment. (J Am Coll Cardiol Img 2010;3:235–43) © 2010 by the American College of Cardiology Foundation
Poor Acquisitions

No zoom

Flat flow convergence
The PISA requires meticulous attention to technical details.

1. Image acquisition
The PISA requires meticulous attention to technical details

1. Image acquisition
2. Measurements
Dynamic regurgitant orifice area in IMR

Isovelocity shell defined by velocity=V

M-mode cursor

ERO

Transmitral gradient (LV-LA pressure)

HUNG JACC 1998; 33: 538-45
Changes in Effective Regurgitant Orifice Throughout Systole in Patients With Mitral Valve Prolapse

A Clinical Study Using the Proximal Isovelocity Surface Area Method

Background

Neous changes are not well assessed for changes in systole assessing.

Method

With mitral orifice without late, and velocity to assess. Through significant midsystole and late systole from early and quantitate the approach compare echocardiographic and dimensional echo...

when the $P<.0001$, was used when a $\leq 33 \text{ mm}^2$; calculation was calculated at $\text{m}^2$; $P=.29$

... are obtained effective regurgitant volume in late and the overall measurements a method of regurgitant volume...
Measurements at maximum regurgitant velocity
The PISA requires meticulous attention to technical details.

1. Image acquisition
2. Measurements

Reproducibility 4% in experienced hands
European Association of Echocardiography recommendations for the assessment of valvular regurgitation. Part 2: mitral and tricuspid regurgitation (native valve disease)

When feasible, the PISA method is highly recommended to quantitate the severity of MR. It can be used in both central and eccentric jets. An EROA ≥
Does it mean that PISA has no limitation?
Hemispheric Asumption

V = 20 cm/sec
V = 50 cm/sec
V = 100 cm/sec
Geometry of the proximal isovelocity surface area in mitral regurgitation by 3-dimensional color Doppler echocardiography: Difference between functional mitral regurgitation and prolapse regurgitation

Yoshiki Matsumura, MD, Shota Fukuda, MD, Hung Tran, RDCS, Neil L. Greenberg, PhD, Deborah A. Agler, RDCS, Nozomi Wada, MD, Manatomo Toyono, MD, James D. Thomas, MD, and Takahiro Shiota, MD Cleveland, OH

Background

which the geometry of PISA was measured with color Doppler echocardiography.

Methods

lengths of the ERO area were calculated.

Results

coaptation length was estimated the ERO area by 2D quantitative Doppler method (by 24%) in functional MR, but not in MVP.

Conclusions The geometry of PISA in functional MR was elongated, distinctly different from the more focal pathology of MVP, leading to underestimation of the ERO area by PISA method. (Am Heart J 2008;155:231-8.)
Distorted and constrained flow convergence zone by the lateral myocardial wall
Mid-Late Mitral regurgitation
Yes the PISA has limitations
But do we have a better method?
Quantitative Doppler

Regurgitant Volume

$$= \text{Mitral SV} - \text{Ao SV}$$

$\times$ Mitral TVI

Mitral (annulus)
Quantitative Doppler

Regurgitant Volume = Mitral - Aortique SV

- Mitral annulus
- LVOT diameter
- Mitral TVI
- LVOT TVI
■ End-diastolic and End-systolic volumes are calculated according to the Simpson’s biplane

■ \[ \text{EDV} - \text{ESV} = \text{Ao SV} + \text{RVol} \]
Left Ventricular Volumes
Simpsons’ Biplane
Contrast Echocardiography Improves the Accuracy and Reproducibility of Left Ventricular Remodeling Measurements

A Prospective,Randomly Assigned,Blinded Study

Helen L. Thomson, MD, PhD,* Arsene-Joseph Basmadjian, MD,* Andrew J. Rainbird, MD,* Mehdi Razavi, MD,* Jean-Francois Avierinos, MD,* Patricia A. Pellikka, MD, FACC,* Kent R. Bailey, PhD,† Jerome F. Breen, MD,* Maurice Enriquez-Sarano, MD, FACC*

*Rochester, Minnesota

OBJECTIVES

We sought to assess the impact of contrast injection and harmonic imaging, on the measure by echocardiography of left ventricular (LV) remodeling.

Table 1. Echocardiographic Assessment of Left Ventricular Volumes: Comparison With EBCT

<table>
<thead>
<tr>
<th></th>
<th>EDV (ml)</th>
<th>ESV (ml)</th>
<th>SV (ml)</th>
</tr>
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<tbody>
<tr>
<td>EBCT</td>
<td>195 ± 55</td>
<td>58 ± 24</td>
<td>137 ± 35</td>
</tr>
<tr>
<td>Echocardiography without contrast injection</td>
<td>119 ± 34</td>
<td>40 ± 16</td>
<td>79 ± 24</td>
</tr>
<tr>
<td>p value vs. EBCT</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
<td>&lt; 0.0001</td>
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</tbody>
</table>

Table 2. Intraobserver and Interobserver Variabilities

<table>
<thead>
<tr>
<th></th>
<th>EDV Abs.*</th>
<th>EDV %†</th>
<th>ESV Abs.*</th>
<th>ESV %†</th>
<th>SV Abs.*</th>
<th>SV %†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraobserver variability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echocardiography without contrast injection</td>
<td>15</td>
<td>9</td>
<td>13</td>
<td>14</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Echocardiography with contrast injection</td>
<td>10</td>
<td>7</td>
<td>7</td>
<td>13</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>p Value</td>
<td>0.004</td>
<td>0.05</td>
<td>0.0004</td>
<td>0.64</td>
<td>0.007</td>
<td>0.001</td>
</tr>
<tr>
<td>Interobserver variability</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Echocardiography without contrast injection</td>
<td>22</td>
<td>13</td>
<td>14</td>
<td>17</td>
<td>22</td>
<td>28</td>
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<tr>
<td>Echocardiography with contrast injection</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>15</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>p Value</td>
<td>0.001</td>
<td>0.01</td>
<td>0.0001</td>
<td>0.33</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
CONCLUSIONS  The RT3DE-derived LV volumes are underestimated in most patients because RT3DE imaging cannot differentiate between the myocardium and trabeculae. To minimize this difference, tracing the endocardium to include trabeculae in the LV cavity is recommended. With the understanding of these intermodality differences, RT3DE quantification of LV volume is a reliable tool that provides clinically useful information. (J Am Coll Cardiol Imag 2008;1:413–23) © 2008 by the American College of Cardiology Foundation
Diagnostic Value of Vena Contracta Area in the Quantification of Mitral Regurgitation Severity by Color Doppler 3D Echocardiography

Xin Zeng, MD, PhD; Robert A. Levine, MD; Lanqi Hua, RDCS; Eleanor L. Morris, RDCS; Yuejian Kang, RDCS; Mary Flaherty, RDCS; Nina V. Morgan, RDCS; Judy Hung, MD

Background—Accurate quantification of mitral regurgitation (MR) is important for patient treatment and prognosis. Three-dimensional echocardiography allows for the direct measure of the regurgitant orifice area (ROA) by 3D-guided planimetry of the vena contracta area (VCA). We aimed to (1) establish 3D VCA ranges and cutoff values for MR grading, using the American Society of Echocardiography–recommended 2D integrative method as a reference, and (2) compare 2D and 3D methods of ROA to establish a common calibration for MR grading.

Methods and Results—Eighty-three patients with at least mild MR underwent 2D and 3D echocardiography. Direct planimetry of VCA was performed by 3D echocardiography. Two-dimensional quantification of MR included 2D ROA by proximal isovelocity surface area (PISA) method, vena contracta width, and ratio of jet area to left atrial area. There were significant differences in 3D VCA among patients with different MR grades. As assessed by receiver operating characteristic analysis, 3D VCA at a best cutoff value of 0.41 cm² yielded 97% of sensitivity and 82% of specificity to differentiate moderate from severe MR. There was significant difference between 2D ROA and 3D VCA in patients with functional MR, resulting in an underestimation of ROA by 2D PISA method by 27% as compared with 3D VCA. Multivariable regression analysis showed functional MR as etiology was the only predictor of underestimation of ROA by the 2D PISA method.

Conclusions—Three-dimensional VCA provides a single, directly visualized, and reliable measurement of ROA, which classifies MR severity comparable to current clinical practice using the American Society of Echocardiography–recommended 2D integrative method. The 3D VCA method improves accuracy of MR grading compared with the 2D PISA method by eliminating geometric and flow assumptions, allowing for uniform clinical grading cutoffs and ranges that apply regardless of etiology and orifice shape. (Circ Cardiovasc Imaging. 2011;4:506-513.)
Two-Dimensional Integrative Method
The 2D integrative method recommended by the ASE as follows was used as the reference standard for MR grading because this method does not rely on only 1 color Doppler method and is used widely in clinical laboratories. To categorize MR within a certain grade, at least 2 of 3 color Doppler methods listed above were assessed within the same grade with at least 1 supportive data (pulmonary vein flow; mitral inflow; density of continuous wave Doppler MR jet; left atrial enlargement). The integrative grading and 3D VCA measurement were done independently, and the results were blinded to each other.

+ lower temporal and spatial resolution
+ ERO is dynamic so when?
A three-dimensional insight into the complexity of flow convergence in mitral regurgitation: adjunctive benefit of anatomic regurgitant orifice area

Sonal Chandra,1 Ivan S. Salgo,2 Lissa Sugeng,1 Lynn Weinert,1 Scott H. Settlemier,2 Victor Mor-Avi,1 and Roberto M. Lang1

1University of Chicago Medical Center, Chicago, Illinois; and 2Philips Healthcare, Andover, Massachusetts

Submitted 18 March 2011; accepted in final form 6 June 2011

Chandra S, Salgo IS, Sugeng L, Weinert L, Settlemier SH, Mor-Avi V, Lang RM. A three-dimensional insight into the complexity of flow convergence in mitral regurgitation: adjunctive benefit of anatomic regurgitant orifice area. Am J Physiol Heart Circ Physiol 301: H1015–H1024, 2011. First published June 17, 2011; doi:10.1152/ajpheart.00275.2011.—Mitr al effective regurgitant orifice area (EROA) using the flow convergence (FC) method is used to quantify the severity of mitral regurgitation (MR). However, it is challenging and prone to interobserver variability in complex valvular pathology. We hypothesized that real-time three-dimensional (3D) transesophageal echocardiography (RT3D TEE) derived anatomic regurgitant orifice area (AROA) can be a reasonable adjunct, irrespective of valvular geometry. Our goals were to (1) determine the regurgitant orifice morphology and distance suitable for FC measurement using 3D computational flow dynamics and finite element analysis (FEA), and (2) to measure AROA from RT3D TEE and compare it with 2D FC derived EROA measurements. We studied 61 patients. EROA was calculated from 2D TEE images using the 2D-FC technique, and AROA was obtained from zoomed RT3D DE TEE acquisitions using prototype software. 3D computational fluid dynamics by FEA were applied to 3D TEE images to determine the effects of mitral valve (MV) orifice geometry on FC pattern. 3D FEA analysis revealed that a central regurgitant orifice is suitable for FC measurements at an optimal distance from the orifice but complex MV orifice resulting in eccentric jets yielded nonaxisymmetric isovelocity contours close to the orifice where the assumptions underlying FC are problematic. EROA and AROA measurements correlated well ($r = 0.81$) with a nonsignificant bias. However, in patients with eccentric MR, the bias was larger than in central MR. Intermeasurement variability was higher for the 2D FC technique than for RT3D-DE-based measurements. With its superior reproducibility, 3D analysis of the AROA is a useful alternative to quantify MR when 2D FC measurements are challenging.
In 2011, a quantitative assessment of MR degree is mandatory.

The PISA method is the simplest, fastest and probably the most reproducible. THE BEST WE HAVE.

However, the PISA method has limitations and pitfalls and MR severity should be based on an integrative approach:

- Quantitative measurements PISA +++
- Semi-quantitative measurements
- Mechanism
- Left atrial and left ventricular remodeling, SPAP
Thank You