Three-Dimensional Color Doppler Echocardiography Versus Two-Dimensional Derived Method in the Quantification of Tricuspid Regurgitation Orifice Area

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Background

Quantification of tricuspid regurgitation (TR) is rarely performed in clinical practice due to time constraints and difficulty in obtaining measurements. The utility and feasibility of directly measured anatomic orifice area (AROA) by three-dimensional (3D) transthoracic color Doppler echocardiography as well as its correlation with conventional two-dimensional (2D) measures of TR remain incompletely understood.

Methods

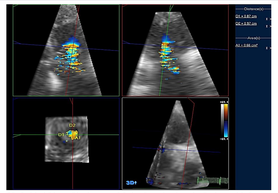
Patients: 92 patients with > mild TR (without multiple TR jets) prospectively underwent 2D and 3D transthoracic echocardiography. Patients with atrial fibrillation (AF) were excluded if the ventricular rate was uncontrolled or if there was significant variation in cardiac cycle length.

Measurements: 2D quantification included TR jet area/right atrial (RA) area ratio, vena contracta width (VC), and effective regurgitant orifice area (EROA) using the flow convergence method. Full-volume breathhold 3D color datasets of TR were obtained using a real-time 3D echocardiography system (iE33; Philips Medical Systems, Bothell,WA) with a 1 to 5-MHz 3040-element X5-1 transthoracic transducer. AROA was directly quantified from the 3D full-volume datasets by 3D guided 2D direct planimetry (multiplanar measurement) of the TR color jet AROA using custom software package (QLAB7, Philips Medical Systems, Bothell,WA) **[Figure 1]**. Five measurements were averaged in patients with AF. Blinded comparisons of EROA and AROA were made. Subgroup analysis included presence of a pacemaker (PPM), eccentricity of TR jet direction, ellipticity of AROA, underlying mechanism of TR and baseline rhythm.

Disclose

No relevant financial relationship(s) for any of the authors.

Figure 1



3D-Guided Direct Planimetry of Color Doppler Jet of a Patient with Severe TR

Results

Baseline Characteristics: 42 men and 50 women were enrolled (mean age of 71.3+/-14.8 years). Twenty patients with AF were included, 29 patients with PPM and 20 patients with eccentric TR jets **[Table 1]**.

Table 1

	All Patients, n=92		All Patients, n=92
Age (years)	71.3 ± 14.8	RV pressure gradient (mmHg)	48.4 ± 16.1
Male	42 (46)	TAPSE (cm)	1.9 ± 0.8
AF rhythm	20 (21.7)	Severity of TR	
Pacemaker	29 (31.5)	Mild	18(19.5)
Eccentric	20 (21.7)	Moderate	18(19.5)
Heart rate (bpm)	68.6 ± 12.4	Severe	56(60.9)
Systolic BP (mmHg)	117.5 ±19.1	JA/RAA ratio	0.4 ± 0.1
Diastolic BP (mmHg)	67.1 ± 1.0	TR peak velocity (cm/s)	308.4 ± 54.2
LV EF(%)	56.6 ± 13.9	VCW	0.6 ± 0.2
LA Volume Index	52.7 ± 22.6	PISA radius (cm)	0.7 ± 0.22
Cardiac Output Index	2.9 ± 0.78	Elliptical AROA	53 (57.6)

Results

Comparisons of AROA and EROA: AROA was similar to EROA and correlated well with EROA **[Figure2]**. AROA moderately correlated to 2D VC width and was weakly correlated to 2D TR jet area/RA area ratio **[Figure 3]**.

Figure 2

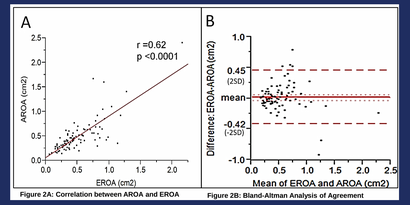


Figure 2A: Correlation between AROA and EROA

Figure 2B: Bland-Altman Analysis of Agreement

Figure 3

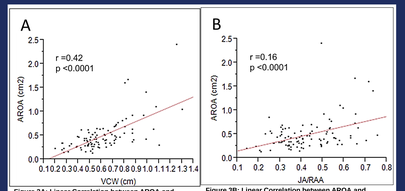


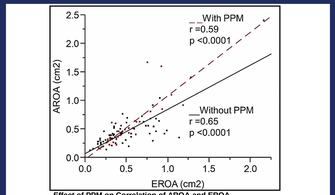
Figure 3A: Linear Correlation between AROA and VCW

Figure 3B: Linear Correlation between AROA and JA/RAA

Results

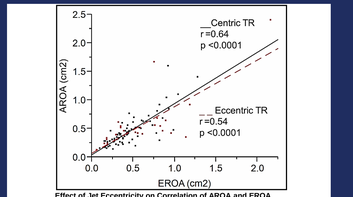
Subgroup Analysis: The correlation of AROA with EROA was better for patients without pacemaker (n=63) than with pacemaker (n=29) **[Figure 4]**, better for central (n=72) than eccentric TR (n=20) **[Figure5]**, better for circular AROA (n=39) than elliptical AROA (n=53) **[Figure 6]**, better for organic (n=18) than functional TR (n=74) **[Figure 7]** and better for regular rhythm (n=72) than AF (n=20) **[Figure 8]**.

Figure 4



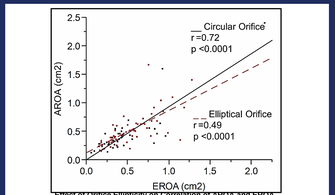
Effect of PPM on Correlation of AROA and EROA

Figure 5



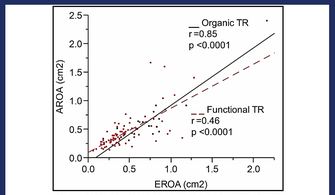
Effect of Jet Eccentricity on Correlation of AROA and EROA

Figure 6



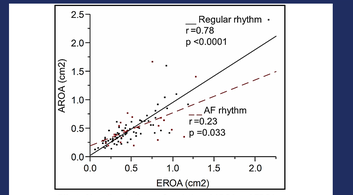
Effect of Orifice Ellipticity on Correlation of AROA and EROA

Figure 7



Effect of Underlying Mechanism on Correlation of AROA and EROA

Figure 8



Effect of baseline rhythm on Correlation of AROA and EROA

Conclusions

- Direct measurement of AROA from 3D color Doppler echocardiography is feasible and obtainable in the majority of patients but not performed well in AF patients.
- Direct measurement of AROA from 3D transthoracic color Doppler echocardiography correlates well with 2D EROA derived from the flow convergence method.
- Although direct measurement of AROA from 3D transthoracic color Doppler echocardiography correlates with 2D TR jet area/RA area ratio and VC width, the correlation was not as strong.
- Direct planimetry of 3D color jet AROA shows promise as an alternative for quantification of TR.