SCIENTIFIC LETTER

Evaluation of rheumatic tricuspid valve stenosis by real-time three-dimensional echocardiography

Ashraf M Anwar, Marcel L Geleijnse, Osama I I Soliman, Jackie S McGhie, Attila Nemes, Folkert J ten Cate

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Rheumatic heart disease causes tricuspid valve stenosis in up to 8% of patients.¹ Unfortunately, tricuspid valve stenosis is easily missed at clinical examination except in advanced cases when a high degree of clinical suspicion exists.² Undetected and thus uncorrected tricuspid valve stenosis may lead to postoperative low cardiac output despite successful relief of left-sided valve disease and carries a high mortality and morbidity.³ Two-dimensional echocardiography (2DE) can detect thickened tricuspid valve leaflets and a reduced tricuspid valve orifice diameter, and continuous-wave Doppler allows estimation of the tricuspid transvalvular pressure gradient.⁴ However, in most patients, it is not possible to visualise all three tricuspid valve leaflets simultaneously with 2DE.⁵ Transthoracic real-time three-dimensional echocardiography (RT3DE) may be a valuable imaging modality for the examination of stenotic tricuspid valves because all leaflets can be seen simultaneously and studied from both atrial and ventricular aspects. This study aimed to apply RT3DE for tricuspid valve assessment in patients with rheumatic tricuspid valve stenosis.

PATIENTS AND METHODS

Five patients (mean (SD) age 33 (7) years, four men) with an established diagnosis of rheumatic tricuspid valve disease were examined by 2DE (Philips Sonos 7500 with S3 probe, Best, The Netherlands) and RT3DE (same system with X4 probe). These patients were compared with eight patients (mean (SD) age 35 (4) years, five men) with rheumatic heart disease without relevant tricuspid valve involvement and 13 controls (mean (SD) age 31 (6) years, eight men) without rheumatic heart disease. With 2DE, the tricuspid valve was assessed from the apical four-chamber and parasternal short-axis views. 2DE data obtained were: (1) tricuspid valve leaflet separation (TV-LS_{2D}) defined as the distance between the tricuspid valve tips at the maximal opening obtained from an apical four-chamber (TV-LS_{2D-AP4CH}) and parasternal short-axis window (TV-LS_{2D-PSAX}); (2) tricuspid annular diameter (TAD_{2D}) obtained from an apical four-chamber (TAD_{2D-AP4CH}) and parasternal short-axis (TAD_{2D-PSAX}) view at an end-diastolic still-frame; and (3) descriptive morphology of the tricuspid valve leaflets including thickness, mobility and calcification. Each descriptor was graded as mild when less than one whole tricuspid valve leaflet was involved, moderate when a one or two whole tricuspid valve leaflets were involved, and severe when all three tricuspid valve leaflets were involved.

The apical-recorded full volume three-dimensional dataset was analysed with TomTec software (Unterschleissheim, Munich, Germany). RT3DE data obtained were: (1) TAD_{3D} defined as the widest TAD that could be measured from an end-diastolic still frame; (2) maximal tricuspid annulus area (TAA_{3D}) obtained from an end-diastolic still frame and measured by manual planimetry; (3) tricuspid valve area (TVA_{3D}) defined as the narrowest part of the tricuspid valve

at the time of maximal tricuspid valve opening and measured by manual planimetry; (4) descriptive tricuspid valve morphology as described before in the 2DE section, but now separately scored for each tricuspid valve leaflet; and (5) commissural width for each tricuspid valve commissure (anteroseptal, anteroposterior and posteroseptal), obtained from an end-diastolic still frame.

RESULTS

TV-LS_{2D-AP4CH} and TV-LS_{2D-PSAX} were well correlated ($r = 0.89$, <0.05) with comparable mean (SD) values for TV-LS_{2D-AP4CH} and TV-LS_{2D-PSAX} (11.8 (2.6) vs 11.8 (3.4) mm, respectively). As table 1 shows, mean TV-LS_{2D} values were not significantly different in the three studied groups.

Acquisition and post-processing of RT3DE data were successfully performed in all patients. TAD_{3D} was larger than TAD_{2D} in all patients with tricuspid valve stenosis, regardless of the 2DE view used (mean values were 46 mm for TAD_{3D}, 38 mm for TAD_{2D-AP4CH} and 35 mm for TAD_{2D-PSAX}). Mean (SD) TVA_{3D} in the patients with significant tricuspid valve stenosis was 216 (61) mm², which correlated well with mean TV-LS_{2D} ($r = 0.95$, $p < 0.01$). Owing to the small number of patients, TVA_{3D} was not significantly related to the transtricuspid mean pressure gradient ($r = -0.76$).

RT3DE and morphological description (including thickness, mobility, calcification and position) were possible for each separate tricuspid valve leaflet. The grade of tricuspid valve leaflet affection scored with 2DE and RT3DE were similar in terms of thickness, mobility and calcification. However, RT3DE could also assess individual tricuspid valve leaflet position (relative to other tricuspid valve leaflets) and the extent of tricuspid valve affection. In addition, all three commissures could be adequately evaluated with RT3DE, including assessment of commissural width during maximal tricuspid valve opening. As seen in table 1, patients with tricuspid valve stenosis had significantly smaller commissural width.

DISCUSSION

Rheumatic tricuspid valve inflammation causes scarring and fibrosis of tricuspid valve leaflets with fusion of its commissures, resulting in tricuspid valve stenosis. Estimation of the transtricuspid pressure gradient is usually only performed when a morphologically abnormal tricuspid valve is seen. Therefore, good morphological imaging and description of the tricuspid valve are essential in identifying tricuspid valve stenosis. With RT3DE, each separate tricuspid valve leaflet can be assessed with regard to thickness, mobility, calcification

Abbreviations: 2DE, two-dimensional echocardiography; RT3DE, real-time three-dimensional echocardiography; TAD, tricuspid annular diameter; TVA, tricuspid valve area; TV-LS, tricuspid valve leaflet separation

Table 1 Comparison of patients with rheumatic heart disease with tricuspid valve stenosis, without tricuspid valve stenosis, and controls

	Rheumatic HD TV with stenosis (n = 5)	Rheumatic HD TV without stenosis (n = 8)	Controls (n = 13)
Male sex, n (%)	4 (80)	5 (63)	8 (62)
Age (years)	33 (7)	35 (4)	31 (6)
TV-LS _{2D} (mm)	11.8 (2.9)	12 (4.8)	15 (3.3)
TVA _{3D} (mm ²)	216 (61)*	381 (92)	518 (207)
3D commissural width (mm)	2.6 (0.2)*	4.1 (0.5)	5.9 (1.6)

2D, two dimensional; 3D, three dimensional; HD, heart disease; LS, leaflet separation; TV, tricuspid valve; TVA, tricuspid valve area.

Values are represented as mean (SD) unless otherwise specified.

*p<0.005 versus patients with rheumatic HD without significant TV involvement and p<0.001 versus controls.

and its relationship to other tricuspid valve leaflets. In addition, RT3DE provides unique tricuspid valve measurements such as TVA_{3D} and commissural width at the time of maximal tricuspid valve opening. This distance between the tricuspid valve commissures during diastole may be a new indicator of tricuspid valve stenosis severity. Although the tricuspid valve leaflets can sometimes be visualised simultaneously by 2DE from an angulated subcostal view, measurement of TVA is only rarely possible because even when all leaflets are visualised, simultaneously the image cross section will not be at the correct TVA level. Unfortunately, from all other 2DE views, including the atypical parasternal projection,³ only two tricuspid valve leaflets can be visualised simultaneously. In our study, TVA_{3D} had better discriminative value than TV-LS_{2D} for the separation of patients with rheumatic heart disease with tricuspid valve involvement from those with rheumatic heart disease without tricuspid valve involvement or from normal controls (table 1). Importantly, in rheumatic tricuspid valve involvement, TVA_{3D} best correlated with the mean transtricuspid pressure gradient. Obviously, our findings should be confirmed in larger studies and some of our findings should be validated using a gold standard such as magnetic resonance imaging. By combining all information obtained by RT3DE, the diagnostic and therapeutic decision-making process regarding the tricuspid valve may be facilitated.

Authors' affiliations

Ashraf M Anwar, Osama I I Soliman, Department of Cardiology, Al-Husein University Hospital, Al-Azhar University, Cairo, Egypt
Marcel I Geleijnse, Jackie S McGhie, Attila Nemes, Folkert J ten Cate, The Thoraxcenter, Erasmus MC, Rotterdam, The Netherlands

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Correspondence to: Dr F J ten Cate, Thoraxcenter, Room Ba 302, Erasmus MC, Dr Molewaterplein 40, 3015 GD Rotterdam, The Netherlands; f.j.tencate@erasmusmc.nl

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