

MINI-FOCUS ISSUE: CONGENITAL HEART DISEASE

INTERMEDIATE

IMAGING VIGNETTE: CLINICAL VIGNETTE

Anteroposterior Contraction of the Systemic Right Ventricle



Underrecognized Component of the Global Systolic Function

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ABSTRACT

Accurate echocardiographic evaluation of the systemic right ventricle is challenging because of its specific morphology and contraction patterns. We present a detailed multimodality assessment of the systemic right ventricle, analyze the relative contribution of the longitudinal, radial, and anteroposterior components of systolic function, and identify reasons for a potential discrepancy among imaging modalities. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:728–30) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

CASE DESCRIPTION

A 30-year-old asymptomatic woman with transposition of the great arteries and a previous Mustard repair presented for follow-up. Findings on 2-dimensional echocardiography (2DE) demonstrated a severely dilated systemic right ventricle (SRV), markedly abnormal septal motion with the interventricular septum bulging toward the left in systole, and severe systolic dysfunction (**Figures 1A to 1C, Video 1**).

Despite concerning 2DE findings, other test results were reassuring:

- During bicycle stress echocardiography, the patient exercised for 8:35 min on the World Health Organization protocol with an adequate hemodynamic response, reaching 90% of maximum heart rate. She remained asymptomatic, with no electrocardiographic changes and SRV systolic function visually improving at peak.
- Cardiac magnetic resonance (CMR) showed an SRV end-diastolic volume of 275 ml and an ejection fraction (EF) of 40%. Late gadolinium enhancement suggested only mild fibrosis in a small area of free wall and septal insertion point (**Figure 1D**).
- Right-sided heart catheterization demonstrated normal pulmonary artery pressures (26, 8, and 16 mm Hg) and normal end-diastolic pressure (5 mm Hg).
- B-type natriuretic peptide level was 72 ng/l.
- 3-dimensional echocardiography (3DE) demonstrated an SRV end-diastolic volume of 286 ml and an EF of 35% (**Figure 1E**).

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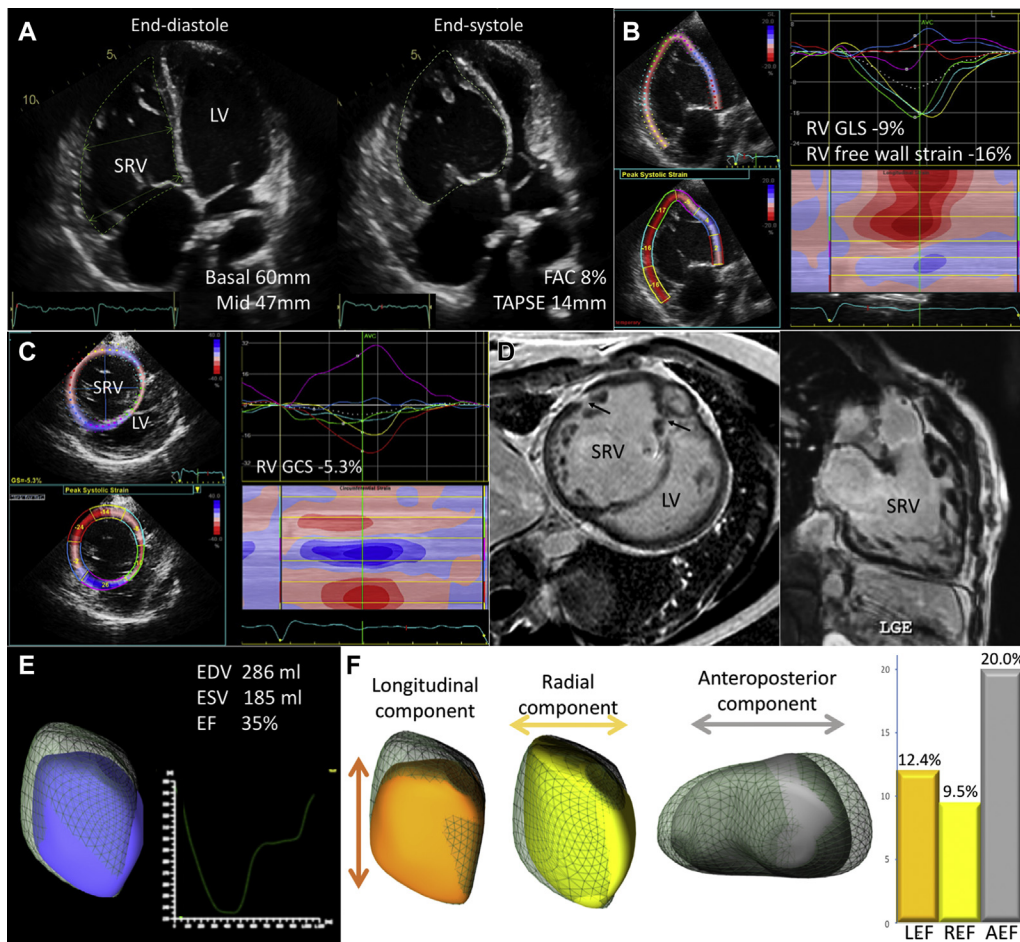
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To analyze the reasons for significant underestimation of SRV systolic function by 2DE (e.g., fractional area change [FAC] 8%) versus other tests (CMR EF 40%, 3DE EF 35%, good exercise test results, and B-type natriuretic peptide level), we performed the advanced 3DE analysis using the ReVISION software (Argus Cognitive, Lebanon, New Hampshire) and aiming to quantify the contribution of the longitudinal, radial, and anteroposterior components of the SRV wall motion separately. A 3DE mesh model of the SRV was decomposed along 3 directions providing longitudinal, radial, and anteroposterior EF (Figure 1F). The relative contribution of the anteroposterior component was dominant (20.0%) compared with longitudinal (12.4%) and radial (9.5%) components. These results suggest that shortening in the anteroposterior direction caused by the circumferentially oriented myofibers provided partial compensation for impaired longitudinal (post-cardiac surgery) and radial components (secondary to abnormal septal motion resulting from the pressure difference between the ventricles).

**ABBREVIATIONS
AND ACRONYMS**

- CMR** = cardiovascular magnetic resonance
- EF** = ejection fraction
- FAC** = fractional area change
- SRV** = systemic right ventricle or ventricular
- TAPSE** = tricuspid annular plane systolic excursion
- 2DE** = 2-dimensional echocardiography
- 3DE** = 3-dimensional echocardiography

FIGURE 1 Assessment of SRV Systolic Function



(A) 2-dimensional echocardiographic apical 4-chamber view. (B) 2-dimensional echocardiographic speckle tracking longitudinal strain showing severely reduced global strain partially contributed to by the stretched septal segments (dark blue and red curves). (C) 2-dimensional echocardiographic speckle tracking circumferential strain demonstrating a dominant contribution of the anterior and anterolateral segments (light blue, yellow, and red curves) and abnormal septal motion (purple curve). (D) Cardiac magnetic resonance demonstrating limited areas of fibrosis (arrows). (E) 3-dimensional echocardiographic volumetric analysis. (F) The ReVISION method analysis (Argus Cognitive, Lebanon, New Hampshire). AEF = anteroposterior ejection fraction; EDV = end-diastolic volume; EF = ejection fraction; ESV = end-systolic volume; FAC = fractional area change; GCS = global circumferential strain; GLS = global longitudinal strain; LEF = longitudinal ejection fraction; LGE = late gadolinium enhancement; LV = left ventricle; REF = radial ejection fraction; RV = right ventricular; SRV = systemic right ventricle; TAPSE = tricuspid annular plane systolic excursion.

During 2-year follow-up, the patient remained asymptomatic and had a successful pregnancy.

Given that SRV dysfunction is a key factor associated with morbidity and mortality, the accurate evaluation of SRV performance is crucial (1). Accuracy of conventional echocardiographic parameters is suboptimal: neither tricuspid annular plane systolic excursion (TAPSE) nor S' correlated with CMR-derived SRV EF, whereas FAC showed only moderate correlation (2). Conversely, 3DE provides more granular understanding of the role of different components of the SRV systolic function (3). Importantly, FAC, TAPSE, and longitudinal strain do not take into account anteroposterior contraction, thus leading to underestimation of SRV systolic function by these parameters. SRV systolic function is more accurately assessed by 3DE and CMR. Our results highlight the importance of 3DE imaging in the thorough assessment of SRV systolic function.

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transposition of the great arteries, 3-dimensional imaging

 **APPENDIX** For a supplemental video, please see the online version of this article.

KEY WORDS echocardiography, cardiac magnetic resonance, right ventricle,