EDITORIAL

Right Heart Dimensions: Pushing the Yardstick beyond "One Size Fits All"

Dimensiones del ventrículo derecho según un criterio de medición más allá del "talle único"

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Identifying right ventricular (RV) dilation has implications for diagnosis and for prognosis. Linear dimensions obtained from the apical (basal and mid-RV dimension), parasternal long-axis [right ventricular outflow tract (RVOT)] and parasternal short axis (RVOT) are recommended to quantify RV size. (1) Ignoring the potential technical issues in quantifying RV dimensions, such as the complex RV geometry and limited visualization of the RV free wall and RV endocardium, quantifying RV dimensions remains a challenge for various reasons. While the current non-indexed cut-off values are simple to use, one could question their diagnostic accuracy. Conceptually, it is plausible that the non-indexed values may inappropriately identify RV dilation in a healthy man with a body surface area (BSA) of 2.2 m^2 and fail to identify RV dilation in a woman with an atrial septal defect and a BSA of 1.5 m^2. Supporting this argument is the use of relative RV size as compared to the left ventricular (LV) size despite normal non-indexed RV linear dimensions.

In the most recent chamber quantification guidelines, (1) endorsed by the American Society of Echocardiography (ASE) and the European Association of Cardiovascular Imaging (EACVI), cut-off values for RV dimensions are non-indexed and not referenced to gender, despite gender-specific indexed cut-off values for LV dimensions and aortic dimensions. If the dimensions of other cardiac structures are referenced to BSA and gender, then why isn't the right ventricle?

There is an expanding body of literature highlighting that RV dimensions are correlated with BSA. Willis et al. (2) studied 205 healthy volunteers, observing that RV dimensions correlate with BSA. Furthermore, normal indexed cut-off values for basal RV dimensions of 13-21 mm/m^2 were proposed for both males and females. Similarly, D'Oronzio et al., (3) observed that RV dimensions correlated with BSA in a cohort of 1,625 subjects with normal echocardiographic exams.

The study by Romero et al. (4), published in this edition, adds to our understanding of the relationship between RV dimensions and body size. In a prospective cohort of 1,045 patients undergoing transthoracic echocardiograms, BSA correlated with RV basal dimension ($r = 0.20$, $p < 0.01$) and mid-RV dimension ($r = 0.09$, $p < 0.01$). Although the correlation is modest, it is significant, and indexing does not add any complexity to the performance of the examination. Notably, only the mean absolute basal RV dimensions in the top quartile of BSA is above the normal absolute ranges (>42 mm) proposed in the 2015 ASE/EACVI Chamber Quantification Guidelines (1) and the indexed cut-offs proposed by Willis et al. (2) In the study by Romero et al., subjects with BSAs between 1.7-2 m^2 have reference limits very similar to published norms.

Within the realm of echocardiography, gender and age-specific indexed values are provided for three-dimensional (3D)-derived RV volumes (4). Gender-specific cut-off values for 3D-derived RV volumes and RV end-diastolic area are specified in the 2015 ASE/EACVI Chamber Quantification Guidelines. (1) Their routine use may be limited by the additional time required to obtain these parameters, as compared to linear dimensions, due to a complex learning curve, limited feasibility and the additional software and hardware required to analyze 3D volumetric data sets of the RV. Despite these limitations, if appropriate expertise is available, the ASE and EACVI do endorse using indexed RV volumes. (1)

Looking at other non-invasive imaging modalities, magnetic resonance imaging (MRI) is often seen as the gold standard in the assessment of RV size. The perceived superiority of MRI in the assessment of the right ventricle may relate to its ability to obtain images in any plane providing enhanced visualization of the

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right ventricle, the improved visualization of the RV endocardial border and the potential use of gender-specific indexed reference values. Cut-off values for abnormal indexed RV volumes have been defined for males and females. (5-7) Furthermore, indexed RV end-diastolic volumes are provided as diagnostic criteria for arrhythmogenic right ventricular cardiomyopathy (8) and as criteria for pulmonary valve replacement in tetralogy of Fallot. (9) The widespread use of indexed cut-off values for RV dimensions strengthens the argument for their use in transthoracic echocardiography.

Although indexation of dimensions offers advantages, there are challenges that need to be taken into consideration. Firstly, the cohort needs to be carefully selected. The subjects included in studies to derive normative values need to be truly normal without cardiovascular or pulmonary disease. The cohort used in this study consisted of patients attending a regular health exam without known cardiomyopathy, RV or LV dysfunction, significant valve disease, pulmonary disease, or pulmonary hypertension. Beyond these exclusion criteria, patients with atrial fibrillation, hypertension, smoking status, or obstructive sleep apnea, among others, could also be listed for exclusion. Secondly, recognizing that values for indexed LV dimensions were obtained by compiling seven databases, the subjects included in the cohort need to represent a complete spectrum of body sizes and ethnicities. Lastly, indexation to BSA may not be sufficient; gender-specific indexed cut-off values are likely to be required.

Willis et al. (2) proposed gender-specific cut-off values for indexed RV dimensions. Similarly, D'Oronzio et al. (3) identified that females had smaller indexed-RV dimensions than males. So, why were gender-specific indexed dimensions not recommended in the latest recommendations? (1) The main reason is that sufficient patient level data from large studies were not available to perform meta-analyses to establish robust cut-off values. The current study by Romero et al. (4) is an example of the data that we were lacking when developing our recommendations.

Despite these challenges, establishing gender-specific indexed cut-off values for RV linear dimensions in a large cohort of healthy volunteers could advance our ability to diagnose and prognosticate patients. Such cut-off values could maintain the simplicity while potentially increasing the accuracy of linear RV dimensions. Careful selection of healthy volunteers could ensure derivation of accurate cut-off values. By proposing gender-specific indexed linear RV dimensions, we could push the yardstick beyond "one size fits all" to benefit all patients.

Conflicts of interest

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(See authors' conflicts of interest forms on the website/ Supplementary material).

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