Right Atrial Contractile Function in Pediatric Pulmonary Hypertension

A Novel Marker for Disease Severity?

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Predicting outcomes in children with pulmonary arterial hypertension (PAH) remains challenging. This is related to the rarity of the disease, the variable etiologies, the different pathophysiology in nonidiopathic pediatric PAH and the constantly changing treatments. Data from adult PAH studies cannot be readily extrapolated to pediatric cohorts as disease progression and specific pediatric studies are necessary. Recent guidelines summarize the current knowledge on pediatric PAH and its clinical management.[1]

See Article by Jone et al

Apart from clinical parameters and exercise capacity (6-minute walk test), the role of imaging parameters has become well established in outcome prediction of both adult and pediatric PAH. Echocardiography, in particular, plays an important role in diagnosis and follow-up. In recent years, different echocardiographic parameters have been identified to be useful in identifying high-risk patients who are likely to develop adverse clinical outcomes. In particular, a progressive increase in right ventricular (RV) size and deterioration in RV functional parameters results in increased risk for adverse outcomes. How the RV adjusts and copes with the increased ventricular afterload resulting from the pulmonary vascular changes, importantly influences patients' clinical status and long-term clinical outcomes. Recent data demonstrated that parameters reflecting RV size (RV dimensions and volumes) and RV systolic function (RV ejection fraction, fractional area change, and RV longitudinal strain values) can serve as outcome predictors also in pediatric PAH.[2–5]

The most recent studies have focused on the assessment of RV parameters and provided limited information on right atrial (RA) size and function. This is surprising, as earlier studies in adults with PAH demonstrated that RA size, as a surrogate for RA pressure, is an important determinant of outcomes, predicting death or the need for transplant. Data in children on the impact of RA size are less convincing and there certainly is a need for a better understanding of how RA imaging can be helpful in defining functional status and outcomes. Recently, the development of speckle-tracking echocardiography has provided new tools for studying the different components of atrial function. In adults, assessment of RA function has proven useful in outcome prediction for adult patients but to date limited data have been available in children.[6]

In this issue of *Circulation: Cardiovascular Imaging*, Jone et al[3] study parameters of RA size and function in children with pulmonary hypertension. It is a retrospective singe-center study including 66 children with PAH caused by different etiologies with idiopathic PAH being the predominant diagnosis (75% of the cohort), the remaining being PAH secondary to congenital heart disease and other causes. The authors use offline speckle-tracking echocardiography of the RA walls from an apical 4-chamber view to assess the different components RA function (reservoir function during atrial filling, conduit function during atrial emptying, and atrial pump function during atrial contraction). Based on RA volume assessment, maximal and minimal RA volumes were measured and RA emptying fraction reflecting the percent difference between the 2 was calculated. The authors compared the results to a normal control group and also looked at the effect of RA size and function on adverse outcomes. The authors detect significant changes in RA functional parameters and found weak but significant correlations between RA function and RV systolic and diastolic functional parameters. The authors provide up to 10-year follow-up data, which indicated that RA reservoir function, RA pump function, and RA minimal volumes were predictors for adverse events in their study group. This is important novel information for the follow-up of children with PAH as, to date, the data on the utility of RA size and function assessment have been limited.

The study also includes important physiological information as it highlights potential differences in disease progression between children and adults. Although in adults with PAH, RA contractile function is more affected at the time of diagnosis, it is more preserved in children. Interestingly, Jone et al[3] suggest that in children a decrease in RA pump function (atrial contraction) is associated with clinical deterioration and is predictive of adverse clinical events. This indicates that preservation of RA contraction is important for maintaining RV filling as the RV gets stiffer and less compliant related to the development of pathological hypertrophy and RV fibrosis.

These findings indicate that assessment of RA size and function may be a useful technique for assessing RV diastolic properties. Traditional echocardiographic parameters for RV diastolic function assessment are still poorly validated. The utility of assessing RV diastolic function based on tricuspid valve inflow, tissue Doppler velocities,

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and hepatic venous flow is largely based on assumptions RV changes in diastolic function are similar to changes observed in the LV. This is questionable as these parameters are influenced by different confounders like respiration and respiratory disease. A limitation for using RA size and function is that it cannot be used in the presence of atrial shunting and significant tricuspid valve regurgitation or stenosis. In all other circumstances, RA size and function parameters could be very useful for RV diastolic function assessment. Recent data from adults on left atrial function has demonstrated the peak left atrial strain values could potentially be used for grading left ventricular diastolic dysfunction.[7] The current data indicate that RA functional data could be used for RV diastolic functional assessment.

Obviously, more research work remains to be done. The methodology for RA strain assessment needs to be further standardized and validated. The current technique is based on speckle-tracking technology using an apical 4-chamber view for assessing RA longitudinal motion. As the atrial walls are extremely thin (around 3 mm), the impact of spatial resolution of the current speckle-tracking techniques on accuracy of atrial functional analysis needs to be further studied. Furthermore, the software used for atrial analysis was developed for analyzing LV strain and needs further validation. Also, the assumption that atrial fibers are oriented longitudinally needs further study. Pashakhanloo et al[8] looked at myoarchitecture of the atrial walls and their analysis suggests that some atrial fibers run from superior to inferior in the RA posterior walls. This suggests an RA apical 2-chamber view could be better for RA function assessment. Also, inclusion of the atrial septum and the foramen ovale is questionable, as this structure is not expected to actively contribute to atrial contraction. Finally, it can be questioned how much RA strain changes are related to changes in RA size. Jone et al[3] demonstrate a weak correlation between RA size and RA functional parameters. Conceptually, a larger RA can be expected to have a different compliance influencing reservoir function. A larger RA volume can be expected to result in increased RA contraction as a result of the atrial Frank–Starling relationship. Stretching the atrium too much may, however, result in a progressive decrease in atrial contraction. The main contribution of the current article is that it recognizes the importance of RA contractile function. This is a novel contribution to understanding the pathophysiology of disease progression in pediatric patients PAH and hopefully these data can be used for future larger studies.

Disclosures

None.

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