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EDITORIAL COMMENT

Make Right Heart Remodeling in Secondary Tricuspid Regurgitation as Simple as Possible, But Not Simpler*

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Functional or secondary tricuspid regurgitation (STR) is highly prevalent and associated with a dismal prognosis.[1] Epidemiological studies have reported that clinically significant (moderate or higher grade) STR has a prevalence of 0.55% in the general population, increasing with age and reaching 6.6% in patients older than 75 years.[1] STR was independently associated with increased morbidity and mortality.[2] Accordingly, different scores have been developed to stratify the risk of death in patients with clinically significant STR.[3-5] However, all of those studies included patients with STR without considering the underlying pathophysiology.[1,6]

Recently, it has been clarified that STR has at least 3 phenotypes: ventricular-related, atrial-related, and type B of the cardiac implantable electronic device-related STR.[7] Ventricular-related STR can be caused by left-sided myocardial or valvular diseases that induce pulmonary hypertension and afterload mismatch of the right ventricle (RV). The RV dilates and becomes more elliptical (ie, increases its mid diameter). The papillary muscles are displaced toward the apex and horizontalized, and they pull the chordae tendineae, causing tethering and tenting of the tricuspid valve (TV) leaflets. Conversely, atrial-related STR has been associated with atrial fibrillation or heart failure with preserved ejection fraction. The main mechanism is the dilation of the right atrium (RA) that induces the enlargement of the tricuspid annulus (TA) and consequent loss of coaptation of the TV leaflets that show no or minimum tethering. The RV is normal or mildly dilated and maintains its triangular shape with enlargement of the basal diameter.[8,9] Type B cardiac implantable electronic device-related STR is like the ventricular STR, but the mechanism is the RV dilation and dysfunction induced by permanent pacing.

Several reports have shown that the atrial STR is associated with better prognosis in patients managed conservatively[10,11] and in those who underwent transcatheter tricuspid valve repair.[12] Interestingly, Gavazzoni et al[10] reported that in patients with ventricular STR, both the severity of STR and the function of the RV were independently associated with patient outcomes. Conversely, in patients with atrial STR, the severity of STR was the only independent parameter associated with outcomes. These observations raised the issue of the different effects of the right heart remodeling on the different phenotypes of STR.

In this issue of *JACC: Cardiovascular Imaging*, Bombace et al[13] report a meta-analysis of 14 studies, enrolling 4,394 patients with at least moderate STR, to investigate the association between right heart remodeling and long-term (longer than 12 months) all-cause mortality. The duration of the follow-up was 39 months (ranging from 16 to 73 months), and the mortality rate was 31%. They found that higher mortality was associated with RV dysfunction (identified by reduction of tricuspid annular plane systolic excursion and fractional area change). In contrast, there was a decrease in mortality by increasing RA areas and TA dimension. They conclude that these findings support the hypothesis that atrial STR may have a more favorable prognostic outcome than ventricular STR.

Although the results of this meta-analysis confirm the results of the observational studies[10-12] and further support the need to consider separately the

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atrial and the ventricular phenotypes of STR in studies that examine the natural history and the effects of treatment in this heart valve disease, the data used to reach such a conclusion deserve some comments.

The distinction between atrial and ventricular STR based on RV basal diameter, tricuspid annular plane systolic excursion, fractional area change, and RA area is too simplistic and potentially misleading.[7,8] The basal RV diameter is an inaccurate and poorly reproducible metric of actual RV volume.[9] It overestimates the size of the RV in atrial STR, where the RV basal diameter is usually large but the RV volume is normal or only mildly dilated, and underestimates the RV size in ventricular STR, where the enlargement is mainly at the midcavity level.[9] The RA is usually dilated in ventricular STR, too. The peculiarity of atrial STR is the disproportionate dilation of the RA compared to the RV.[7,8]

Most of the data used in this meta-analysis were obtained from retrospective, observational studies that used measurements performed during routine, clinically indicated echocardiographic studies. The RV and the RA are complex 3-dimensional structures in the anterior mediastinum. Conventional M-mode and 2-dimensional linear or area measurements are unsuited to reflect their actual size and function, and they are poorly reproducible if not taken in a standardized way and using dedicated views, which is unlikely to occur in clinical routine, across multiple laboratories, and over a large time-span (2014-2021). The RA volume is grossly underestimated, and its reproducibility is lower if not obtained from a dedicated RV-focused apical view.[14] Both RV size and function are underestimated, and their variability is higher using the conventional 4-chamber than the RV-focused view.[15] TA size is underestimated by the linear dimensions obtained from the conventional 4-chamber and the RV-focused views compared with the 3-dimensional area.[16,17] STR severity is significantly underestimated when the conventional PISA method is not corrected for the tethering angle of the TV leaflets and the relatively low velocity of the regurgitant jet.[18]

Finally, the message that RA dilation suggests a better prognostic outcome is questionable.[19] Several papers coming from different Institutions have reported that the dilation and dysfunction of the RA are independent predictors of bad outcomes in patients with STR.[20-22]

In summary, the paper by Bombace et al[13] strongly advocates considering the pathophysiological differences between the various phenotypes of STR when evaluating the natural history and treatment effects in these patients. However, we need a consistent way of classifying these patients and a standardization of how we assess the geometry and function of the right heart structures and the severity of STR to compare data collected from different studies. All of these indications are available in the published reports, and it is the task of echocardiographers and researchers to implement them.

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