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EDITORIAL COMMENT

Tackling Tricuspid Regurgitation

A "Horses for Courses" and Earlier Approach Is the Future*

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Recent months have borne witness to substantial progress in the transcatheter treatment of tricuspid valve disease, with both the Evoque (Edwards Lifesciences) orthotopic transcatheter tricuspid replacement (TTVR) system and the TriClip (Abbott) transcatheter tricuspid edge-to-edge repair (T-TEER) system gaining Food and Drug Administration approval.[1,2] Other tricuspid device strategies such as caval valve implantation (CAVI) and spacer systems are also within early feasibility evaluation with subsequent Investigational Device Exemption pivotal trial planning underway. Therefore, we are likely to see a transcatheter tricuspid "toolbox" emerge in the near future. These developments are exciting for the field, where thousands of vulnerable patients with severe tricuspid regurgitation (TR) represent an ongoing major unmet clinical need.

In this issue of *JACC: Cardiovascular Interventions*, von Stein et al[3] from Germany present their consolidated transcatheter tricuspid valve annuloplasty (TTVA) experience for severe functional TR, dividing patients into atrial functional tricuspid regurgitation (AFTR) or nonatrial functional tricuspid regurgitation (NAFTR). AFTR was defined as tricuspid valve tenting height ≤10 mm, mid-right ventricular diameter <38 mm, and left ventricular ejection fraction >50%. Using these criteria, they evaluated 1-year follow-up in their TTVA population using the Cardioband system (Edwards Lifesciences). The authors found significant and sustained reduction in TR severity as well as symptomatic improvement (NYHA functional class) in both functional TR subgroups. Greater TR reduction, more frequent achievement of ≤2+ TR, and significantly higher survival at 1 year were observed in patients with AFTR compared to those with NAFTR. Not surprisingly, patients with concomitant right ventricular dysfunction in either subgroup experienced lower survival at 1 year.

The authors suggest that AFTR and NAFTR may not necessarily represent 2 distinct disease entities but rather a spectrum of disease (with AFTR representing an earlier clinical phenotype). Although this is somewhat controversial, the argument that specific FTR phenotypes may benefit more from different interventions or simply from earlier intervention is intriguing and highly relevant. The findings of the current study are encouraging; however, they may lack applicability to the broader TR population. Outside of a select group of highly specialized centers in Europe, TTVA remains technically challenging and imaging intense and often results in long procedural times. Although there remain ongoing challenges with catheter-based annular anchoring, as demonstrated in the current study, TTVA is technically feasible and effective in the right patient population.[3]

With 2 recent Food and Drug Administration approvals in the transcatheter tricuspid space, knowing when to perform what intervention in which patient has become a difficult task with no current high-quality, randomized data to guide treating clinicians. Surgical data would suggest that tricuspid repair has advantages over replacement.[4,5] Whether this can be extrapolated to transcatheter technologies remains unclear, especially given not all mechanisms of repair are the same. At present, anatomic valve parameters such as large coaptation gaps, pacemaker/implantable cardioverter-defibrillator lead presence, and leaflet morphology often drive decisions about T-TEER suitability. Assessment of right ventricle size, function, and right ventricular/pulmonary arterial

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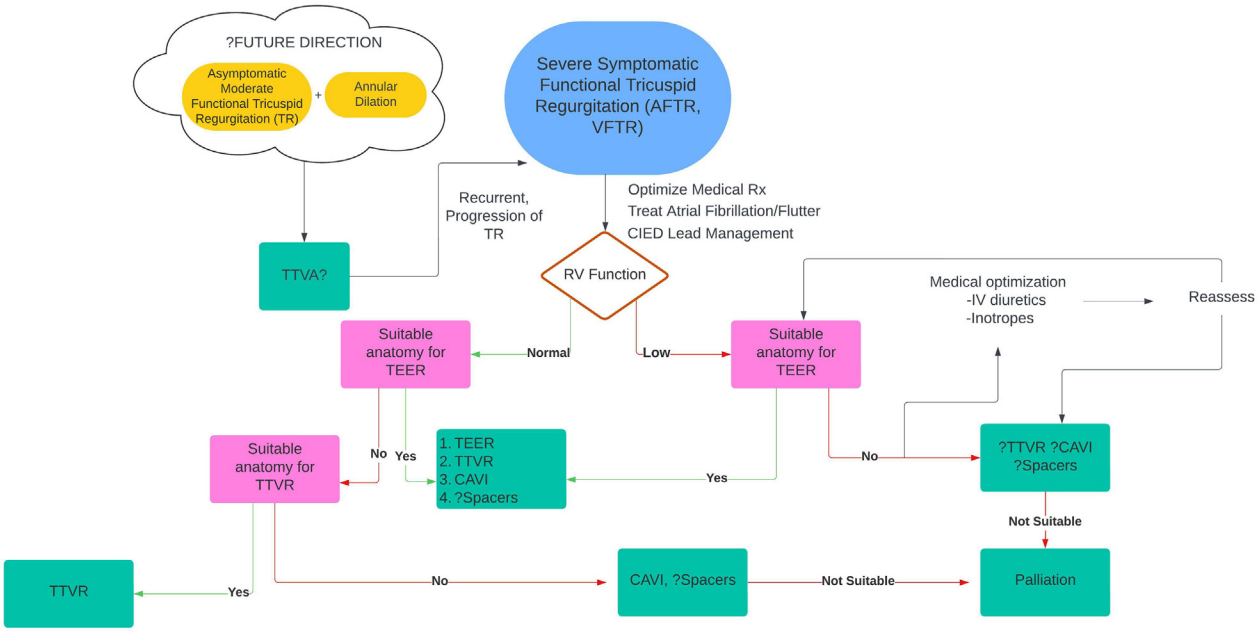
FIGURE 1 **Proposed Algorithm for the Treatment of Severe Symptomatic Functional TR as Well as Possible Future Directions for Early Intervention**



AFTR = atrial functional tricuspid regurgitation; CAVI = caval valve implantation; CIED = cardiac implantable electronic device; IV = intravenous; TEER = transcatheter edge-to-edge repair; TIVA = total intravenous anesthesia; TR = tricuspid regurgitation; TTVR = transcatheter tricuspid replacement; VFTR = ventricular functional tricuspid regurgitation.

coupling may identify patients who may not tolerate complete eradication of TR with TTVR or may benefit less from treatment in general.[6] TTVA in current practice may play a role in patients with atrial/annular predominant remodeling and those that are anatomically unsuitable for TTVR, respectively (**Figure 1**). However, the results of clinical trials may ultimately alter this paradigm, with the emergence of CAVI and tricuspid valve spacer technologies.

As with most valvular pathology, TR is similar in that intervention is typically performed in relatively advanced stages of the disease. By the time of intervention, clinically overt right heart failure, hepatic congestion, right ventricular dysfunction, and cardiorenal syndrome are often already manifest. Despite significant, durable improvements in quality of life metrics, it remains challenging to demonstrate meaningful reductions in heart failure hospitalizations and mortality when end organ damage from long-standing TR has been present for years. Functional TR (even in the absence of symptoms) does not occur overnight. True therapeutic impact may emerge if we are able to prevent severe TR from arising in the first place by tackling the disease process and anatomical substrate early. There is some support for this concept in the cardiac surgical literature when tricuspid annuloplasty is performed in the context of progressive (nonsevere) functional TR and tricuspid annular dilation when undergoing left-sided surgical procedures.[7-9]

Akin to the various mitral valve disease substrates, tricuspid valve pathological substrates do not engender themselves to a "1-stop shop" treatment approach. Although anatomical feasibility and physiologic parameters currently drive intervention choice, optimal timing for intervention (within the evolution of TR in an individual patient) is a worthy topic of much further evaluation. Earlier intervention, especially in the setting of risk factors for TR progression (such as atrial fibrillation, pacing/implantable cardioverter-defibrillator leads, tricuspid annular dilation), may prove to be impactful in either preventing severe TR or delaying its progression. In the future, a reliable, scalable, and durable catheter-based TTVA approach may represent a viable option for earlier TR intervention that does not necessarily preclude subsequent T-TEER, TTVR, or CAVI should it be necessary. With a rapidly expanding device market, it is only a matter of time before heart teams are able to adopt a "horses for courses" approach for treating TR, adapting for its lifetime management in at-risk individuals.

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