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EDITORIAL COMMENT

Atrial Arrythmias in Ebstein Anomaly

A Common Clinical Conundrum*

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Ebstein anomaly accounts for approximately 0.5% of all types of congenital heart disease, with a prevalence of 1 per 20,000 live births.[1] It is considered a type of right ventricular (RV) myopathy that is characterized by a dysplastic tricuspid valve with incomplete delamination of the lateral and posterior leaflets and rotational displacement of the septal leaflet toward the apex. The resulting tricuspid regurgitation can lead to right and sometimes left ventricular dysfunction. Common coexisting conditions include atrial septal defects in 10% to 20% and accessory pathways in 15% to 25% of cases, the latter being right sided in over 90%, multiple in 30%, and exhibiting atypical conduction properties in 10%.[2] Consequently, the spectrum of clinical manifestations is broad, ranging from the asymptomatic patient with an incidental finding discovered during adulthood to severe RV dysfunction in neonates prompting palliative shunts and univentricular surgical repair (ie, Fontan surgery). It has been estimated that <30% of patients with Ebstein anomaly undergo tricuspid valve repair/replacement during their lifespan, with surgical indications that are largely driven by symptoms, associated heart failure, declining exercise capacity, and/or progressive RV dilation or dysfunction.

In the issue of *JACC: Advances*, Martin de Miguel et al[3] contribute to characterizing clinical manifestations of Ebstein anomaly by reporting the Mayo Clinic's comprehensive experience with atrial arrhythmias in 682 adults (mean age 36 years). Excluded were accessory pathway-mediated and atrioventricular node-dependent tachycardias because of their different pathophysiological implications. The authors' careful analysis draws upon the Mayo Clinic's large clinical experience in adults with Ebstein anomaly and calls attention to a strikingly high burden of atrial arrhythmias. Indeed, the prevalence of atrial arrhythmias before the first encounter at their adult congenital heart disease clinic (ie, "baseline") was 34%, with 18% having had atrial fibrillation (AF) and 21% atrial flutter (AFL) or atrial tachycardia. The cumulative incidence of new episodes of AF and AFL over the ensuing 10 years was 16% and 22%, respectively. In patients with a documented atrial arrhythmia, recurrences occurred in 40% with similar recurrence rates in those with AF and AFL.

In addition to documenting the high prevalence and incidence of atrial arrhythmias, Martin de Miguel et al elucidated associated factors. Although risk factors per se cannot be derived from a cross sectional analysis of baseline data for a variety of reasons, including the uncertain temporal relationship between exposures and outcomes, the large sample size allowed the authors to explore correlations. In so doing, they introduced novel echocardiographic parameters that carry the potential to influence clinical practice. Independent associated factors included older age at clinical assessment, right and left atrial volumes, and right atrial reservoir strain. Although the association between atrial arrhythmias and atrial myopathy is well established in patients without congenital heart disease, metrics of atrial dysfunction have yet to be systematically assessed and routinely reported by echocardiography laboratories. It remains to be determined whether or not routinely evaluating these factors will translate into measurable clinical benefits. Nevertheless, there are precedents for

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taking into consideration echocardiographic atrial parameters in arrhythmia management, such as in weighing risks and benefits of AF ablation procedures and in guiding decisions to forego rhythm control in favor of rate control. As such, the authors provide promising data in support of adding atrial strain and volumetric assessment to the follow-up of patients with Ebstein anomaly.

With this in mind, how might these findings eventually be integrated in the management of this markedly heterogenous population beyond increased awareness for atrial arrhythmias?

One potential avenue is in considering atrial arrhythmias along with RV size and function in informing decisions for optimal timing of tricuspid valve surgery. RV function is often assessed by echocardiography (albeit with limited reproducibility[4]) and cardiac magnetic resonance imaging. In recent guidelines, surgical indications for intervening on the tricuspid valve are primarily based on cardiovascular symptoms and RV metrics.[5] Small RV volumes and systolic dysfunction are associated with poorer outcomes after surgical valve repair/replacement. It remains unknown whether parameters of right atrial dysfunction could reliably predict adverse RV remodeling and offer a window of opportunity to intervene before developing features associated with high surgical risk. Along a similar vein, might the extent of fibrosis be a useful early marker to indicate surgery akin to mitral regurgitation? Should we wait for atrial arrhythmias to emerge or adopt a preemptive approach by advocating for earlier valve repair/replacement based only on atrial volumes and right atrial dysfunction? Naturally, further studies are required to address these and other questions related to integrating atrial arrhythmias in clinical decision-making. Moreover, research is required to clarify the link between parameters of atrial dysfunction and stroke risk, along with indications for thromboprophylaxis.

Current guidelines recommend performing electrophysiological studies and catheter ablation before surgery in patients with Ebstein anomaly.[5] The logic behind this approach is to eliminate arrhythmic substrates before Cone repair or valve replacement impedes access for catheter ablation. In a recent retrospective multicenter study on 136 patients with tricuspid valve surgery, Moore et al[6] reported longer, less successful ablation procedures and higher recurrences of atrial arrhythmias associated with a tricuspid valve ring or valve replacement. Given the high prevalence of AFL and AF in adults with Ebstein anomaly exposed by the Martin de Miguel et al[3] study, a second potential consideration is whether a proactive approach to transcatheter or surgical cavotricuspid isthmus ablation should be favored before, or concomitant with, valve surgery? The underlying rationale would be similar to eliminating accessory pathways when access for ablation is optimal. Might this be further extended to a right atrial Maze type procedure by also including other ablation lines, such as one that connects the atriotomy to the inferior vena cava? It remains to be determined whether integrating the described echocardiographic parameters into a comprehensive preoperative assessment could help guide decisions regarding combined arrythmia and tricuspid valve interventions. After catheter ablation of atrial arrhythmias in patients with Ebstein anomaly, Hassan et al[7] reported recurrence rates of 10.0% and 41.2% at 1 and 5 years of follow-up. Might there be a role for antiarrhythmic drugs alone or in combination with catheter or surgical ablation? Is the relationship between arrhythmias and atrial myopathy bidirectional such that reducing the burden of atrial arrhythmias could potentially results in improved echocardiographic metrics of atrial myopathy?

Finally, investigators from the Mayo Clinic previously reported an 8.3% rate of ventricular arrhythmias/sudden cardiac death in patients with Ebstein anomaly by the age of 50 years.[8] Although the anatomic severity of Ebstein anomaly, degree of RV enlargement, and severity of tricuspid regurgitation were not predictive of ventricular arrhythmias and sudden death, a correlation was observed with atrial arrhythmias. Therefore, it might also be worthwhile exploring whether echocardiographic parameters of atrial dysfunction are linked to malignant ventricular arrhythmias and could be of prognostic value for risk stratification. As for many well-conducted studies that expand our knowledge base, the Martin de Miguel et al[3] study raises numerous additional questions and paves the way for further research on integrating atrial arrhythmias and their associated factors into clinical decision algorithms to improve outcomes in the diverse population of adults with Ebstein anomaly.

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