Diagnosis and Management of Ebstein Anomaly of the Tricuspid Valve

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Opinion Statement

Ebstein anomaly (EA) is a rare congenital heart defect that may not be detected until late in adolescence or adulthood. Since the original description in a 19-year-old laborer with severe tricuspid valve (TV) regurgitation in 1866, our understanding of this rare condition has increased to the recognition that it is an abnormality not only of the TV, but also of the right ventricle (RV). EA is the result of failure of delamination of the TV leaflets from the interventricular septum, resulting in adherence of the leaflets to the underlying myocardium. This results in a wide variety of abnormalities, including apical and posterior displacement of the dilated TV annulus; dilation of the “atrialized” portion of the RV; and fenestrations, redundancy, and tethering of the anterior leaflet of the TV. The malformed TV is usually regurgitant, but may rarely be stenotic. The clinical manifestations of EA in the adult depend on several factors, including the extent of TV leaflet distortion, degree of tricuspid regurgitation (TR), right atrial pressure, and presence of a right-to-left atrial level shunt. Over the past several decades, advances in diagnostic imaging and surgical techniques have contributed to our current management of this challenging congenital heart defect.

Introduction

Ebstein anomaly (EA) is a rare congenital heart defect that encompasses a wide spectrum of anatomical and functional abnormalities of the tricuspid valve (TV) and right ventricle (RV). The incidence of EA is ~1 per 200,000 live births, accounting for less than 1 % of all cases of congenital heart disease. The etiology of EA is not known; however, in rare cases, genetic factors such as mutations in the transcription factor NKX2.5, 10p13-p14 deletion and 1p34.3-p36.11 deletion have been described. The morphologic defect of EA involves
a failure of delamination of the TV leaflets, resulting in adherence of the leaflets to the underlying myocardium. This results in a wide variety of abnormalities, including apical and posterior displacement of the dilated TV annulus, dilation of the “atrialized” portion of the RV, and fenestrations, redundancy, and tethering of the anterior leaflet. The malformed TV is usually regurgitant, but may rarely be stenotic. Table 1 lists the clinical and morphological features of the unoperated EA patient. The clinical manifestations of EA in the adult depend on several factors, including the extent of TV leaflet distortion, degree of tricuspid regurgitation (TR), right atrial pressure, and presence of a right-to-left atrial level shunt. Additional cardiac associations, such as pulmonary valve stenosis or left ventricular (LV) non-compaction, may further contribute to a patient’s clinical presentation. Asymptomatic patients with EA without right-to-left shunting or significant cardiomegaly may be managed medically and may not require intervention. When the diagnosis of EA is made in adults, the presentation is often symptomatic arrhythmia or right-sided heart failure symptoms. The physical examination findings may include a RV lift, loud first heart sound with systolic clicks and a holosystolic murmur of TR. The jugular venous pressure may often be normal, despite severe TR, due to the large, compliant right atrium. If an associated atrial level septal defect [Atrial septal defect (ASD) or patent foramen ovale (PFO)] is present, the patient may be cyanotic due to right-to-left shunting. The cardiothoracic ratio on chest radiograph is enlarged, transthoracic echocardiography (TTE) confirms the diagnosis, and additional imaging modalities are used when appropriate. Adults with EA may not recognize their exercise limitations, and objective exercise testing is useful, particularly for documenting any cyanosis with exercise, due to a right-to-left atrial shunt. Atrial arrhythmias are common, with accessory pathways present in ~50% of these patients. Indications for surgical interventions include symptoms of right-heart failure or decreased exercise tolerance, cyanosis, para-

Table 1. Clinical features and evaluation of unoperated patient

<table>
<thead>
<tr>
<th>The disorder has the following features in common:</th>
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<tr>
<td>• Adherence of the tricuspid valve leaflets to the underlying myocardium (failure of delamination)</td>
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<tr>
<td>• Apical displacement of the septal and posterior leaflets of the tricuspid valve below the AV junction in the right ventricle</td>
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<tr>
<td>• Atrialization and dilation of the inflow of the right ventricle to varying degrees</td>
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<td>• Redundancy, tethering, and fenestrations of the anterior tricuspid valve leaflet</td>
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<tr>
<td>• Varying degrees of TR</td>
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<td>• Enlargement of the right atrium</td>
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<td>• Varying degrees of cyanosis.</td>
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<td>Associated lesions include the following:</td>
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<td>• More than 50% of patients have a shunt at the atrial level with either a PFO or secundum ASD, which results in varying degrees of cyanosis</td>
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<td>• One or more accessory conduction pathways, increasing the risk of atrial tachycardias (approximately 25%)</td>
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<td>• VSD</td>
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<td>• Varying degrees of anatomic and physiological RVOT obstruction</td>
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<td>• Occasionally, other anomalies such as mitral valve prolapse</td>
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<td>• Abnormalities of LV morphology and function.</td>
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AV, atrioventricular
TR, tricuspid regurgitation
PFO, patent foramen ovale
ASD, atrial septal defect
VSD, ventricular septal defect
RVOT, right ventricular outflow tract
LV, left ventricular
doxical embolism, progressive cardiomegaly, RV dil-
lation or dysfunction [1]. Surgical options include
tricuspid valve repair or replacement, closure of
any interatrial communications, and antiarrhythmia
procedures. This article highlights the diagnosis and
management of adults with EA.

Diagnostic Testing

Echocardiography

- Transthoracic echocardiography (TTE) is the cornerstone of imaging the
patient with Ebstein anomaly of the tricuspid valve. The goals of the TTE
are to a) distinguish EA from other etiologies of TV disease, b) deter-
mine TV anatomy c) assess the degree of TV dysfunction, d) evaluate
right ventricular (RV) function, and e) identify associated anomalies
such as an atrial septal defect, right ventricular outflow tract obstruction,
or myocardial non-compaction. TTE is essential in assessing the valve
morphology and eligibility for surgical repair [2]. While other types of
TV disease (rheumatic, endocarditic, traumatic, carcinoid, dysplastic
valve) can mimic EA, EA is unique in that the insertion site of the septal
leaflet is apically displaced≥0.8 cm/m² relative to the anterior mitral
leaflet insertion site (Fig. 1). In more severe cases, the posterior leaflet is
apically displaced as well [3, 4]. These findings are usually best visual-
ized from the apical window. In EA, the septal leaflet has excessive
attachments to the interventricular septum as a result of incomplete
delamination of the septal and posterior leaflets from the myocardi-

Figure 1. Apical four-chamber echocardiogram of a patient
with Ebstein anomaly. The tricuspid valve is apically dis-
placed from the tricuspid valve annular plane (bracket). RA,
right atrium; RV, right ventricle; LA, left atrium; LV, left
ventricle.
The septal and posterior leaflets can be thickened, dysplastic and muscularized which complicate surgical repair.

- The anterior leaflet of the TV is not displaced but is usually elongated, redundant, often fenestrated [8, 9], and may have restricted motion. It is best imaged from the apical four-chamber view. Other findings, such as severe tricuspid regurgitation (TR), severe right atrial or RV dilation and dysfunction, are common in EA. Due to the apical displacement of the septal and posterior leaflets, the functional TV annulus is apically displaced, which directs the valve coaptation point anteriorly and, in severe cases, into the right ventricular outflow tract [10]. This is best imaged from a parasternal window, either in short-axis view or long-axis view with anterior angulation of the transducer probe. The true annulus of the TV is identified at the insertion site of the anterior leaflet. The severity of apical displacement of the TV annulus and the amount of atrialized RV has been correlated with worse outcomes [11]. Most patients with EA have at least moderate TR. Tricuspid regurgitation severity can be evaluated using color Doppler, and confirmed by flow reversal in the hepatic veins. However, due to the eccentricity of the TR jet and highly compliant right atrium, hepatic vein flow reversal is not always seen, even in the setting of severe TR.

- Transesophageal echocardiography (TEE) may be helpful in determining TV morphology; however, because the valve is positioned anteriorly, remote from the transducer, the visualization may be limited. Intraoperatively, TEE is used routinely. Three-dimensional echocardiography is useful in its ability to acquire an “en face” view of the TV, and demonstrates not only the valve leaflet positions, but also may demonstrate fenestrations in the leaflets and show tethering of the leaflets to the RV free wall.

- Echocardiography should also attempt to evaluate RV function, although this can be difficult due to its complex, non-geometric shape. Several techniques to measure RV performance have been explored, but none has gained universal acceptance. Right ventricular systolic function can be assessed by fractional area change using two-dimensional echocardiography [12, 13], or by tricuspid annular plane systolic excursion measured by M-mode (TAPSE). Preserved TAPSE appears to be associated with prolonged asymptomatic phase, even in the setting of severe valve malformation [14]. RV systolic dysfunction has been associated with both early and late post-operative mortality [15].

- It is important to identify associated cardiac defects in patients with EA, such as an intra-atrial communication (patent foramen ovale or secundum type atrial septal defect), which is present in 49–75% of patients [8, 16, 17]. Left heart abnormalities are increasingly recognized in association with EA, and can include LV systolic dysfunction, diastolic dysfunction and non-compaction [18–20]. Diastolic dysfunction may be related to ventricular-ventricular interaction, whereby a volume-overloaded RV compresses the LV, impairing filling. However, intrinsic abnormalities in LV compliance are also present and do not entirely resolve after surgery [21], and may be related to intrinsic myocardial stiffening or fibrosis.
Cardiac Magnetic Resonance Imaging

- Cardiac magnetic resonance imaging (CMR) is well suited for the evaluation of patients with EA as it has excellent spatial resolution, an ability to clearly distinguish the blood-myocardial border, and proven reproducibility in the measurement of RV size and function [22–24, 25••]. Measurements of atrial and ventricular volumes are typically performed in axial or short-axis orientation with endocardial contours drawn in end-systole and end-diastole. Steady state free precession imaging should be performed in multiple planes, including two-chamber and four-chamber orientations. Analysis of both the functional RV and atrialized RV is performed. The functional RV is the portion of the ventricle apical of the attachment points of the TV leaflets, whereas the atrialized RV is the area between true tricuspid annular plane and the functional tricuspid annulus [25••]. The ability to accurately and reproducibly measure RV volume is important, as RV size has been associated with outcomes in patients with EA [12].

- CMR also has an excellent ability to detect associated cardiovascular abnormalities, including LV systolic dysfunction and non-compaction [20, 26]. EA is often associated with thinning and dyskinesis of the RV free wall. The degree of intracardiac shunting and TR can be accurately and reproducibly measured using phase-contrast CMR [27]. Late gadolinium enhancement can detect LV fibrosis, which may lead to insights into the underlying myocardial abnormalities in these patients, and this has prognostic significance, given the relatively poor outcome of EA patients with LV dysfunction [28].

Exercise Testing

- While the optimal timing of elective surgery in patients with EA remains unknown, symptoms are a common indication for surgery [1]. However, patients with congenital heart disease are often unaware of functional limitations, and deterioration in exercise capacity has important prognostic implications [29]. Even relatively asymptomatic patients with EA have significant decreases in exercise performance and their peak oxygen consumption is significantly reduced [29, 30]. Right-to-left shunting can be exacerbated during exercise, and exercise-induced cyanosis can be a powerful impact on exercise capacity [31]. This can manifest as inefficient ventilation and an elevated VE/VCO₂ [30]. Progressive decline in exercise performance should be considered a relative indication for surgery, even in the absence of overt symptoms [31].

Electrocardiogram

- The surface electrocardiogram (ECG) can give important clues about the patient’s anatomy, presence of an accessory pathway and predisposition for atrioventricular re-entrant tachycardia [32]. The surface ECG of a patient with EA is rarely normal (Fig. 2). A wide P wave with a prolonged PR interval indicates slowed conduction through a dilated atrium [33]. Right bundle branch block is common [34]. However, patients
may also have RV conduction delay associated with hypertrophy, pseudonormalization of the right bundle branch block through a slow accessory pathway [35], or overt preexcitation. The morphology of the right bundle branch block and terminal portion of the QRS is bizarre due to late activation through a scarred atrialized right ventricle [32].

- Wolff–Parkinson White syndrome, defined as manifest preexcitation, is seen in as many as 20% of EA patients. However, concealed accessory pathways are present in up to 50% of patients [35–38]. The majority of accessory pathways are right-sided and located in the right posterior and right posteroseptal region [39••, 40]. Many patients have multiple accessory pathways [10, 32, 38, 39••]. ECG algorithms for precise accessory pathway localization have relatively poor accuracy in patients with EA [41]. Patients with EA are at particular risk for primary atrial tachycardia due to severe right atrial enlargement, and can be predisposed to rapid conduction down the accessory pathway [42].

Figure 2. Twelve-lead electrocardiogram of a patient with Ebstein anomaly of the tricuspid valve. It demonstrates normal sinus rhythm with a premature ventricular contraction, right axis deviation, complete right bundle-branch block with bizarre terminal portion of the QRS (*) consistent with severe RV conduction delay.
Preoperative Electrophysiological Study

- Due to multiple potential arrhythmic substrates—which include primary atrial tachycardia, orthodromic reentrant tachycardia, atrioventricular node reentrant tachycardia and ventricular tachycardia—recent data suggest that all EA patients that are planning to undergo cardiac surgery undergo preoperative electrophysiology (EP study), regardless of symptoms [34, 40, 43]. Localization of accessory pathways is often challenging due to a massively enlarged right heart, displaced tricuspid annulus and distortion of anatomic landmarks, all of which can make catheter stability difficult [40].

- Percutaneous ablation of accessory pathways should be performed with caution in those EA patients with a right-to-left interatrial communication (ASD, PFO) due to the risk of paradoxical embolus. The EP study serves to individualize the surgical management of arrhythmias, as EA patients may require focused cryoablation of atrial circuits, annular accessory pathways, or sites of ventricular tachycardia. These focused arrhythmia interventions are often combined with a right atrial Maze procedure or bilateral Maze procedure for those with atrial fibrillation.

Cardiac Catheterization

- With advances in CMR and TTE, routine hemodynamic catheterization is no longer warranted in most patients with EA. In the rare patient with suspected pulmonary arterial hypertension, hemodynamic catheterization can be used for preoperative risk stratification. The presence and magnitude of intracardiac shunting can also be determined by catheterization. Preoperative coronary angiography is warranted in men 35 years and older, premenopausal women over 35 with coronary heart disease risk factors, and post-menopausal women [1].

Treatment Options

Medical Management

- Patients with mild forms of EA should undergo regular evaluation by a cardiologist with expertise in adult congenital heart disease (ACHD). The evaluation must include thorough assessment of the patient’s heart rhythm, as atrial arrhythmias are particularly common. Exercise testing provides assessment of functional capacity and any arterial desaturation with exertion. If signs or symptoms of right-sided heart failure are present, standard heart failure medications are employed; however, there is little evidence for the efficacy of these agents in patients with EA. Medical management of arrhythmias should be individualized. Recommendations for physical activity are summarized in the Task Force 1 on Congenital Heart Disease [44]. Adults with mild EA, nearly normal heart size, and no arrhythmias are not restricted from sports participation. However, those with severe, unrepaired EA are precluded from sports.

- The late survival of unoperated adults with EA is less than expected. In a natural history study of 72 unoperated EA patients, survival was 89 %,
76%, 53% and 41% at 1, 10, 15 and 20 year follow-up, respectively. Multivariate predictors of cardiac-related death included male gender, cardiothoracic ratio greater than or equal to 0.65, and the severity of TV leaflet displacement on TTE [45].

- Many women with EA have successfully carried full-term pregnancies. In a literature review of 127 pregnancies in women with EA, 3.9% were complicated by arrhythmias and heart failure was reported in 3.1% [46]. Women with EA should undergo pre-pregnancy counseling with a multidisciplinary team with expertise in adult congenital heart disease (ACHD) [1].

- Antibiotic prophylaxis is usually not necessary in the acyanotic, unoperated patient with EA. However, antibiotic prophylaxis before dental procedures is reasonable in cyanotic EA patients, and recommended in patients with a prosthetic heart valve.

### Catheter Interventions

- Adults with EA may have varying degrees of right-to-left shunting across an atrial level septal defect. Although there is a paucity of data, percutaneous closure of these shunts in selected cases may reduce cyanosis and improve functional capacity [47].

- EA patients with symptomatic arrhythmias should undergo electrophysiological study and radiofrequency ablation by an electrophysiologist experienced in management of ACHD. The success rates for catheter ablation in EA patients is lower than in those with structurally normal hearts, and the risk of recurrent arrhythmia is increased [32, 38, 48]. Rarely, radiofrequency ablation in these patients has resulted in right coronary artery stenosis [49]. The success rates for catheter ablation in EA patients is lower than in those with structurally normal hearts, and the risk of recurrent arrhythmia is increased [32, 38, 48].

### Surgical Interventions

- Table 2 lists the ACHD Class I guidelines for tricuspid valve repair or replacement in EA patients, as well as indications for arrhythmia surgery [1].

- The operative management of patients with EA includes a) tricuspid valve repair or replacement, b) right reduction atrioplasty, c) closure of any atrial septal communications, d) antiarrhythmia procedures (Maze procedure, surgical division of accessory conduction pathways, or cryoablation of atrioventricular node reentrant tachycardia), e) correction of any associated cardiac anomalies (pulmonary stenosis) and f) consideration of plication of the atrialized portion of the RV. Advantages to plication of the RV include a reduction in the size of the nonfunctional portion of the RV, theoretically improving the transit of blood through the RV; b) reduction of LV compression and improving LV filling; c) reduction of the tension on the TV suture lines; and d) provision of more space for the lungs (particularly in smaller patients). However, RV plication has the potential risk of injury to the right coronary artery that may lead to arrhythmias and ventricular dysfunction. There is also concern that the area of plication creates a folded area of tissue that may be par-
particularly arrhythmogenic. Therefore, careful epicardial inspection is warranted to minimize coronary injury during the plication procedure. Tricuspid valve repair is usually preferred over TV replacement in patients with EA. Bidirectional cavopulmonary shunt (Glenn procedure) may be considered in selected EA patients with severe RV dysfunction and preserved LV systolic function and low left atrial pressure. Older EA patients often have septal dyskinesis, likely due to the massively dilated RV, and the LV ejection fraction may improve after surgery. EA patients with severe LV systolic dysfunction rarely may be considered for heart transplantation [50]. In considering surgery for adults with EA, it is important to recognize that these patients may have undergone prior cardiac surgery; comprising over 25% of patients in the Mayo clinic experience. The Mayo clinic recently reported low early mortality in a group of EA patients >50 years old; however, the long-term survival was less than expected; suggesting that interventions in adults with EA may need to be considered earlier [51].

Table 2. Recommendations for surgical interventions

| Class I |
|-----------------|-------------------------------------------------|
| 1. Surgeons with training and expertise in CHD should perform tricuspid valve repair or replacement, with concomitant closure of an ASD, when present, for patients with Ebstein’s anomaly with the following indications: |
| a. Symptoms or deteriorating exercise capacity. (Level of Evidence: B) |
| b. Cyanosis (oxygen saturation less than 90%). (Level of Evidence: B) |
| c. Paradoxical embolism. (Level of Evidence: B) |
| d. Progressive cardiomegaly on chest x-ray. (Level of Evidence: B) |
| e. Progressive RV dilation or reduction of RV systolic function. (Level of Evidence: B) |
| 2. Surgeons with training and expertise in CHD should perform concomitant arrhythmia surgery in patients with Ebstein’s anomaly and the following indications: |
| a. Appearance/progression of atrial and/or ventricular arrhythmias not amenable to percutaneous treatment. (Level of Evidence: B) |
| b. Ventricular preexcitation not successfully treated in the electrophysiology laboratory. (Level of Evidence: B) |
| 3. Surgical re-repair or replacement of the tricuspid valve is recommended in adults with Ebstein’s anomaly with the following indications: |
| a. Symptoms, deteriorating exercise capacity, or New York Heart Association functional class III or IV. (Level of Evidence: B) |
| b. Severe TR after repair with progressive RV dilation, reduction of RV systolic function, or appearance/progression of atrial and/or ventricular arrhythmias. (Level of Evidence: B) |

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Volume 52, Issue 23, 2 December 2008, Pages e143–e263
CHD, congenital heart disease
ASD, atrial septal defect
RV, right ventricular
TR, tricuspid regurgitation
Tricuspid Valve Repair

- TV repair is preferable to TV replacement. Factors that are favorable for reparability include a large, mobile anterior leaflet with a free leading edge, delamination of the inferior leaflet, and the presence of adequate septal leaflet tissue. Whereas, significant leaflet tethering (adherence to the edge or body of the leaflet to the RV free wall) and severe apical displacement of the coaptation point with TV leaflet tissue in the right ventricular outflow tract make repair more difficult. TV repair for EA was first described in 1958 by Hunter and Lillehei [52]. In 1972, Danielson developed a repair that included a longitudinal plication of the free wall of the atrialized RV, posterior tricuspid annuloplasty and excision of the redundant RA wall. This repair resulted in a monocuspid valve with the functional TV annulus brought up to the true TV annulus, and competency of the valve is achieved by coaptation of the anterior TV leaflet with the ventricular septum [53]. Since that time, multiple modifications of the TV repair technique have been described [54–56]. Two major modifications have been to repair the valve in the position that it maintains in the RV, by bringing the RV free wall papillary muscles down to the ventricular septum, and to perform transverse RV plication. The Mayo clinic reported the surgical outcomes of 539 patients with EA, 182 of which had undergone TV repair. Early mortality was 5 % for the entire cohort, and freedom from late reoperation was 84 %, 73 % and 56 % at 10, 15, and 20 years, respectively. Independent predictors of death or reoperation included male gender, pulmonary valve stenosis, significant postoperative LV dysfunction, prior cardiac procedures, or a Maze procedure [15, 57]. A recent TV repair described by da Silva known as the “cone reconstruction” has the advantage of a near anatomic repair by coaptation of leaflet tissue with leaflet tissue, similar to a normal TV mechanism. The reconstructed TV is reattached at the true TV annulus at the atrioventricular junction. RV plication reduces the size of the enlarged RV and reduces the tension on suture lines. Relative contraindications to the cone reconstruction include age > 50 years, moderate pulmonary hypertension, severe LV dysfunction, or complete failure of delamination of septal and inferior leaflets with poor delamination of the anterior leaflet [58]. Due to severe true tricuspid annulus enlargement, an annuloplasty ring is often placed [43]. In the early reported surgical experience of 40 patients who had undergone the cone reconstruction, there was one operative mortality. At a mean follow-up of 4 years, one additional patient had died and two required repeat TV surgery [58].

Tricuspid Valve Replacement

- When TV repair is not feasible, bioprosthetic valve replacement is a reasonable alternative for adults with EA. Porcine bioprosthetic valves are preferred over bovine bioprosthetic valves, as the latter tend to cal-
cify at a faster rate in the TV position. Porcine valves are also preferred over mechanical valves due to good durability in the TV position and lack of need for warfarin anticoagulation [59]. In adults who require warfarin anticoagulation for another reason (i.e., atrial fibrillation), a mechanical valve may be considered, but should be avoided in cases of significant RV dysfunction, due to a greater propensity of TV thrombosis. The surgical technique involved in TV replacement involves deviating the suture line toward the atrial side of the atrioventricular node and membranous septum inferiorly to avoid injury to the conduction system, as well as cephalad to the atrioventricular groove anteriorly to avoid right coronary artery injury.

One and One-Half Ventricle Repair

- A bidirectional cavopulmonary shunt may be performed in select cases of severe RV dysfunction or if the TV repair has resulted in significant stenosis (mean gradient > 6 mmHg), which is often present in very cyanotic patients. By directing the superior vena caval blood to the branch pulmonary arteries, this procedure reduces the hemodynamic stress by reducing the volume of the RV by 35–45%, depending on the patient’s size. However, it is important to confirm that the pulmonary vascular resistance and left atrial pressures are low in order for this strategy to be effective [60, 61]. Disadvantages of the bidirectional cavopulmonary shunt include pulsations of the head and neck veins, facial swelling, and development of pulmonary arteriovenous malformations.

Summary

Ebstein anomaly is a rare, complex congenital heart defect with a broad anatomical and clinical spectrum. A thorough understanding of the underlying pathology and associated defects is critical to caring for the adult with EA. Newer imaging modalities are allowing increased understanding of the mechanisms of TV and RV function, and surgical modifications continue to be proposed in hopes of improving the long-term outcomes of patients with EA.

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Disclosure

No potential conflicts of interest relevant to this article were reported.
References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:

- Of major importance,
- Of importance,


The first paper to describe the technique for measuring the functional and anatomic right ventricle by cardiac MRI in patients with Ebstein anomaly. The right ventricle may be difficult to image by echocardiography and this paper will allow for standardized measurements.


Describes the clinical and procedural data of 32 catheter ablations in patients with EA. Accessory pathways were most common followed by intra-atrial reentry tachycardia and > 50% of patients had > one arrhythmia. Procedural success rates were high suggesting that catheter ablation is a reasonable first line therapy.


This large series demonstrated very good long term results with both tricuspid valve repair and replacement. In patients with a bioprosthetic valve, durability was good with 74% free of re-operation at 10 years.


