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EDITORIAL COMMENTARY

Cone the valve be repaired?

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See related article on pages 1144-50.

There have been more techniques of tricuspid repair described for Ebstein malformation than for any other valve abnormality. This is largely due to the apparently infinite anatomic variability present with this anomaly. The cone operation represents an important addition to the surgeon's armamentarium. Although there are basic principles for performing the cone repair, each reconstruction is slightly different depending on the anatomy of the valve and the subvalvular apparatus. The cone reconstruction is the most anatomically natural of all repairs described and can be applied across a wide range of valve morphology and ages. Early results of the cone reconstruction and operative technique have been reported previously by many investigators. In this issue of the *Journal*, Ibrahim and colleagues report their early results with a small series of patients ($n = 27$), with attention to postoperative outcome,

biventricular function, and exercise capacity.¹ Their results of reduction in tricuspid regurgitation grade and improvement in New York Heart Association functional class are similar to other reports in the literature. Two issues that Ibrahim and colleagues attempted to address in their current report that are lacking in the literature include detailed postoperative analysis of right ventricular (RV) size, RV function, and exercise capacity.

In the series of Ibrahim and colleagues,¹ all patients underwent a biventricular repair with atrial septal fenestration. Echocardiographic and magnetic resonance (MR) imaging demonstrated normal left ventricular function before and after the operation. MR imaging showed increased forward pulmonary blood flow and increased left ventricular filling that was probably due to tricuspid competence and not necessarily unique to the cone procedure per se. Interestingly, there were no postoperative reductions in RV end-diastolic and end-systolic dimensions. A reduction in RV size after tricuspid surgery for Ebstein anomaly has not been documented in the literature. Although we have seen the RV get smaller in some patients with Ebstein anomaly after tricuspid surgery, this has been unpredictable. This may be because of insufficient or inaccurate RV dimensions recorded by MR examinations before and after the operation, selective plication of the atrialized RV, the presence of a bidirectional cavopulmonary shunt, and a variable RV remodeling effect. In addition, MR imaging in this review demonstrated no evidence of postoperative improvement in RV function. Similarly,

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Disclosures: Author has nothing to disclose with regard to commercial support.

Received for publication Jan 10, 2015; accepted for publication Jan 12, 2015; available ahead of print Feb 19, 2015.

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0022-5223/\$36.00

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<http://dx.doi.org/10.1016/j.jtcvs.2015.01.016>

investigators have yet to predictably demonstrate objective improvement in RV function after any type of Ebstein anomaly repair.

The results of exercise testing before and after the operation were reported for 13 patients, and Ibrahim and colleagues observed a significant postoperative increase in oxygen consumption.¹ This increase in aerobic capacity after repair of Ebstein anomaly is consistent with reports from other centers. It is generally believed that the increment in aerobic capacity is related primarily to the elimination of the right-to-left shunt at the atrial level. It is unclear how much, if any, of the increase in aerobic capacity results from improving the competence of the tricuspid valve. Ibrahim and colleagues failed to report the peak heart rates that were achieved during preoperative and postoperative testing.¹ Documentation of the peak heart rate that was attained is critical to determining whether the change in oxygen uptake was related to improved aerobic capacity or simply to increased effort during the postoperative exercise test. Blood oxygen saturation did not change significantly from before to after the operation. In the report of Ibrahim and colleagues, the preoperative saturation was 87% and postoperative saturation 93%.¹ It is unclear whether the systemic arterial blood oxygen saturations that Ibrahim and colleagues report were rest saturations or peak

exercise saturations. In any event, it would be very unusual for the blood oxygen saturation *not* to increase after operation, unless some of the patients had an insignificant preoperative atrial shunt or a significant postoperative shunt. Ibrahim and colleagues should have provided more detailed information regarding the degree of atrial shunting in this cohort.

It is clear that the cone reconstruction for Ebstein malformation is the most anatomically natural of all repairs available. Early results demonstrate low early mortality and successful application to the many anatomic variations encountered with this defect. Whether these findings will translate into superior valve durability in the long term only can be answered with additional follow-up. The absence of change in RV size and function after cone reconstruction in this small cohort requires further prospective study with larger numbers of patients for a better understanding of the limitations and advantages of the procedure. Functional status and exercise tolerance appear to improve predictably after the operation.

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