Author has nothing to disclose with regard to commercial support.

INTRAOPERATIVE BALLOON DILATION IN TETRALOGY OF FALLOT: IS THERE A “SECRET SAUCE”?

Reply to the Editor:

Drs Vida and Stellin are to be congratulated for doggedly pursuing techniques that render pediatric cardiac surgery less morbid. One of the areas they are known for is the use of intraoperative balloon dilation in tetralogy of Fallot surgery. In their hands, intraoperative balloon dilation is only 1 step within a comprehensive management of the pulmonary valve during tetralogy of Fallot repair.¹ They have championed the use of more complex plasty maneuvers, including surgical delamination of hypoplastic or dysplastic leaflets, as well as patch reconstruction of damaged leaflets. Our unit has had a similar approach, using the same calibration of balloons they describe, aiming for an increase of the pulmonary annulus (after commissurotomy and balloon dilation) of 2 to 3 mm. However, our own results, specifically regarding long-term avoidance of reinterventions, have not been as good as the results reported in this letter.

Although I agree with the criticism that the choice of balloon size may have been too aggressive in Boston, resulting in a 20% rate of leaflet tears,² I don't agree with this letter's conclusion, which is that their results are superior simply because they size their balloons differently and perform different (or more aggressive) leaflet plasty maneuvers. The study by Hofferberth and colleagues² is a matched cohort analysis of 162 patients, a statistically speaking superior design, whereas the data from Padua are purely historical/retrospective data, which render biases such as hindsight bias almost impossible to eliminate. One may also ask why this technique has not been adopted widely. As far as published data, only Boston, Padua, and New York³ are on the map. It may be time to actively engage other centers, debate the technique in an open forum, and try to move the field forward.

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VALVE-SPARING REPAIR IN TETRALOGY OF FALLOT: DOES VALVE BIOLOGY DETERMINE LONG-TERM OUTCOME?

Reply to the Editor:

We appreciate the interest of Drs Vida and Stellin in our study and their thoughtful comments. We commend the Padova group for their innovative technical approaches to valve-sparing tetralogy of Fallot (ToF) repair.¹⁻³ Over the past decade, several valve-sparing techniques have been reported, but comprehensive long-term follow-up data have been lacking. As a consequence, valid assessment and comparison of surgical approaches remains a significant challenge.

The goal of our study was to comprehensively evaluate the midterm outcomes of a single valve-sparing repair technique performed at our center in 162 consecutive patients with ToF-pulmonary stenosis over the past decade. We found that valve-sparing repair with intraoperative balloon dilation is associated with a 15% early reintervention rate for residual valvar stenosis, the development of progressive pulmonary regurgitation, and subsequent right ventricular dilation.⁴ We believe these suboptimal results warrant careful reevaluation of the role of valve-sparing repair in the management of ToF-pulmonary stenosis. Moreover, these outcomes suggest that we, as a surgical community, may be best served to consider the impact of biological substrate on long-term valve function.

In our study, we observed that patients who underwent valve-sparing repair with intraoperative balloon dilation exhibited significant growth of the pulmonary valve annulus, with normalization of the annular z-score at midterm follow-up.⁴ Yet, over the same follow-up period, the cohort developed progressive pulmonary regurgitation, suggesting that valve leaflet growth was not commensurate with annular growth. This finding raises an intriguing

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question: Is the observed lack of leaflet growth/remodeling due to abnormal valve biology? More specifically, is long-term pulmonary valve function in ToF driven primarily by biological factors rather than surgical technique?

Although there are no existing data to directly address this question, previous reports, along with our own center's experience, may offer some valuable insights. In 2015, Vida and colleagues⁵ reported a histologic and morphologic analysis of pulmonary valve specimens obtained from 79 patients with uncorrected ToF. The study demonstrated mucoid dysplasia with fibrotic thickening at the leaflet free edge in 49% of pulmonary valve specimens. Furthermore, the authors found that the prevalence of valvar dysplasia was significantly higher in unicuspid (79%) and bicuspid valve (51%) specimens compared with patients with normal tricuspid valve morphology (29%).⁵ Our study found the presence of thickened/dysplastic valve leaflets was a risk factor for earlier-onset pulmonary regurgitation. Moreover, our center's overall experience with valve-sparing ToF repair

(including patients who underwent surgical commissurotomy only) demonstrated unicuspid valve morphology is associated with higher rates of early reintervention for residual valvar stenosis (Figure 1). These findings suggest an important interplay between native valve leaflet biology and morphology that may strongly influence long-term pulmonary valve function in ToF. Surgical intervention may acutely alter valve morphology to achieve a satisfactory short-term outcome. However, even in patients with excellent early valvular function, eventual valve deterioration seems common, suggesting that long-term biological behavior is not altered by surgical intervention. In the era of precision medicine, perhaps best long-term results may require a strategy tailored to the biological and genomic footprint of the pulmonary valve and the patient.

Irrespective of surgical technique, the results of our study highlight the importance of detailed follow-up in all patients undergoing valve-sparing ToF repair. We recommend that all centers performing valve-sparing ToF repair carefully monitor their outcomes. Comprehensive follow-up will enable accurate assessment of long-term pulmonary valve function and right ventricular function, which in turn will help inform better patient selection and choice of optimal surgical approach. Finally, alternative strategies

Pulmonary valve reintervention for residual stenosis

All valve-sparing repair cases at BCH - 2007-2015 (N = 207):
Pulmonary valve reintervention, N = 32

Unicuspid	18	9	4	4	2	2	1	1	0
Bicuspid	151	99	75	61	46	34	26	20	6
Tricuspid	38	28	24	20	17	14	9	4	1

FIGURE 1. Freedom from pulmonary valve reintervention for residual stenosis after valve-sparing ToF repair; stratified by valve morphology.

to creating a functional pulmonary valve at the time of primary ToF repair may be worth exploring.

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