Biventricular Conversion After Single Ventricle Palliation in Patients With Small Left Heart Structures: Short-Term Outcomes

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Background. Patients with borderline small left heart (LH) structures who initially undergo single ventricle palliation (SVP) may eventually become candidates for biventricular conversion (BC). The purpose of this study was to describe our surgical experience with BC in patients with small LH.

Methods. We reviewed our institution’s records for patients who underwent BC after an initial SVP between 1995 and 2012. Patients underwent an aortopulmonary amalgamation procedure as a part of their initial palliation. Data on imaging, BC operative details, and reinterventions after BC were collected.

Results. Twenty-eight patients underwent BC. Twenty patients had hypoplastic left heart syndrome (HLHS), 7 patients had unbalanced common atrioventricular canal (uCAVC), and 1 had interrupted aortic arch with VSD. Stage of palliation at BC was stage 1 in 6 patients (21.4%), bidirectional Glenn in 19 (67.9%), and Fontan in 3 (10.7%). Prior to BC, the median left ventricular end-diastolic volume (LVEDV) by echocardiography was 58.1 mL/m² in the HLHS group and 28.1 mL/m² in the uCAVC group. After BC, the LVEDV increased to 91.3 mL/m² in the HLHS group and 58.5 mL/m² in the uCAVC group (p < 0.05 compared with pre-BC in both groups). Right ventricular pressure was less than half systemic in 8 patients (53.3% of those measured). Seventeen patients (61%) have required either catheter-based or surgical reintervention. Twenty-five patients (89.3%) were alive at a median follow-up of 2.6 years.

Conclusions. Biventricular conversion can be applied to patients with HLHS and uCAVC and borderline LH with acceptable short-term results. Left heart size increases after BC, but follow-up for potential left atrial hypertension is warranted.

Select patients with borderline small LH structures who have undergone SVP may become candidates for biventricular conversion (BC), which may improve their long-term outcome. Biventricular conversion is characterized by takedown of the aortopulmonary anastomosis and reestablishment of separate left- and right-sided circulations. In neonates who are at high risk for initial biventricular repair, we have applied a staged left ventricular recruitment strategy in which the circulation is initially supported with SVP, and staged procedures are subsequently employed to relieve inflow and outflow tract obstructions and promote blood flow through the LV [7]. Approximately one-third of the patients with HLHS or Shone’s variants undergoing this strategy may eventually become candidates for BC. The purpose of this study was to describe our surgical experience and early outcomes with BC in patients with borderline small LH structures who have undergone previous SVP with initial palliative stage 1 reconstruction.

Patients and Methods

Patients with small LH structures who underwent BC after initial SVP between 1995 and 2012 at Boston...
Children’s Hospital were retrospectively reviewed. The SVP was defined by performance of neonatal or infantile stage 1 (Norwood or hybrid) procedure. We excluded patients who underwent aortopulmonary shunt alone or main pulmonary artery banding without aortopulmonary amalgamation. The decision to perform SVP in these patients was based upon the presence of 1 or more small left heart structures (z-score < −3) or significant LV dysfunction. We excluded patients who underwent SVP despite presence of adequate-sized left heart structures. Biventricular conversion was defined as takedown of a previously established aortopulmonary amalgamation in addition to takedown of either an aortopulmonary or cavopulmonary shunt. Patients who underwent BC after pulmonary artery banding, bidirectional Glenn procedure, or Fontan without previous aortopulmonary amalgamation were excluded. The study was approved by the Boston Children’s Hospital Institutional Review Board.

The hospital record was reviewed to collect demographic data, operative details, re-interventions after BC, and intensive care unit length of stay. All initial, pre-BC, and most recent echocardiograms were reviewed. Measurements were indexed to body surface area when appropriate. Right ventricular pressure (RVP) was estimated from the velocity of the tricuspid regurgitation jet (when present) and used as a surrogate for pulmonary arterial pressures. Hemodynamic measurements from cardiac catheterization were recorded preoperatively and postoperatively.

The primary outcomes of this study were technical details of BC and short-term clinical outcomes (mortality, need for re-intervention). Secondary outcomes included change in size of LH structures (indexed to body surface area) over time, as measured by echocardiography and magnetic resonance imaging (MRI).

All values are expressed as median (range). Comparisons were made with nonparametric Mann-Whitney tests. Statistical analysis was performed in GraphPad Prism version 6.0 for Mac (GraphPad Software, La Jolla CA).

Results
Patient Characteristics
Twenty-eight patients underwent BC during the study period. Twenty patients (71.4%) had hypoplastic left heart syndrome (HLHS), 7 (25.0%) had right-dominant unbalanced common atrioventricular canal (uCAVC), and 1 (3.6%) had interrupted aortic arch with ventricular septal defect (IAA-VSD). The initial SVP was performed at our institution in 15 cases (28.6% of uCAVC patients, 65% of HLHS patients). Risk factors for poor outcome with SVP (genetic syndrome, tricuspid regurgitation, or right ventricular dysfunction) were present in 14 (50.0%) of patients. Five patients (18.0%) had genetic abnormalities (1 with Turner’s syndrome, 3 with trisomy 21, 1 with a homozygous polymorphism). Four patients (14.3%) had significant AV valve regurgitation, and 6 patients (21.4%) had significant right ventricular dysfunction. At the time of BC, 6 patients (21.4%) had undergone only the stage I procedure (3 Norwood and 3 hybrid), 19 patients (67.9%) had undergone bidirectional Glenn, and 3 patients (10.7%) had undergone Fontan procedure. The median age at the time of BC was 42 months (4 to 95 months) in the entire cohort, and differed based upon diagnosis; 46.5 months (4.5 to 73.8 months) in the HLHS group and 11.3 months (5.1 to 95 months) in the uCAVC group. The patient with IAA-VSD was 6.9 months at the time of BC. Ten patients (50.0%) with HLHS and 4 patients (57.1%) with uCAVC were male; the patient with IAA-VSD was male.

The median number of surgical procedures prior to BC (including SVP) was 3 (1 to 5) and 2 (1 to 4) in the uCAVC group. In the HLHS group, 10 patients (50.0%) had endocardial fibroelastosis (EFE) resection, 11 patients (55%) had AV repair, 14 patients (70.0%) had MV repair, 5 patients (25.0%) had tricuspid valve repair, and 15 patients (75.0%) had atrial septal defect (ASD) restriction prior to BC. In the uCAVC group, 1 patient (14.3%) had atrioventricular valve repair and another patient (14.3%) had ASD restriction prior to BC.

Prior to BC, the median LV end diastolic volume (LVEDV) by echocardiography was 58.1 mL/m² (26.6 to 92.5 mL/m²) in the HLHS group and 28.1 mL/m² (16 to 86.2 mL/m²) in the uCAVC group. Preoperatively, 24 patients had cardiac MRI (85.7%). The median tricuspid valve to mitral valve flow ratio in HLHS patients was 1.08 (0.52 to 6.2). At preoperative cardiac catheterization, the median LV end diastolic pressure by was 12 mm Hg (6 to 20 mm Hg) in the HLHS group (n = 16) and 8 mm Hg (7 to 10 mm Hg) in the uCAVC group (n = 4). Three patients with intact ventricular septum and restrictive ASD had balloon occlusion of the ASD with measurement of left atrial pressure with loading of the LV.

Operative Details
Biventricular conversion procedure was performed through a reoperative median sternotomy and hypothermic cardiopulmonary bypass with single arterial and dual venous cannulation. The mean bypass time and cross-clamp times for BC were 152 ± 71 minutes and 90 ± 35 minutes, respectively.

Aortic Reconstruction
Aortic reconstruction was by direct re-anastomosis in 19 (68%) patients who had adequate sized LVOT and functional aortic valve. Pulmonary autograft reconstruction (Ross procedure) was necessary in patients with irreparable aortic insufficiency or residual LVOTO (n = 5 HLHS patients; 25.0%). The aorta was augmented with a patch in 9 patients (32.1%). Aortic reconstruction was as follows: GoreTex (W. L. Gore and Associates, Flagstaff, AZ) in 2 patients (22.2%), bovine pericardium in 3 patients (33.3%), pulmonary graft in 2 patients (22.2%), Dacron (DuPont, Wilmington, DE) in 1 patient (11.1%), and CorMatrix (CorMatrix Cardiovascular, Inc, Roswell, GA) in 1 patient (11.1%). Adequate mobilization of the coronary buttons is necessary during a Ross procedure because the native aortic root is significantly smaller than the pulmonary root. The coronary buttons are often implanted somewhat
more cephalad on the neo-aortic root in order to prevent distortion.

Right Ventricular Outflow Tract Reconstruction
Homograft conduit was utilized for 5 patients who underwent pulmonary autograft reconstruction of the LVOT. Direct re-anastomosis of the pulmonary artery was performed in 9 patients (32%). The pulmonary artery was patched in 14 patients (50%) as follows: GoreTex in 6 patients, bovine pericardium in 6 patients, pulmonary homograft patch in 1 patient, and CorMatrix in 1 patient.

Cavoatrial Reanastomosis
The superior vena cava was reanastomosed to the right atrium in 21 patients (75%). All patients (n = 3) with Fontan circulation had lateral tunnel type Fontan, which was amenable to simple baffle resection. Early in the series, superior vena cava (SVC)-atrial anastomosis was performed without patch augmentation, and led to SVC stenosis requiring balloon dilation and stenting (n = 2). Patch augmentation of the anterior portion of the SVC-right atrial junction was performed in 19 patients (67.9%) with either GoreTex (14 patients), bovine pericardium (3 patients), or CorMatrix (2 patients).

Management of Atrial Septum
Management of the atrial septum was based upon the surgeon’s subjective impression of the adequacy of LH structures at the time of BC. The atrial septal defect was completely closed at the time of BC in 10 patients (35.7%), whereas fenestrated closure was performed in 18 patients (64.3%). In patients undergoing fenestrated closure, the methods of atrial septal reconstruction included primary tissue reapproximation in 9 (32.1%) and patch closure with bovine pericardium or GoreTex and fenestration with 4 mm punch in 9 (32.1%). Our current practice is to close the ASD with a patch, and place a 4 mm fenestration. This seems to provide a balance between decompression of the left atrium and maintenance of adequate cardiac output.

Additional Procedures at BC
Table 1 shows associated operative procedures performed at the time of BC. Atrioventricular valve repair and resection of endocardial fibroelastosis were commonly required.

Clinical Outcomes
The median intensive care unit length of stay after BC was 18 days (3 days to 2.9 years) for the entire cohort. Postoperative extracorporeal membrane oxygenation was necessary in 3 patients (11%). At a median follow-up of 31.7 months (0.3 to 107 months), 25 (89%) patients are alive (Fig 1). One patient has required heart transplantation due to ventricular dysfunction secondary to technical complications involving coronary re-implantation. Seventeen patients (61%) have required either catheter-based or surgical re-intervention; including 6 of 7 uCAVC patients (85.7%) and 11 of 21 HLHS patients (55.0%). In total, 5 (17.9%) had transcatheter ASD dilation, 2 had stent placement in the SVC (7.1%), 8 (28.6%) had MV repair, and 1 (3.6%) had tricuspid valve repair. Figure 2 displays the rate of surgical re-intervention. Re-intervention for SVC stenosis was required in patients undergoing primary re-anastomosis without patch augmentation, but was not observed in patients who underwent anterior patch augmentation. Of “high-risk patients” (genetic abnormality, significant preoperative AV valve regurgitation, preoperative RV dysfunction), 6 HLHS patients (60%) and 4 uCAVC patients (100%) required re-intervention after BC. Of normal-risk patients, 5 HLHS patients (50%) and 2 uCAVC patients (66.7%) required re-intervention after BC. The median time to re-intervention in the high-risk HLHS and uCAVC groups was 4.6 and 3.1 months, respectively. The median time to re-intervention in the normal-risk HLHS and uCAVC patients was 11.2 and 3.1 months, respectively.

Left Heart Dimensions and Hemodynamics
After BC, the most recent median LVEDV by echocardiography had significantly increased to 91.33 mL/m² (56.6 to 251.5) in the HLHS group and 58.5 mL/m² (45.7 to 69.0) in the uCAVC group compared with the preoperative values (p < 0.05 in both groups). By postoperative catheterization, the most recent median LV end diastolic pressure was 17 mm Hg (9 to 29) in the HLHS group (n = 7, p < 0.05 compared with preoperative measurements) and 11 mm Hg (8 to 24) in the uCAVC group (n = 5, p = 0.079 compared with preoperative measurements). The RVp could be estimated by tricuspid regurgitation jet in 15 patients; RVp was less than half systemic in 8 (53.3%) of those patients. Of those with estimated greater than half-systemic RVp, a numeric RVp could not be estimated.

Table 1. Operative Interventions Employed During Biventricular Conversion

<table>
<thead>
<tr>
<th>Operative Intervention</th>
<th>HLHS-Variant (n = 20)</th>
<th>uCAVC (n = 7)</th>
<th>IAA (n = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic valve repair</td>
<td>6 (30%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Mitral cleft closure</td>
<td>0 (0%)</td>
<td>3 (42.9%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Non-cleft MV repair</td>
<td>11 (55%)</td>
<td>0 (0%)</td>
<td>0 (%)</td>
</tr>
<tr>
<td>Ross procedure</td>
<td>5 (25%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>EFE resection</td>
<td>4 (20%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Fenestrated ASD Closure</td>
<td>15 (75%)</td>
<td>2 (28.6%)</td>
<td>1 (100%)</td>
</tr>
</tbody>
</table>

ASD = atrial septal defect; EFE = endocardial fibroelastosis; HLHS = hypoplastic left heart syndrome; IAA = interrupted aortic arch; MV = mitral valve; uCAVC = unbalanced common atrioventricular canal.
in all cases. Of those that could be quantified, the median RVp was 61 mm Hg (50 to 70).

Comment

This study reports a single institutional experience with BC in a select group of children with borderline small LH who had undergone previous SVP with stage 1 reconstruction. Biventricular conversion was performed in patients with LVEDV as low as approximately 20 mL/m² in patients with uCAVC and as low as 30 mL/m² in patients with HLHS. Re-intervention after BC to address residual AV valve regurgitation and restrictive atrial septum was common. The LV size continued to increase after BC, yet persistent elevated left atrial pressure and right ventricle hypertension were observed at mid-term follow-up.

The goal of BC is to avoid the long-term complications associated with SVP. Fontan circulation is associated with a variety of long-term sequelae, including arrhythmias, thromboembolic events, hepatic dysfunction, protein-losing enteropathy, exercise intolerance, and neurocognitive deficits [8]. Transplantation is usually performed once complications have become progressive, and the waitlist as well as post-transplantation mortality is high in this population [9]. Certain populations of SVP with borderline LH, particularly those with tricuspid regurgitation, RV dysfunction, genetic syndromes, noncardiac comorbidities, and elevated pulmonary vascular resistance, are known to have the highest risk for poor long-term outcome, and BC may be a viable alternative in these patients who have the poorest long-term outcomes. More aggressive application of BC to patients without risk factors for poor SVP outcome may be warranted if long-term outcomes with BC, particularly left atrial pressure, are found to be favorable.

Data on BC after SVP are limited. Pearl and colleagues [10] reported on 6 patients with IAA-VSD who underwent SVP with subsequent BC, concluding that suitable candidates for biventricular repair were those with normal-sized LVs and mitral valve z scores of -3 or more. None of their 6 patients died, with a mean follow-up of 32 months. Data from our group demonstrated that a staged LV recruitment strategy in patients with borderline LH disease who underwent SVP increased LH dimensions over time. In a subset of patients, this strategy allowed establishment of biventricular circulation. While LV recruitment can include EFE resection, aortic or mitral valvuloplasty, transcatheter interventions, and addition of accessory pulmonary blood flow, ASD restriction was most strongly associated with an increase in LH dimensions over time and eventual BC [7]. Erez and colleagues [11] reported on a series of 13 neonates with IAA-VSD managed with initial Norwood palliation, and 6 eventually underwent biventricular repair (3 with Ross-Konno, 2 with Rastelli, 1 with VSD closure and LVOT resection). The current study expands the concept of BC to include patients with HLHS and uCAVC.

Timing and patient selection for BC after SVP requires careful assessment of clinical factors and size and function of LH structures by echocardiography and MRI. Mitral valve atresia is a contraindication to this approach, as is aortic atresia in patients with intact ventricular septum. Consideration should be given to the size of the mitral valve and presence of EFE, which may impede successful conversion but can be surgically addressed at a separate procedure or concomitant with BC. Patients with intact ventricular septum who have a small ASD can
be evaluated by cardiac catheterization and balloon occlusion of the ASD to assess left atrial pressure associated with loading the LV with a full cardiac output. Although there is not a threshold pressure beyond which BC is contraindicated, pressures less than 20 mm Hg upon balloon occlusion were generally considered acceptable. Even if a patient is technically a candidate for BC, the risk of SVP must be weighed against the potential for elevated left atrial pressure associated with biventricular circulation, especially given that BC shifts the cumulative risk of palliation in the hopes of avoiding the long-term complications of Fontan circulation.

Some of the increase in LV volume after BC may be attributed to septal shift associated with a decrease in right ventricular pressure. The septal position in patients with HLHS and uCAVC with large ventricular septal defect is often midline due to systemic right ventricular pressures, which complicates accurate assessment of true LV volume. Once the ventricular septal defect is closed and the right ventricular pressure drops, the septum shifts rightward, immediately increasing the LV volume. Accurate assessment of LV volume in patients with uCAVC by MRI or echocardiography is complicated by lack of septum at the base of the heart, leading to inter-observer variability in volume estimation. This may partly explain why patients with uCAVC may undergo BC with ostensibly smaller LV volumes on preoperative imaging compared with patients with HLHS.

The optimal timing of BC remains unclear. The majority of patients in this series underwent BC after bidirectional Glenn but prior to Fontan. In a series of patients undergoing staged LV recruitment, the greatest increase in LH dimensions occurred after bidirectional Glenn [7]. These patients have had additional time for flow-mediated remodeling of the LH. Additionally, LH rehabilitation procedures, including EFE resection and valvuloplasty, may be more feasible at the time of bidirectional Glenn [7]. Finally, complex intraventricular repairs associated with BC are more comfortably performed in an older infant beyond 1 year of age, and SVP may be well-tolerated in the first year of life, alleviating the urgency of biventricular conversion.

Long-term follow-up is necessary to determine the fate of left atrial and right ventricular pressures. Patients with congenital aortic valve stenosis demonstrate elevated left atrial pressures at late-term follow-up, raising concern of dysfunction in even a normal-sized left ventricle with a history of left side obstructive lesions [12]. Intrinsic myocardial abnormality may impair the diastolic function of these ventricles, thus limiting the long-term success of BC.

There are several limitations to this study. This is a single institution, retrospective study and is therefore inherently limited by selection bias and variability in practice as it involves a broad study period. This study is a descriptive series of a small number of patients, and it does not address risk factors for adverse outcomes from BC. Objective criteria for the selection of patients for BC and the various techniques are in evolution.

In patients at high risk for neonatal biventricular repair, SVP with eventual BC is a viable option. Biventricular conversion may be particularly attractive in patients at high risk for SVP. Although short-term survival is acceptable, re-intervention is common, and elevated left atrial pressures remain a concern for long-term follow-up. Until a larger body of data has been accumulated, these procedures should be performed in a select few centers with close monitoring of the outcomes.

References
least preservation of function. Are you really demonstrating growth here or just unmasking some difference in dimension with a difference in loading?

DR EMANI: I have been reticent to call it growth. We can call it increase in size at this point. To get to this, I think we need a precise method to noninvasively measure LV [left ventricle] mass to volume ratios to follow the LV. But what you really want to know is, what is the myocardium doing, how healthy is the myocardium. One way to get at this is by obtaining myocardial biopsies; another may be using newer MRI [magnetic resonance imaging] and PET [positron emission tomography] techniques to measure extracellular fluid. I think that remains an opportunity for future investigation. Perhaps that’s one of the reasons why left atrial pressures can continue to be elevated if you do relieve all anatomic obstructions; we know this is a concern in patients with critical aortic stenosis who otherwise have a normal size left ventricle. Even if you get good acute outcome from a balloon dilation, they come back years later, and even though they do not have any residual obstructive lesions, their left atrial pressures are elevated, and it probably points to some degree of diastolic dysfunction.

DR TWEDDELL: My other question is, you have provided median follow-up and overall survival, but I don’t see any survival curves. Do you think that would be helpful in looking at this?

DR EMANI: Certainly the majority of the events were early postoperatively. We’re still pretty early in the experience and the numbers are pretty small.

DR TWEDDELL: Well, you have got 17 years of data, right; 1995 to the present? That should be long enough to develop a survival curve.

DR EMANI: The numbers are still pretty low, but, yes, absolutely.

DR TWEDDELL: And perhaps comparing the outcome of this group to a control group that’s similar except that they remained in the single-ventricle pathway would be something else that might be worth looking at.

DR EMANI: I think matching with a cohort with similar risk factors and comparing long-term outcomes following single ventricle versus biventricular repair would be helpful. That is a little bit hard to do in our single institution because a lot of the patients with this type of anatomy would either undergo initial two-ventricle circulation if they have an LV that is okay, or biventricular conversion following staged left ventricular recruitment. But I think this is something that would be nice to compare in a multi-institutional study.

DR TWEDDELL: Thank you.

DR PETER J. GRUBER (Salt Lake City, UT): In your summary slide you had some discrete suggestions for LV volumes, and you said that in your analysis you used both echo MRI and cath. Can you expand a little bit on what cath [catheter] did or you used to inform your decision on this challenging set of patients?

DR EMANI: The MRI and echo obviously can give you a little bit of structural information. The cath, particularly if you can perform provocative testing, test occlusion of the atrial septal defect in patients who have an intact ventricular septum, may be helpful. I would say most of the AV [atrioventricular] canal patients, the cath was purely to document what the pulmonary vascular resistance was, and in the patients, particularly with trisomy 21 or elevated pulmonary vascular resistance, it confirmed our suspicion that they are going to be high risk for a single-ventricle palliation.

DR GRUBER: So you used cath on what percent of the patients?

DR EMANI: Pretty much all these patients got cathed.

DR GRUBER: And for those where you did test ASD [atrial septal defect] occlusion, what numbers were your cutoffs?

DR EMANI: Usually if the left atrial pressures were less than 20, then we would proceed. You have to add into the mix if there were residual defects from mitral regurgitation or aortic insufficiency that you can ameliorate at the time of the repair, then you would be more hopeful. So we put all of that together in making the decision.

DR JOSEPH FORBESS (Dallas, TX): Were any of these patients first stage palliated at your home institution or were they all done elsewhere?

DR EMANI: Combination.

DR FORBESS: Because the question that I would like to ask is, I am curious about what instigates the thought to go down this pathway. The patients with TR [tricuspid regurgitation], are they symptomatic, or is it just an inclination looking at their echo, hey, we can take them down a two-ventricle pathway? And then do you look at their panel reactive antibodies [PRAs]? Do you see how sensitized they are? Because I am just curious if you had a patient who has got a lot of TR who is living as a stage 1, if you look at their PRAs and they were insignificant, nothing, would you go down transplant or would you take them through this approach? I just wanted to hear your thoughts on that.

DR EMANI: A lot of the patients that we operate on we sort of a priori can enroll them into the strategy. So we know up front, okay, it’s probably going to be a high-risk biventricular repair and we will do it in stages, and I think that has sort of been the approach. And then down the road, if it turns out that there are risk factors for a biventricular conversion, then I think a transplant would be a more reasonable approach.

I think we are still trying to hone our criteria for saying this patient is more likely to fail a biventricular conversion versus not and then go down the transplant pathway. And for us, it’s a little bit confused by the fact that wait times and other issues with transplantation play into this. But I think in the future that’s the way that the decision making is likely to go.

DR DAVID M. OVERMAN (Minneapolis, MN): Congratulations, that was a nice presentation. I had a question about the smaller group of unbalanced AVSD [atrioventricular septal defect] patients, and maybe I missed it, but can you give us a sense of the amount of left AV valve dysfunction in that subset of patients after biventricular repair, and do you have any insights in terms of AV valve morphology or things that might favor or contraindicate biventricular conversion in that patient subset?

DR EMANI: We tend to be pretty aggressive in our management of the AV valve. Three of the patients who had an unbalanced AV canal who also had conversion ultimately had reoperations for...
mitral or left-sided AV valve insufficiency. A lot of patients obviously have single papillary muscles; they have complex anatomy that makes closure of the cleft more difficult. Again, we tend to split the papillary muscles, tend to try to create a more normal subvalvular anatomy to allow cleft closure to prevent left-sided AV valve regurgitation. It works sometimes, but we have to sometimes use other techniques, patch augmentation of leaflets and other repair techniques, to get it right, and one of the patients ultimately is probably going to need a mitral valve replacement.

I think that continues to be a work in progress and we are trying to refine our techniques of managing the very difficult AV valve.

DR PAUL CHAI (St. Petersburg, FL): That was a nice talk. I saw that in a few of your patients you did a hybrid procedure. I have a couple of questions about that. One is, if it seemed like they were borderline, why not just do a hybrid procedure instead of doing a Norwood, which you would end up having to take down? My second question is, how do you counsel these families who are already down the single-ventricle pathway? What do you tell them when you say you are thinking about converting them to a two-ventricle pathway? It seems to me it would be difficult to talk to families about that if their child seems to be doing well with a single-ventricle pathway and what it means to try to convert them to a two-ventricle pathway where it is maybe unclear whether two ventricles is really better?

DR EMANI: I am going to answer the second one first. I think it is a little bit easier when the kids come to us with RV [right ventricular] dysfunction, elevated pulmonary vascular resistance, they have genetic abnormalities or other things that put them at a higher risk, and I think the discussion is a little easier. A lot of the patients who have an otherwise good risk profile, if you will, for single-ventricle palliation, the discussion is a little more sanguine. I try to be as objective as possible with the discussion.

Again, the difficulty here is really trying to predict what's going to happen down the road. We know that up to the Fontan or even up to several years after the Fontan a lot of these kids do great. It's when they get into adolescence and into the adult years that we start to get into trouble. And so, the discussion really has to again weigh “pay me now or pay me later,” and I'm a pay me now kind of guy.

Southern Thoracic Surgical Association: Sixtieth Annual Meeting

The Sixtieth Annual Meeting of the Southern Thoracic Surgical Association (STSA) will be held October 30–November 2, 2013 at the Hyatt Regency Scottsdale Resort & Spa at Gainey Ranch.

The meeting will feature Surgical Motion Pictures, the STSA Post Graduate Program, an Ethics Debate, a Coding Update for 2014, and the STSA Scientific Sessions—including adult cardiac, general thoracic, congenital, and transplant breakout sessions.

The President's Invited Speaker is Doug Hanson. His talk on Friday morning titled “Distinctions of Success and Significance” will take place just prior to Robert J. Cerfolio, MD’s STSA Presidential Address titled “The Athleticism of Surgery and Life: How to be a super performer at work, home and in life.”

The Southern Thoracic Surgical Association is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians. STSA designates this educational activity for a maximum of 21.25 AMA PRA Category 1 Credit(s). Physicians should only claim credit commensurate with the extent of their participation in the activity.

Review a detailed program and register online at www.stsa.org through October 7. After this date, attendees must register on-site at the Annual Meeting; there will be an additional $50 charge for attendees registering on-site.