Venous valve saves the day for a patient with single ventricle and atrioventricular valve disease

Sitaram M. Emani, MD

From the Boston Children's Hospital, Boston, Mass.

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

Received for publication June 27, 2018; accepted for publication June 28, 2018; available ahead of print Aug 11, 2018.

Address for reprints: Sitaram M. Emani, MD, Department of Cardiovascular Surgery, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115 (E-mail: Sitaram.Emani@cardio.chboston.org).

J Thorac Cardiovasc Surg 2018;156:e215-6

0022-5223/\$36.00

Copyright © 2018 by The American Association for Thoracic Surgery

<https://doi.org/10.1016/j.jtcvs.2018.06.064>

Patients with a single ventricle with regurgitation of the systemic atrioventricular (AV) valve are among the most complex patients we treat. Repair of the tricuspid or common AV valve in newborn infants is seldom successful and associated with high mortality. Valve replacement options are limited and rarely offered to newborn or older infants. In a case report, Luo and colleagues¹ describe implantation of an externally stented bovine jugular vein graft (Melody Transcatheter Pulmonary Valve; Medtronic, Minneapolis, Minn) to replace the systemic common AV valve in a patient with single ventricle palliation.

Pediatric cardiac surgeons have become familiar with off-label use of devices and are frequently forced to modify existing technology for clinical application. The story of the Melody valve for surgical valve replacement is a good example of this reality. Originally designed for transcatheter pulmonary valve replacement in adolescents and adults, it has been repurposed for surgical valve replacement in children with small annuli (<15 mm).^{1,2}

Did the surgeons have any other choice of valve replacement? The annulus of the valve in this case report was approximately 20 mm. At this size, there are certainly mechanical and bioprosthetic options that are commercially available. Does a Melody valve provide any advantage over any of these other valves? Mechanical valves require anticoagulation with either warfarin or enoxaparin, which can be quite difficult to manage in an infant, and risk of prosthetic valve thrombosis is a significant complication. On the other hand, bioprosthetic valves do not require long-term anticoagulation, although short-term anticoagulation is prudent. However, an important consideration of bioprosthetic valves and mechanical valves is the relatively large opening and closing forces necessary to maintain adequate function of these valves. In contrast, the bovine jugular vein graft is made of venous valve leaflets that are gossamer, requiring relatively minute opening and closing forces. The contribution of leaflet inertia to early valve function and long-term durability has not been carefully

A valve for any occasion.

Central Message

An externally stented bovine jugular vein graft should be considered for patients with single ventricle atrioventricular valve disease.

See Article page e211.

examined. Theoretically, poor mobility of leaflets early after implantation may predispose to further leaflet immobility through calcification and fibrin deposition. In my opinion, if you have to place an oversized valve into the atrioventricular position and newborn infant or older infant, better to use a venous valve rather than a traditional mechanical or bioprosthetic valve.

Its favorable internal to external orifice diameter is another advantage of the Melody valve compared with other commercially available mechanical or bioprosthetic valves. Especially in children with small annuli, traditional valves suffer from several millimeters of sewing cuff and housing apparatus that result in loss of luminal orifice area. On the other hand, the Melody valve has an extremely thin housing (<0.5 mm), resulting in excellent internal to external orifice area ratio. For most of our patients, every millimeter counts. The patient in this case report had an annulus that was sufficiently larger than what was needed, so a traditional prosthesis may have been an option from this standpoint.

Another feature of the Melody valve that makes it appealing for pediatric valve replacement is an ability to expand the graft over time as a child grows. Previous studies have shown ability to dilate the valve years after implantation. However, the maximal size of expansion for the Melody valve is 22 mm. Melody is advantageous for patients with annular size < 19 mm, the advantage diminishes if the annulus size at implantation is > 19 mm.

The Melody valve is long, and an important technical consideration is modification of the valve to avoid outflow

tract obstruction. In patients with aortopulmonary amalgamation, outflow tract obstruction is unlikely to occur following AV valve replacement. However, in a patient with unbalanced AV canal defect, the position of the ventricular septum is important to consider because it may interfere with the distal aspect of the Melody valve and lead to obstruction of outflow from the distal aspect of the valve. Preoperative planning based on imaging studies is crucial to determine the proper orientation and necessary valve modifications. One must be very cautious about valve modifications that might predispose it to early failure and stent fractures. Our preference has been to avoid any modification of the stent if it can be avoided. The only recommended modification is addition of sewing cuff to the central portion of the valve to facilitate intra-annular implantation and avoid perivalvular leaks. The material used for the skirt should be capable of expansion yet bulky enough to create a seal between the valve and annulus.

A significant concern with valve replacement in patients with single ventricle palliation is management of the chordal support structure. Chord-sparing valve replacement is a popular technique utilized for adult valve replacement, but is less commonly utilized in treatment of newborn infants and older infants. Disruption of the support

structures is likely to permit ventricular dilation over time and may contribute to the poor long-term prognosis of single-ventricle patients who have undergone valve replacement.^{2,3}

The Melody valve has many favorable characteristics that make it suitable for use as a surgical heart valve for newborn and older infants. In patients with single ventricle and irreparable AV valve disease, this technology may play an important role. Detailed analysis of the preoperative anatomy and customized approach are necessary given current valve design. Will this valve provide a lifetime solution for patients with single ventricle and difficult AV valves? Probably not, but at least it gives the children a fighting chance.

References

1. Luo S, Van Arsdel GS, Honjo O. Systemic atrioventricular valve replacement with a Melody valve in an infant with a single-ventricle physiology. *J Thorac Cardiovasc Surg.* 2018;156:e211-3.
2. Emani SM, Piekarski BL, Zurakowski D, Baird CA, Marshall AC, Lock JE, et al. Concept of an expandable cardiac valve for surgical implantation in infants and children. *J Thorac Cardiovasc Surg.* 2016;152:1514-23.
3. Sugimoto K, Hirata Y, Hirahara N, Miyata H, Suzuki T, Murakami A, et al. Mid-term result of atrioventricular valve replacement in patients with a single ventricle. *Interact Cardiovasc Thorac Surg.* June 2, 2018 [Epub ahead of print].