The missing piece of the puzzle?

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A multitude of options are used to replace the dysfunctional mitral valve in pediatric patients,¹ but still we lack a device that offers small size adaptability, allows growth, and proves durable enough to allow the safe deferral of more definitive treatment. The unconventional use of the Medtronic Melody valve (Medtronic Inc, Minneapolis, Minn) in the mitral position has provided an important step toward those objectives.² The early report is that this valve is functional, redilatable to compensate for growth, and suitable for implantation in very small patients.³ The use of the Edwards Sapien 3 transcatheter heart valve (Edwards Lifesciences Corporation, Irvine, Calif) reported by Chai and colleagues in this issue of the *Journal* gives this hybrid approach another exciting twist.⁴

The Sapien 3 valve has characteristics that can address the demanding requirements of mitral valve replacement in infants. The valve has a relatively low frame height, wide strut angles, and a polyethylene terephthalate skirt on its proximal outer aspect. In contrast, the Melody valve, a stent-mounted bovine jugular vein, is relatively long, is covered over its entire length, and lacks an external skirt. The features of the Sapien 3 valve address technical aspects that have previously caused problems with the use of the Melody valve. The longer height of the Melody valve necessitates manual shortening of the frame to ensure adequate positioning in small ventricles.^{5,6} Furthermore, the protrusion into the left ventricular cavity can impair the left ventricular outflow tract. This potential problem has been addressed by an additional left ventricular fixation suture to ensure proper alignment, although such a suture has been used inconsistently in clinical reports.⁵ The open-frame design of the Sapien 3 valve helps to avoid obstruction within the ventricle and left ventricular outflow tract, in contrast to the covered design of the Melody valve. The polyethylene terephthalate skirt, initially thought to reduce paravalvular leakage after aortic valve replacement, can be used for the placement of valve sutures. Analogously, a felt implantation skirt has been constructed manually for the Melody valve to facilitate proper fixation.

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Central Message

The Edwards Sapien 3 transcatheter aortic valve offers design features that make it suitable for mitral valve replacement in infants.

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An aspect that has not been discussed, but that may prove beneficial, is that the Melody and the Sapien valves have been developed initially for different purposes, the former being a pulmonary valve and the latter an aortic valve replacement device. Although we have some information on the durability of the Melody valve in a high-pressure environment,⁷ the favorable applicability of the Sapien valve in the mitral position has already been demonstrated extensively in numerous reports of adult patients.

From the preliminary experience with the Melody valve in the mitral position, we know that the subvalvular apparatus can impair valve position and function. Excision and preservation of the leaflets, chordae, and papillary muscle have therefore both been described.^{3,5} The shorter frame of the Sapien valve may allow preservation of the subvalvular apparatus and thus improve ventricular geometry and function in the long term.

The reported paravalvular leak seen in one of the patients of Chai and colleagues—although small—may indicate that a balance must be sought between properly sealing the mitral annulus with the prosthesis, either by sutures or by expansion of the device, without compromising the valve's potential for redilation. It is unknown how much radial force can be applied to a mitral valve annulus. Furthermore, whether the pliability of the relatively thin jugular vein leaflets is advantageous in an incompletely expanded valve needs to be evaluated. The reduced compliance of bovine

pericardium may have less favorable valve dynamics in this setting.

Publications on the long-term outcome after mechanical mitral valve replacement in the pediatric patient group in the recent era indicate improved perioperative mortality.^{8,9} The lack of annular growth cannot be compensated for by intentionally oversizing the valve prosthesis. In fact, the greater the prosthesis size in relation to the patient size, the worse the outcome.⁹ The Melody and the Sapien 3 valves offer excellent options to overcome this limitation; however, we do not yet know the efficacy or durability of redilation after the initial implantation of these devices.

Although very promising, the current experience with the use of transcatheter valves in the mitral position in pediatric patients is based on a few case reports and series. It will be both fascinating and crucial for patients who have this challenging indication that future reports carefully assess the outcome of this innovative approach for a longer period. It is to be hoped that these reports will also stimulate continuing improvements in prosthetic valve design targeting the neonatal population. The enthusiasm for these new valve prostheses should be tempered by the long legacy of failed design innovations in small valve sizes. Furthermore, recent reports demonstrating the remarkable inherent capacity for adaptive growth of the neonatal mitral valve apparatus after repair of chordal rupture^{10,11} should create a focus on efforts to advance the competitive option of valve repair. Reparative and newer prosthetic options for neonatal mitral valve disorders can be seen as integrated tools for helping more

effectively to address the long unsolved puzzle of infant valve disease.

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