degeneration process for animal-derived tissue would bring more benefit to patients than designing a new transcatheter device based on a regular porcine or pericardial bioprosthesis. Surgeons can lead a collaboration with polymer scientists to develop a biostable and biocompatible polymeric material design to withstand the mechanical microenvironment of a cardiac valve.² Developing an autologous and living valve by tissue engineering is a complex task but needs more brains to be accomplished. Expandable valves or valved conduits that can be implanted surgically in a neonate and expanded at the catheterization lab multiple times to accommodate the growth without implanting a new device each time are currently being developed by some surgeon-scientists.^{3,4}

As Tannous and Nugent¹ nicely show, transcatheter PVR will be a good solution for many patients with native RVOT. But let's not be blinded by transcatheter innovations that

still expose patients to repeat procedures. Let's think disruptive. Let's think revolutionary. Let's think as surgeons.

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Commentary: Transcatheter valve therapy for the right ventricular outflow tract: Right as rain, ready for Roger

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Transcatheter therapy revolutionized the care of pediatric and adult patients with congenital heart disease. More than 2 decades have passed since the introduction of transcatheter pulmonary valve (TPV) implantation by Bonhoeffer and colleagues,¹ which resulted in significant paradigm shift in the way we think about the right

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CENTRAL MESSAGE

Transcatheter pulmonary valve implantation in both native and nonconduit-related right ventricular outflow tract is a valid alternative to standard surgery. Long-term data are needed.

ventricular outflow tract (RVOT). Although the most common underlying indication for TPV is previous surgical repair of tetralogy of Fallot (ToF) with pulmonary stenosis, a fair number of patients have pulmonary atresia with primary transcatheter intervention to open the RVOT.

The indications for pulmonary valve replacement have been clear and the majority of these patients present with chronic free pulmonary regurgitation with evidence of right ventricular volume overload. Transcatheter

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therapy did not emerge as an additional treatment modality only, but it also changed timing of interventions. The idea of not having a repeat operation sooner resulted in a significant number of these patients being followed until symptoms develop that may be associated with worsening right ventricular function that escalates the risk of subsequent surgery. The emergence of this less-invasive modality and the added advantage of having a shorter recovery resulted in lower threshold for reinterventions. However, this should not be the way we think because there should be no difference in the indication or timing for reinterventions, it is only a different approach.

The technology is evolving, and Melody valve (Medtronic, Minneapolis, Minn) is no longer the only option for TPV implantation. Sapien 3 (Edwards Lifesciences, Irvine, Calif) has emerged as a good alternative.² Tannous and Nugent³ have summarized the status of TPV therapy in both native and nonconduit RVOT.³ Although their review is more or less a broader context to the application of TPV therapy, one cannot ignore the following facts:

1. No long-term data are available for the durability of these transcatheter valves.⁴ The expectations that these valves should last at least the same duration as standard surgical prostheses.
2. Apart from ongoing clinical trial, the majority of the use of transcatheter valves has been off label and the reported success rate in the large study by Martin and colleagues⁵ is only 58% which is not acceptable when these are compared with standard surgical prostheses.⁵ Failure was mostly related to a large RVOT. Newly developing prostheses and the introduction of self-expanding valves may change this.⁶
3. Although mortality is low, procedural complications are not trivial, and include conduits disruption, prosthesis malposition or embolization, and injury to cardiac structures such as the tricuspid valve.⁷
4. Infective endocarditis risk remains, however high in comparison to standard surgery—especially in younger patients.⁸ Although these data are more related to transcatheter valves in conduits and valve-in-valve therapy. The risk, theoretically, could be lower in native RVOT, but we have no evidence to support that yet.
5. Patient satisfaction and expectations are important in the decision making, but patients have to be provided with the full story, especially when it comes to placement of these prostheses in native RVOT. Majority of these patients are young and realistically the majority will need at least 1 operation during their lifetime. Is it better to proceed with standard surgical placement followed by valve-in-valve later or to proceed with native RVOT TPV placement first? This question remains unanswered, and mostly left to each center's practice pattern.

Other questions remain to be answered:

1. Will the behavior of these prostheses be different in native versus nonconduit RVOT?
2. What is the expected longevity of these prostheses in patients with pulmonary ventricle to pulmonary artery conduits? In other terms, does placement in orthotopic versus extra-anatomical position make a difference in the longevity of these prostheses?

Currently, the majority of transcatheter therapy is performed in nonconduit patients but this may change with improving results and longevity of those requiring pulmonary ventricle to pulmonary artery conduits. It will be also interesting to see the future trends in transcatheter therapy for those with previous repair of ToF. As we know, the surgical technique for ToF repair has evolved as well. The old concepts of cutting all muscles in the RVOT, removing native valve leaflets, and creating a large transannular patch have changed. The goal of the repair now is preservation of native pulmonary valve competency at all cost. Leaving the operating room with an acceptable RVOT gradient is justified to protect right ventricular function for the long-term.

It all starts with the first operation, and proper surgical planning will probably decrease the number of patients who will require repeat operations, at least in the most common category: ToF with pulmonary stenosis. When it comes to reintervention, a heart team approach should be the standard of care with both surgeon and interventional cardiologist involved in the discussion with the patient, so the patient can hear all sides of the story.

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