found that stentless porcine valves were significantly less durable than either stented porcine or bovine tissue valves.

Because of the heterogeneity of congenital heart lesions, the differing techniques for valve implant and right ventricular outflow tract reconstruction, the numerous valve types available for PVR, the different manufacturing techniques, and the continued introduction of new bioprosthetic valves into clinical practice, it is difficult—if not impossible—to determine the optimal valve choice in the pulmonary position. Adding to the complexity of the decision of valve choice are new techniques for transcatheter valve-in-valve replacement, and all future PVRs should account for the feasibility of future transcatheter interventions. Kwak and colleagues⁵ have provided valuable clinical insights comparing 2 specific valves in the pulmonary artery position and have demonstrated superior durability in the porcine bioprosthetic valve. Nevertheless, literature offering insights into valve choice is almost entirely retrospective, and this article is no different. There are not enough data to extend their conclusions to other or future bioprosthetic valves. Rigorous scientific studies are needed to determine the best type of xenogenic pericardial material

(bovine vs porcine) and if there may be an individualized response to these valves (preformed or acquired antixenogenic antibodies).

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Commentary: The conundrum of pulmonary valve substitutes

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Bioprosthetic valves have become the preferred option for pulmonary valve replacement in many congenital cardiac centers.¹ In their report in this issue of the *Journal*, “Long-Term Durability of Bioprosthetic Valves in Pulmonary Position: Pericardial Versus Porcine Valves,” Kwak and colleagues² have retrospectively reviewed their

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Tissue-engineered pulmonary valve conduit seeded with cord mesenchymal stromal cells.

CENTRAL MESSAGE

Considering their significant tissue degeneration at follow-up, is it time to reverse the trend toward using bioprosthetic valves for pulmonary valve replacement in young patients for the next decade?

experience with the Hancock II (Medtronic, Minneapolis, Minn) and Carpentier-Edwards Perimount (Edwards Lifesciences, Irvine, Calif) valves in 248 patients from 2

institutions between 2001 and 2009. Their main message is the superiority of the Hancock II valve in terms of reoperation and prosthetic valve failure free rate compared with the Carpentier-Edwards Perimount valve at 15 years of follow-up. Conducted as it was in 2 separate centers, this observational study inevitably presents significant bias, particularly regarding differences in the indication for reintervention and variability in echocardiographic assessment of velocities through a bioprosthetic valve, influencing the definition of valve deterioration. Furthermore, the Kaplan-Meier estimates at 15 years are not valid, because the number at risk drops sharply below 10% of the starting number being studied, making the comparison between the 2 groups at 15 years of follow-up not accurate.

Despite these limitations, Kwak and colleagues² are to be congratulated for presenting one of the largest series of pulmonary valve replacements comparing two very commonly used bioprosthesis. The principal underlying pathologic process of bioprosthetic valve deterioration is leaflet calcification,³ and this process is markedly accelerated in younger patients although the mechanisms accounting for the effect of age are uncertain.⁴ The pathologic analysis of the explanted bioprosthesis in this study showed leaflet calcification and fibrosis to be the single most important mechanism in structural valve degeneration in the Carpentier-Edwards Perimount valves, whereas the Hancock II valves were more prone to leaflet tearing, with milder calcium deposition and fibrotic changes.

Despite these histologic differences, the main message from this study is still the significant structural degeneration observed in both bioprostheses at follow-up, especially in the young population. The overall freedoms from prosthetic valve failure were 98.8% at 5 years, 84.4% at 10 years, and 57.0% at 15 years. Other studies of bioprosthetic valves in the pulmonary position have shown 10-year cumulative incidences of reintervention ranging from 10% to 35%, with valve dysfunction as high as 50%.⁵⁻¹⁰ In their series, Kwak and colleagues² used only aspirin postoperatively, although the use of vitamin K antagonist might have played a protective role against subclinical thrombosis triggering the degenerative process,^{11,12} especially in the Carpentier-Edwards Perimount valves.

Our group has recently reported a long-term comparison between different types of bioprostheses versus homografts in the pulmonary position, showing lower transvalvular gradients and lower incidence of structural valve deterioration in the homograft group.¹ Furthermore, decellularized

pulmonary valve homografts as pulmonary valve replacements have also shown good functionality and freedom from reoperation.¹³ While we wait for new cellular tissue engineering developments to be translated into clinical studies, is it time to reverse the trend for the next decade and reduce the number of bioprosthetic valve used for pulmonary valve replacement in the young population?

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