The revolution and evolution of mechanical valves: The ball has left the cage

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Significant advances have been made during the last half century in the design of mechanical valves. The 1960s, especially, was a significant period in terms of valve innovation and development. Ball valves were first implanted in the descending thoracic aorta by Hufnagel and colleagues (circa 1950s).¹ Harken and colleagues² later, in the early 1960s, implanted the caged ball valve in a subcoronary position. It was not, however, until a retired pump engineer, Miles Edwards, and a young cardiac surgeon, Albert Starr, designed the Starr-Edwards (SE) ball-in-a-cage mitral valve (MV), with promising initial results.³ SE MV design initially began with the poly(methyl methacrylate) cage design and was later refined into the cobalt-chromium alloy cage design with cloth-covered valve orifice and bare metal struts. Valve design and development progressed remarkably with the advent of the tilting single-disc design to the contemporary bileaflet design, which led to the extinction of the SE valves after discontinuation of their production in 2007.

In this issue of the *Journal*, Battaglia and colleagues⁴ report an interesting case of a patient whose SE MV had been implanted 42 years previously (1974) for rheumatic mitral stenosis. Impressively, the patient denied any significant thrombotic or hemorrhagic complications and had only had dyspnea and fatigue develop 2 years previously. Transthoracic echocardiography showed mildly elevated transvalvular gradients with early-onset pulmonary hypertension, tricuspid regurgitation, and right heart dysfunction. At surgery, extensive pannus formation and mitral annular calcification were noted, which necessitated decalcification. Replacement of the SE valve with a 25-mm bileaflet valve, concomitant biatrial cryomaze, and tricuspid repair with a 27-mm Duran band (Medtronic Inc, Minneapolis, Minn) was performed. The patient demonstrated extreme diligence in managing her anticoagulation, which also likely helped to avoid any hemorrhagic and thromboembolic complications such as are often reported with the SE MV.⁵⁻⁸

More than half a million SE valves were implanted globally between 1960 and 2007, with 300,000 implanted during

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Central Message

The engineering prowess and creativity with the Starr-Edwards mitral valve has been revolutionary. In many ways, it ushered the modern era of valve surgery.

See Article page e147.

the last 7 years of its production (company data). Although lower survivals at 30 years with the SE valves have been reported, recent case reports have demonstrated durability beyond 30 and even 40 years.⁵⁻⁸ The observation that many patients still have these valves warrants accurate assessment by clinicians caring for these patients. Accurate assessment of pressure gradients across an SE valve is difficult because of the unique (noncentral) flow pattern. Likewise, pannus formation is challenging to visualize on transthoracic echocardiography,⁹ which may also influence treatment decisions. Timing of reoperative mitral surgery in the setting of SE MVs, although arguable, should be based on coexisting symptoms of pulmonary hypertension or right heart failure.

Can the ball-in-a-cage valve make a comeback? This is very doubtful for surgical implants. Perhaps one day, however, a catheter-based mechanical valve may be based on a cage design with a collapsible ball that could be deployed percutaneously. After all, who would have imagined 10 years ago that bioprosthetic transcatheter valve replacement would become an established reality? For now, it is safe to say that the ball has left the cage.

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