

# NEXT-GENERATION TAVR



**A look at the future of  
percutaneous valve replacement.**

# Lotus Valve

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**T**ranscatheter aortic valve replacement (TAVR) has demonstrated promising outcomes, with significant reductions through 2-year follow-up in mortality and repeat hospitalization rates compared to standard medical therapy in patients who are unsuitable for surgical valve replacement<sup>1</sup> and similar mortality rates compared to surgical valve replacement in high-risk patients.<sup>2</sup> However, TAVR is associated with an increase in the stroke risk compared to surgical valve replacement.<sup>2,3</sup> In addition, paravalvular regurgitation occurs more frequently

after TAVR compared to surgical valve replacement and has been associated with an increased risk of mortality.<sup>2,4</sup>

Although careful patient selection is important in determining the risk of adverse events and the potential benefit of TAVR,<sup>5,6</sup> improvements in valve design may also reduce the risk of adverse events by facilitating more accurate placement, reducing the learning curve, and minimizing or eliminating paravalvular aortic regurgitation. The Lotus aortic valve replacement system (Boston Scientific Corporation,

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## COVER STORY

(*Lotus Valve, continued from page 47*)

Natick, MA) is a fully repositionable device that is designed to facilitate accurate delivery with minimal paravalvular regurgitation. This article describes the design and function of the Lotus valve, presents a case study highlighting valve implantation, and describes the REPRIS clinical program.

### LOTUS DEVICE OVERVIEW

The Lotus valve system incorporates several features that are intended to facilitate safe and accurate placement and reduce paravalvular aortic regurgitation: (1) the valve is preattached to the delivery system to simplify preparation and eliminate the need for special tools or fixtures for valve preparation and loading; (2) a simple, predictable deployment process with valve function early in deployment to facilitate correct placement of the implant during initial deployment; (3) the ability to reposition the device if the initial deployment is considered to be suboptimal, as the valve can be completely retracted into the delivery sheath if necessary; (4) the ability to safely retrieve the device during the procedure if the decision is made to not implant the valve; and (5) the addition of the Adaptive Seal on the exterior of the implant to minimize paravalvular regurgitation.

The Lotus valve system is composed of two principal elements: a bioprosthetic aortic valve implant and a catheter-based delivery system for introduction and delivery of the valve implant. The Lotus valve is preattached to the delivery system in an integrated package to facilitate ease of use (Figure 1). The delivery system incorporates an ergonomic and intuitive handle design with two controls: a control knob and a release collar (Figure 2). The control knob deploys and locks the device when turned counterclockwise and unlocks and retrieves the device when turned clockwise. The device can be repositioned and redeployed at any time prior to final release by turning the control knob in the desired direction. Valve release is accomplished by sliding the release collar forward and turning it clockwise. These functions and turning directions are indicated by images on the handle.

The components of the bioprosthetic aortic valve implant are shown in Figure 3. The implant consists of three bovine pericardial leaflets that are supported on a braided nitinol frame. A radiopaque marker is located at the vertical center of the implant. The Adaptive Seal surrounding the ventricular portion of the device is designed to conform to irregular surfaces of the native anatomy to reduce paravalvular aortic regurgitation.

An important feature of the Lotus valve is that the device begins to function early in deployment, allowing the operator ample time to precisely position the device and subtly advance or retract the valve as needed. If initial deployment is deemed to be suboptimal, the valve can be partially or



**Figure 1. Valve and delivery system.** The valve is preattached to the delivery system to simplify preparation and eliminate special tools or fixtures for valve loading.

fully resheathed and repositioned at any time prior to the final release.

### CASE PRESENTATION

This case example is presented to illustrate the deployment of the Lotus valve. This case was conducted as part of the REPRIS clinical study (described later).

#### Demographics and Medical History

The patient was an 86-year-old woman with type II diabetes mellitus (diet controlled), obesity, a history of esophageal ulcer (> 5 years preprocedure), diverticulitis with previous sigmoid colectomy, osteoarthritis, polymyalgia rheumatica, vitamin B<sub>12</sub> deficiency, and asbestos plaques on computerized tomography scan. She presented with severe symptomatic aortic stenosis (New York Heart Association class III), and echocardiography revealed a mean pressure gradient of 41 mm Hg, a peak pressure gradient of 70 mm Hg, an aortic valve area of 0.8 cm<sup>2</sup>, and a left ventricular ejection fraction of 65%. She had no history of cardiac surgery. Angiography that was performed prior to the procedure showed no significant coronary artery disease. She had a previous cerebrovascular accident (> 12 months before the procedure) and was taking aspirin and dipyridamole. She had mortality and morbidity Society of Thoracic Surgeons scores of 6.06% and 26.49%, respectively, and a logistic EuroSCORE of 11.96%.

#### Procedure

A temporary pacing wire was placed via a 6-F sheath in the right internal jugular vein, and a 6-F sheath was placed in the left femoral artery. Simultaneous pressure measurements in the left ventricle and aorta showed a peak-to-peak gradient of 54 mm Hg. An 18-F Lotus introducer sheath

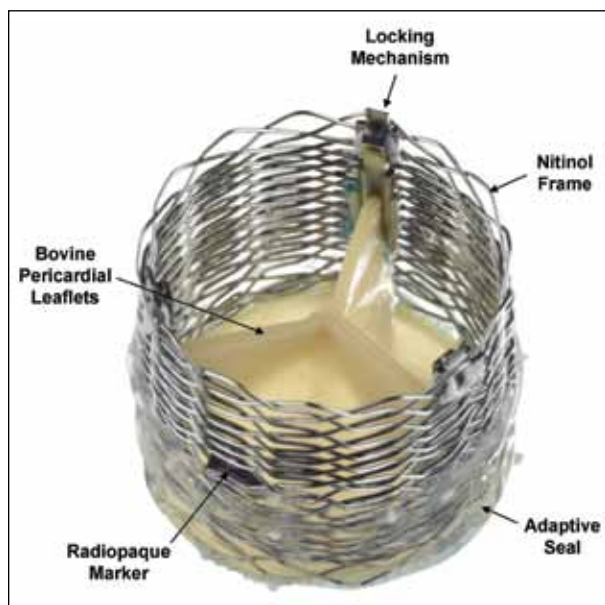


**Figure 2.** Delivery system handle design. The handle consists of two components: the control knob (blue), which unsheaths and locks the valve when rotated counterclockwise or unlocks and resheaths the valve when rotated clockwise, and the release collar, which releases the valve from the delivery system with clockwise rotation. The handle design ensures that the sheathing, locking, and release steps are performed in the appropriate sequence. Positioning of the valve can be adjusted at any point up until the final release.

was introduced into the right femoral artery, and balloon valvuloplasty was performed with an 18-mm X 4-cm balloon with rapid ventricular pacing under direct fluoroscopic guidance. There was no significant waist after valvuloplasty. Images of the Lotus valve implantation procedure are shown in Figures 4 and 5.

**Crossing the annulus.** The catheter was advanced across the annulus over a super stiff guidewire (0.035-inch, 260-cm) and positioned so that the tip of the catheter was just on the ventricular side of the annulus (Figure 4A).

**Valve unsheathing.** Unsheathing was initiated by rotating the control knob of the handle counterclockwise. During



**Figure 3.** Lotus aortic valve components. The valve consists of three bovine pericardial leaflets attached to a braided nitinol frame. A radiopaque marker, situated in the center of the valve frame, facilitates accurate placement, while the Adaptive Seal, located on the outside bottom half of the frame, is designed to minimize paravalvular regurgitation. The valve implant is attached to the delivery catheter through a locking mechanism.

unsheathing (Figure 4B), the once-elongated valve frame shortens and radially expands, and the radiopaque marker advances from its initial position and moves toward the ventricle. Once in the optimal position, the operator manipulated the catheter to maintain marker position. Valve function began early in the deployment process, approximately at the point when the marker band exited the catheter, providing hemodynamic stability of the patient during the procedure and enabling the operator to complete the delivery process in a careful and controlled fashion. While maintaining marker alignment, the operator continued to unsheath the valve (Figure 4C and D), resulting in radial expansion and anchoring the valve within the aortic annulus. At this stage, aortography (Figure 5E) and transesophageal echocardiography were performed to evaluate valve position. Based on these assessments, it appeared that the valve was positioned slightly too ventricular.

**Repositioning and locking.** The valve was partially resheathed, and the catheter was retracted slightly (approximately 2 mm) back into the aorta, as shown in Figure 5F. When optimal positioning was achieved, the deployment process was reinitiated. The valve was then locked (Figure 5A and B).



## COVER STORY

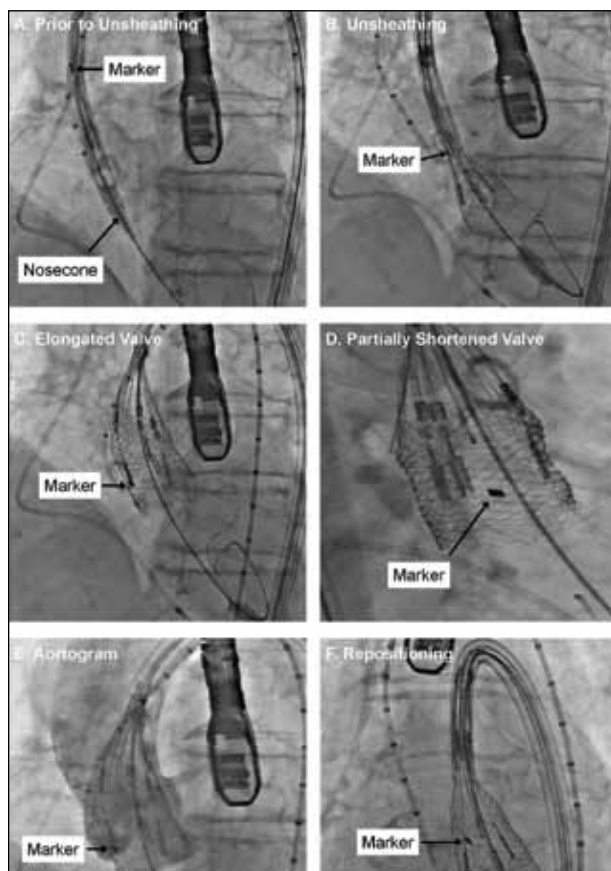


Figure 4. Case presentation, valve deployment, and positioning (please see text for details).

**Valve release and catheter removal.** Once the valve was locked and in the desired position (Figure 5C), the release process was begun by sliding the release window and rotating the release collar clockwise, resulting in the release of the valve from the delivery catheter (Figure 5D). The delivery catheter was then resheathed and the nose cone resealed, and the device was retracted through the introducer sheath (Figure 5E). The final result is shown in Figure 5F. Throughout the procedure, the patient's blood pressure remained stable. The patient was discharged from the hospital 3 days postprocedure. Echocardiographic assessments at discharge and 30 days after the procedure revealed mean gradients of 9.7 mm Hg and 10 mm Hg, respectively, and aortic valve areas of 1.4 cm<sup>2</sup> and 1.5 cm<sup>2</sup> by the echocardiography core laboratory. Trivial aortic regurgitation was noted at both discharge and 30 days.

### THE REPRIS CLINICAL PROGRAM

The Lotus valve is being evaluated in the REPRIS clinical program, with three clinical studies currently planned (Table 1). Enrollment into the REPRIS I feasibility study is complete, whereas REPRIS II and REPRIS III are currently in

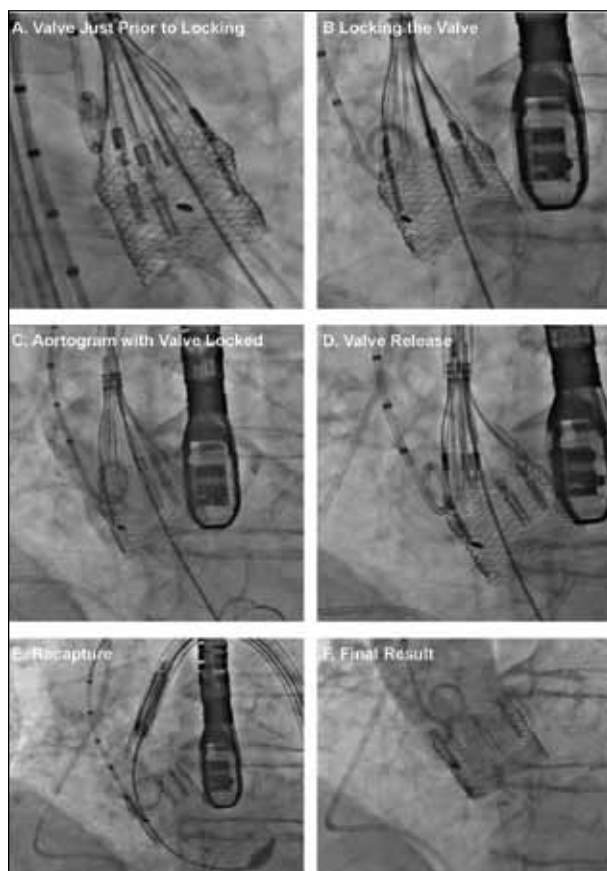


Figure 5. Case presentation, valve locking, and release (please see text for details).

the planning stages (REPRIS II is expected to begin enrollment in 2012).

REPRIS I is a prospective, single-arm, three-center feasibility study that is designed to assess acute safety and performance of the 23-mm Lotus valve in symptomatic patients with calcified stenotic aortic valves who are considered to be high risk for surgical valve replacement. The primary endpoint was clinical procedural success, defined as successful implantation of a Lotus valve system (device success) without in-hospital MACCE through to discharge or 7 days after the procedure, whichever came first. Device success was defined per the VARC definition,<sup>7</sup> and MACCE (using VARC definitions) was defined as the composite of all-cause mortality, periprocedural myocardial infarction  $\leq$  72 hours after the index procedure, major stroke, or urgent or emergent conversion to surgery or repeat procedure (surgical or interventional) for valve-related dysfunction.

Secondary endpoints were successful repositioning of the Lotus valve system (if attempted), successful retrieval of the Lotus valve system (if attempted), and the incidence of central and paravalvular aortic valve regurgitation. Other key endpoints include bleeding, acute kidney injury, vas-

TABLE 1. THE REPRISE CLINICAL PROGRAM

|                  | REPRISE I                                                                                 | REPRISE II                                                                            | REPRISE III                 |
|------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------|
| Objective        | Feasibility                                                                               | CE Mark                                                                               | IDE/PMA                     |
| Valve diameter   | 23 mm                                                                                     | 23 and 27 mm                                                                          | 23 and 27 mm                |
| Primary endpoint | Clinical procedural success: device success (VARC) without MACCE through discharge/7 days | Device performance: 30-day mean pressure gradient; safety: 30-day all-cause mortality | TBD                         |
| Study design     | Single arm                                                                                | Single arm                                                                            | Randomized controlled trial |
| N                | 11 patients                                                                               | Up to 120 patients planned                                                            | TBD                         |
| Sites            | 3 sites in Australia                                                                      | 15 sites in Australia, France, Germany, and the United Kingdom                        | Global                      |
| Status           | Enrollment and 7-day follow-up complete; long-term follow-up ongoing                      | Enrollment to start at the end of 2012                                                | Planning                    |

Abbreviations: IDE, investigational device exemption; MACCE, major adverse cardiovascular and cerebrovascular events; PMA, premarket approval; TBD, to be determined; VARC, Valve Academic Research Consortium.

cular complication rates, new conduction disturbances or cardiac arrhythmias requiring a new permanent pacemaker, valve performance (effective orifice area, mean and peak aortic gradients, peak aortic velocity, and grade of aortic regurgitation, as assessed by transthoracic echocardiography), valve thrombosis and endocarditis, cardiac function (pulmonary artery systolic pressure, left atrial dimension, left ventricular diameter, and left ventricular ejection fraction), and functional status as evaluated by the New York Heart Association class. Additionally, health status and quality of life will be evaluated by SF-12 and EQ-5D questionnaires at baseline, 6 months, and 1 year after valve implantation.

As of May 2012, REPRISE I enrollment and 7-day follow-up was complete, with 11 patients enrolled at three centers in Australia (Monash Medical Center, Melbourne; Royal Adelaide, Adelaide; St. Vincent's Hospital, Melbourne). The primary endpoint results were presented at the Paris Course on Revascularization in Paris, France (May 15–18, 2012),<sup>8</sup> and preparation of the primary endpoint manuscript is underway. Additional follow-up is planned at 30 days, 3 months, 6 months, 12 months, and annually to 5 years after the index procedure.

## SUMMARY

The Lotus aortic valve replacement system is a fully repositionable device that is designed to facilitate accurate delivery with minimal paravalvular regurgitation. In the presented case study, the valve was positioned precisely and successfully with only minor aortic regurgitation after the procedure. Results of the REPRISE clinical program will provide safety and efficacy outcomes on the use of this device in symptomatic patients with calcific aortic stenosis. ■

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