Between November 2012 and August 2013, after multi-disciplinary evaluation, 3 high-risk patients underwent transfemoral tricuspid valve-in-ring implantation (TVIRI) for refractory congestive heart failure because of deterioration of their tricuspid surgery, using Sapien XT valves (Edwards Lifesciences Inc, Irvine, CA).

Patient 1: 44-year-old man, drug abuse, 4 episodes of tricuspid endocarditis, 2 previous cardiac surgeries for mitral homograft in tricuspid position with 30-mm Classic Carpentier Edwards annuloplasty ring (2001), presenting with massive central tricuspid regurgitation (TR; Figure 1A).

Patient 2: 69-year-old man, tricuspid endocarditis treated by valve replacement with 30-mm bioprosthesis (1982), mitral homograft in tricuspid position with 30-mm Carpentier Edwards annuloplasty ring and coronary artery bypass grafting (1998), presenting severe homograft degeneration with stenosis and severe central TR (Figure 1B).

Patients 3: 58-year-old woman, rheumatic heart disease, mitral valve repair, and tricuspid annuloplasty with a 32-mm rigid Carpentier Edwards annuloplasty ring (1988), mechanical mitral valve replacement (1999), with severe central TR (Figure 1C).

The choice of the Sapien XT valve size was based on ring diameters determined by computed tomography, three-dimensional (3D) transesophageal echocardiography and fluoroscopy, with the aim of implanting a valve whose diameter was closest to the mean inner diameter of the ring (Figure 2). However, considering that 23-mm Sapien XT valves would completely seal the open segment with the transcatheter heart valve, the latter concerned a patient presented in this series (patient 1).

All procedures were performed via the transvenous femoral approach, under general anesthesia and transesophageal echocardiography guidance. The tricuspid valve was crossed with a Judkins right or a balloon floating catheter placed through a Mullins sheath. A J-preshaped 0.035 Amplatz SuperStiff wire was placed at the apex of the right ventricle. Then, the Sapien XT valve, mounted on a Novaflex catheter in an antegrade position, was deployed by slow balloon inflation under rapid ventricular pacing. Rapid ventricular pacing was performed using a permanent pacemaker via the epicardium (patient 1) or the coronary sinus (patients 2 and 3). In all patients, a 26-mm Sapien XT valve was successfully implanted. After the final results had been evaluated in the catheterization laboratory by echocardiography and fluoroscopy, patients underwent a computed tomographic scan before discharge using computed 3D reconstruction (Figure 3).

On predischarge echocardiographic examination, mean transvalvular gradients ranged from 3 to 5 mmHg and paravalvular TR around the Sapien valve was mild in patient 1, absent in patient 2, and moderate-to-severe in patient 3 (Figure 1A–C; Movies I–IV in the Data Supplement). At 30-day follow-up, there was no complication and all patients had a significant improvement in their functional status (New York Heart Association classes I or II). At 1-year follow-up, they were alive with no change in their functional status. The tricuspid gradients remained stable.

**Discussion**

Although the feasibility of transcatheter valve-in-ring implantation in mitral position has been demonstrated,\(^1,2\) only 2 case reports on the immediate results of TVIRI have been published,\(^3,4\) using the transatrial and the transfemoral approaches, and the latter concerned a patient presented in this series (patient 1).

One important difficulty is the proper evaluation of the prosthesis size, because the Edwards Classic tricuspid rings are oval, open, and surrounded by valvular tissue, which cannot be detected by computed tomographic scanner or fluoroscopy. In this series, 2 patients (1 and 3) had a residual paravalvular leak at the level of the open portion of the ring, probably because of the oval shape and the inability to completely seal the open segment with the transcatheter heart valve. Balloon sizing might have been performed and led to implantation of a 29-mm Sapien XT valve, with less degree of paravalvular leakage.
of paravalvular TR. However, the difficulty of changing the rings’ geometry is illustrated by Figure 3 showing computed tomographic acquisitions before and after balloon-expandable valve implantation, along with the diameters (Figure 3).

Thus, TVIRI with the current generation of Sapien XT valves should be considered with caution. In the presence of severe residual paravalvular TR, its immediate correction should be technically feasible and might be considered. In the future, more conformable or repositionable valves, with additional sealing capacity may help to reduce regurgitation after TVIRI.

The transfemoral approach has the advantage of being less invasive than a transatrial approach and the avoidance of a thoracotomy was desirable given the high-risk profile of our patients.

Rapid ventricular pacing had to take into account the potential damage to the lead of a permanent pacemaker across the ring and also avoid jailing a temporary pacing lead. In 2 patients who had permanent pacemaker, we chose to implant another lead in the coronary sinus. The third patient had a permanent epicardial pacemaker placed before the procedure because of sinus dysfunction.

This small series suggests that transfemoral TVIRI after failure of tricuspid surgery is feasible and may improve hemodynamic and functional status in highly selected patients, both immediately and at 1-year follow-up. Larger series with longer follow-up are needed to assess the potential role of this technique and will certainly be useful for future tricuspid transcatheter valve therapies with dedicated devices.

**Disclosures**

Dr Himbert is a consultant and a proctor for Edwards Lifesciences. Drs Iung and Vahanian received speaker’s fees from Edwards Lifesciences. The other authors report no conflicts.

**References**


**Key Words:** transcatheter aortic valve implantation  •  tricuspid valve
Figure 1. Color transesophageal echocardiography (TEE) image of tricuspid regurgitation (TR) before implantation on the left panels. 

A, Patient 1: severe TR with 2 jets, one emanating from the center of the homograft and the second from the medial part of the prosthetic annulus. 

B, Patient 2: severe central intraprosthetic jet. 

C, Patient 3: severe central intraprosthetic jet. 

Color TEE image of TR after valve-in-ring implantation on the right panels: 

A', Patient 1: mild residual TR with an excentric jet coming from the medial part of the prosthetic annulus. 

B', Patient 2: trace TR coming from the medial part of the prosthetic annulus. 

C', Patient 3: moderate-to-severe residual paravalvular TR with a jet coming from the medial part of the prosthetic annulus. 

Mid-esophageal two-dimensional (2D) TEE view at 0°, compare black and white and color Doppler. 

Mid-paravascular 2D TEE view at 90°, compare black and white and color Doppler. 

Mid-esophageal Xplane 2D TEE view with color Doppler (left corresponds to 0°, right to 90°). RA indicates right atrium; and RV, right ventricle.
Figure 2. Measurement of the inner diameter of an annuloplasty ring by fluoroscopy, showing the long and short axis (black lines) taken into account to measure the mean inner diameter (A), computed tomography (B), and three-dimensional transesophageal echocardiography (TEE; C). Mean inner diameter measurements using the 3 methods (D). CT indicates computed tomography.

Figure 3. Computed tomographic (CT) images of patient 3 ring before (A) and after (B and C) the Sapien XT valve implantation. Inner rings’ diameters using CT scan measurements (D).

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Transfemoral Tricuspid Valve-in-Ring Implantation Using the Edwards Sapien XT Valve: One-Year Follow-Up

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