The patient is a 38-year-old woman with rheumatic heart disease requiring surgery 21 years ago. She received a St. Jude mechanical prosthesis in the mitral position and a Carpentier-Edwards Perimount bioprosthesis (size 31) in the tricuspid position.

Over the past 2 years, she has become progressively more short of breath with regular admissions for congestive heart failure despite medical treatment. Transthoracic echocardiography showed a severely dilated right atrium and a calcified tricuspid prosthesis with a mean gradient across the valve varying between 9 and 12 mm Hg (Figures 1 and 2). The mitral valve prosthesis functioned well.

A decision was made to replace the tricuspid valve, but in consultation with the heart team, it was agreed that, given that the mitral valve prosthesis was functioning well, the risk of a second sternotomy to replace only the tricuspid valve was difficult to justify if an alternative option was available. Given the limited lifespan of a bioprosthesis in a young person, she would then require her third (and likely final) sternotomy at a young age. A joint decision was therefore made to offer the patient a minimally invasive tricuspid valve replacement by a transcatheter procedure. The risks of a transcatheter procedure were discussed with her, and she provided written informed consent.

The option of a transatrial approach was considered, but this would still have required a thoracotomy, and with the introduction of the new 19F Edwards-SAPIEN XT valve (Edwards Lifesciences, Irvine, CA), transjugular access was preferred. Because the old prosthesis was a size 31, there was concern that the 26-mm Edwards valve would not fit securely. Transesophageal echocardiography showed extensive calcification of the prosthesis, which was viewed as adequate to anchor the Edwards prosthesis. We furthermore decided to overexpand the prosthesis to 27 mm, because the anticipated central regurgitation of the valve resulting from the overexpansion was likely to be mild and well tolerated.

The patient was admitted for intravenous heparinization, and her oral warfarin was stopped. The procedure was performed in the catheterization laboratory with the patient under light general anesthesia to enable constant transesoph-
A cardiopulmonary bypass system was prepared, and rapid conversion to open surgery could be achieved if required. A venogram of the right jugular vein was performed to confirm adequate size, and this was followed by surgical cutdown and purse string preclosure of the vein. Heparin was given intravenously to attain an activated clotting time of >250 seconds. A straight-tip 0.035-inch guidewire was passed over an Amplatz left 3 catheter (the Judkins right catheter did not provide enough backup to cross the tricuspid valve) into the right pulmonary artery. This was exchanged for a 260-cm-long Amplatz extrastiff 0.035-inch (Cook Medical Inc, Bloomington, IN) guidewire. Rapid ventricular pacing to stabilize the prosthesis during expansion was not anticipated, but to assess stability during inflation, we first performed a predilatation of the valve with a 16×40-mm Tyshak balloon (NuMED Inc, Hopkinton, NY) (Movie I in the online-only Data Supplement). This balloon remained very stable during inflation, but we encountered significant difficulty in crossing the valve because the tricuspid valve was almost horizontal (Figure 3), and downward pushing force resulted in prolapse of the device down toward the inferior vena cava. At this point, a final decision was made to use a transfemoral Edwards SAPIEN XT device rather than the transapical one, with its much shorter delivery system, because the transfemoral Novoflex delivery system has a tip that can be deflected to aid in aiming the device in the direction of the tricuspid valve. The device was passed over the valve with significant difficulty. A partial inflation was performed to stabilize the valve, and final positioning could then be achieved (Figures 4 and 5 and Movie II in the online-only Data Supplement). At this point, full inflation of the balloon to 27 mm was performed with good expansion and good anchoring of the device (Figure 6 and Movie III in the online-only Data Supplement). Echocardiography revealed no complications and good valve function with no paravalvular regurgitation (Figures 7 and 8 and Movies IV and V in the online-only Data Supplement). The Novoflex delivery system and sheath were removed with surgical closure of the jugular vein.

The patient was extubated on the table and mobilized on day 1. She lost 10 kg in weight in the next 4 days and reported immediate improvement in dyspnea symptoms. Postprocedural transthoracic echocardiography showed that the device was well anchored, with no paravalvular leaks. The mean gradient across the valve was 3 mm Hg. Oral anticoagulation was reestablished before discharge.

At 2 months after the procedure, the patient is still in New York Heart Association class 1 functional class despite cessation of diuretic treatment.

Discussion

With the advent of transcatheter aortic valve implantation, a new treatment option has become available for patients with
inoperable aortic valve stenosis. The calcified degenerated native aortic valve has a rough inner surface that acts as an effective anchor for the prosthesis. The irregular inner surface and metal frame of a degenerated bioprosthesis have similar characteristics, and form an ideal docking station for a transcatheter valve. This has led to a number of valve-in-valve implants, mostly in the aortic position. The first case of transcatheter valve-in-valve tricuspid valve replacement was described by Hon et al. Their approach was, however, via a thoracotomy and direct puncture of the right atrium. This has definite advantages with regard to delivery of the device, but remains more invasive. The first transcatheter tricuspid valve-
in-valve procedure was performed by Leen van Garsse, but differed from the case described here in a number of ways: The patient described by van Garse was not a surgical candidate, she was placed on extracorporeal circulation for the duration of the procedure, the valve was deployed under rapid ventricular pacing, and the older 24F Edwards SAPIEN device was used.

Using the new Edwards SAPIEN XT device required mounting it on the balloon shaft in an orientation opposite to its design. When the balloon is pulled back into the device after exiting the distal end of the delivery sheath, it has the potential to cause folding or damage to the valve cusps. We did not encounter this, and believe that this theoretical risk is well justified by the smaller caliber of the delivery sheath.

Other potential pitfalls we considered included stability of the device within the tricuspid prosthesis; the degenerate bioprosthesis tends to have less bulky calcification than a senile aortic stenosis valve, but the wire frame of the valve adds to the potential of the valve to grip the transcatheter valve, and the low pressure system of the right heart will place less strain on the new prosthesis. Undersizing of our transcatheter valve was a concern, and in the future, one could consider larger valves when they become available. Size of the access vessel was a consideration, but because of the severely congested venous system, this concern was unfounded. Crossing of the degenerated tricuspid prosthesis was difficult because of its angle and downward prolapsing of the device when pressure was applied. A femoral approach may prove easier, because the route may be straighter with better transmission of pushing forces.

This patient presented with a rare combination of problems, and it is unlikely that this procedure would become widely used. If indicated, however, it is feasible provided that a large enough device is available and the approach is evaluated carefully. Rapid ventricular pacing and extracorporeal circulatory support are not mandatory.
Disclosures
Dr Weich is a proctor for implantation of transcatheter aortic valves for Edwards Lifesciences.

References
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