Editorial

Sutureless aortic valve replacement in patients with active infective endocarditis: is it contraindicated or recommended?

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Because radical debridement of infected tissue is essential to the treatment of infective endocarditis (IE), transcatheter aortic valve replacement (TAVR) is contraindication of patients with IE. Although sutureless aortic valve replacement (SU-AVR) is considered an off-label procedure for IE and is listed as contraindicated in the instruction for its use, in the introduction to the article by Zubarevich *et al.* in this issue of the *Journal of Thoracic Disease*, the authors state, "*A major advantage of the sutureless aortic valve is the minimal amount of artificial tissue which mainly consists of the leaflets mounted onto the stent. The latter could hypothetically contribute to its' lower susceptibility to infectious processes*". Based on this hypothesis, their aim was to examine the feasibility of SU-AVR in 13 consecutive high-risk patients with active infective aortic valve endocarditis (1).

It is well-known that bacteria adhere more tightly to braided sutures which leads to more infections than when monofilament sutures are used (2). We consider the "*minimal amount of artificial tissue*: *braided sutureless*" to also be one of the major advantages of SU-AVR over conventional AVR.

In the study presented by Zubarevich *et al.*, all patients underwent SU-AVR via median sternotomy, but minimally invasive cardiac surgery (MICS), which avoids median sternotomy, might be a better way to achieve less invasive surgery. Successful treatment MICS AVR via an upper partial sternotomy has already been reported by Liu *et al.* (3), and the same procedure via right anterior minithoracotomy has been reported by Zhigalov *et al.* (4).

Another advantage of SU-AVR is that requires shorter cardiopulmonary bypass and cross-clamp times in comparison with standard AVR. In view of all above advantages, MICS-SU-AVR, may be the least invasive AVR procedure for the treatment of IE in high-risk patients.

In IE patients, the microorganisms primarily damage the valve cusps and leaflets, which results in regurgitation. Simple AVR is a suitable method of treating such "non-extensive" IE cases, but when the IE extends to the valvular annulus and/or subvalvular apparatus, surgical treatment becomes more difficult and complicated. The surgical procedure should be planned according to the location and extent of the annular and/or subvalvular lesion. Zubarevich *et al.* used xenogenic pericardium in two cases to stabilize the infected area and aortic annulus. Because of the limited ability of preoperative diagnosis by computed tomography (CT), ultrasonic cardiogram (UCG), and magnetic resonance imaging (MRI) to define the boundary between normal and infected tissue, occasionally intraoperative decisions and flexible operative strategies according to the extent of the lesion(s) are required. Although completely removing infected material, foreign bodies, and necrotic tissue to minimize the residual infectious burden is a basic principle of surgery, we often face situations in which aggressive debridement is impossible because it would result in an atrial/ventricular/aortic defect that would make reconstruction impossible. We received the approval of the ethics committee of our institution to apply infrared energy with a newly developed device to disinfect and reinforce unresectable lesions in such difficult situations, and we have used it to treat 15 consecutive patients with extensive IE and an annular abscess and obtained good results without any complications or reinfections (5).

The presence of an annular abscess increases the

risk of "early" prosthetic valve endocarditis (PVE). Microorganism can directly invade the prosthetic valve as a result of intraoperative contamination, or they can spread hematogenously anytime from the operative day to several weeks postoperatively. Microorganisms can directly reach to the prosthesis-annulus interface and the tissue along the "suture" in the paravalvular area, and they can adhere to the fibrinogen and fibronectin in the paravalvular area, which causes abscess formation in the prosthetic valve (6). *Staphylococcus aureus* for the highest number of PVE cases. From 2 to 12 months postoperatively, *Streptococci*, *Staphylococcus aureus*, and coagulase-negative *Staphylococci* are the most common pathogens, and they are followed by *Enterococci*. *Staphylococcus epidermidis* is the most common coagulase-negative *Staphylococcus* in the 2- to 12-month postoperative period, and it is usually methicillin-susceptible (7,8).

Late PVE develops as a result of community-acquired infection, and the causative organisms are similar to those of native valve endocarditis. The most frequent pathogens are *Streptococci* and *Staphylococcus aureus*, followed by coagulase-negative *Staphylococci* and *Enterococci*. Mortality in late PVE is high in patients with multiple comorbidities who develop endocarditis after being admitted to hospitals for other reasons (9-13).

The type of causative microorganism is also important to determining the prognosis of IE/PVE. Williams *et al.* investigated risk factors for 30-day mortality and major postoperative morbidity based on the Society of Thoracic Surgeons Adult Cardiac Surgery Database in IE cases that had been treated by cardiac surgery in the United States and Canada during the period from 2011 to 2016 (14). The results showed that in left-sided IE, fungal > *Staphylococcal* > culture negative > *Streptococcal* IE and PVE *vs.* native valve endocarditis were associated with significantly higher 30-day mortality. They also showed significantly longer hospital stays in cases caused by *Staphylococci* and fungi than in cases caused by *Streptococci*. Analyzing outcomes according to causative microorganism is one of the next steps that will need to be taken to accurately validate the efficacy of SU-AVR in IE.

A pooled analysis of pacemaker implantation after Perceval SU-AVR revealed 7% of postoperative PM implantation (15). Although the patient population in the study reported by Zubarevich *et al.* was small, it is noteworthy that there were no cases of 3rd degree atrioventricular block (AVB) and no cases of pacemaker implantation. Special care needs to be exercised in cases treated by SU-AVR, because SU-AVR tends to be associated with a high incidence of postoperative AVB, which requires PM implantation, and that may worsen the IE patient's prognosis.

Avoiding "too-deep" intra-annular implantation of the prosthesis is an important technical measure that reduces the incidence of postoperative rhythm disturbance. The snugger method may contribute to avoiding such "too-deep" implantation by tightening the snuggers to fix the prosthesis in place and thereby improve proper positioning.

The economic aspect of IE treatment is still an important issue. Alkhouli *et al.* assessed contemporary trends in the incidence, characteristics, outcomes, and cost of hospital admissions for IE in the United States between 2003 and 2016 (16), and they found that the incidence of IE-related hospitalizations increased from 34,488 in 2003 to 54,405 in 2016. The annual volume of valve surgery for IE rose from 4,049 in 2003 to 6,460 in 2016, and there were increases in risk-adjusted rates of stroke (from 8.0% to 13.2%), septic shock (from 5.4% to 16.3%), and mechanical ventilation (from 7.7% to 16.5%) during the same period. Although risk-adjusted mortality decreased from 14.4% to 9.8%, mean inflation-adjusted cost showed almost same from $43,810 in 2003 to $43,020 in 2016. While total expenditures for in-hospital care for IE increased $1.58 billion to $2.34 billion during the same period. Villa *et al.* retrospectively compared outcomes and resource consumption when the Perceval S prosthesis was used as opposed to other tissue valves, and the results showed that the SU-AVR group had a higher risk profile than the sutured group (17). The SU-AVR patients were older and more likely to be overweight, diabetic, anemic, frail, and have symptomatic heart failure, systemic and pulmonary hypertension, higher trans-valvular pressure gradients, and smaller aortic annuli compared with who underwent standard-AVR. Although the average operative risk score was significantly higher in SU-AVR group, cardiopulmonary bypass and cross-clamp times were significantly shorter in SU-AVR group, and there were no significant differences between the groups in hospital mortality, intubation time, intensive care unit stay, ward stay. Hospital costs (excluding the cost of the prosthesis) were $12,825 per patient for SU-AVR and $12,386 per patient in ST-AVR. They conclude that SU-AVR in high-risk patients neutralizes the expected worse hospital outcome maybe because of its less invasiveness.

Zubarevich *et al.* performed mitral valve surgery concomitant with SU-AVR in 6/13 (61.6%) of their patient.

The Commando procedure is one of the options to replace the mitral valve, the aortic valve and the aortic mitral curtain, when these are severely affected by IE. However, because Commando procedure is invasive in the sense of requiring a longer cardiopulmonary bypass time and complicated operative procedure, the combination of mitral valve surgery + SU-AVR may be another option for treating "high risk" patients.

Two of the patients in Zubarevich *et al.*'s study died of fatal lung bleeding. Postoperative fatal lung bleeding is uncommon after cardiac surgery. Pulmonary artery injury due to Swan-Ganz catheter penetration is the one of the causes of postoperative fatal lung bleeding. Since postoperative fatal lung bleeding might not be related to the infection itself, identifying the cause of the lung bleeding and taking measures to prevent it should enable better 30-day mortality outcomes after SU-AVR than in the authors' cohort.

The authors are to be congratulated for demonstrating the possible usefulness of the SU-AVR in early IE/PVE. Case accumulation and long-term follow-up may strengthen the evidence for the effectiveness of SU-AVR in "high-risk" patients, and they may also show that SU-AVR is superior to standard AVR in "low-risk" IE patients as well as in "high-risk" IE patients.

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