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Utilization of minimally invasive approaches for transcatheter aortic valve replacement explant: when and how?

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Clinical vignette

An 81-year-old male patient with persistent *Enterococcus faecalis* (*E. faecalis*) bacteremia despite long-term antibiotic therapy presented with endocarditis. His past medical history was significant for chronic kidney disease, congestive heart failure, diabetes mellitus, permanent pacemaker, deep venous thrombosis with inferior vena cava filter placement, and prostate cancer. He had previously undergone a transcatheter aortic valve replacement (TAVR) procedure on June 2016, which was uneventful [Society of Thoracic Surgeons Predicted Risk Mortality score (STS-PROM) of 10.6%; Edwards 29-mm S3 valve; Edwards Lifesciences Corp, Irvine, CA, USA]. An echocardiogram showed a 2.4-cm mobile mass attached to the transcatheter heart valve (THV). After discussion at the multidisciplinary valve conference, it was decided to attempt a minimally invasive approach for TAVR explantation via a right thoracotomy.

Surgical techniques

Preparation

The patient was placed in a supine position and induced with general anesthesia. He was prepped and draped with a gel roll under the right hemithorax.

Exposition

The patient's left femoral vessels were exposed, and both venous and arterial cannulas were inserted and advanced into position via Seldinger technique under a combination of fluoroscopic and echocardiographic guidance. A right anterior thoracotomy was created in the 3rd intercostal space. Once the intercostal retractor was placed, an inverted U-shaped aortotomy was performed at the level of the aortic fat pad, providing an excellent view of the THV.

Operation

An attempt was made to remove the THV by debriding the surrounding tissue, but the valve was firmly embedded. Consequently, the removal process required serial clamping and crushing of the frame from the aortic wall into the center of the aortic lumen, followed by resection of the native leaflets which were firmly adherent to the aortic wall. Upon removal, the vegetation was observed on the ventricular aspect of the THV. The remaining native valve tissue was excised using sharp dissection and rongeurs. A 27-mm Edwards Magna Ease bioprosthetic valve was then sized and implanted in the standard fashion with pledgeted mattress sutures.

Completion

We closed the aortotomy with two double-armed running 4-0 prolenes. The cross-clamp was removed, and we checked for bleeding, the function of the new valve, and for air. The vents were then removed, and we gave protamine and closed the thoracotomy in layers with absorbable suture. The cross-clamp and bypass times were 75 and 130 minutes,

respectively. The patient had an uncomplicated post-operative course.

Comments

Although rates of TAVR explantation still remain low, it is one of the fastest growing procedures due to rise in TAVR procedures among younger and lower risk patient populations with longer-life expectancies (1). The most common indications for TAVR explant include endocarditis (43%), structural valvular degeneration (20%), significant paravalvular leak (18%), patient-prosthesis mismatch (11%) and delayed valve migration (2,3).

When a THV fails, there are two main approaches: open surgical, and minimally invasive explantation. Both methods have different merits, with an open approach preferred when there is a need for concomitant cardiac surgery (28%), unfavorable coronary anatomy (13%), prior valve-in-valve procedures, oversized annulus, coronary obstruction (11%), and endocarditis (11%) (4). Despite improvements in surgical techniques, TAVR explants are associated with significant morbidity, and 30-day mortality rates at approximately 16.7% (5). Therefore, if the case permits, minimally invasive approaches are an appealing alternative to a full sternotomy.

Advantages

A thoracotomy may be the preferred option for patients with structural valve deterioration (SVD), those with early presentations of THV failure (6 months), and those at low risk of coronary obstruction (2). Minimally invasive TAVR explantation portends a decrease in blood loss, quicker recovery times with shorter intensive care stay, and reduced post-operation hospital stay compared to open surgical explantation (5 *vs.* 11 days, respectively) (3). This method also has lower mortality rates within the first thirty days (3.4% *vs.* 13.6%) (3), likely due to improved mobility and reduced risk of operative complications, such as infection or trauma to surrounding tissues.

Caveats

Although a minimally invasive approach may have morbidity and mortality benefits, it is not feasible in up to 34% of cases (2), primarily due to unfavorable anatomy (i.e., high risk of coronary obstruction, aneurysmal aorta, mediastinal adhesions, prior intervention in the right hemithorax), or prior valve-in-valve replacement (3). Additionally, with TAVR explantation, there is a 56% chance of undergoing a concomitant procedure such as root replacement (11%), root enlargement (17%), mitral repair (20%), and coronary artery bypass grafting (18%) (3). Although there is no clear consensus regarding type of valve and method of explantation, trends have shown that self-expanding valves have higher incidences of needing a root replacement (2) compared to balloon-expandable valves, potentially favoring an open surgical approach. In complex cases, surgeons should always be prepared to convert to open if necessary (i.e., aortic dissection, hemodynamic instability secondary to hemorrhage, or coronary obstruction). Furthermore, with a deeply deployed TAVR valve, one must be aware of possible injury to the anterior leaflet of the mitral valve upon extraction that may require patch reconstruction.

In cases of a self-expanding valve, an endarterectomy blade can be used to sweep the tissue from the frame towards the aorta, followed by leaflet excision while being careful not to injure the root. For balloon-expandable valves that sit intra-annular, as in our case, an effective approach is to serially crush the valve at opposite ends while removing surrounding tissue. Another technique involves cutting the wire frame down the non-coronary cusp, thus releasing its radial force and facilitating its explantation.

Given the complexity of these techniques, TAVR explantation requires extensive training and expertise in both implantation and explantation techniques. Even experienced cardiac surgeons can face steep learning curves with this procedure due to its intricacies. Surgeons often need to perform around 7–10 minimally invasive TAVR explants to feel comfortable with the procedure.

With adequate preoperative planning tailored to individual patient characteristics and anatomical considerations, minimally invasive TAVR explantation can significantly improve patient outcomes, reduce recovery times, and minimize procedural risks.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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