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Masters of Cardiothoracic Surgery

Explanting transcatheter aortic valves: comparative insights and surgical nuances in native versus valve-in-valve scenarios

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Clinical vignette

We present various clinical scenarios, including native transcatheter aortic valve replacement (TAVR) and valve-in-valve TAVR (VIV-TAVR) in the context of failed balloon-expandable or self-expandable transcatheter valves.

VIV-TAVR

- Case 1: 60-year-old male with two previous sternotomies with a 27 mm stentless prosthesis and subsequent VIV-TAVR in 2015 using a 29 mm self-expandable valve.
- Case 2: 71-year-old male with a 23 mm surgical bioprosthesis implanted in 2013 and a 23 mm balloon-expandable VIV-TAVR in 2021.
- Case 3: 68-year-old male with a previous history including four sternotomies, with a 26 mm self-expandable TAVR placed within a homograft in 2015, presenting with valve degeneration and severe aortic insufficiency.

Native TAVR

- Case 1: 64-year-old female with a 26 mm self-expandable TAVR placed in 2019, complicated by valve embolization and implantation of a second TAVR, presenting with severe aortic stenosis of the TAVR valve.
- Case 2: 64-year-old male with a 34 mm self-expandable TAVR placed in 2017 presenting with severe aortic insufficiency.
- Case 3: 80-year-old female with a 26 mm balloon-expandable TAVR ×2 in 2020 in the presence of a 4.8 cm ascending aortic aneurysm. She presented with type A aortic dissection and was noted to have moderate aortic stenosis with leaflet thrombosis.

Surgical techniques

Irrespective of TAVR valve chronicity, patients with VIV-TAVR exhibit minimal adhesions and the valve typically detaches from the surrounding structures spontaneously or with little traction, as the surrounding prosthetic materials (i.e., surgical bioprosthesis, Dacron graft) offer protection. Conversely, the degree of TAVR valve incorporation into the surrounding tissues varies widely in native TAVR cases.

Preparation

Preoperative computed tomography angiography evaluation of the TAVR valve, focusing on its location within the aortic root and integration with surrounding structures, is critical for safe TAVR explantation, particularly in native TAVR cases. Dark density inside the TAVR stent frame—a surrogate marker of severe TAVR valve incorporation—requires carefully assessment, as valve position relative to the anatomical landmarks and the characteristics of the aortic root must be well-understood. This facilitates safe TAVR explant and any unplanned surgical repairs.

Exposition

Aortic cannulation should be performed as distal as possible to ensure sufficient surgical working space, especially in patients with tall-frame TAVR valves. Direct access to the coronary ostia for cardioplegia delivery is often challenging due to the small cell openings of the TAVR stent frame. Bi-

caval venous cannulation and direct coronary sinus catheter insertion following right atriotomy represent a bailout option, in cases where standard transatrial coronary sinus catheter placement is difficult. Standard aortotomy can be used for balloon-expandable valves. A high transverse aortotomy at the palpable distal edge of the TAVR stent cage is typically used for self-expandable valves.

Operation

The near-total absence of severe adhesions to the surrounding prosthetic materials in VIV-TAVR explantation enables rapid TAVR valve removal using a single Kocher clamp with a twisting maneuver. However, careful separation is required at the direct contact points between the valve and native tissue. For instance, in patients with previous root replacement without ascending aortic replacement, the native ascending aorta and the distal stent cage of a self-expandable valve may be adherent. In contrast, native TAVR explantation necessitates the "double Kocher clamp technique", which involves applying two Kocher clamps perpendicularly to compress the flared part of the stent cage. Before applying the first Kocher clamp, careful separation of the distal stent cage from the aortic tissue is required. Due to adhesions, a twisting maneuver of the TAVR valve after the first Kocher clamp application is neither effective nor advisable, as it may cause surrounding tissue injury. In our practice, ice-cold saline for the nitinol frame is not used, as the Kocher clamp technique sufficiently deforms TAVR valves ensuring safe explantation.

Completion

Leaving compromised tissues with questionable quality after TAVR explantation must be avoided. Regardless of the pattern of aortic injury, partial aortic repair with or without patching of the aortic root and/or short-segment ascending aortic replacement for the sino-tubular junction is sufficient. Once the TAVR valve is removed, standard surgical aortic valve replacement (AVR) is performed. Patients undergoing TAVR explantation often have suboptimal VIV-TAVR anatomy, typically excluding them from redo TAVR due to a small aortic root. Therefore, a low threshold should be adopted for performing aortic root enlargement, particularly in younger, lower-risk patients.

Comments

Clinical results

Historically, TAVR explantation has been considered a high-risk procedure, with operative mortality reported as high as 20% (1). These poor outcomes were thought to result from a combination of procedural complexity, the surgeon's learning curve, and patient comorbidities. However, more recent studies have shown that post-TAVR reoperation, with increased experience, is associated with low technical difficulty (2). There is a clear learning curve for TAVR explant surgery, though individual surgeon experience remains extremely limited. Given the current rarity of TAVR explant procedures, an objective scoring system, the TAVR Explant Difficulty Index Score, has been developed (2). Notably, the TAVR Explant Difficulty Index was significantly lower in the VIV-TAVR group compared to the native TAVR group, as demonstrated in the video. Conversely, a TAVR in a native small aortic root appears to amplify the complexity due to the severity of adhesions between the TAVR valve and surrounding tissue.

Advantages

In our opinion, at least 20 cases are necessary to adequately experience the various procedural pitfalls. A surgeon's learning curve and experience, which involves understanding and preparing for the unique challenges associated with TAVR valve explantation, maximize the safety of the procedure. This will undoubtedly facilitate more timely surgical interventions for failed TAVR valves and lead to improved outcomes on a global scale.

Caveats

As discussed, patients with significant adhesions should be prepared to undergo concomitant procedures such as aortic root/ascending aortic replacement for sino-tubular junction involvement, mitral valve repair/replacement if the anterior mitral leaflet is impinged, or ventricular septal defect repair if there is a risk of membranous septum injury during TAVR explantation. Although VIV-TAVR explantation is technically less complicated, extreme caution must be exercised at the direct native tissue contact points during TAVR valve removal. Optimization of the aortic

root anatomy following TAVR explant is a crucial aspect of lifetime management to achieve favorable long-term outcomes.

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