Dos and Don'ts of Removing Failed Thoracic Aortic Stent Grafts

Decision-making when surveillance detects a failing endograft.

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Thoracic endovascular aortic repair (TEVAR) has transformed the treatment of the descending thoracic aorta. It is now first-line therapy for anatomically suitable descending thoracic aneurysms, transections, and complicated acute type B aortic dissections. Nonetheless, concerns about its long-term durability remain. As the first group of stent graft patients ages, more are experiencing device failures and returning for additional treatment.

Late open conversion occurs in approximately 3% to 8% of TEVAR procedures.[1] When it happens, the surgeon faces the challenge of deciding how to manage the endograft, which is an issue not usually encountered in standard redo aortic surgeries. The device can be left in place, partially removed, or fully explanted. This decision greatly impacts the perfusion strategy and risk of paraplegia.

Most explantations at Sanger Heart and Vascular Institute are the result of infection, and in this context, success relies less on a specific technical shortcut and more on three key factors: early failure detection, proactive planning before the patient becomes critically ill, and approaching the explant as a standalone procedure. Our lessons for planning for explantation of a thoracic stent graft are summarized in the Sidebar.

MONITORING FOR DEVICE FAILURE, DISEASE PROGRESSION, AND INFECTION

Failure following TEVAR is frequently silent and occurs late. In a series of 33 delayed open conversions, the average time from TEVAR to the conversion was nearly 3 years, with some patients presenting over 10 years after their initial repair.[2]

As part of our protocol, each patient receives electrocardiogram–gated CTA at 3 and 12 months and then annually thereafter. Gating is important for imaging the thoracic aorta. Motion artifacts near the arch can hide small proximal type I endoleaks or early new entry tears at the graft edge. We increase the level of scrutiny when we observe any of these signs:

- Sac growth, with or without a visible endoleak
- A type I or III endoleak
- Migration, fracture, or collapse of the device
- A stent graft–induced new entry (SINE) tear
- Progression of disease beyond either end of the repair

Infection can manifest in various ways and is often difficult to detect early. Early signs are usually clinical rather than visible on imaging, such as unexplained fever, consistently elevated inflammatory markers, or weight loss that can occur months or even years after TEVAR. Hemoptysis or hematemesis should be viewed as potential signs of an aortobronchial or aortoesophageal fistula until proven otherwise. On CT scans, late-stage indicators such as periaortic fluid, soft tissue stranding, or the presence of gas near the graft should lead to immediate intervention. When infection is suspected, positron emission tomography–CT (PET-CT) is performed to confirm if infection is the cause, as this information is critical for guiding appropriate surgical treatment.

CANDIDATES FOR EXPLANTATION

Published series outline a common set of indications for explantation, although their distribution varies significantly depending on referral patterns. In the study by Joo et al, type I endoleak was the most common reason for conversion, followed by SINE, retrograde type A aortic

DOs AND DON'Ts OF PLANNING FOR EXPLANTATION OF A THORACIC AORTIC STENT GRAFT

DOs

- Confirm or rule out infection with PET-CT before choosing a strategy
- Get the index operative note and know the device's proximal fixation (bare stents, hooks, barbs)
- Favor revision TEVAR for endoleak when anatomy allows; reserve open conversion for infection, retrograde type A aortic dissection, and failed endovascular salvage
- Plan perfusion in advance: femorofemoral bypass with proximal clamping when feasible, 18°C circulatory arrest when the entire graft must come out
- Protect the spinal cord: routine CSF drainage and patch reimplantation of large intercostals
- Remove only as much stent graft as a sound distal anastomosis requires when there is no infection
- Debride widely and place antibiotic beads in the left chest when complete explantation is not possible
- Cover the graft with vascularized tissue: omental pedicle first, latissimus or intercostal muscle flap as alternatives
- Commit to lifelong surveillance: gated CTA at 3 months, then annually

DON'Ts

- Don't wait for rupture or sepsis to decide
- Don't clamp blindly over bare stents or barbs
- Don't leave infected graft behind without a plan for local and systemic control
- Don't underestimate spinal cord ischemia risk
- Don't attempt explantation without a perfusion and backup plan in place

dissection, migration or fracture, and infection.[2] However, Melissano et al reported a different pattern, with stent graft infection or fistula accounting for roughly one-third of 30 late conversions.[3]

We distinguish failures into two categories. The first, mechanical failure, encompasses endoleak secondary to device migration and disease progression at the proximal or distal landing zones. Most mechanical failures can be managed endovascularly, with revision TEVAR the preferred approach when anatomy permits. The advent of fenestrated and branched endografts for the aortic arch and thoracoabdominal aorta has extended endovascular options to patients without suitable landing zones. Favorable early results with these devices have substantially reduced the need for open explantation, particularly in elderly patients. The only exception is retrograde type A aortic dissection, which necessitates open surgery. In such cases, complete removal of the endograft is rarely needed, and typically only a short segment of the proximal stent graft is removed to secure a proper distal anastomosis, leaving the rest untouched.

The second category pertains to infection, which is our most frequent cause for explantation. Infection influences the decision-making process because an infected endograft usually cannot be resolved with antibiotics alone, so removal is typically necessary. Surgical removal generally leads to better outcomes than medical therapy alone, although some TEVAR series report mortality rates as high as 70%.[4,5] Patients often present with sepsis and malnutrition, which do complicate surgery, but surgery remains their best choice.

PREOPERATIVE PLANNING

Many decisions regarding the approach to explantation are determined prior to making an incision. We follow the same checklist for each case.

- **Review the operative note from the initial procedure to understand the device's manufacturer, model, and sizes, focusing on the proximal fixation.** Devices with bare-metal proximal stents, hooks, or barbs are firmly anchored into the aortic wall and are not easily removable by pulling. Their design affects safe clamping points and the extraction method for the graft.
- **Map the anatomy meticulously.** Use the CTA to determine the proximal and distal landing zones of the device and how close each end is to the arch vessels and visceral arteries. Arch involvement

substantially raises the risk of complete explantation and often would require either a median sternotomy or, in rare cases, a clamshell incision to facilitate surgery. In one study, hospital mortality reached 9.1%, with all deaths occurring in patients whose repairs involved the arch.[2]

- **Choose the perfusion strategy in advance.** Our standard method is femorofemoral bypass with proximal clamping, used when a safe clamp site exists above the device. If the entire graft must be removed and proximal clamping is not possible, we cool the patient to 18°C and use circulatory arrest. Other teams describe similar strategies; in the largest TEVAR explant series, 94% of infection-related explants were performed under hypothermic circulatory arrest.[5] This decision should be made before surgery, not during.
- **Protect the spinal cord.** Routinely use cerebrospinal fluid (CSF) drainage and reimplant large intercostal arteries as patches. Long-segment coverage can often weaken the collateral network, and this risk may be underestimated in redo procedures.
- **Assemble the team, including experienced cardiac anesthesia and perfusion specialists.** If a fistula is present, coordinate with a thoracic or foregut surgeon to plan the bronchial or esophageal repair before the procedure.
- **Whenever feasible, optimize treatment.** If the clinical scenario allows, delay surgery briefly so that infected patients can receive nutritional support and antibiotics based on culture results before surgery.

INTRAOPERATIVE TECHNIQUE

Exposure aligns with specific anatomic regions. Typically, a left thoracotomy is performed for most descending thoracic explants. If the device or disease reaches the visceral segment, a thoracoabdominal incision is needed. When the arch is involved, either a sternotomy or a combined approach is required.

The Clamp Mechanism

Applying a clamp directly on a bare-metal proximal stent can cause aortic tears. Before clamping, carefully locate the uncovered struts and barbs. If healthy aorta is present above the device, position the clamp there. If not, do not squeeze the stent graft with a clamp; instead, consider switching to circulatory arrest to perform an open proximal anastomosis.

Removal of the Stent Graft

Removing the graft involves opening the aorta, allowing the device's main part to detach smoothly from the thrombus inside the sac (Figure 1). The fixation zones present the most difficulty. Several techniques can help facilitate this process.

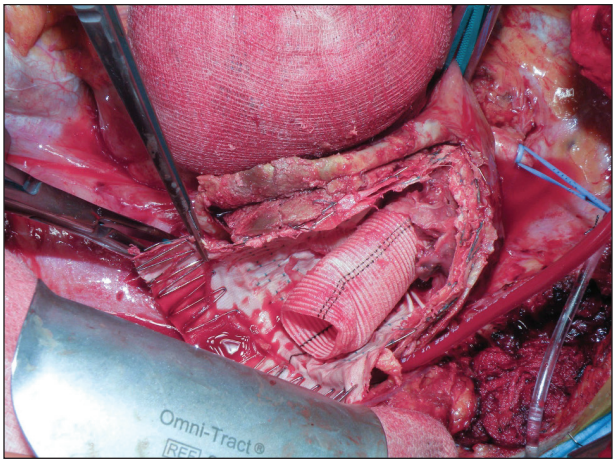


Figure 1. Intraoperative view after opening the aneurysm sac. The failed stent graft, with its fabric and metal stents, has been divided and is being freed from the aortic wall, and a polyethylene terephthalate elephant trunk graft lies within the sac.

- Secure the stent prior to pulling. Ties around the device, cold saline, or a short sheath can cause the self-expanding nitinol to collapse and reduce its radial force.
- When incorporating the struts, cut instead of pulling. Although dividing the struts and removing the device in parts is slower, it is safer than forcing a fixed segment out of the wall.
- Handle the barbs carefully, removing them one at a time and monitoring closely to avoid shearing the intima.

The extent of removal depends on the case. For mechanical failures without infection, only the necessary parts are taken out. Typically, this means excising a short proximal segment so the distal anastomosis can connect to healthy tissue, while leaving the rest of the device undisturbed. Melissano et al noted that it was usually feasible to leave the proximal part of the stent graft in place during most late conversions.[3] When suturing to an aortic segment still containing the stent graft, we include both the graft fabric and the aortic wall in the suture line and reinforce it with felt (Figure 2).

Infection Management

Infection management strategies vary. The goal is to completely remove the device, thoroughly debride the infected periaortic tissue, and repair any bronchial or esophageal fistulas. Both polyester grafts (with or with-

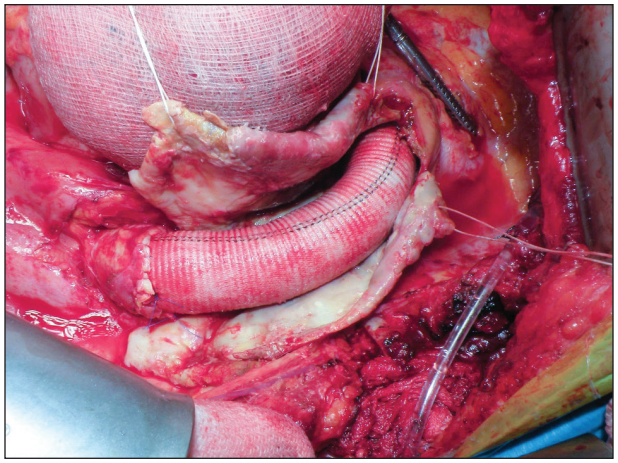


Figure 2. Completed repair with a polyethylene terephthalate graft in the descending thoracic aorta after removal of the endograft. The opened aneurysm sac surrounds the new graft.

out rifampin) and homografts are effective options as conduits in infected regions.[5]

Complete removal may sometimes be unfeasible because the proximal end might be anchored deep in the arch or the patient might not tolerate extended circulatory arrest. In such situations, we safely remove what we can extract and insert antibiotic beads into the left chest for local infection control, alongside long-term systemic antibiotic therapy. This approach is a compromise, and we monitor the patient closely for potential recurrent infection.

POSTPROCEDURE CARE AND FOLLOW-UP

Postprocedure, prioritize the spinal cord, kidneys, and blood pressure. Keep the CSF drain in place during initial recovery, and ensure proper perfusion pressure to support the spinal cord. Any sudden leg weakness should be treated as an emergency. Protect the kidneys by avoiding nephrotoxins and limiting contrast use after prolonged surgeries with visceral ischemia.

Patients with infections are initially co-managed by infectious diseases specialists. They typically receive extended courses of culture-guided intravenous antibiotics, and many stay on oral suppression long term, particularly when devices or prosthetic grafts are involved in the infected area.

Explantation does not end surveillance. We track the new repair and any remaining stented segment using the same gated CTA schedule as after TEVAR: at 3 months and then annually. Late complications, including recurrent infection, anastomotic pseudoaneurysm, and disease progression at the repair edges, may still occur.

CONCLUSION

Explantation after TEVAR for endoleak or aneurysm expansion can be done with outcomes comparable to standard open descending and thoracoabdominal repair, and partial explantation with a retained, incorporated endograft is a sound strategy.[3,5] Explantation for infection remains the highest-risk scenario, demanding complete removal, wide debridement, vascularized coverage, and prolonged antimicrobial therapy. Because failures come early and fall disproportionately on young patients with dissection or heritable aortopathy, the most effective intervention is careful selection and lifelong surveillance at the index TEVAR. When open surgery is required, understanding the device, planning perfusion strategies in advance, protecting the spinal cord, and assembling a skilled team are vital for safety. Patients tend to have better outcomes when quickly referred to specialized centers that perform these procedures frequently, ideally before rupture or sepsis occurs. ■

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