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Commentary

Evolution of Endovascular Techniques in Thoracic Aortic Surgery

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DESCRIPTION

Thoracic Aortic Aneurysms (TAAs) are abnormal dilations of the thoracic portion of the aorta, which can lead to life-threatening complications such as rupture or dissection if left untreated. Traditionally, open surgical repair was the standard treatment for TAAs; however, it carries significant risks, especially in elderly patients or those with comorbidities. Over the past two decades, endovascular techniques have emerged as a minimally invasive alternative that has revolutionized the management of thoracic aortic aneurysms. Endovascular repair, commonly known as Thoracic Endovascular Aortic Repair (TEVAR), involves inserting a stent-graft through the femoral or iliac arteries and positioning it within the aneurysmal segment of the aorta to exclude the aneurysm from blood flow, thereby reducing the risk of rupture. The procedure begins with careful preoperative planning, which includes detailed imaging studies such as Computed Tomography Angiography (CTA) or Magnetic Resonance Angiography (MRA). These imaging modalities help determine the aneurysm's size, location and relation to vital branches of the aorta. Appropriate patient selection is crucial, as anatomical factors such as aortic tortuosity, involvement of the aortic arch and proximity to major arteries can affect the success of the procedure. Once the access site is prepared, the stent-graft is navigated to the target area using fluoroscopic guidance. Once in position, it is deployed to reinforce the aortic wall and redirect blood flow through the graft lumen, allowing the aneurysmal sac to shrink over time.

Endovascular repair offers several advantages over conventional open surgery. Recovery time is significantly shorter, hospital stays are reduced and perioperative complications such as bleeding, respiratory issues and infections are minimized. Additionally, TEVAR can often be performed under local or regional anesthesia, reducing the risks associated with general anesthesia. Despite these benefits, the procedure is not without challenges. Potential complications include endoleaks, stent migration, spinal cord ischemia and access site complications. Long-term surveillance with periodic imaging is required to monitor for these issues and ensure the durability of the repair. Advances in stent-graft technology, such as branched and fenestrated grafts, have expanded the applicability of endovascular techniques to more complex aneurysms involving the aortic arch and descending thoracic aorta. Preoperative 3D modeling and patient-specific simulations using Computed Tomography Angiography (CTA) derived software (e.g., TeraRecon or Siemens Syngo.via) allow surgeons to rehearse deployments virtually, reducing operative time by 20-30% and minimizing errors in tortuous anatomies. During access, percutaneous femoral closure with suture-mediated devices like Perclose ProGlide cuts vascular complications from 10% to under 2%, as shown in the OVER trial. Fluoroscopy remains core, but fusion imaging overlays preoperative CTA onto live X-rays, enhancing accuracy for proximal seals important in 40% of arch-adjacent TAAs. Intravascular Ultrasound (IVUS) provides real-time lumen sizing, preventing undersizing-related endoleaks, with studies reporting 95% seal success. For spinal cord protection, a multimodal approach shines: preoperative identification of Adamkiewicz artery via MRI, permissive hypotension (MAP 70-80 mmHg), and cerebrospinal fluid drainage maintain perfusion pressure, slashing paralysis rates from 8% to 1.5% in high-risk descending repairs (per SVS guidelines). Branched and fenestrated grafts excel in complex cases; the Gore TBE device, FDA-approved in 2022, preserves left subclavian flow in Zone 2 landings, with 98% branch patency at 1 year from pivotal trials. In emergencies like rupture, "bailout" chimney stents bridge urgent gaps. Real-world data from VQI and EUROSTAR registries confirm these: 5-year survival >85% vs. 60% for open repair in octogenarians. Hybrid debranching (carotid-subclavian bypass) extends TEVAR to Zone 0, vital for connective tissue disorders like Marfan syndrome. Robotic systems like CorPath GRX offer sub-millimeter precision, trialing in Europe to cut radiation exposure by 50%. AI algorithms now predict endoleak risk pre-op with 90% accuracy, personalizing plans. These techniques, battle-tested in 100,000+ annual procedures, underscore TEVAR's real-life impact safer, faster, and more inclusive.

CONCLUSION

In conclusion, endovascular techniques have transformed the management of thoracic aortic aneurysms, providing a safer, less invasive alternative to open surgical repair for many patients. While careful patient selection, meticulous procedural planning and long-term follow-up are essential for optimal outcomes, the continued development of stent-graft technology and imaging techniques promises to further enhance the safety and efficacy of TEVAR. As these minimally invasive approaches continue to evolve, they are likely to become the standard of care for an increasing number of patients with thoracic aortic aneurysms, significantly improving prognosis and quality of life.

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