Retrograde aortic dissection during thoracic endovascular aortic repair: How to prevent and treat

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Today, thoracic endovascular aortic repair (TEVAR) is the recommended treatment of descending thoracic aortic aneurysms, complicated type B aortic dissection (TBAD), and traumatic aortic injury, when anatomically suitable.[1] Its use in uncomplicated TBAD is increasing.

As with any emerging technology and treatment, new complications arise. Retrograde type A aortic dissection (RTAD) is a catastrophic and life-threatening complication. The incidence of RTAD is 2% to 5% of all patients undergoing TEVAR.[2-6] To minimize the incidence of RTAD and improve the outcomes when it occurs, it is essential first to understand the risk factors for its development, how to avoid them, and the best methods to manage RTAD when it occurs.

RISK FACTORS

The occurrence of RTAD after TEVAR is associated with several key risk factors, as elucidated in the literature. Some of those factors are patient or tissue related. One significant factor is the underlying disease process itself that required the TEVAR. According to the literature, patients treated for TBAD are more prone to the occurrence of RTAD, even with treatment landing in a "seemingly healthy" aorta. Most likely, the inflammation and disease process extends beyond the visible pathological segments of the aorta.[7-9] Other conditions, such as hereditary thoracic aortic diseases or bicuspid aortic valves, also significantly increase the risk for RTAD, with an incidence reported as high as 25%.[3,6,10] The aortic diameter is another critical factor, with an ascending aorta diameter >40 mm identified as a risk factor for RTAD after TEVAR.

A few factors are related to the technical aspects of performing TEVAR. The proximalization of the landing zone beyond zone 2 increases the risk of RTAD, most likely due to the mismatch between the elastic ascending aorta and the rigid stent graft. The design of the proximal edge of the stent graft has also been a topic of debate. A few studies have demonstrated that a proximal bare stent (PBS) resulted in a higher incidence of RTAD compared with treatment without PBSs.[5,11] The metal tip of the PBS can damage the aortic intima, thereby, promoting dissection development.[3,11]

Another identified risk factor is the oversizing of stents by >20%.[3,12] This practice increases the radial force on the aortic wall, making it more susceptible to dissection. Applying balloon dilation after stent implantation and reinforcing the stent attachment can also elevate tension on the aortic wall, particularly in cases of acute aortic dissection, posing a risk for RTAD.[3] Iatrogenic aortic dissection induced by catheters during surgical procedures is also recognized as a risk factor. Injuries to the aortic wall, especially when guidewires and catheters are improperly manipulated, can lead to the formation of a tear, contributing to RTAD.[3,11,12]

The presence of an endoleak, a common TEVAR complication, can elevate the risk of RTAD by maintaining blood flow in the false lumen.[3,10,12] Uncontrolled hypertension after TEVAR is also associated with an increased risk of RTAD, because it generates longitudinal and transverse shear stress on the aorta, contributing to dissection expansion.[3] Understanding and addressing these diverse risk factors are imperative to developing comprehensive strategies aimed at preventing RTAD after TEVAR and, thereby, enhancing the safety and success of the procedure.[10,13]

PREVENTION

Keeping these risk factors in mind, preventing RTAD after TEVAR necessitates a multifaceted strategy, encompassing both patient selection and procedural techniques. A judicious approach to patient evaluation and selection is crucial, involving a thorough assessment for underlying conditions, such as heritable thoracic aortic disease, bicuspid aortic valve malformation, or an aortic diameter >40 mm.[4,5,12,13] In complicated TBAD, TEVAR might be necessary as a lifesaving event in this high-risk population and might not be avoidable. Therefore, awareness of this possible complication is essential and using imaging modalities, such as intravascular ultrasound or echocardiography, at the end of the

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procedure in such populations is helpful for an early diagnosis and management of RTAD.

In terms of procedural techniques, selecting an appropriate stent is pivotal, with factors such as diameter and length carefully considered. Oversizing the stent by >10% to 20% should be avoided to prevent an increase in radial force on the aortic wall, which could lead to dissection. The choice of stent design is also critical, with covered stents preferred over PBSs, which have been linked to RTAD.[3,5,10,13] Balloon dilation after stent implantation should be approached cautiously and avoided when possible, particularly in cases of acute aortic dissection.[14] Minimizing aortic wall injury during the procedure is imperative to avoiding iatrogenic aortic dissection induced by catheters, which emphasizes the need for proper manipulation of guidewires and catheters.

Postoperative care and monitoring play a significant role in preventing RTAD. Management of preexisting hypertension is paramount, because it is important to ensure adequate hypertension control after TEVAR. This might require admission to an intensive care unit and continuing anti-impulse therapy while transitioning the patient to an adequate oral regimen. Implementing a structured follow-up plan for patients after TEVAR is essential, given that RTAD can occur at various intervals after the procedure. Educating patients about the potential symptoms, such as new-onset chest pain, and encouraging prompt reporting of symptoms are key components of postoperative care. Regular imaging surveillance, including computed tomography angiography, during follow-up is crucial for detecting signs of RTAD or related complications.[10,13,15,16]

TREATING RTAD

Treatment of RTAD after TEVAR involves surgical interventions aimed at managing the complications associated with this condition. Various surgical strategies have been used, and the outcomes reported in the literature highlight the effectiveness of these approaches. Postoperative mortality ranges from 4.2% to 11.1%,[7,17-20] and sometimes higher, surpassing those of spontaneously occurring acute type A aortic dissection. Subgroup analyses indicate that patients experiencing RTAD during TEVAR—particularly those with proximal stent graft-induced new entry—exhibit poorer outcomes compared with those with RTAD detected during follow-up.[7,10,13,15] Consequently, opting for subsequent open conversion is deemed the preferred treatment to mitigate these life-threatening complications. A Duke group report revealed that 66% of RTADs occurred intraoperatively, with 75% initially identified through transesophageal echocardiography or intravascular ultrasound, underscoring the critical importance of a swift diagnosis and the potential role of intraoperative diagnostic tools in early RTAD detection.[4,13,18]

RTADs associated with wire and/or sheath manipulation typically manifest in the distal ascending aortic arch or proximal aortic arch in approximately one half of patients. Moreover, proximal stent graft-induced new entry, occurring more frequently along the greater curve, encompasses the entire ascending aorta in most (83%) cases.[7,18,19] Consequently, the presumed cause and location of RTAD could significantly affect the chosen treatment strategy. The preferred surgical repair involves substituting the entire aortic arch with direct vascular graft suturing to the endograft.[4,7,10,13,15,16,18]

Rarely used, an alternative strategy involves complete removal of the endograft and Dacron graft replacement using the modified "elephant trunk" technique.[17] Conservative treatment finds application in selected cases, particularly for those with wire-induced wall injury or the presence of focal, asymptomatic lesions.[7,17-20]

The late outcome of survivors after an operation for RTAD was optimal.[20] Idrees et al[21] reported 16.7% (4 of 24) aortic reoperations at a median follow-up period of 26 months. In contrast, Li et al[22] reported no deaths and only one reoperation for replacement of the thoracoabdominal aorta at a mean follow-up of 32.2 months. The overall prognosis of this group was also very good, with no late deaths and only one aortic reoperation during the follow-up period.

CONCLUSIONS

A multidisciplinary collaboration among vascular surgeons and other specialists, such as cardiac surgeons, cardiologists, and anesthesiologists, is vital. This collaborative approach facilitates a comprehensive evaluation of patients, enabling discussion of the best strategies for prevention and management based on individual patient characteristics. Preventing and treating RTAD after TEVAR involves meticulous patient selection, optimal procedural techniques, vigilant postoperative care, and a multidisciplinary approach, with a continuous refinement of practices based on evolving research findings for enhanced safety and improved outcomes in TEVAR.

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DISCLOSURES

None.

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