Masters of Cardiothoracic Surgery

Techniques for repair of retrograde aortic dissection following thoracic endovascular aortic repair

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The advances in thoracic endovascular aortic repair (TEVAR) offer patients who are otherwise unsuitable for open surgery an alternative in treating their aortic arch pathologies. However, the adoption of TEVAR carries inherent complications unique to itself, notably the occurrence of Type A retrograde ascending aortic dissections, which can range from 1-3%. Several key technical considerations are must be heeded to minimize the risks of these complications. It is important to completely excise the primary entry tear through a careful and methodical approach. The proximal and distal reconstruction must be hemodynamically sound, with care taken to stabilize both the root and the distal aorta. Neuroprotection strategies, such as antegrade cerebral perfusion, should be utilized if the duration of circulatory arrest is anticipated to be greater than 30 minutes. This report details the operative techniques for the repair of retrograde aortic dissections following TEVAR.

Keywords: Retrograde aortic dissection; TEVAR; dissection repair; arch pathology

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Introduction

Thoracic endovascular aortic repair (TEVAR) has revolutionized the treatment of thoracic aortic diseases. One devastating iatrogenic complication of TEVAR not previously seen with open aortic replacement is the occurrence of retrograde ascending (Type A) aortic dissection. The incidence of retrograde type A aortic dissection in case series and registries ranges from 1% to 3% (1,2). Retrograde dissection may present either at the time of the initial implant or in follow-up. Frequently, these dissections are found in asymptomatic patients with routine follow-up CT scans.

Operative techniques

General technical considerations

The operation should be set up to account for a wide variety of anatomic problems and perfusion strategies. Techniques to treat retrograde aortic dissection after TEVAR can include type II hybrid arch debranching, which incorporates the replacement of the ascending aorta with an open distal hemi-arch anastomosis to the dissected aorta, rerouting of head vessels and placement of an antegrade stent from the surgical aortic graft to the TEVAR graft, total arch replacement with a circumferential anastomosis to the aortic stent graft, or simply ascending aortic placement with a hemi-arch anastomosis. The key principle of surgical repair is to completely excise the primary aortic tear. In the most isolated cases where a single protruding metal element of the aortic stent graft is the site of the entry tear and this is a very small defect on the lesser curve, an extended hemi-arch anastomosis that fully excludes this tear and bevels into the stent graft along the lesser curve may be sufficient. More frequently, there is a larger tear that incorporates a larger portion of the circumference of the aorta at the interface between the stent graft proximal edges in the native aorta. If the stent graft is placed fairly proximally, such as between a bovine trunk and the left subclavian artery origin, then a total arch approach with a circumferential surgical anastomosis to the aorta and stent graft is preferable. In this situation the location of the arch anastomosis is anterior enough to be able to be construct through a sternotomy incision. In cases where the anatomy is unfavorable for this type of anastomosis, a type II hybrid arch debranching procedure, in which the dissected ascending aorta is replaced with a hemi-arch anastomosis that is circumferentially sewn to the native aorta. The head vessels are debranched with separate grafts arising from the ascending aorta and a stent graft is placed between the new surgical ascending aortic graft and the original TEVAR from which the retrograde dissection originated. In this situation, seal of the entry tear is achieved with the aortic stent graft.

As key elements of the arch reconstruction portion of the surgery may not be predictable until the arch is actually opened under circulatory arrest conditions, it is imperative to have all options for cerebral perfusion available. Our strong preference is for axillary artery cannulation in these cases, although in certain situations, such as complex innominate artery dissection, direct ascending aorta cannulation over a wire or femoral cannulation may be required (3). The surgeon should be ready to directly perfuse the head vessels with balloon tip cannulas placed from inside the arch in such cases. We advocate for moderate to deep hypothermia (18-28 ℃) in these cases. Although not the strategy of choice for complex arch reconstruction, retrograde cerebral perfusion may also be a useful adjunct. In cases where only a hemi-arch anastomosis is needed, retrograde perfusion with deep hypothermia (18 ℃) may be used as the sole cerebral protection therapy if the total circulatory arrest time is anticipated to be less than 30 minutes. In complex arch reconstructions antegrade cerebral perfusion is a superior approach.

Technical aspects of the proximal reconstruction

The complexity of proximal reconstruction is dependent on the degree of involvement of the aortic sinuses in the dissection process. In cases where the root is severely dilated or there are secondary tears within the sinuses, full root replacement should be undertaken. Often, retrograde aortic dissections will stop at the level of the sinotubular junction as they form a blind end pouch which thromboses. In this case, resection of the aorta to the level of the sinotubular junction will allow for a standard anastomosis of the aortic graft to the non-dissected aorta. In cases where the dissection flap extends below the sinotubular junction, our approach to sinus reconstruction is to re-create the media layer in the dissected portion, thereby stabilizing the root and providing a robust substrate to sew the proximal anastomosis. In this repair, strips of Teflon felt are placed to completely fill the space between the dissected layers of the aorta (4). The commissures are then resuspended with pledgeted mattress sutures, thereby permanently affixing the commissure to the aortic adventitia, eliminating the possibility of late prolapse. Typically, the right to non-coronary commissure is prolapsed by the dissection flap. A suture-line is then placed around the entire dissected portion of the aorta to secure the felt within the layers. The aortic graft is then sewn to the reconstructed sinus segment. With this type of repair, the load bearing suture line is entirely placed within either the non-dissected aorta, or the dissected aorta that has been buttressed by Teflon felt. With every bite, that graft is invaginated into the reconstructed root. This creates an ‘on-lay’ anastomosis which tends to seal better when the aorta is pressurized than a traditional end-to-end anastomosis. This is a very robust suture line that tends to be hemostatic. The Teflon felt within the medial layer of the sinus segment also allows the layers to scar back together and likely prevent late root dilatation.

Technical aspects of the distal reconstruction

The distal anastomosis in a retrograde aortic dissection is uniquely challenging. Due to the presence of metal stent elements, some of which may be exposed, or even perforated through the aorta, there is an extra level of complexity such that repair times are often substantially longer than other forms of arch reconstruction. When performing a complete circumferential arch anastomosis to a thoracic aortic stent graft, achieving a hemostatic repair is paramount. Our approach has been to completely excise any protruding metal springs, covered or bare, using wire cutters. This leaves a fabric surface to incorporate into the anastomosis. The presence of the residual metal stent tends to create gaps and typically a two or three suture line anastomosis is required to adequately seal the bleeding. It is paramount to never remove the stent graft as the distal aorta has a tendency to completely fall apart when this is done. To seal the distal anastomosis, the stent graft is sewn to the native aorta with the first suture line. This is done to prevent future type I endoleak and significantly facilitates the anastomosis between the graft and the aorta. The second suture line is between the graft and the joined aorta/stent-graft. As with the proximal suture line, the graft is deeply invaginated into the stent-graft with every bite to create an ‘on-lay’ anastomosis. A third suture line, which can be done after reinstitution of systemic flow, is composed of interrupted pledgeted mattress sutures and will seal the anastomosis. A strip of Teflon felt may be added as external support to the first suture line. The head vessels may be approximated onto the aortic graft either in the anatomic position or using debranching type techniques.

Comments

Retrograde type A dissection after TEVAR is a significant surgical challenge. Techniques have been developed to allow for robust reconstructions with hemostatic suture lines. The key principles are to completely eliminate the entry tear, stabilize the distal aorta, and stabilize the root. Development of more conformable devices may help prevent this catastrophic complication in the future.

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