Technical Aspects of Ascending Aortic TEVAR

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Procedural Considerations

In patients meeting anatomic criteria (Figure 1), retrograde aortic access via the femoral arteries can be achieved in patients with vessel diameter of at least 7mm. Bilateral arterial cannulation is necessary for device delivery on one side and IVUS/angiogram on the contralateral side. Femoral venous access for temporary pacing and/or cannulation access in the event cardiopulmonary bypass is urgently needed. Transapical access will require a left small thoracotomy between the 5th and 6th intercostal space. The pericardium is opened and two pursestring sutures are placed into the myocardium of the left ventricular apex. Benefits of the transapical approach include minimal interaction of wires and devices in the aortic arch minimizing embolic events and progression of aortic injury. Additionally, it allows for coaxial deployment of the stent graft which promotes adequate proximal landing zone seal, minimizing risk of 1A endoleak.

Intraoperative Monitoring

Ascending TEVAR is best performed in a hybrid operating room. Advanced imaging capabilities paired with the ability to convert to an open surgical case in the event of complications is crucial for these complex cases. Cardiopulmonary bypass should be available on standby. Transesophageal echocardiogram is necessary to evaluate the aortic valve and cardiac function before and after the procedure, it is also useful for confirming position within the true lumen. New onset wall motion abnormalities after deployment of the stent graft can be an indicator of coronary ostial obstruction. Neurophysiologic monitoring including transcranial Doppler, transcutaneous near-infrared spectroscopy, and transcranial cerebral oximetry can detect micro-emboli and changes in cerebral blood flow. Intravascular ultrasound (IVUS) is used to confirm wire position within the true lumen, identify the position of branch vessels and aortic injury, and measure landing zones for the stent graft (Figure 2&3). After deployment of the stent graft, IVUS can confirm vessel wall apposition of the graft.

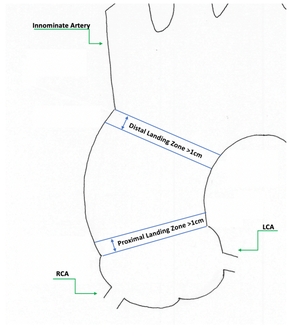


Figure 1: Ascending TEVAR landing zones

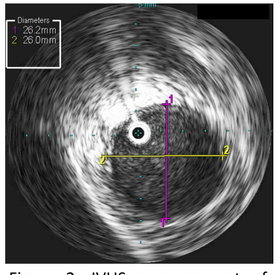


Figure 2: IVUS measurement of luminal diameter

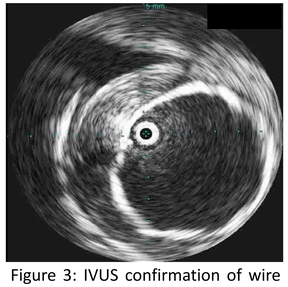


Figure 3: IVUS confirmation of wire in true lumen

Procedural Review

Arterial access is achieved with a micropuncture needle and wire using Seldinger technique under ultrasound guidance. Percutaneous suture-mediated closure devices are placed, navigating J-tipped guidewire is then advanced under fluoroscopy to the descending aorta. Guidewire is advanced simultaneously with IVUS catheter to ensure wire position within the true lumen. At this point, the navigating wire is exchanged through the IVUS catheter for a stiff wire with soft tip and advanced into ascending aorta. Measurements are obtained via IVUS for luminal diameter at the proximal and distal landing zones, length of coverage, location of intimal disruption, and ostia of the coronary arteries and innominate artery. Wire is advanced and positioned through the aortic valve into the left ventricle. Aortography can be performed through a 5F pigtail catheter to verify location of landmarks (Figures 4 & 5) After landmarks and landing zones are confirmed, systemic heparin is administered to a minimum ACT of 250 seconds. Device is then advanced over the guidewire into location with final confirmation of positioning with both fluoroscopy and TEE (Figure 6). Cardiac output is minimized using either ventricular pacing at a rate of 160-180bpm or a 36mg dose of intravenous adenosine is administered. During reduced cardiac output period, device is deployed with continuous TEE monitoring and under fluoroscopy. Following deployment, triple imaging (IVUS, angiogram, TEE) is performed to confirm position, rule out endoleak, verify adequate function of aortic valve, and confirm no change in cardiac function or increase in pericardial effusion.

Technical Aspects

There are some unique considerations for the ascending aorta when compared to more distal segments. For instance, the ascending aorta is larger in diameter and shorter in length.

It is highly elastic and dynamically, there is up to 15% variation in aortic size during the cardiac cycle. Stent graft sizing must take this into account, measurements should be obtained during systole, with oversizing of 5-10% in patients with aortic dissection. Curvature of the aortic arch can lead to an oblique orientation of the stent graft when using transfemoral approach. In a horizontal aorta, this can make coaxial deployment of the stent graft near impossible, a transapical approach would be preferred in these cases.



Figure 3: Aortography of proximal landing zone



Figure 4: Aortography of distal landing zone



Figure 5: Confirmation angiogram prior to device deployment

Potential Complications

There are numerous potential complications with TEVAR in the ascending aorta. Appropriate patient selection and thorough pre-planning is mandatory to minimize these complications. As in all endovascular stent graft cases, there is a risk for endoleak and extension of dissection, however there are also some unique risks when working with the ascending aorta. Guidewire manipulation into the ventricle leads to the potential for injury to the aortic valve and wire perforation of the left ventricle. Careful wire handling is crucial in these cases. Marking drapes on the operating table after wire positioning can help the team visualize if the wire location has been inadvertently changed during catheter and device exchanges. Injury of the aortic root and coronary arteries is a risk, exercise caution when manipulating wires and catheters in the proximal aorta. With transfemoral access, guidewires, catheters, and devices traverse through the aortic arch and into the ascending aorta. Any thrombus, calcifications, or atherosclerotic debris has the potential of being released into the blood stream with the brachiocephalic vessels being the first branch vessels encountered. Curved wires and advancing gently can reduce the trauma to vessel walls. Through the transapical approach there is less manipulation beyond the innominate artery which may reduce the risk of neuroembolization. Malalignment of the stent graft landing zones can lead to occlusion of coronary arteries, innominate artery, and entrapment of aortic valve leaflets. Triple imaging with IVUS, angiography, and TEE can help thoroughly identify these important landmarks before, during, and after deployment.

Conclusion

Open surgical repair is the standard treatment for patients with acute type A aortic dissection, however for those with prohibitive surgical risk, endovascular treatment is a feasible option for patients with adequate anatomic characteristics. Preoperative imaging with ECG gated CTA aids in accurate measurements of landing zones, identification of intimal tears, and evaluation of important anatomic landmarks. Intraoperative IVUS, angiography, and TEE provide real-time data for accurate and safe deployment of the stent graft.

References

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