TEVAR for complicated acute type B dissection with malperfusion

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Submitted Apr 19, 2014. Accepted for publication May 12, 2014.
doi: 10.3978/j.issn.2225-319X.2014.05.03
View this article at: http://dx.doi.org/10.3978/j.issn.2225-319X.2014.05.03

Clinical scenario

A patient presents with an acute type B aortic dissection (ABAD) and malperfusion is in his fifth or sixth decade of life, with a history of hypertension and an acute moment of chest pain and left leg pain. He then develops associated abdominal pain and persistent left leg pain with diminishing sensation and movement. This type of patient requires urgent intervention, with the currently preferred modality of treatment being thoracic endovascular aortic repair (TEVAR) (1). TEVAR allows restoration of end-organ perfusion and may allow for favorable reverse remodeling to heal the aorta.

Surgical techniques

Preparation

The patient is placed in a supine position under general anesthesia with mechanical ventilation, and a lumbar drain is placed in the selected patient following induction of general anesthesia. Antibiotics are administered prior to the procedure and the patient is prepped and draped in a standard fashion.

Exposition

Stent graft delivery is usually accomplished through a transfemoral approach, involving a standard transverse infrainguinal incision to expose the common femoral artery. Percutaneous access is attained through the contralateral femoral artery to advance a marker pigtail catheter for angiography.

Operation

Intravascular ultrasound (IVUS) is critical to ensure that the working wire and stent graft will lie within the true lumen. The stent graft is positioned under fluoroscopic guidance and IVUS is used for optimal guidance. Following deployment, the stent graft location is evaluated using aortography and IVUS, and if type I and/or type III endoleaks are revealed, they are instantly treated. Balloon dilation of the overlap zones is performed if multiple stent grafts are deployed. Branch vessel investigation is conducted using arteriography and branch vessel pressure manometry. If residual malperfusion is identified due to static obstruction, branch vessel stenting with self-expanding stents is performed.

Completion

All catheters and wires are withdrawn, followed by primary repair of the femoral artery using interrupted 5-0 Prolene. Doppler signals are checked and confirmed. 2-0 Vicryl is used for primary closure of the deep and superficial fascia, and 4-0 Monocryl is used for subcutaneous closure of the skin. This is followed by administration of protamine to neutralize heparin.

Comments

Clinical results

Of the 454 patients presenting with ABAD in our practice at the University of Michigan Health System from 1995-2012, 49 patients underwent TEVAR, of whom seven suffered malperfusion. The in-hospital mortality in this group of patients was 14.3% (1 of 7) (2). A significant number of the patients during this time period were treated with percutaneous flap fenestration and true lumen stenting as an alternative to open repair or TEVAR. However, with

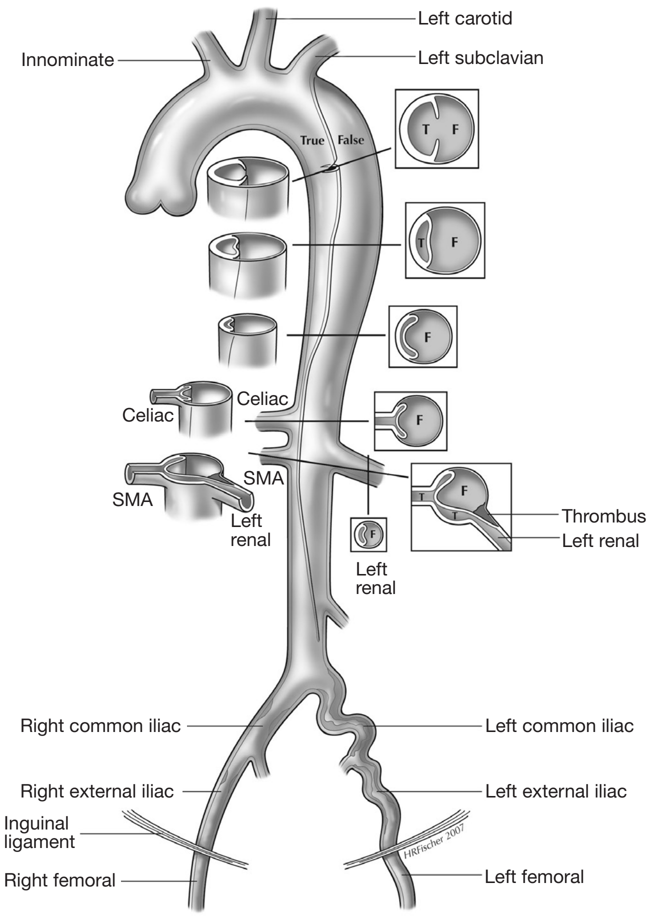

Figure 1 A type B aortic dissection is depicted detailing the anatomy. Intravascular ultrasonography (IVUS, catheter not shown) is a primary aid in the treatment of acute type B aortic dissection with malperfusion. The cross-sectional images of the aorta and branch vessels correlate to the images seen on IVUS. IVUS demonstrates which branches are likely to be compromised and by what mechanism, by depicting the relation of the dissection flap to branch artery origins. Due to the high frequency of multi-organ compromise, branch artery manometry and arteriography with hand-injections of contrast (not shown) are performed. These tests confirm patency and perfusion of renal, superior mesenteric, and if indicated, the iliac arteries. In this figure, the primary entry tear is situated in the proximal descending thoracic aorta. The dissection flap distal to this shows evidence of collapse of the true lumen with dynamic obstruction of the celiac and superior mesenteric arteries. In these vessels, the dissection does not extend into them but rather occludes them by intermittent obstruction of the flap during the cardiac cycle. In contrast, the left renal artery shows evidence of dissection without re-entry in the course of the branch vessel. In this branch, there is formation of a thrombus in the left renal artery false lumen, which in turn causes a static obstruction and renal malperfusion. F, false lumen; SMA, superior mesenteric artery; T, true lumen. Adapted from Patel *et al*. with permission of Elsevier (5).

the acceptance of TEVAR as a primary treatment option, our strategy has evolved towards this type of management (3,4).

Advantages

Preoperative workup for TEVAR with malperfusion should include dynamic computed tomography (CT) imaging from the thoracic inlet to the femoral arteries. This imaging modality can give information on whether branch vessel obstruction is present and by which mechanism, and also if an associated aortic aneurysm exists. Preoperative planning with 3D reconstruction of CT scans is even more important for the durability of TEVAR, using adequate sizing and assisting in determining suitability of TEVAR itself. Not only does the affected segment and landing zones need to be analyzed, but the access vessels can also be assessed during the preoperative imaging workup.

In our practice, left subclavian revascularization is only performed selectively and concomitantly in patients with a dominant left vertebral artery, left internal mammary artery (LIMA) to left anterior descending (LAD) coronary artery graft, or a left vertebral artery directly arising from the aortic arch.

The stent graft is deployed to cover the primary entry tear within the true lumen. Subsequently, the true lumen expands, and dynamic branch vessel compromise is ameliorated. By eliminating flow through the primary entry tear, false lumen thrombosis is induced due to significantly reduced false lumen flow. If static branch vessel obstruction occurs at this point, it is treated with self-expanding stents. This approach may treat both the malperfusion component and the initial pathologic aortic condition. In contrast, percutaneous fenestration and true lumen stenting only treats the malperfusion component.

The different pre- and intraoperative steps of TEVAR for patients with ABAD, complicated by malperfusion, are further illustrated in *Figures 1-5*.

Caveats

At times, branch vessel obstruction from dynamic malperfusion may be suspected on preoperative imaging and clinical findings. When performing the operation, a lack of malperfusion of selected branch vessels may be identified. The etiology of this could include the following. Firstly, the patient may have sustained multiple re-entry tears from the time of the initial imaging study to the time of operation,

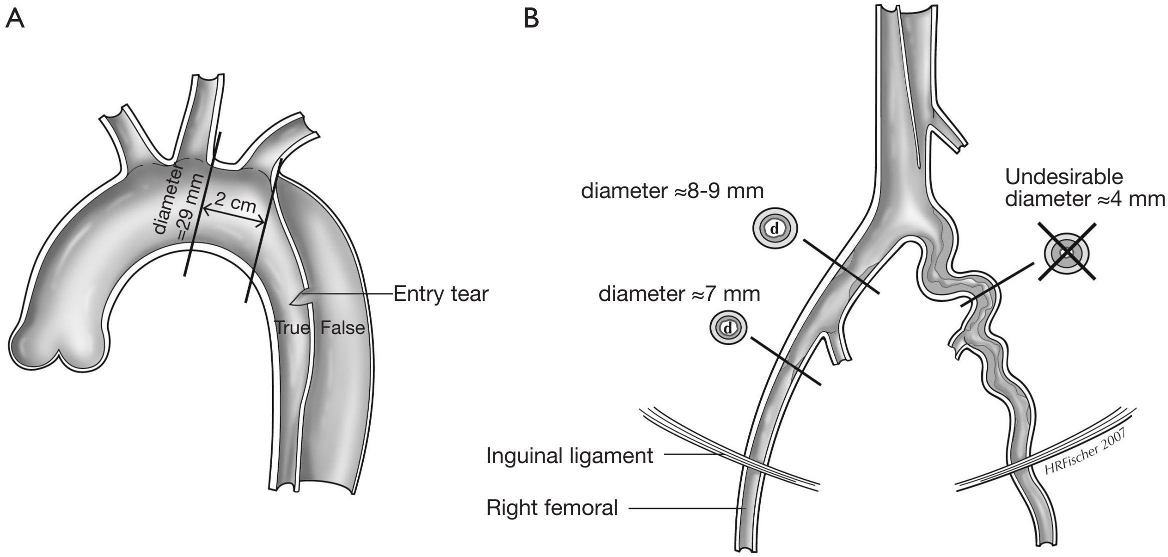

Figure 2 Preoperative CT scanning is essential to determine adequacy of the proximal landing zone. We typically extend coverage up to the left subclavian artery in cases of type B aortic dissection, often noting the need for complete coverage to obtain a 2-cm landing zone (A). To determine the correct stent graft size, we obtain measurements at the proximal edge of the pathologic problem and then at 1 cm proximal increments. The selected stent graft should have a diameter no more than 10% larger than the aortic diameter at the landing zone. For (A), a 31-mm graft would be selected. Finally, we commonly utilize a short (10-15 cm) stent graft length to avoid extensive intercostal artery coverage. Additional anatomic requirements for TEVAR include the absence of a tapered neck, the presence of a 2 cm proximal margin, and a relatively "flat" arch (in contrast to a "Gothic" arch) to allow for suitable apposition of the stent graft to the aortic lesser curvature. Finally, the access vessels are determined. The ideal vessel is straight, not calcified, and of adequate diameter to accommodate the delivery sheath for the stent graft (such as the right femoral artery in B). We have used intraoperative iliac angioplasty liberally to allow for femoral delivery in cases of short discrete iliac stenosis. If these access vessel requirements are not met, we plan to deliver via a conduit placed on the common iliac artery or through an internal endoconduit approach. In our experience, the iliac arteries of patients with aortic dissection are often more ectatic than stenotic. The need for adjunctive iliac angioplasty is reduced, especially when compared with the population of patients with degenerative thoracic aneurysms. d, luminal diameter. Adapted from Patel *et al*. with permission of Elsevier (5).

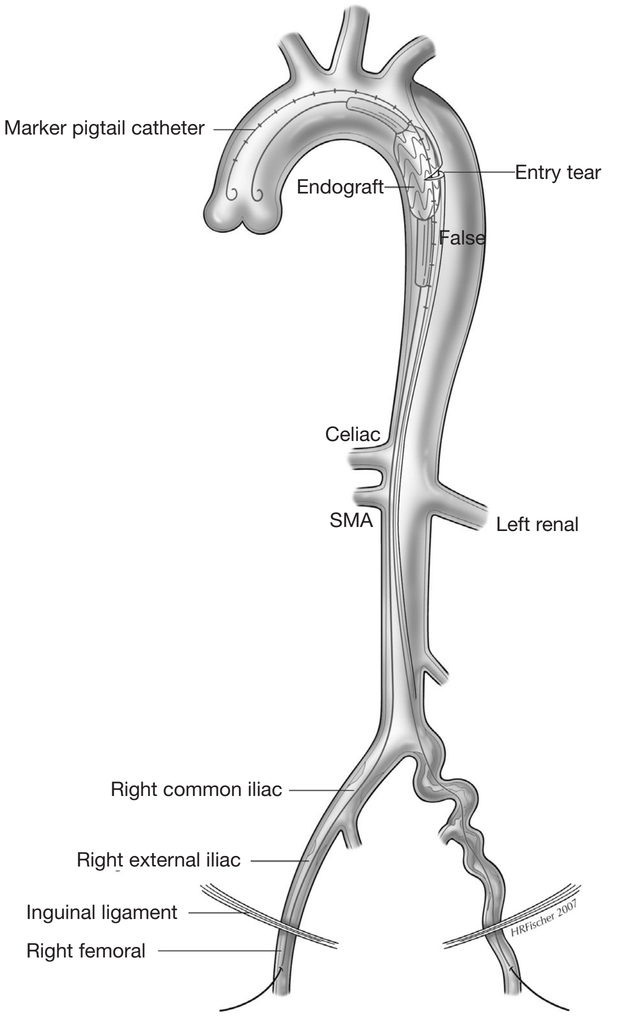

Figure 3 After IVUS examination coupled with initial angiography of the arch to determine great vessel origin (*Figure 1*), the access vessels are cannulated. The tortuous left iliac artery in this case serves as the route for percutaneous placement of a marker pigtail catheter, used for both angiography and assistance in marking the site of deployment. The delivery sheath is placed into the terminal aorta (not shown) over a stiff Lunderquist wire via an open exposure of the right femoral artery. The wire position is typically maintained in the ascending aorta throughout the procedure. Note that it is important to ensure true lumen placement of both wires to avoid the catastrophic complications of false lumen stent graft deployment or of dissection extension to type A. Finally, the stent graft is situated in the correct site and deployment is begun. SMA, superior mesenteric artery. Adapted from Patel *et al*. with permission of Elsevier (5).

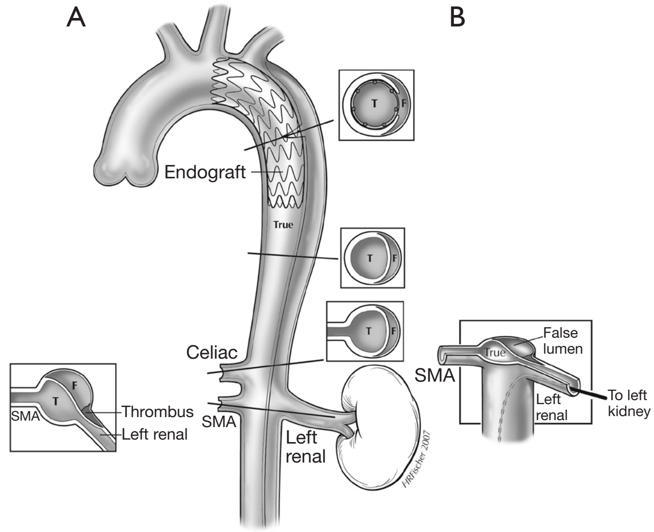

Figure 4 After stent graft deployment, balloon dilation to profile can only be performed at the proximal landing zone (not shown). We have however been somewhat reluctant to do this for fear of tearing the already inflamed aorta. Completion aortography demonstrates accurate deployment and elimination of flow via the entry tear. IVUS examination of the remaining non-treated aorta confirms resolution of dynamic obstruction (A). However, as is shown in this figure, the left renal artery demonstrates static obstruction and this is confirmed by obtaining pressure gradients from the aorta to the renal hilum in the renal artery true lumen (B). F, false lumen; SMA, superior mesenteric artery; T, true lumen. Adapted from Patel *et al*. with permission of Elsevier (5).

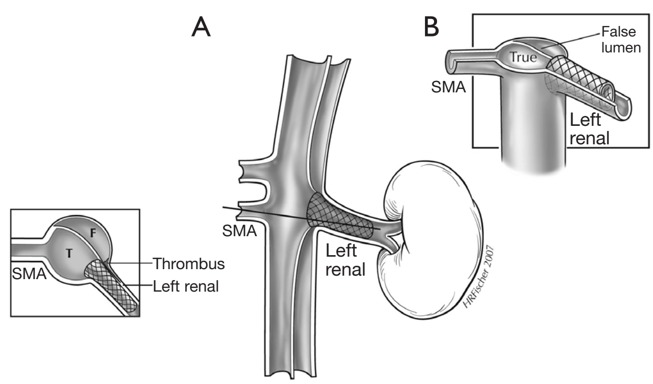

Figure 5 In the event of angiographically significant stenosis, or measurement of a 20 mmHg systolic gradient, the renal true lumen is stented with a self-expanding stent that is sized 10% more than the diameter of the renal artery. Completion manometry demonstrates branch vessel patency and adequate antegrade branch vessel flow. F, false lumen; SMA, superior mesenteric artery; T, true lumen. Adapted from Patel *et al*. with permission of Elsevier (5).

which could spontaneously resolve the malperfusion syndrome. Secondly, the initial imaging study may have had ill-timed contrast boluses, suggesting a lack of blood flow to viscera. This would not have been apparent if phase delay imaging had been performed.

Acknowledgements

Dr. HJ Patel and Dr. DM Williams have consulting relationship and patent with WL Gore.

Disclosure: The authors declare no conflict of interest.

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Cite this article as: van Bogerijen GH, Williams DM, Patel HJ. TEVAR for complicated acute type B dissection with malperfusion. Ann Cardiothorac Surg 2014;3(4):423-427. doi: 10.3978/j.issn.2225-319X.2014.05.03