Snorkel Procedures for TEVAR

Two case studies demonstrate how this procedure ensures left carotid artery patency during thoracic endovascular aortic repair.

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The inherent angulation of the aortic arch and presence of vital branch vessels can make attaining a proximal seal difficult. In cases when purposeful or inadvertent encroachment on vessels occurs, patency can be achieved through the placement of additional stents. "Snorkel procedures" are when stents are placed within a branch vessel and extend parallel to the aortic stent graft,[1] although terms such as "double-barrel technique"[2] and "chimney graft"[3] have also been used. Knowledge and familiarity of these techniques allow the treatment of patients with compromised fixation zones and allow the use of commercially available stent grafts while branched and fenestrated devices are being developed.

Thoracic endovascular aortic repair (TEVAR) is increasingly being used for diverse pathologies and indications. In addition to being the treatment of choice for descending thoracic aortic aneurysms, it has a growing role in the treatment of type B dissections with malperfusion, penetrating aortic ulcers, intramural hematomas, and traumatic transections. Patients whose aortic pathology extends close to branch vessels pose a problem, because effective endograft exclusion classically requires a 15-mm seal proximal and distal to the lesion. Furthermore, the angulation of the arch may make accurate landing of the device difficult.

Debranching procedures to allow for zone 2 landing (coverage of the left subclavian artery) of the device are currently approved for TEVAR. Despite this, there may not be enough of a seal zone distal to the left common carotid artery to allow for stent graft repair. Branched and fenestrated grafts would preserve patency of branch vessels, however, they remain unavailable in the United States. Incorporating snorkel procedures into one's armamentarium effectively lengthens the proximal seal zone while preserving patency to arch branch vessels. This method will be compared and contrasted in the two cases in this article.

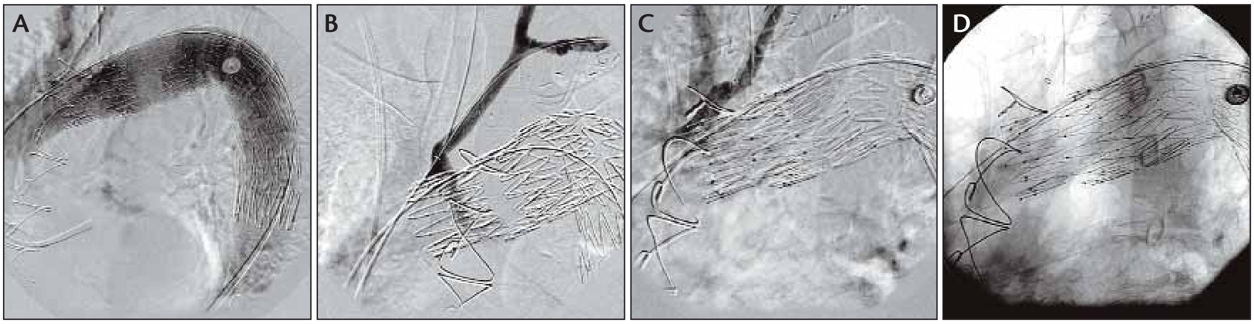

Figure 1. Angiogram showing encroachment of the proximal extension across the origin of the left common carotid artery (A). Note the presence of the marker pigtail through the common carotid artery into the aorta. Angiogram showing the carotid-subclavian bypass and wire access through the left common carotid into the aorta (B). Sheath injection again showing impingement of the stent graft extension across the common carotid artery origin (C). Fluoroscopic image of the stent in the common carotid artery origin extending past the thoracic stent into the aorta (D).

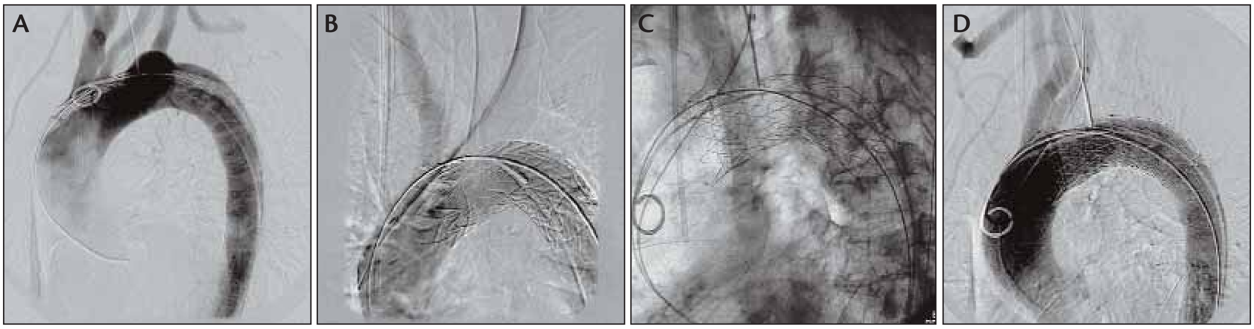

Figure 2. Arch arteriogram showing contained rupture of a distal arch aneurysm (A). Angiogram showing that the thoracic stent graft has encroached on the left common carotid artery origin (B). Note the presence of a Brite Tip sheath (Cordis Corporation, Bridgewater, NJ) in the ascending aorta. Fluoroscopic image of a balloon-expandable stent in the origin of the left common carotid artery and extending past the thoracic stent (C). Completion angiogram showing exclusion of the aneurysm and intact flow to the innominate and left common carotid artery (D).

CASE ONE

An 83-year-old man with a history of abdominal aortic aneurysm repair presented with a 5.3-cm saccular distal aortic arch aneurysm. His preoperative imaging studies are shown in Figure 1. He underwent a left carotid-subclavian bypass in anticipation of a zone 2 landing. He was taken back to the operating room 2 days later for TEVAR. A right groin cutdown for common femoral access was used for device deployment, and the left brachial artery was used for angiographic access. Wire/catheter access was maintained through the carotid-subclavian bypass, through the left common carotid artery, and into the aortic arch. After deployment and ballooning of the thoracic stent graft, a type I endoleak was noted. At this point, it was clear that encroachment of the left common carotid artery origin would be necessary to achieve a seal. A proximal extension was deployed, partially covering the left carotid artery, the location of which was demonstrated by road map guidance as well as the presence of the wire (Figure 1A). A long 7-F sheath was advanced through the carotid-subclavian bypass through the left common carotid artery into the aortic arch (Figure 1B). Two 10- X 25-mm balloon-mounted stents were then deployed extending from within the aortic arch proximal to the stent graft into the left common carotid artery (Figure 1C). The proximal seal was ballooned gently, as were the junctional and distal seal zones. An angiogram showed complete exclusion of the aneurysm sac and flow into the left carotid artery (Figure 1D).

CASE TWO

A 71-year-old woman presented with a penetrating ulcer and contained rupture of a distal arch aneurysm (Figure 2A). Upon review of the films preoperatively, we believed that partial coverage of the left common carotid artery would be likely because the rupture was at the level of the left subclavian artery. During the procedure, the thoracic stent graft was deployed with partial coverage of the left common carotid artery. After ballooning the graft, we noted exclusion of the aneurysm sac but compromised flow through the left common carotid artery (Figure 2B). An incision was made at the base of the left neck anterior to the sternocleidomastoid muscle, and the left common carotid artery was identified. Retrograde access was achieved, and a long 7-F sheath was advanced into the aortic arch. A 10- X 35-mm balloon-expandable stent was deployed from the aortic arch into the left common carotid artery (Figure 2C). An aortic angiogram at this point showed good flow to the left common carotid artery (Figure 2D). The sheath was removed from the left carotid artery, and the arteriotomy was repaired with a prolene stitch.

DISCUSSION

These cases illustrate two different approaches for retrograde carotid stenting as bailout procedures in difficult zone 2 landing cases. Revascularization of the left subclavian artery in instances of anticipated coverage has been extensively studied and published previously.[4-8] In short, elective patients who have an aortic lesion located within 15 mm of the left subclavian origin, where coverage of the left subclavian artery would be anticipated, should undergo subclavian artery revascularization, either via a left carotid-subclavian artery bypass or subclavian transposition to preserve a left-dominant vertebral artery or a patent left internal mammary artery graft, and/or to prevent spinal cord ischemia, arm ischemia, or vertebrobasilar insufficiency. When utilizing a carotid-subclavian bypass, if we anticipate difficulty sealing with sole coverage of the left subclavian artery, we maintain wire access through the carotid-subclavian bypass graft in the event that carotid encroachment occurs and stenting is necessary. Although there may be a theoretical increased risk of stroke from embolization from manipulation of wires in the left common carotid artery, we have not found this to be the case, and wire access in these situations greatly facilitates restoring flow through the carotid in an expedient manner.

In the absence of a carotid-subclavian bypass, retrograde access can be rapidly achieved with a neck cutdown and isolation of the left common carotid artery. It is clear that retrograde access is preferred to antegrade access, because the reverse curve in cannulating the left common carotid artery is made more difficult by the presence of graft encroachment on the orifice of the artery. Although the wire can often be passed into the left common carotid artery from this approach, catheters and sheaths have difficulty tracking. We prefer balloon-expandable stents in these situations given the higher precision with deployment as well as greater radial force afforded against the thoracic stent graft. Both covered and uncovered stents were used in these situations. Criado's description of the technique for preservation of arch branch patency during TEVAR involved bare-metal stents with respectable patency in the six patients followed from 10 to 32 months.[9] Ohrlander's group describes the usage of covered stents for branch preservation during TEVAR.[3]

It is not entirely clear that either type of stent offers any advantage with regard to patency or prevention of a type I endoleak, but we have favored the use of uncovered stents. We have not had to reaccess these carotid stents in follow-up, because we have observed good primary patency thus far. The snorkel technique for preservation of renal flow during endovascular repair of short-neck abdominal aortic aneurysms was described by Hiramoto et al at the University of California, San Francisco.[1] Similarly, this technique can be used to preserve flow to important arch vessels during difficult aortic arch landings with TEVAR. We have not observed any type I endoleaks in patients who have been treated in this manner despite the lack of apposition of the thoracic stent graft to the aortic wall at the site of the carotid stent.

Theoretically, the usage of unlike metals (eg, nitinol in the thoracic stent graft vs stainless steel in the balloon-expandable stent) could cause issues with corrosion, but we have not observed this to be the case. Furthermore, the recent treatment of electropolishing of nitinol has improved its static corrosion behavior as well its as ability to resist surface damage. In vitro studies suggest that nitinol is galvanically similar enough to stainless steel that corrosion is not an issue.[10]

CONCLUSION

Snorkel procedures for the left common carotid artery can be performed to ensure patency of the artery when planned or inadvertent encroachment on the origin of the left common carotid artery occurs during TEVAR. Until branched and fenestrated grafts become available in the United States, knowledge of these preventive and bailout procedures is important for navigating the difficult arch and managing compromised seal zones with current commercially available devices. ■

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