Abdominal aortic aneurysm repair: The carotid approach

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We present the case of a 61-year-old man with a 5.8 cm infrarenal aortic aneurysm with extensive iliac disease that did not permit conventional EVAR, who was also judged to be too high risk for open surgery. Despite these factors, the aneurysm was still successfully repaired using endovascular means and an alternative access technique. This involved a specially commissioned Zenith aorto-uniliac endograft reverse mounted onto a TX2 delivery device, delivered via the carotid artery. (J Vasc Surg 2009;49:763-6.)

Hostile ilio-femoral anatomy is the principal constraining factor to contemporary thoracic and abdominal endovascular aneurysm repair (EVAR). Herein, we describe a case where access via the common carotid artery (CCA) is used for EVAR of an abdominal aortic aneurysm (AAA) using a modified Cook Zenith (Cook Medical, Bjaeverskov, Denmark) device.

CASE REPORT

A 61-year-old man was referred to our unit with a tender AAA. He also suffered from 200 m intermittent claudication and two years previously had been treated for a mesothelioma by a pleurodesis and chemotherapy. Computed tomography (CT) confirmed the presence of a 5.7 cm infra-renal AAA with a neck 34 mm wide and 10 mm long. The left common iliac artery (CIA) was occluded and the right heavily diseased with a maximal diameter of 5 mm. Although there was no evidence of rupture on CT, there were areas of the aneurysm wall that showed marked thinning.

Cardiopulmonary exercise testing, using the hand-cycling method in view of his iliac disease, showed a poor anaerobic threshold (8.5 mL/min/kg), high EqCO₂, and impaired pulmonary function. These data suggested a prohibitively high risk for open repair and the small diameter of his common iliac artery made EVAR via the usual access sites or an iliac conduit impossible. Rather than being loaded on the standard Zenith delivery system, this endograft was mounted onto a Cook TX2 thoracic endograft delivery system. The device featured a shortened 11 mm blunt-tipped nose cone and was mounted in the reverse direction. The trigger wires were in such a way as to allow deployment in a caudal-to-cranial direction. Deployment was broadly similar to a conventional TX2 distal device apart from having the gold markers identical to those of a standard Zenith endograft, and focusing on these during deployment to ensure that they lie just distal to the origin of the lowermost renal artery. The stent graft retained the hydrophilic Flex delivery system, supra-renal barbed fixation and Z-stent configuration characteristic to the Zenith platform. The bare supra-renal stent was however contained in a ‘bottom’ cap as opposed to a ‘top’ cap and its deployment required withdrawing as opposed to pushing, in a similar way to deployment of the distal bare barbed stent on the thoracic device.

Procedure. The patient underwent general anesthesia and received fluoxacillin anti-microbial prophylaxis. The right groin and neck were prepared and draped. The proximal left common carotid artery was exposed via a longitudinal arteriotomy and neck. From this exposure, the left CIA was exposed from a cranial access point (Fig 2). Rather than being loaded on the standard Zenith delivery system, this endograft was mounted onto a Cook TX2 thoracic endograft delivery system. The device featured a shortened 11 mm blunt-tipped nose cone and was mounted in the reverse direction. The trigger wires were in such a way as to allow deployment in a caudal-to-cranial direction. Deployment was broadly similar to a conventional TX2 distal device apart from having the gold markers identical to those of a standard Zenith endograft, and focusing on these during deployment to ensure that they lie just distal to the origin of the lowermost renal artery. The stent graft retained the hydrophilic Flex delivery system, supra-renal barbed fixation and Z-stent configuration characteristic to the Zenith platform. The bare supra-renal stent was however contained in a ‘bottom’ cap as opposed to a ‘top’ cap and its deployment required withdrawing as opposed to pushing, in a similar way to deployment of the distal bare barbed stent on the thoracic device.

Device characteristics. A Zenith aorto-uniliac (40 mm × 108 mm × 12 mm) endograft was commissioned to allow delivery from a cranial access point (Fig 2). Rather than being loaded on the standard Zenith delivery system, this endograft was mounted onto a Cook TX2 thoracic endograft delivery system. The device featured a shortened 11 mm blunt-tipped nose cone and was mounted in the reverse direction. The trigger wires were in such a way as to allow deployment in a caudal-to-cranial direction. Deployment was broadly similar to a conventional TX2 distal device apart from having the gold markers identical to those of a standard Zenith endograft, and focusing on these during deployment to ensure that they lie just distal to the origin of the lowermost renal artery. The stent graft retained the hydrophilic Flex delivery system, supra-renal barbed fixation and Z-stent configuration characteristic to the Zenith platform. The bare supra-renal stent was however contained in a ‘bottom’ cap as opposed to a ‘top’ cap and its deployment required withdrawing as opposed to pushing, in a similar way to deployment of the distal bare barbed stent on the thoracic device.

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at the cranial part of the endograft were positioned as described above and the device deployed (Fig 3, A). After full deployment of the covered part of the stent-graft, another angiographic run confirmed correct positioning. The cranial trigger wire was released and the ‘bottom cap’ opened by unscrewing the safety lock on the telescoping handle, and while stabilizing the inner cannula, sliding the telescoping handle together with the gray tube and outer sheath cranially, to deploy the suprarenal bare stent, fixing the stent-graft permanently in place. The final trigger wire should not be released until the position of the stent graft is satisfactory. During this maneuver, it was essential that the inner cannula did not move since the caudal part of the stent was still secured to it by the caudal trigger wire, thereby preventing cranial migration of the stent-graft during deployment of the suprarenal bare stent. Removal of the caudal trigger wire completed stent-graft deployment.

Following withdrawal of the inner cannula and nose-cone, the CCA arteriotomy was closed using 6/0 Prolene sutures in a standard fashion (Ethicon, Cincinnati, Ohio) leaving the Lunderquist wire to protrude between the stitches. A self-expanding Fluency stent (C. R. Bard, Murray Hill, NJ) was introduced over the Lunderquist wire via the common femoral artery to extend the aortic graft into the common iliac artery since a 12 mm Tri-Fab limb extension could not be advanced through the iliac system. A Coda balloon (Cook Medical Ltd, Bloomington, Ind) was then introduced via the common femoral artery to mould the stent-grafts. The Lunderquist wire was then replaced for an angiographic pigtail catheter via the groin. Digital subtraction angiography confirmed complete exclusion of the aneurysm.

Postoperatively, the patient made an uncomplicated recovery with no neurological or ischemic sequelae and was discharged after four days. The patient remains well 6 months after surgery with no evidence of endoleak or deterioration in walking distance (Fig 3, B).

DISCUSSION

Evolution of modular stent graft technology to include fenestrated and branched devices has widened its applicability to deal with complex aneurysm morphologies. Thus in the contemporary endovascular era, the predominant constraint to endovascular aneurysm repair (EVAR) is unfavorable iliac anatomy.1 The European Collaborators on Stent-Graft Techniques for Abdominal Aortic Aneurysm Repair (EUROSTAR) registry has reported access problems in 13% of patients selected for EVAR owing to excessive iliac tortuosity, occlusive disease, or small caliber vessels.2 This problem is more often encountered in women, with twice as many female patients deemed unsuitable for EVAR than males in one early study (62.3% vs 33.6%).3 Strategies to manage difficult access include super-flexible hydrophilic devices, conduits, ‘cracking and paving’,4 and alternative access sites. With regards to the latter, our and other institutions5-7 have described use of the common carotid artery to access the thoracic aorta. The presented

Fig 1. Computed tomogram images demonstrating the common iliac artery occlusion on the left side and a very narrow vessel on the right. The arrow highlights a region of heavy calcification of the patent right common iliac artery with a luminal diameter of 2.5 mm.

Fig 2. Exposed aorto-uniliac stent positioned in a reverse fashion over a modified TX2 delivery device. A, Caudal trigger wires. B, 12 mm caudal end of stent-graft. C, 40 mm cranial part of stent-graft to seal infra-renal aorta. D, Supra-renal uncovered stent within the ‘bottom’ cap.
case, to the best of our knowledge, is the first description of an infra-renal EVAR via the CCA.

A number of technical considerations should be borne in mind to overcome challenges presented by the infra-renal aorta. A 12 mm TFLE limb was unable to be negotiated through the disease iliac segment and hence a Fluency stent was used since it can be introduced through a 10 F sheath. Our endograft was designed with a shortened, blunted nose-cone since the iliac artery was too narrow to accommodate it and we wanted the Zenith stent-graft to lie as close as possible to the iliac orifice in order to reduce the risk of a type 3 endoleak in the future. An arteriotomy in the CCA was, however, required because of this blunted nose-cone. Like thoracic EVAR via the CCA, the stent is deployed in a caudal-to-cranial direction and it is essential that the proximal markers be observed at all times to prevent inadvertent migration. We have found the ‘body-floss’ technique useful in establishing control and stability of the endograft and bridging stent. The use of a long sheath to protect the CAA origin and aortic arch from injury by the stiff guidewire is essential. We consider the Cook Zenith platform as optimal in the present context as the hydrophilic ‘Flex’ sheath affords maneuverability through the aortic arch and the barded supra-renal fixation provides stability in the presence of challenging neck anatomy. Furthermore, a 40 mm neck diameter configuration was obtainable with the modified Zenith platform for this case. The left CCA was utilized as it presented a more approach to descending thoracic aorta than the right side. Manufacture of the endograft to our specification required ten days, costing approximately £10,000 ($17,600).

Stroke through hypoperfusion, carotid injury, or embolism is a specific concern with this approach. It is desirable that both carotid arteries be disease-free to accommodate an 8 mm/24 F endograft and maintain cerebral perfusion. Preoperative CT imaging had demonstrated an open Circle of Willis, though this is not the case in 6.6% to 26% of patients. Though not performed in this case, either electroencephalography or transcranial doppler (TCD) of the middle cerebral artery may be performed to quantify cerebral perfusion following internal carotid occlusion prior to endograft introduction. In the presence of a dampered TCD tracing, extracorporeal axillo-carotid bypass to maintain cerebral perfusion has been described in the context of thoracic EVAR via the CCA. In this case, the carotid arteriotomy was closed prior to cannulation of the iliac limb to reduce cerebral ischaemia time.

This case contributes to the evidence that the CCA may be used as an alternative access route for EVAR, which is now not limited to the thoracic aorta. With imaginative modification of existing endografts and delivery devices, we envisage that bifurcated abdominal EVAR may be performed via the CCA route in the future to maintain hypogastric artery perfusion in the presence of bilateral occluded ilio-femoral segments.

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