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Novel endovascular procedures and new developments in aortic surgery

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Abstract

Endovascular repair has evolved to become a viable mainstream treatment for aortic pathology in both acute and elective settings. As technology advanced, traditional anatomical barriers were progressively tackled using new devices and novel procedures, and there are now multiple options available to the vascular surgeon. In the abdominal aorta, advances in endovascular aneurysm repair have been in the treatment of hostile aortic necks using new sealing concepts and ancillary procedures, and in branch preservation using fenestrations and snorkels. Access challenges have been met with a percutaneous approach and low-profile devices, and standard protocols have improved mortality for ruptured aneurysms. In the thoracic aorta, more invasive hybrid procedures have given way gradually to branched endografts. Particular challenges to the anaesthetist include blood pressure control and the prevention of stroke and paraplegia. Current focus in the thoracic aorta is in treating aortic arch pathology and in optimal management of acute and chronic dissections. This review describes the latest trends in the endovascular treatment of aortic diseases and examines the current evidence for different modalities of management.

Key words: aorta; aortic aneurysm; endovascular procedures

Editor's key points

- In most vascular surgery centres, 60–80% of abdominal aortic aneurysm repairs are now endovascular.
- New stent designs make it likely that the use of endovascular repair for abdominal aortic aneurysm will increase further.
- Thoracic endovascular aneurysm repair is increasingly used to treat type B thoracic aortic dissections.
- Fenestrated endografts have transformed the treatment of thoracoabdominal aneurysms.

Endovascular repair of major aortic pathology, such as aneurysms, dissections, and traumatic rupture, has gained wide patient and surgeon acceptance during the last two decades because of lower morbidity and mortality. Advanced catheter skills have become a requirement for training in vascular surgery. This rapid transformation in the practice of vascular surgery has also had a significant impact on the provision of anaesthesia and intensive care. As endovascular surgery matures, major developments focus on product improvements to enhance delivery, ensure durability, and meet challenging anatomy. Technological advances have been complemented by the continuing refinement of surgical skills and innovation by pioneers in the field. This article gives an overview of these advances in endovascular treatment in the thoracic and abdominal aorta and the potential influence on anaesthetic practice.

Endovascular repair of abdominal aortic aneurysms

Since its introduction in the early 1990s, endovascular aneurysm repair (EVAR) has become firmly established as a viable treatment

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for abdominal aortic aneurysms. Current commercial aortic stent grafts are in their third to fourth generation. Most endografts are based on a modular bifurcated system, with self-expanding stents on low-porosity fabric and supra- or infrarenal fixation. The graft is introduced via flexible hydrophilic sheaths through bilateral common femoral arterotomies.

The benefits of avoiding laparotomy and aortic cross-clamping, intensive care stay, reduced blood loss, and lower morbidity and mortality compared with open surgery have been well established in randomized trials.[1] In most vascular surgery centres, 60–80% of abdominal aortic aneurysm repairs are now endovascular. The EVAR involves very little physiological perturbation and can be completed under monitored anaesthesia care, with regional or general anaesthesia. A preference for the latter mainly pertains to control of respiration and better digital subtraction images.

Modern developments in EVAR focus on several key areas, as follows: (i) refinement of existing stent graft materials to enable a lower-profile delivery system yet maintaining endograft strength and durability; (ii) simplifying steps in delivery; (iii) allowing for adjustments in positioning for accuracy of placement; (iv) minimizing endoleak and stent graft migration with improved and assisted fixation and seal; (v) improving performance in instances of adverse aortic anatomy; and (vi) extended coverage, with branch preservation.

Percutaneous approach and lower-profile devices

Most endograft manufacturers are moving towards lower-profile endografts that can be introduced percutaneously. With new material, thinner fabrics, and better sheaths, the latest generation of EVAR delivery systems have reduced significantly in size from 20–22 Fr to as low as 14 Fr gauge, and they can be introduced into narrow access vessels <6 mm in diameter. Percutaneous EVAR (PEVAR) is a completely percutaneous procedure that involves a pre-close technique, in which percutaneously placed closure device(s) are applied before the introduction of the stent graft. PEVAR has been shown to be equally effective and safe, with minimal access-related complications, and is non-inferior to standard femoral cut-down.[2 3] With PEVAR, the hospital stay can be further reduced to a 1 day procedure in selected patients.

Endovascular aneurysm repair for ruptured aneurysms

Where expertise and equipment are available, EVAR has fast become the gold standard and preferred choice for treating ruptured aneurysms. Multiple randomized studies have shown equivalent results to open repair, with lower morbidity and blood loss in favour of EVAR.[4 5] Recent randomized trials have confirmed that EVAR had similar 30 day and 1 yr mortality when compared with open surgical repair, yet incurred less complications, blood transfusions, and intensive care unit stay.[6] Endovascular aneurysm repair also consumes less hospital resources, with better quality of life and cost-effectiveness, leading to long-term socio-economic gains.[7]

Modern management of patients with ruptured abdominal aortic aneurysms advocates permissive hypotension and a percutaneously introduced suprarenal aortic balloon to effect temporary haemostasis before EVAR. In extremely unstable patients, an aorto-uni-iliac stent graft can achieve an instant seal of the aneurysm, although a femoral–femoral bypass is then required. Most experienced clinicians would now prefer to use a standard bifurcated device. The main limitation of emergency EVAR is postoperative abdominal compartment syndrome, and occasionally, a laparotomy for decompression has to be carried out after successful EVAR. Patients requiring laparotomy after emergency EVAR generally have worse prognosis.

Branch preservation and extension of seal: fenestrated endovascular aneurysm repair

Traditional EVAR requires a healthy infrarenal 'neck' length of about 10–15 mm below the lowest renal artery origin for secure proximal fixation. Inadequate neck length or excessive angulation are key causes of attachment (type Ia) endoleaks and graft migration. In patients with a short or unhealthy aneurysm neck, the proximal landing zone has to be extended upwards. Fenestrated endografts were designed to land in the suprarenal aorta, with preservation of vital visceral branches of juxtarenal aneurysms. These endografts are custom manufactured to contain scallops (gaps in the fabric on the top of an endograft, reinforced on three sides) or fenestrations (small circular or oval 'holes' in the graft body reinforced by a nitinol wire ring) in the fabric to match the origin of 'target' vessels, such as the coeliac axis, superior mesenteric artery, and both renal arteries. The main graft is unsheathed, yet restrained by diameter-reducing wires to allow adjustments of position. The target vessels are then individually accessed via a contralateral femoral (or brachial) approach and bridged to the main graft body with a balloon-expandable covered stent (Fig. 1). Large series have confirmed that this is a viable approach, with low mortality and

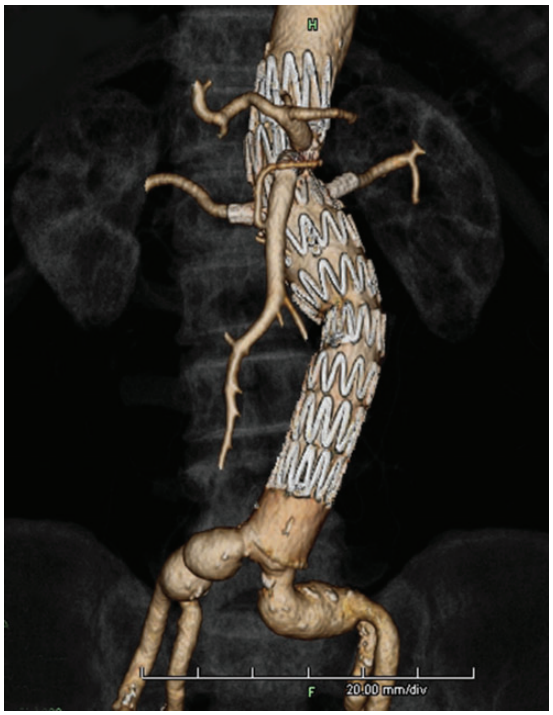

Fig 1 A juxtarenal aneurysm treated with a fenestrated endograft. The coeliac axis was preserved by a scallop, and three fenestrations to the superior mesenteric artery and renal arteries were bridged by covered stents.