Endovascular abdominal aortic aneurysm repair

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Anatomical and surgical considerations

About one-third of AAAs have anatomical features that make them suitable for endovascular repair. The neck of the aneurysm must be straight (as opposed to the usual fusiform shape) and longer than 15 mm. Additionally, there must be minimal atherosclerotic plaque inside the neck so that a good seal between the stent graft and the wall of the aorta can be obtained. Distally, there must be disease-free zones in the iliac arteries to ensure good leg perfusion and at least one of the femoral arteries should be ≥8 mm in internal diameter. This is to enable insertion of the stent through the arteriotomy. (A collapsed stent graft has an external diameter up to 7.5 mm.)

Several types of endovascular stent grafts are available; all have a fine metal skeleton supporting a very thin Dacron membrane. Most in current use are self-expanding whereas the early stents required expansion with a balloon. Some grafts are supported throughout their length by a metal skeleton while some are supported only at the ends. The early stents were tube grafts but current availability of bifurcated grafts or ‘Y’ grafts has made many more patients suitable for endovascular repair.

Surgical procedure

Endovascular aneurysm repair (EVAR) is usually carried out by a radiologist and a vascular surgeon working together either in a specialized radiology suite or an operating theatre that has specialized angiography equipment. The choice of location depends on local facilities and preferences. The patient is positioned supine on a tilting radiolucent table or trolley and prepared as for conventional surgery. The initial part of the operation is usually performed by the surgeon exposing both femoral arteries with longitudinal groin incisions. Alternatively, only one artery is exposed surgically with access to the other being carried out percutaneously by the radiologist.

Angiography is then performed to confirm the anatomy of aneurysm (Fig. 1). Careful positioning of the endoluminal guide wire is essential to permit accurate placement of the graft. This will require the patient’s active cooperation when regional anaesthesia is used as they may be asked to hold their breath temporarily. The large endovascular graft delivery system is

Key points

- Endovascular aneurysm repair is a relatively new method of treating abdominal aortic aneurysms.
- Short-term outcome is good with appropriate case selection.
- Perioperative morbidity, hospital stay, blood loss and need for blood transfusion are reduced compared with open surgery.
- Long-term outcome is not known.
introduced via an arteriotomy of the femoral artery and advanced
under fluoroscopic guidance to the diseased aortic segment. The
graft is usually inserted on the right side provided the femoral
artery meets the minimum diameter requirements. When the
final position is reached, the stent graft is deployed within the
aorta. Angiography is then performed again to confirm that
there is no leakage of blood into the aneurysm sac (Fig. 2).
When leakage is observed, the stent position may be adjusted
or a second graft inserted to obstruct the leak.

Anaesthetic considerations

Successful outcome of EVAR requires good communication
between surgeon, radiologist and anaesthetist plus appropriate
patient selection based upon the anatomical features of the
aneurysm.

Pre-operative assessment

This should be no different from that of a patient listed for open
AAA repair: careful evaluation of associated co-existing medical
conditions (cardiac, renal, respiratory and other vascular patho-
logy). Patients should be informed about the choice of anaesthesia
(local, regional or general) and the rare possibility of an open
repair being required.

Monitoring

Direct arterial pressure monitoring is considered essential in
order to detect beat-to-beat variations in blood pressure during
deployment of the stent graft. Central venous pressure (CVP)
monitoring is rarely necessary unless there is significant comor-
bidity because there is usually minimal blood loss. Bladder
catheterization is indicated to monitor urine output.

Anaesthetic technique

The procedure can be performed using local infiltration anaes-
thesia (LA), general anaesthesia (GA) or regional anaesthesia (RA).
The latter may be performed as a spinal, epidural or combined
spinal epidural (CSE). The potential advantages of LA and RA are
that there is usually excellent perioperative and postoperative
analgesia with a stable cardiovascular system. However, there is
no evidence to suggest that outcome is improved with LA or RA
compared with GA.

In our hospital, a typical anaesthetic plan includes insertion of
a large bore venous cannula and radial arterial line in the right
hand followed by a single shot spinal or CSE. The latter has the
advantage of rapid onset with the possibility of top ups via the
epidural in the event of an unexpectedly prolonged procedure, or
simply to provide post-operative analgesia. Continuous spinal
anaesthesia has also been used successfully. Local infiltration
anaesthesia of the groins is equally successful since it is only
this anatomical area in which anaesthesia is required. Deployment
of the stent graft within the aorta is usually pain free. The right
hand is used for the venous and arterial cannulation as access to
the aorta via the left axillary artery may be required on very rare
casions. Such an occasion would be when the radiologist wishes
to reduce haemorrhage by placement of a balloon catheter above
the aneurysm when direct femoral cannulation has failed. This requires conversion to GA. Regional anaesthesia is usually supplemented with sedation, either by a continuous low dose infusion of propofol or small intermittent boluses of midazolam. In an extremely restless patient, conversion to GA may be required.

**Intraoperative period**

Usually, the whole procedure is completed within 2 h and i.v. heparin 5000 IU is administered after the femoral arteries have been exposed. Blood loss is not usually significant and ‘group and save’ of serum is usually adequate. The results of a recent multicentre trial comparing open surgical repair with EVAR showed that the patients who underwent EVAR had a 60% lower blood loss (650 ml) compared with open repair (1600 ml) and only 12% of the EVAR patients required blood transfusion compared with 40% in the open repair group.

Some radiologists will request that i.v. hyoscine 20 mg is administered to reduce intestinal motility during screening, thereby improving the digital subtraction angiography image obtained. Local infiltration of the groin with bupivacaine provides very effective post-operative analgesia and is strongly recommended.

**Post-operative period**

Ideally, the patient should be nursed in an environment where arterial pressure can be monitored continuously for several hours. Because the EVAR procedure involves the liberal use of contrast media to assist placement and deployment of the graft to ensure proper exclusion of the aneurysmal sac, it is worthwhile ensuring that the patients are well hydrated to prevent postoperative renal impairment. There is no current evidence to support routine use of diuretic agents during EVAR.

Several non-randomized or retrospective studies have demonstrated that hospital and ICU/HDU stay are reduced by 50% when EVAR is compared with open surgical repair.

**Complications**

Surgical complications include primary endoleak, damage to the femoral arteries, dissection, embolization, ischaemia, aneurysm rupture, reaction to contrast media, neurological deficit, bleeding, myocardial ischaemia, renal failure, hypotension, delayed stent displacement and other device-related complications. Endoleak is defined as persistent blood flow outside an endovascular graft, but within the aneurysm sac. This can be immediate or delayed. Studies have shown that the incidence of endoleak can be as high as 18%, but the average incidence is 5–10%. Delayed aortic rupture may occur in a few patients because of increased growth of the stented aneurysm (~1–2 mm per annum). The reasons for this are uncertain; it may be because of the pressure transmitted through the stent or caused by de novo endoleak at the distal end of the stent graft.

Post-implantation syndrome is sometimes observed after EVAR. This is characterized by fever, raised plasma C-reactive protein and white cell count in the absence of infection. It may last 2–10 days and responds to non-steroidal anti-inflammatory drugs.

Conversion to open repair is necessary in ~2% (aneurysm rupture, inability to deploy the graft, femoral and iliac vessels more diseased than anticipated). However, a patient with a contained, leaking aneurysm may be eligible for treatment using the EVAR technique.

**Mortality and morbidity**

Most published reports have shown that perioperative mortality after endoluminal aneurysm repair is similar to that reported for open repair. Some of the larger studies showed mortality rates between 4% and 6%, including the UK Small Aneurysm Trial (5.8%), Canadian Aneurysm Study (4.7%), and Michigan State-wide Study (5.6%). European investigators have shown that, in patients with infrarenal aortic aneurysms, endovascular repair is associated with a risk of subsequent rupture of 1% per annum. The rate of conversion to open repair is 2% per annum.

In 1994, the EUROSTAR registry (European collaborators on Stent-graft Techniques for Abdominal aortic aneurysm Repair) was established for the purpose of the collection and analysis of data on patients who undergo EVAR. Data from nearly 3000 procedures performed between 1994 and 2000 showed that the incidence of device-related complications decreased from 21.7 to 7.3%. This has been attributed to better case selection, improved stent devices and delivery systems together with increased operator experience.

<table>
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<tr>
<th>Table 1 Advantages and disadvantages of EVAR</th>
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<tr>
<td><strong>Advantages</strong></td>
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<td>Less invasive surgically</td>
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<td>Shorter duration operation (usually ~2 h)</td>
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<td>Avoids short- and long-term complications of laparotomy</td>
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<td>Reduced haemodynamic and metabolic stress response</td>
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<td>during and after the procedure</td>
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<td>Decreased incidence of perioperative morbidity and mortality</td>
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<td>Large blood transfusion and potential coagulopathy unlikely</td>
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<td>Early ambulation possible (next day usually)</td>
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<td>50% decrease in length of hospital stay</td>
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Continuing Education in Anaesthesia, Critical Care & Pain | Volume 4 Number 3 2004
A number of retrospective and non-randomized studies have shown that cardiovascular and inflammatory responses and short-term morbidity are reduced after EVAR compared with open surgery, although no prospective randomized data are available. However, the national multicentre randomized EVAR 1 and 2 trials (which are currently recruiting in the UK) are aiming to compare both the complications and outcomes of endovascular and open surgical repair in suitable patients (EVAR 1) and the outcome after EVAR compared with non-intervention in less fit patients (EVAR 2). The results of these trials are anticipated in the near future. Consequently, the long-term durability of the EVAR technique is still not yet known. The advantages and disadvantages of EVAR are summarized in Table 1.

**Key references**


Laheij RJF, Van Marrewijk Cj on behalf of the EUROSTAR group. The evolving technique of endovascular stenting of abdominal aortic aneurysm; time of reappraisal. *Eur J Vasc Endovasc Surg* 2001; 22: 436–42


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See multiple choice questions 66–68.