

Anaesthesia for interventional vascular radiology

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Abstract

Interventional vascular radiology is a rapidly expanding field, but can broadly be split into embolization and stent-grafting techniques. Frequently these can be performed percutaneously with local anaesthetic infiltration and do not require the involvement of an anaesthetist. Some procedures, particularly endovascular aneurysm repair (EVAR) require surgical access to the vasculature, necessitating anaesthesia. Solid organ embolization can be painful and patients for haemorrhage control may also require our input to manage ongoing resuscitation and stabilization. Each procedure is different and communication and team working is essential to understand the planned procedure and the requirements for anaesthesia and operating conditions.

This article will discuss the different procedures performed (excluding neurological and cardiological interventions) with a focus on EVAR, and the anaesthetic implications of them.

Keywords Anaesthesia; embolization; endovascular aneurysmal repair; interventional vascular radiology; stent grafting

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Introduction

Interventional vascular radiology (IVR) covers a spectrum of interventions, the nature of the procedure varies wildly as does the need for anaesthetic input. Due to differences in vascular anatomy and the clinical effects of the individual defect, there is no standard procedure that covers all and therefore no standard anaesthetic either; the anaesthetic must be tailored to the specific case. For the purpose of this review we will be looking at the anaesthetic implications of vascular interventional radiology excluding the highly specialized areas of neurological and cardiological interventions and concentrating more on endovascular aneurysm repair (EVAR).

Many procedures may be performed without the presence of an anaesthetist.

Anaesthesia is often only required at the site of vascular access, although solid organ embolization may be painful. Anaesthetic involvement may be required due to factors such as haemodynamic instability due to haemorrhage, lack of patient co-operation and long duration of procedure.

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Learning objectives

After reading this article, you should be able to:

- recognize the different vascular interventional techniques
- select an appropriate anaesthetic technique for individual procedures and patients
- recognize the potential benefits of endovascular repair for abdominal aortic aneurysm, but that it may not be the best treatment for all patients

IVR is broadly split into embolization and stent-grafting interventions; the former relates to intentional occlusion of a vessel and the latter to restoring flow in a vessel which is either blocked, perforated or aneurysmal. The purpose of embolization is to halt haemorrhage; a number of products are available depending upon the cause, severity and site of the haemorrhage. Temporary embolization can be performed with a gelatin foam sponge; this would be of use in the event of life-threatening haemorrhage from major trauma. Permanent embolization uses coils, plugs, particulate agents, glues or sclerosants to irreversibly stop flow through a particular vessel. It is worth noting that sclerosants can be extremely painful which can in itself be an indication for anaesthesia.

The procedures which commonly require anaesthetic input include aortic EVAR, transjugular intra-hepatic portosystemic shunt (TIPSS), life-threatening gastrointestinal (GI) or uterine haemorrhage, bronchial artery occlusion for haemoptysis, major trauma and vascular malformations.

Preoperative

Interventional vascular radiology requires a team approach. A preoperative team briefing is essential to understand the planned procedure, the limitations and possible complications, where vascular access will be gained, requirements for drugs and specific manoeuvres (i.e. breath-holding).

Investigations will be dictated by patient physiology, urgency and the procedure; this may well include electrocardiography (ECG), full blood count (FBC), urea and electrolytes (U&Es) and clotting studies.

Anaesthetic considerations

The type of anaesthetic will be determined by a number of factors:

- the site of sheath insertion will affect our physical access to the patient, determine the area that needs to be anaesthetized and affect the site of our own intravenous and intra-arterial cannulation
- the size of the sheath will dictate whether percutaneous access can be gained or if a surgical cut-down is required
- need for immobility and patient breath-holding
- duration of procedure
- regional anaesthesia options may be limited by usual contraindications (e.g. coagulopathy, sepsis, refusal).

Intraoperative heparin and antibiotics may be required and should be discussed at the preoperative team meeting.

Postoperative considerations

Postoperative care will be determined by clinical need. High-risk procedures such as EVAR and massive gastrointestinal (GI) bleed

may require close monitoring in level 2 care as complications from the procedure, the resuscitation or the associated co-morbidities may be high. Particular organ dysfunction will be related to the site, the stent or embolization, but certain complications are common to all. Stent occlusion is an obvious risk, which will be lessened by intraoperative heparin and perioperative antiplatelet therapy.

Post-embolization syndrome is a common occurrence, especially prevalent with embolization of large solid organs such as the liver. Although not fully understood it is essentially an inflammatory mediator response which results in flu-like symptoms such as fever, pain and vomiting. It is self-limiting but must be distinguished from an infective cause of similar symptoms.

Endovascular aneurysm repair (EVAR)

EVAR is a rapidly advancing technique in the field of IVR. The benefits of such over open surgical repair (OSR) are under some debate. The short-term mortality is significantly better than OSR but that benefit has not extended into the long-term mortality with worse 4-year outcomes related to aneurysmal complications, resulting in an overall equivalent mortality between the two groups.¹ In those patients for whom an OSR is considered too hazardous due to their co-morbidities EVAR produces a decrease in the rate of aneurysm-related complications in the long term compared to conservative treatment, but does not appear to improve overall mortality due to death from the aforementioned co-morbidities.² The rapid and progressive advancements in stent technology and expertise may well prove to ameliorate some of the disappointing long-term complications associated with EVAR.

Types of stenting

The type and number of stents that are to be used will be determined by the location and anatomy of the aneurysm. Close proximity to visceral artery branches or a tortuous aneurysmal neck can cause problems with stent insertion. Preoperative computerized tomography angiography (CTA) allows accurate location of the aneurysm and assesses the suitability for EVAR versus OSR. If EVAR is deemed appropriate, there are a number of stent options as follows.

Standard infra-renal EVAR: for insertion of the standard infra-renal aortic stent the radiologist inserts the stent through the femoral artery (accessed via a surgical cut down) then passes it up to the proximal end of the aneurysm. The stent is deployed in two steps: firstly the abdominal portion is opened, this is a trouser stent with a large leg leading down to the iliac that the stent is being inserted through and a short leg on the other, the long trouser leg is then deployed (Figure 1a). The contralateral femoral artery is then accessed and the second stent telescoped into the short trouser (Figure 2a). Aneurysmal proximity to the bifurcation of the iliac arteries can cause problems with stent insertion.

Complex EVAR – fenestrated and branched: complex EVAR requires preoperative CTA to produce custom-made stent with specifically placed fenestrations and scallops in line with the patient's anatomy (Figure 1b). The fenestrations are aligned

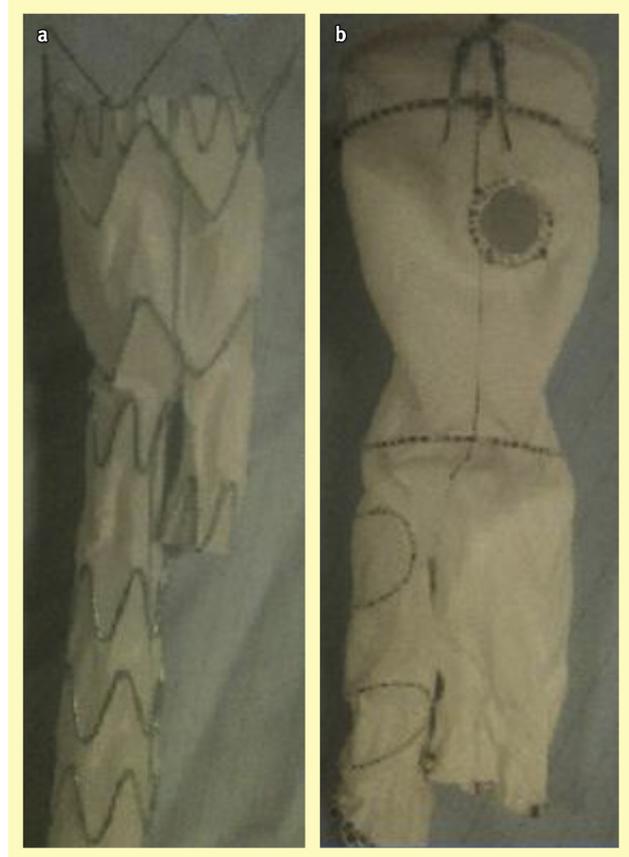


Figure 1 (a) Infra-renal stent and (b) fenestrated stent.

with the visceral arteries when the stent is deployed. The arteries are then cannulated and further stents inserted. The scallops are open fenestrations which abut the vessel at the proximal end of the stent. The insertion of these stents may take significantly longer than the standard EVAR due to the increased technical difficulty of cannulating the visceral arteries (Figure 1b).

Re-intervention for endoleak

Endoleak is continued leakage into the aneurysmal sac following EVAR.

There are five types of endoleak:

- **Type 1** – leak due to poor graft attachment at proximal or distal end
- **Type 2** – leak into aneurysmal sac from collateral branches such as lumbar or inferior mesenteric arteries
- **Type 3** – leak through graft due to separation or defect
- **Type 4** – leak through graft due to graft material porosity
- **Type 5** – leak of unknown origin, but continued expansion of the aneurysmal sac (endotension).

Types 1 and 3 both may require re-intervention.

Anaesthetic considerations

Preoperative assessment: for elective aneurysm repair, patients should undergo assessment and investigations to aid estimation of their mortality and morbidity risk for open and endovascular repair. These risks then need to be balanced against the risk of rupture (dependent on size and shape) and suitability for

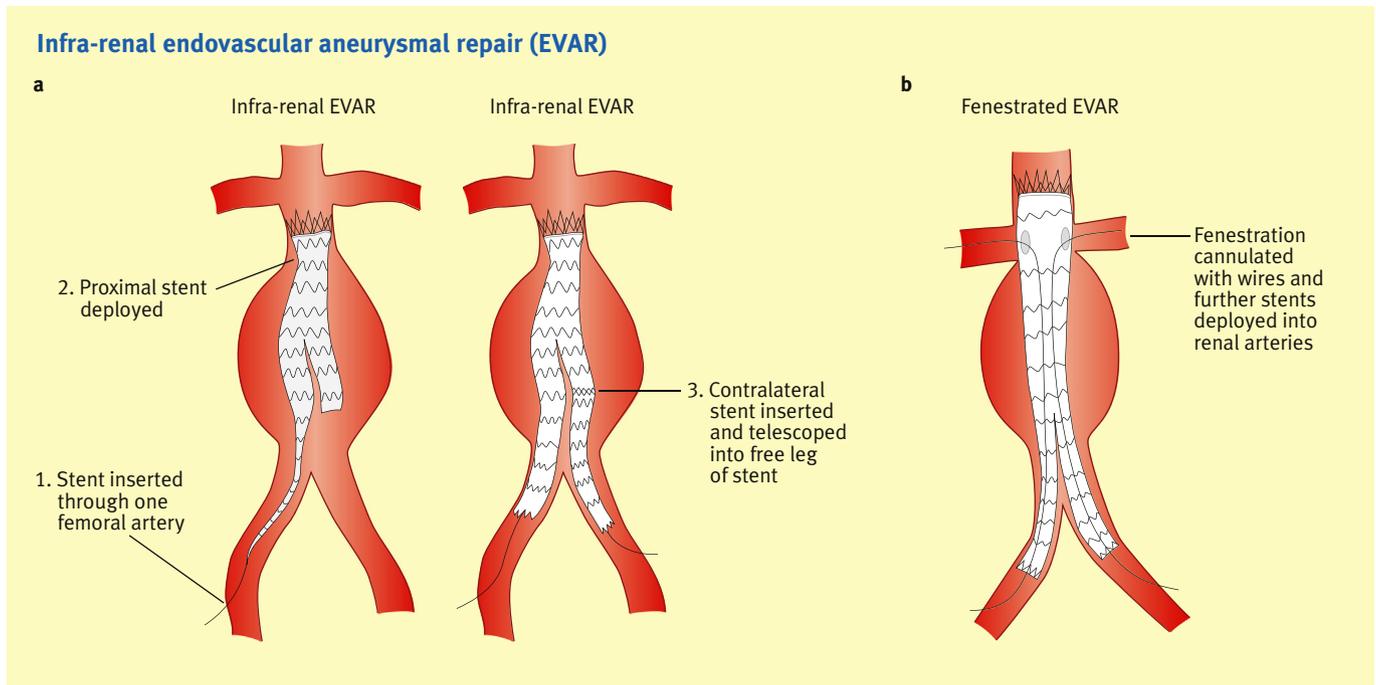


Figure 2

endovascular repair. 'Unfit' patients may not benefit from any intervention.² Various different risk prediction models are in existence (e.g. POSSUM, Lee Revised Cardiac Risk Index, Ergorova et al., ASA, Surgical Mortality Probability Model), but debate continues as to their relative merits and reliability and we cannot recommend one over another.

Whilst there have been numerous co-morbidities reported to impact on surgical risk from different studies, the frequently quoted ones are:

- history of ischaemic heart disease (myocardial infarction more than angina)
- history of a cerebrovascular event (CVE)
- history or diagnosis of heart failure
- chronic kidney disease (serum creatinine $>177 \mu\text{mol/l}$)
- history of peripheral vascular disease
- insulin-dependent diabetes mellitus
- poor functional capacity or exercise tolerance.

Cardiopulmonary exercise testing is likely to be a useful tool in objectively quantifying exercise capacity. Key parameters that have been associated with increased risk in the perioperative period (but not specific for EVAR) include:

- peak oxygen consumption (peak VO_2) less than 15 ml $\text{O}_2/\text{kg}/\text{min}$
- anaerobic threshold (AT) less than 11 ml $\text{O}_2/\text{kg}/\text{min}$
- ventilatory equivalents for CO_2 – a measure of gas exchange efficiency (VE/VCO_2) more than 42
- inducible cardiac ischaemia.

In our institution we aim to perform cardiopulmonary testing, echocardiography, ECG, FBC, serum biochemistry, clotting studies (and glucose, $\text{HbA}_{1\text{C}}$, liver function tests as appropriate) on all AAA patients and then for them to be seen and risk assessed by one of the vascular anaesthetist in the pre-operative assessment clinic. The results of these are then discussed at the multidisciplinary team meeting, where the anatomy is also

assessed (from CT angiography) for suitability for endovascular repair, and an agreement reached on the best choice of treatment. Younger, 'fitter' patients with a low risk of perioperative morbidity and mortality, even with suitable anatomy for an endovascular repair, are likely to be better served with an open repair in the long run despite the greater surgical insult.

At the preoperative consultation, percentage mortality and morbidity risks are openly and frankly communicated with the patients and their views on intervention are sought. The choice of anaesthetic technique is also discussed, although the final decision is made by the anaesthetist and patient on the day.

The usual risk and balance of stopping antiplatelet and anticoagulation drugs applies to EVAR but may also impact on the option of regional anaesthesia. Poorly controlled non-insulin-dependent diabetics and insulin-dependent diabetics should be commenced on a variable rate insulin infusion. Metformin should be omitted 48 hours before EVAR due to the contrast load and risk of renal impairment. Other oral hypoglycaemic should be omitted on the morning of surgery. Otherwise all medications should be continued as normal. Most patients are already taking a statin but should commence one if not, although the evidence of benefit for initiating perioperative β -blockade is less clear.

Intraoperative care: this should be considered a specialist procedure and the presence of consultant anaesthetist, preferably a vascular anaesthetist, is essential. It is often performed in a 'hostile' environment (due to radiology equipment) and may also be in a remote site in the radiology department.

All patients will require large bore intravenous access and an arterial line for close monitoring but central venous access is not always essential and should be inserted depending on the requirements of the individual case.

Prophylactic antibiotics will be given, as will intravenous heparin prior to arterial cannulation. Hyoscine butylbromide

(Buscopan) may be required to reduce intestinal peristalsis to improve fluoroscopic images.

The anaesthetic technique depends on a number of factors. The radiologist needs the patient to be still and to intermittently hold their breath during fluoroscopy, which incidentally may cause an unpleasant warm sensation. The duration of the procedure varies depending upon case complexity and operator skill but will typically last 2–6 hours. These factors mean that an assessment of the patient needs to be made to determine whether they will be able to cooperate. The usual choice is between regional blockade with a combined spinal epidural and general anaesthetic. Local anaesthetic infiltration is a possibility especially if percutaneous access is used, but this is not widely used in the UK. There are little data, and no randomized data, to support the use of one technique over another.³

Spinal cord and renal protection are areas for consideration. Ischaemia of the spinal cord during the procedure is a recognized complication. One measure to try and prevent this is a cerebral spinal fluid (CSF) drain used in an attempt to decrease the CSF pressure in order to improve spinal cord perfusion pressure. This tends to be used more in thoracic aorta repair. Regarding renal protection there is little evidence for any particular methods to prevent renal damage intraoperatively, the main aetiologies of this being contrast nephropathy and artery occlusion, however avoidance of profound intraoperative hypotension will naturally be helpful. Preoperative renal dysfunction is a risk factor for both postoperative renal failure and increased mortality.⁴

Postoperative care: patients should be monitored closely post-operatively, probably receiving routine postoperative level 2 care, irrespective of their pre-morbid state. Risk of postoperative organ dysfunction, especially renal failure, is high and should be closely monitored for. A systemic inflammatory response to aortic stenting has been reported (termed post-implantation syndrome) but needs to be differentiated from an infective cause.⁵

In the long term all EVAR patients require life-long follow-up and graft surveillance, due to the possibility of the graft failure and of endoleak; this is not true of OSR patients, highlighting a disadvantage of EVAR.

Emergency EVAR: although EVAR for ruptured AAA was not recommended in the NICE review in 2009, it is regularly performed in many centres.⁶

Local anaesthetic infiltration by the radiologist may be the anaesthetic of choice; this maintains the tamponade effect of an

awake patient's intra-abdominal tone and reduces the cardiovascular consequences of regional and general anaesthesia.

If possible an occluding balloon will be inserted above the aneurysm and inflated to halt bleeding, but blood loss is still likely to be significant. The blood lost remains intra-abdominal and therefore not measurable or available for use in cell salvage. As with an open repair of a ruptured aneurysm, two or more anaesthetists and OPDs can be helpful in maintaining adequate cardiovascular resuscitation. Another significant issue is that of patient cooperation; they need to be still and hold their breath when requested, despite increasing ischaemic leg pain and discomfort from prolonged difficult procedures. Anxiolytics and analgesia may be needed but should be used with caution as they may blunt the patient's ability to cooperate.

Summary

IVR is a unique and rapidly progressing speciality employing a wide variety of techniques. Anaesthesia is principally required for surgical access to vessels and embolization pain, however our expertise is often required in managing haemodynamically unstable patients during these procedures. ◆

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