Anaesthesia for elective interventional vascular radiology

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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 understand that it may not be the best treatment for all patients

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 their anaesthetic implications.

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 cooperation and long duration of procedure.

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).

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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 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 of 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 verses OSR. If EVAR is deemed appropriate, there are a number of stent options as follows.

Standard infra-renal EVAR: for insertion of the standard infrarenal 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 a custom-made stent with specifically placed fenestrations and scallops in line with the patient's anatomy (Figure 1b). The fenestrations are aligned 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 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 μmol/litre)
- 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 O_2/kg/minute
- anaerobic threshold (AT) less than 11 ml O_2/kg/minute
- ventilatory equivalents for CO_2 – a measure of gas exchange efficiency (VE/VCO_2) more than 42
- inducible cardiac ischaemia.

