Anaesthesia for elective open abdominal aortic surgery

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Abstract

The prevalence of abdominal aortic aneurysm (AAA) and the number of patients undergoing aneurysm repair is increasing. The UK has worked hard to reduce its operative mortality rates for elective open AAA repair with the introduction of a quality improvement programme and death from ruptured aortic aneurysm through the national screening programme. Despite the increased prevalence of disease and intervention, the popularity of open repair is diminishing since the advent of endovascular repair (EVAR). The short-term benefits of EVAR when compared to open repair are evident, however, the long-term survival benefits have yet to be proven. The choice of technique for emergency AAA repair is contentious, with the more traditional approach of open repair being rapidly overtaken by endovascular options. In this article we outline current approaches to risk stratification, describe the key physiological changes that occur during open repair and describe an overview of the approach to perioperative management.

Keywords AAA quality improvement programme (AAAQIP); abdominal aortic aneurysm (AAA); cross-clamping; endovascular aneurysm repair (EVAR); national AAA screening programme (NAAASP)

Royal College of Anaesthetists CPD Matrix: 3A05, 2A03, 2A04, 2A05, IL05

Learning objectives

After reading this article you should be able to:

- describe the incidence and risk factors associated with abdominal aortic aneurysm
- discuss the rationale for the national abdominal aortic aneurysm screening programme
- define the indications for intervention and identify the factors that govern whether open or endovascular repair is the technique of choice
- outline the risk stratification scoring systems applicable to aneurysm surgery and their merits
- list the key perioperative considerations for open abdominal aortic surgery

Epidemiology, risk factors and natural history

The prevalence of abdominal aortic aneurysm (AAA) has increased steadily over the past 50 years. It now affects between 4 and 8% of men aged 65–80. The comparatively low prevalence found in women (1.3%), led to their exclusion from screening trials as cost-effectiveness could not be demonstrated.[1] This was despite their increased risk of aneurysm rupture and associated mortality rates.

Aside from advancing age and gender, important risk factors for the development of an AAA include a positive family history and chronic tobacco use. Smokers are four times more likely to develop an AAA when compared to non-smokers. Smoking is also associated with an increased rate of aneurysm growth.

Aortic aneurysms are usually asymptomatic and increase in size at varying rates over time. The annual risk of aneurysm rupture increases exponentially when the antero-posterior diameter exceeds 5.5 cm. On this basis, elective intervention is considered in all those meeting this criterion. Ruptured AAA accounts for the death of around 7000 men in England and Wales every year and is associated with a mortality rate in excess of 75%.

Anatomical classification of AAA

Diagnosis of an AAA requires evidence of a dilatation of 50% or more of the normal aortic diameter. An infrarenal aortic diameter of 3.0 cm or more is considered aneurysmal. AAAs are commonly described based on their relationship to the renal arteries. Most AAAs occur in the segment between the renal and inferior mesenteric arteries. Only around 5% of AAAs involve the renal or visceral arteries. Up to 40% of AAAs are associated with iliac artery aneurysms.

The commonest cause of AAA is atherosclerosis. The tensile strength of the vascular wall is weakened as increased elastase and protease activity results in decreased elastin and collagen fibres. Associated inflammatory changes and thrombus formation also contribute to aneurysm formation.[2]

National screening programme

A National AAA Screening Programme (NAAASP) was set up in 2012 on the background of evidence presented by the Multicentre Aneurysm Screening Study (MASS) group. This suggested that screening could halve AAA-related deaths in men aged 65–74 and presented evidence supporting surgical intervention in AAAs of 5.5 cm or more.[3]

Screening is currently offered to all men aged 65 in the UK. These men are screened by ultrasound and managed according to a nationally agreed clinical pathway. It is recommended that patients identified via the NAAASP should undergo intervention within 8 weeks of diagnosis, with those diagnosed incidentally, following a similar timeframe. The screening programme's success hinges on the premise that the risk associated with intervention is less than the risk of harm associated with natural disease progression and the risk of aneurysm rupture.

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AAA quality improvement framework and centralization of services

The UK was reported to be a significant outlier compared to our European counterparts when crude mortality rates following elective open AAA repair were reported in 2008. In response to these data, a national quality improvement framework was conceived and a nationwide programme promoting best practice was delivered. In addition to encouraging standards of best practice, the framework aimed to reduce variance in clinical practice and reduce operative mortality rates.[4]

The AAA Quality Improvement Programme (AAAQIP) emphasized the importance of preoperative assessment. Vascular networks are strongly encouraged to incorporate multidisciplinary team (MDT) discussion in the decision-making process regarding patient suitability for elective AAA intervention. This should take place after formal CT angiography has been performed. Patients considered for intervention should be involved in this process and given consistent advice about the potential risks involved to ensure they can make an informed decision about their management.

A volume–outcome relationship in favour of centres undertaking higher caseloads has been proven to be beneficial overall. High-volume centres demonstrated reduced length of stay and improved survival after complications.

Clinical and process data on aneurysm repairs should be entered into the national clinical audit via the National Vascular Registry (formerly the National Vascular Database). This should be done in real time or within 2 weeks of discharge or death.

The screening programme and quality improvement recommendations appear to be having the desired effect as the overall mortality rate for AAA repair in the UK has fallen from 2.4% in 2010 to 1.8% in 2013.[5]

Indications for intervention

In the elective setting, the decision regarding when to operate is guided by the size and rate of growth of the aneurysm. Current evidence supports intervention when AAAs are 5.5 cm or greater. Aneurysms 5.5 cm and lower have a relatively low annual rupture rate ($\leq$1%). Studies from both sides of the Atlantic showed no long-term survival benefit between surveillance and surgery for patients with an AAA between 4.0 and 5.5 cm in diameter.[6]

Despite the less invasive nature of endovascular repair, neither the CAESAR nor the PIVOTAL trials could demonstrate a benefit to quality of life or survival when comparing surveillance to EVAR for patients with an aneurysm of 4.0 cm and greater.

Open versus endovascular repair

Since its introduction in the late 1980s, EVAR has seen its popularity grow for both elective and emergency AAA repair. The proportion of elective repairs performed endovascularly has increased from 54% in 2009 to 66% in 2013. The characteristics of patients undergoing endovascular repair is also changing. They tend to be older and have a greater burden of co-morbid disease. The evidence base supporting endovascular repair lies with the multitude of studies comparing EVAR to open aneurysm repair.

EVAR I, the Dutch DREAM trial and the American OVER trial concluded that although EVAR offered lower operative and 30-day mortality rates there was no survival advantage after 2 years. Furthermore, EVAR was associated with increased risks of complications, reinterventions and costs.[6]

The most recent trial comparing open repair to EVAR (the ACE trial) demonstrated similar 30-day mortality rates between the two interventions. The authors concluded that in patients with low-to-intermediate risk, there is no difference in perioperative or mid-term survival or in complication rates.[7]

Data from the National Vascular Registry recently reported an increased length of hospital stay (9 days), compared to those undergoing EVAR (4 days). The overall mortality rate for open aneurysm repair was 3.6% compared to 0.8% with EVAR.[5]

Risk stratification

Individualized risk stratification prior to elective intervention starts with a MDT discussion for each patient with an aneurysm of 5.5 cm or more. Risk models have been used but are somewhat limited in their prediction for an individual. A review of the available risk prediction scoring systems for elective AAA repair showed that the British Aneurysm Repair (BAR) score, Medicare and Vascular Governance North West models provided the most accurate correlation between intervention and outcome. These scoring systems calculate patients' mortality risk based on a number of factors including the type of repair, age, sex, and coexisting disease.[8]

Scoring systems all have their limitations and should only be used to supplement the clinical judgement of experienced vascular surgeons and anaesthetists involved in discussions with the patient and their family.

Cardiopulmonary exercise testing (CPET) is increasingly being used in the preoperative assessment of patients undergoing major surgery. Low or sub-threshold values of certain CPET variables are associated with reduced life expectancy after elective AAA repair (open or EVAR). A cohort of patients with reduced survival at 3 years post-procedure can be identified using these variables. This information may help guide discussions with the patient regarding the options for intervention. For patients predicted to have a relatively short life expectancy (e.g. less than 5 years) open surgery will lead to a significant proportion of what remains of their life being spent in hospital. Coupling this with their increased perioperative risk (which may also be in part determined using CPET) may influence the final decision on choice of management.

The use of serum markers to assist in risk stratification is becoming more prevalent. For example, studies have demonstrated that raised serum N-terminal pro-brain natriuretic peptide (NT-proBNP) is a valuable predictor of perioperative cardiovascular complications after non-cardiac surgery. This is particularly true where the raised serum level is secondary to cardiac failure. There is supporting evidence now that preoperative NT-proBNP measurement outperforms clinical risk indices and may supersede clinical risk factor scoring systems in the future, particularly in vascular surgery where the evidence base is strongest.

It is important to recognize that risk prediction models do not predict the outcome for an individual patient, but provide an estimate of the risk for a population of patients with similar characteristics undergoing the same procedure.

