Anaesthesia for the ruptured aortic aneurysm

Matthew Cheesman

Andrew Maund

Abstract

The perioperative management of ruptured abdominal aortic aneurysms (RAAA) remains a core anaesthetic competency. Changes such as service centralization, aneurysm screening and the developing role of emergency endovascular aneurysm repair (EVAR) are altering the demands upon anaesthetists. Whereas previously on-site general anaesthesia for resuscitative open aneurysm repair (OAR) was standard, now transfer, choice of surgical technique and options for anaesthetic management may need to be considered. We present the key components of emergency anaesthesia for both OAR and EVAR and describe clinical dilemmas arising at preoperative and intraoperative stages.

Keywords Abdominal aortic aneurysm; coagulopathy; emergency anaesthesia; endovascular aneurysm repair; massive haemorrhage; transfusion

Royal College of Anaesthetists CPD Matrix: 2A03, 2A04, 2A05, 2C01, 3A05

Learning objectives

After reviewing this article readers should be able to:

- understand key determinants of surgical and anaesthetic strategies for ruptured abdominal aortic aneurysm (RAAA)
- evaluate patients with RAAA and appreciate the limited scope for patient optimization
- prepare a theatre for emergency open aneurysm repair
- describe key physiological implications of aortic occlusion and tissue reperfusion
- list perioperative complications of both open and endovascular aneurysm repair

Abdominal aortic aneurysm (AAA): the clinical problem

Overview

Ruptured abdominal aortic aneurysm (RAAA) requires urgent management to reduce mortality and major morbidity. Traditional open aneurysm repair (OAR) has only yielded limited incremental improvements in outcome for several decades.[1] Attempts to improve outcomes have focussed on avoiding rupture through screening programmes, service centralization in centres of excellence, and expansion of endovascular aneurysm repair (EVAR) as technology has allowed.

Pathophysiology

Aneurysms are abnormal focal dilatations of greater than 50%; thus AAA diameters exceed 3 cm. Amongst AAAs 90% are infrarenal and 10% juxta-renal or supra-renal. About 10% of aneurysms have an inflammatory cause.[2]

Established aneurysms progressively enlarge although expansion trajectories vary widely. Greater diameter is associated with higher rupture risk, for example 50 mm aneurysms confer a 1% annual rupture rate whereas those greater than 70 mm exceed 20%. More rapidly expanding and symptomatic aneurysms are higher risk, and given aneurysm dimensions represent greater risk in females than males.[3]

Presentation with pain from dissection before frank rupture confers the best chance of survival. With frank rupture around 75% mortality is expected with intra-peritoneal bleeds faring worse than where retroperitoneal haematoma benefits from some tamponade effect. Around 50% of patients survive to presentation, the sub-group not shocked on arrival have a greater than 80% survival rate at 2 hours post-presentation (suggesting opportunity for imaging and transfer in selected individuals).[1,4]

Epidemiology

RAAA is a predominantly male condition (male:female 4:1),[1] the highest incidence of rupture occurs in those aged 65–85 years. Smoking, hypertension and hypercholesterolaemia increase incidence, as do some connective tissue disorders (e.g. Marfan's Syndrome and Ehlers-Danlos Syndrome); the association of diabetes with occlusive vascular disease is not mirrored in aneurysmal pathophysiology.

Service organization

Two key developments have altered AAA management in the UK in the past decade, as follows.

1. Centralization of services – recognition that greater throughput is associated with improved outcomes led to centralization into larger centres with sub-specialized staffing and infrastructure. However, in many centres the 'middle of the night AAA' will be managed by open repair involving generalist anaesthetists. The mortality benefit of centralization outweighs adverse outcomes caused by secondary transfer.[1]
2. The National Abdominal Aortic Aneurysm Screening Programme offers ultrasound imaging to males aged 65. Depending on aortic diameter patients are discharged, listed for episodic imaging, or (if diameter exceeds 55 mm) referred for vascular assessment. However, it leaves patients beyond the screening age un-imaged, and with a 1% annual rupture rate at 50 mm, some ruptures still occur in the screened group.

__Matthew Cheesman__ MBBS FRCA DipIMC is a Consultant Anaesthetist at South Tees Hospitals NHS Foundation Trust, UK. Conflicts of interest: none.

__Andrew Maund__ BA(Hons) MBChB FRCA FCAI RAMC is a Military ST6 Anaesthesia Trainee at South Tees Hospitals NHS Foundation Trust, UK. Conflicts of interest: none.

Patients with RAAA therefore either present at a large centre with on-site vascular services frequently managing this scenario, or to smaller non-vascular centres where communication (with the regional centre), decision making and transfer challenges will be greater.

Clinical management

RAAA management is characterized by complexity and time pressure; therefore communication, delegation and concurrent activity, and pragmatic decision making are key to success.[2] Depending on where the patient presents, different demands may be faced; for example, from immediate theatre transfer and induction for resuscitative OAR, to participation in decision making that intervention or transfer is futile.

EVAR versus OAR

EVAR

EVAR has an expanding role in elective and emergency AAA management.[1] Greater experience and technological improvement allows use for more challenging anatomy with faster procedure times which is more tolerable in the awake patient (allowing fewer general anaesthesia (GA) cases) and reduces ischaemic time. Cases previously judged too unstable for endovascular management may now be initiated with transfemoral balloon occlusion before angiographic assessment of the aneurysm with the option to progress to EVAR or OAR.

The potential benefits of EVAR include:

- potential avoidance of GA and ventilation-associated complications
- less stimulation requires a lighter plane of GA if this technique is chosen
- avoiding the 'dash to clamp' at induction by prior balloon occlusion
- avoiding laparotomy incision
- compared with OAR potentially, quicker, less blood loss, less tissue handling and dissection and easier avoidance of hypothermia.

EVAR is not universally applicable; factors influencing technique include availability of interventional services, surgical preferences and patient comorbidities. Aneurysm factors: site, size, length, neck angulation, tortuosity, landing zone characteristics, presence of intramural thrombus and access vessels also determine suitability.

Evidence remains inconclusive regarding relative merits of EVAR and OAR.[4] The literature recognizes that previous claims for marked EVAR superiority based on observational and registry case series are probably too subject to bias to be reliable. However more recent studies have prospectively examined the outcomes of randomized patients and have allowed sub-group analysis by suitability for EVAR or age. Unfortunately these patient series are too recent to provide long-term outcome.

Preoperative phase

Anaesthetic preoperative priorities involve patient evaluation, optimization, and team preparation of theatre and equipment.

Patient evaluation: in unstable patients this occurs alongside resuscitation although normal responses to ABC findings may be modified (e.g. blood pressure should not be normalized). Unstable patients should not be anaesthetized for transfer/imaging as loss of tamponade and sympathetic drive risks irretrievable hypotension.

Sufficiently stable patients may undergo diagnostic confirmation typically with abdominal CT, this also evaluates the aneurysm anatomy and refines surgical decisions regarding technique.

A focussed anaesthetic history should be obtained; likely co-morbidities include those associated with causing the pathology. There is increased incidence of pathologies associated with atherosclerotic disease (i.e. coronary heart disease, heart failure, cerebrovascular disease and chronic kidney disease).[2]

Initial tests include cross-match (with activation of major haemorrhage pathways), full blood count, urea and electrolytes, liver function tests, calcium and coagulation. Arterial blood gases (ABG) and an ECG should ideally be performed.

Prognosis prediction at presentation has limited success. Scoring systems, including the Hardman Index and Glasgow Aneurysm Score, are insufficiently accurate alone but are useful adjuncts to current cardiovascular status, co-morbid condition and anatomical considerations when senior decision makers evaluate the patient.

Optimization: time constraints limit opportunities for optimization however several useful measures can be undertaken.

Permissive hypotension improves mortality – higher blood pressure accelerates haemorrhage. However, systolic pressures below 70 mm Hg are also associated with increased 30 days mortality.[4,5] Limiting aortic wall stress requires control of significant hypertension through incremental doses of short acting analgesics (where pain drives the hypertension), β-blockers and vasodilators.[2]

Volume status should be carefully evaluated. Normovolaemia is not sought, although in markedly hypovolaemic and hypotensive patients sequential fluid boluses (e.g. 100–250 ml) may be appropriate. Iatrogenic coagulopathy is reversed (e.g. human prothrombin complex for warfarin); the increasing use of anti-platelet drugs and new oral anti-coagulants creates challenges that will require Haematology advice.[2]

Hypothermia increases mortality – exacerbating acidosis and coagulopathy and measures to avoid this should be initiated early.

Analgesia may be beneficial for humanitarian and physiological reasons. Pain can drive both tachycardia with cardiac ischaemia and hypertension, however unthinking administration of opioids can obtund sympathetic drive which may be maintaining cardiovascular stability. Administration should therefore be in titrated small doses.

Preparation: clear leadership and task allocation is required, where possible initially with two anaesthetists and two operating department practitioners involved in preparation – this allows one anaesthetist to remain with the patient while the other focusses on theatre preparation as described in emergency EVAR and open RAAA repair flowcharts (Figures 1 and 2).

All decisions need to be balanced against benefits of 'placement now' against time cost. Choices depend upon patient stability, (e.g. our practice is to gain arterial access pre-induction

