

Abdominal aortic aneurysm

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Abdominal aortic aneurysm is by far the most common type of large-vessel aneurysm and is found in 2% of the population at autopsy; 95% have associated atheromatous degeneration and 95% occur below the renal arteries. Most remain asymptomatic until rupture occurs; the risk of rupture increases with increasing size (diameter) of the aneurysm. Asymptomatic aneurysms are found incidentally on physical examination, radiography or ultrasonography investigation. A UK national screening programme for abdominal aortic aneurysm commenced in 2009 offering an ultrasonography scan to men in their 65th year. Symptomatic aneurysms may cause minor symptoms, such as back and abdominal discomfort, before sudden, severe back and/or abdominal pain develops from expansion and compression of surrounding structures, e.g. aortoenteric fistula or ureteric obstruction.

Asymptomatic abdominal aortic aneurysm

An asymptomatic abdominal aortic aneurysm (Figure 61.39) in an otherwise fit patient should be considered for repair if ≥ 55 mm in diameter, measured by ultrasonography in the anteroposterior plane. The annual incidence of rupture rises exponentially as the aneurysm size passes 55 mm: $\leq 1\%$ are in aneurysms that are <55 mm in diameter, 5–10% are in those that are 55–60 mm in diameter and $\sim 25\%$ are in those that are ≥ 70 mm in diameter. Assuming that open elective surgery (transabdominal) carries a 5% mortality rate, the balance is in favour of elective operation once the maximum diameter is ≥ 55 mm, provided there is no major comorbidity . Regular ultrasonography surveillance is indicated for asymptomatic aneurysms <55 mm in diameter. Investigations Full blood count, electrolytes, liver function tests, coagulation tests and blood lipid estimation should be performed. Blood should be cross-matched a few days prior to surgery . Many

(a) (b) Figure 61.39 Ultrasonogram of an aortic aneurysm showing the large clot-filled sac with a small central lumen (transverse and longitudinal scans).

patients now have an anaesthetic assessment and the need for cardiac and respiratory function tests is decided at this time. ECG and chest radiographs are essential; further assessment may include echocardiograph, cardiopulmonary exercise testing and spirometry . The morphology of the aneurysm is best assessed by computed tomography (CT) scan; this can be reconstructed on imaging software to create a three-dimensional model of the aneurysm (Figures 61.40 and 61.41). Seventy-five per cent of aneurysms are suitable for endovascular (minimally invasive) repair, usually via the femoral arteries in the groin. If occlusive disease that should be assessed by DUS initially . Further assessment with CT , MRA or digital subtraction angiography may be required and angioplasty may be appropriate. The aneurysm is often filled with circumferential clot (Figure 61.42a) that produces a falsely narrowed appearance on DSA (Figure 61.42b); this method should not therefore be used to assess aneurysm size. Choice of operation: open or endovascular repair In recent years there has been much discussion regarding the optimal way to treat an abdominal aortic aneurysm with both open surgical repair and endovascular aneurysm repair (EV

AR) having vocal advocates in the scientific literature. The National Institute for Health and Care Excellence (NICE) in the UK published guidelines in 2020 recommending open surgical repair unless contraindicated, reserving EV AR for high-risk patients or those with a hostile abdomen. This compares to the European Society for Vascular Surgery 2019 guidelines, which recommend EV AR as the first-line treatment option with open surgical repair to be considered for patients with long life expectancy . Pragmatically , the clinician should be prepared to undertake what they and the patient (after a detailed conversation) agree to be the best option, taking into account the skillset and resource availability and often, unfortunately , the financial constraints of the patient or healthcare system. Open aneurysm repair Under general anaesthesia, with the patient lying supine, a full-length midline or supraumbilical transverse incision is made. The small bowel is lifted to the patient's right and the aorta identified. The posterior peritoneum overlying the aorta is opened and the upper limit of the aneurysm identified. The aorta immediately above the dilatation is exposed; this is generally just inferior to the left renal vein and renal arteries (Figure 61.43). The common iliac arteries are then exposed and clamps applied above and below the lesion.

Figure 61.40 Computed tomography of the abdomen showing an infrarenal aortic aneurysm in the coronal plane (arrow). Blood flowing through the thrombus-containing sac is enhanced with contrast agent and appears white. (a) (b) Figure 61.41 (a) Maximum intensity projection reconstruction of an aortic

aneurysm from a spi

ral computed tomogram. (b) Three-dimensional reconstruction of an abdominal aortic aneurysm.

Many surgeons give systemic heparin (3000–5000 /uni00A0 U) before clamping. The aneurysm is opened longitudinally and back- bleeding from the lumbar and mesenteric vessels is controlled by sutures placed from within the sac. Upper and lower aortic necks are prepared to which an aortic prosthesis is then sutured end-to-end inside the sac with a monofilament non-absorbable suture (Figure 61.44). Clamps are released slowly to prevent sudden hypotension. If haemostasis is satisfactory at this point, the aneurysm sac is closed around the prosthesis to exclude both it and the suture lines from the bowel to reduce the risk of adherence and potential fistula formation. The abdomen is then closed. Occasionally , when the iliac vessels are also involved with dilatation or severe atheroma, it is necessary to construct an aortobi-iliac or aortobifemoral bypass, rather than use a simple aortoaortic tube. Endovascular aneurysm repair EV AR is now established in clinical practice and has been shown to reduce mortality compared with open repair over the first 6 years but there are concerns about long-term durability . Currently about 75% of infrarenal aneurysms are suitable for EV AR, depending on the morphology of the aneurysm as assessed by CT scan. Common causes of unsuitability include a short, flared or angulated neck and difficult iliac artery access because of narrowing or tortuosity . The usual technique is to expose both femoral arteries (under general or local anaesthetic), which allows access to the aorta. Then, under radiological control, guidewires and catheters are used to cross the aneurysm and an angiogram performed to mark the level of the renal arteries. The endovascular prosthesis (often termed a ‘stent graft’) is usually made up of three separate parts: a main body (Figure 61.45a) and two limbs that are enclosed in separate delivery catheters (Figure 61.45b). Some types have only two pieces: a main body with an ipsilateral limb attached and a separate contralateral limb. The prosthesis is made from Dacron or PTFE with integral metallic stents for support. The delivery catheter is inserted into the aneurysm sac and the stent-graft deployed by withdrawal of the delivery system. Most systems now have hooks or barbs to anchor the prosthesis in the aortic wall, and some surgeons inflate a moulding balloon catheter in the stent-graft to ensure that the hooks and barbs are engaged and a good seal is obtained (Figure 61.46). Although the top edge of the fabric of the stent-graft has to be deployed below the renal arteries (infrarenal fixation), some systems have additional bare metal stents at the proximal end of the main body that lie across the renal arteries to give better support and fixation (suprarenal fixation). Blood flows between the metal struts of the stent into the renal arteries. Success is dependent on a good seal between the stent-graft and the proximal and distal ‘landing zones’ in the aorta and iliac arteries. Failure to achieve a good seal results in an endoleak, which means that the aneurysm is not excluded from the circulation and may still expand and rupture. Patients who undergo EV AR require lifelong follow-up and surveillance with duplex (Figure 61.47) or CT scans to detect endoleak, disconnection

(b) Figure 61.42 (a) Thrombus removed from an abdominal aortic aneurysm; this thrombus is the reason an angiogram may give a false impression of aneurysm diameter on digital subtraction angiography (b) . Figure 61.43 Operative appearance of a large, non-ruptured infrarenal abdominal aortic aneurysm.

Figure 61.44 (a) Aneurysm sac opened. Note that the posterior wall of the aorta immediately above and below the sac is not divided. A Dacron tube graft is laid in place within the sac ready for suture. (b) The graft is sutured in place and the vascular clamps removed. (a) (a) (b) (b) Figure 61.45 (a) Endovascular prosthesis main body; with separate limbs (b) . Figure 61.46 Infraarenal aortic aneurysm before (a) and after (b) endovascular aneurysm repair.

of the components and migration of the stent-graft, all of which predispose to late rupture (Figure 61.48). Ruptured abdominal aortic aneurysm Abdominal aortic aneurysms can rupture anteriorly into the peritoneal cavity (20%) or posterolaterally into the retroperitoneal space (80%). Less than 50% of patients with rupture survive to reach hospital. Anterior rupture results in free bleeding into the peritoneal cavity; very few patients reach hospital alive. Posterior rupture on the other hand produces a retroperitoneal haematoma (Figure 61.49). Often a brief period ensues when a combination of moderate hypotension and the resistance of the retroperitoneal tissues arrests further haemorrhage and may allow transport to hospital. The patient may remain conscious but in severe pain. If no operation is performed, death is virtually inevitable. Operative mortality is around 50% and the overall combined mortality (community and hospital) is around 80–90%. Ruptured abdominal aortic aneurysm is a surgical emergency; it should be suspected in a patient with the triad of severe abdominal and/or back pain, hypotension and a pulsatile abdominal mass. If there is doubt about the presence of an aneurysm an ultrasonography scan may help but this cannot diagnose rupture. CT scanning should be used to establish the diagnosis and to confirm a rupture and whether an EVAR is possible: EVAR should be considered as the first-line option for all anatomically suitable ruptured aortic aneurysms. Good venous access is needed for infusion of saline or volume-expanding fluids, but the systolic blood pressure should not be raised any more than is necessary to maintain

Figure 61.47 Duplex ultrasonography scan post endovascular aneurysm repair (EVAR), showing the aortic sac in cross-section and two limbs of EVAR (red ovals). There is a type II endoleak from the inferior mesenteric artery, with blood flowing retrogradely into the aneurysm sac (arrow). Figure 61.48 A stent-graft retracted into the aneurysm sac, creating a type Ib endoleak. Figure 61.49 The retroperitoneal haematoma of a ruptured aortic aneurysm. The aortic pulsation is palpated through the haematoma at its upper limit and fingers are insinuated on each side of the aorta. With finger control, the upper clamp is positioned and closed on the aorta. The procedure is then as for a planned case. Here, the clamp is at the proximal end of the aneurysm; the haematoma has spread from the left paracolic gutter to encircle the aneurysm and the aortic bifurcation.

After CT scanning, the patient should be transferred immediately to an operating theatre where a urinary catheter and arterial line are usually inserted. If the patient appears stable, surgery may be delayed until cross-matched blood is available but surgery should commence immediately if haemodynamic instability develops. For open surgical repair the abdomen is usually prepared and draped with the patient awake, minimising potential delays in cross-clamping the aorta as general anaesthesia is often accompanied by haemodynamic deterioration. Endovascular repair can often be performed under local anaesthetic and, if indicated, an aortic occlusion balloon catheter can be inserted to gain control in a patient with significant haemodynamic compromise. Always remember that the treatment of ruptured aneurysm is an operation, not monitoring and resuscitation.

Summary box 61.5 Management of ruptured abdominal aortic aneurysm /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF /uni25CF Symptomatic abdominal aortic aneurysm These patients

most commonly present with abdominal and/ or back pain but the aneurysm is not ruptured on CT scan. Pain may also occur in the thigh and groin because of nerve compression. Gastrointestinal, urinary and venous symptoms can also be caused by pressure from an abdominal aneurysm. About 3% of all aneurysms cause pain as a result of inflammation of the aneurysm itself (Figure 61.50). Finally , a few cause symptoms from distal embolisation of intraluminal thrombus. An operation is usually indicated in patients who are otherwise reasonably fit. Pain may be a warning sign of stretching of the aneurysm sac and imminent rupture; surgery should be performed as soon as possible (usually on the next available operating list). The operative mortality of symptomatic aneurysms is usually higher than that for elective cases. Postoperative complications The most common complications after open repair are cardiac (ischaemia and infarction) and respiratory (atelectasis and lower lobe consolidation). A degree of colonic ischaemia because of a lack of a collateral blood supply occurs in about 10% of patients, but this usually resolves spontaneously . Acute kidney injury is an uncommon event after elective procedures but may complicate procedures undertaken for rupture. Acute kidney injury is more likely if there is preoperative renal impairment or considerable intraoperative blood loss. Neurological complications include sexual dysfunction and spinal cord ischaemia. An aortoduodenal fistula is an uncommon but treatable complication of abdominal aortic replacement surgery . It should be suspected whenever haematemesis or melaena - occurs in the months or years after operation. Prosthetic graft infection is also uncommon; it may require explantation of the original graft and replacement with an autologous deep vein (superficial femoral vein) graft or removal of the original graft with oversewing of the aortic stump and limb revascularisation by insertion of an axillobifemoral bypass. Both techniques are associated with significant risk of perioperative morbidity and - mortality . Cardiac, respiratory , renal and neurological complications are less common after endovascular repair. However, there are complications that are unique to EV AR, such as endoleak (Table 61.3), graft migration, metal strut fracture and graft limb occlusion. Lifelong surveillance with duplex or CT scans (together with plain abdominal radiographs for strut fracture) is required to detect endoleak and migration. High-pressure endoleaks may require repeat ballooning or a proximal cuff or distal limb extension to reseat the endograft. Migration may also require extension of the graft. Overall, 10–20% of patients with EV AR will require secondary interventions to - treat complications at some future date, although many of the interventions can be performed with a percutaneous approach via the femoral artery in the angiography suite.

Early diagnosis (abdominal/back pain, pulsatile mass, shock) Immediate resuscitation (oxygen, intravenous replacement therapy, central line) Maintain systolic pressure, but not >100 mmHg Urinary catheter Cross-match blood Rapid transfer to the operating room Figure 61.50 Anterior abdominal aortic aneurysm. Note the white ‘icing’ effect. Such lesions can be technically difficult to manage.

endovascular aneurysm repair. Type of endoleak Definition Type I Persistent filling of the aneurysm sac owing to an ineffective seal at the proximal (Ia) or distal (Ib) end of the stent-graft Type II Persistent filling of the aneurysm sac owing to retrograde flow of blood from aortic collaterals, e.g. IMA, lumbar arteries Type III Persistent filling of the aneurysm sac owing to structural failure of the stent-graft as a result of component disconnection (IIIa) or stent fabric tear (IIIb) Type IV Persistent filling of the aneurysm sac owing to stent-graft fabric porosity Type V (endotension) Persistent filling of the aneurysm sac without evidence of types I–IV endoleak IMA, inferior mesenteric artery.

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