Aortic Aneurysm Graft

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Further reading

E. Macaulay and J. Engeset Abdominal aortic aneurysms
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Acknowledgement

We are most grateful for information about grafts from Nick Chant, Vascular National Sales Manager, B. Braun Medical Ltd., Thorncliffe Park, Sheffield. S35 2PW United Kingdom.
Operations covered in this script

- Aorto-aortic straight graft
- Aorto-bifemoral Y graft
- Elective and emergency operations
- Aortic transection and aortic inlay techniques
- Procedures for concurrent distal aneurysms and stenoses
- Femoral embolectomy

Operations not covered in this script

- Stenting
- Retroperitoneal approach to aorta and iliac vessels
- Redo grafting operations
Introduction to Pantogen Surgical Scripts

A Pantogen Surgical Script aims to present all the operative information that an expert surgeon uses when operating.

Ninety percent of this information is “not in the books”. Traditionally such information has been learned by experience during the course of operating on many cases over many years.

However, much of this information is very simple and can be absorbed outside the operating theatre. The trainee’s progress at the operating table subsequently should be faster and more confident, with fewer patients being put at risk.

For experts, the scripts will doubtless be a source for comment and criticism. However, the scripts can be easily edited to match the preferences of any surgeon, thereby creating a surgeon’s personalised operative manual.

Just as the expert surgeon does, the scripts divides even the most complex operation into very small basic steps. For each step, the scripts describe all the information that the expert surgeon uses using during that step. Eg Where to start the step, where to finish, plus how to avoid, prevent and solve problems.

The scripts are written in a manual style with high readability scores, in contrast to the classical essay style.

We recommend that trainees skim through the overview, the sections and then one or two of the steps to get a general idea of the scope of the work. Then they should read the whole script before assisting an expert performing the operation. The trainee can make notes and comments in the script after assisting. Rereading the script after the operation should reinforce what has been learned at the operation. Within a surprisingly short space of time the trainee will reach a stage to perform the operation, or parts of it, under supervision.

Always check with a trained surgeon before using any of the information in these scripts.

Warning
A pantogen script is a useful tool for training and for quality control.

BUT it has major limitations.
It does not cover all the details of the procedures.
It is not a comprehensive training system.
It may complement, but it does not replace standard accepted surgical practices, or accepted forms of surgical teaching and training.
Introduction to Pantogen Surgical Scripts (continued)

It does not set out to establish or impose any specific standard of surgical practice.
It does not set out to impose any particular way of performing an operation.
It describes some procedures which carry an inherent high risk of serious or lethal complications.
It describes some procedures and operations which are changing very rapidly, but the information in a pantogen is only as good as its last update.
The information in a pantogen is only a part of the requirements for successful surgery.

Pantogens assumes certain levels of surgical skill. These skills may have been acquired with the help of more basic pantogens. eg. The steps of an oesophagectomy are far more difficult than the steps in an inguinal hernia repair.

It is possible for a surgeon to follow pantogen steps to the letter, and still get into serious trouble for a large number of reasons, some of which are listed above.

The clinical judgement of the surgeon at all times overrides the information given in pantogens.

We accept that there are entirely acceptable alternatives to the procedures, techniques, equipment, and materials mentioned in pantogens.

We do not claim that any of the procedures, techniques, equipment, and materials in pantogens are in any way superior to others.

While the author and publishers have made strenuous efforts to make pantogens as safe and as reliable as they possibly can, they accept no liability for:

Problems occurring from the use of pantogens in their original or in any modified form, either now or in the future.

Any difficulties encountered in performing any of the techniques, or using any of the equipment or materials, surgical and non-surgical, described in the text.

Changes, discrepancies, errors that may appear in the information as the result of data inputting, programming, system faults, data handling, transmission, and printing or any other computerised process.
Overview of grafting an abdominal aortic aneurysm

Grafting an abdominal aortic aneurysm is one of the major challenges to the vascular surgeon.

The aneurysm is a dilatation of the wall of the aorta, the main artery running to the lower limbs. It is a variant of atheromatous disease, which usually occludes an artery rather weakening it.

There is always some atheromatous disease, either aneurysmal or occlusive, in the rest of the aorta and in the other major arteries of the body.

Aneurysms increase in size with time and with the progression of the disease. The larger the dilatation, the greater the chance of the aneurysm leaking, resulting in fatal bleeding.

A graft, a tube of synthetic fabric, is inserted to take over from the aneurysm.

The upper end of the graft is stitched to the aorta above the aneurysm. The graft lies inside the lining of the aneurysm. The lining (the sac) of the aneurysm itself is not removed. The lower end of the graft is usually stitched into the aorta below the aneurysm as a straight graft.

If the lower aorta is not suitable for stitching, a Y-shaped graft (trouser graft, bifurcation graft) is joined to the arteries of the lower limbs in the upper thighs.

Many aneurysms are clinically silent until they present with leaking. Operating on emergency cases carries a mortality of 40% or more, with half the deaths occurring on the operating table.

In addition to the technical difficulties of operating on older patients with larger aneurysms, other diseases and massive haemorrhage, the surgeon has to decide whether to operate at all, which operation to perform, and if necessary, when to stop operating.

Elective surgery (non-emergency) carries its own problems. The surgeon has to decide at which point, the risks of an aneurysm leaking in a given period of time exceeds risks of elective surgery (30 day postoperative mortality of 2-4%).

This script describes both an emergency operation for a leaking aneurysm and an elective operation. It describes a straight graft and a Y graft. It also describes two major technical methods of stitching the graft to the aorta, the transection and the inlay technique.

The script consists of sections, steps, and information to back up each step. The sections and steps are all numbered for ease of navigation.

All other clinical scenarios and technical variants are described within this framework.
Overview of grafting an abdominal aortic aneurysm (continued)

There is some repetition of details of procedures to accommodate the practices of surgeons who, for instance, use solely an end-to-end technique or an inlay technique.

Where a procedure, such as managing bleeding, is repeated several times in the operation, the details of the procedure are given the first time only. For subsequent times, the script refers the reader back to first account for details.
Anatomy review

Subrenal Aorta
- Aneurysms most commonly occur in the aorta below the renal arteries.
- In health, this section of the aorta is only 5 - 6cm. long and 16-20 mm. in diameter.

Surface markings of the subrenal aorta
- The renal arteries run laterally from the aorta at the level of the xiphisternum. The right renal artery is usually 5mm. or more lower than the left.
- The aorta bifurcates at the level of the umbilicus. This makes good access to the upper abdomen essential for grafting the aorta.

Relations of the subrenal aorta
- A clear knowledge of the anatomy of the subrenal aorta between the renal arteries and the upper end of an aortic aneurysm is the key to successful aneurysm surgery.
- This section of aorta is surrounded behind, on both sides, above, behind and in front by large, interconnecting and fragile veins.

Posterior relations of the subrenal aorta
- The subrenal aorta lies on the front of the bodies of the 2nd to 4th lumbar vertebral bodies, sharing this position with the vena cava on its right.
- The subrenal aorta lies behind the peritoneum of the posterior abdominal wall, but as a result of the lordosis of the lumbar vertebrae, it may be only 5cm. posterior to the anterior abdominal wall.
- The aorta lies on the anterior longitudinal ligament of the vertebral column.
- The aorta gives off pairs of lumbar arteries which contribute to the blood supply of the spinal cord. There are usually adequate anastomotic channels in the spine to sustain a blood supply to the spinal cord if the lumbar arteries are stitched off during aortic surgery.
- Fragile lumbar veins run behind the aorta to drain into the vena cave.
- Very rarely the left renal vein runs behind the aorta to the vena cava and may be double.

Anterior relations of the subrenal aorta
- The upper half of the subrenal aorta is crossed from anterior to posterior by:
  - The transverse colon
  - The fourth part of the duodenum
  - The left renal vein.
  These structures are met in this sequence when exposing the aorta.
Anatomy review (continued)

- The lower half of the subrenal aorta lies immediately behind the peritoneum, between the mesentery of the small bowel on the right and the vessels of the descending colon on the left. This is a convenient route for access to the aorta.

Right lateral relations of the aorta
- The right side of the aorta is closely attached to the vena cava.
- Dissection of the aorta above an aneurysm may tear the vena cave.
- An aneurysm may erode into the vena cave, producing a lethal arterio-venous fistula.

Left lateral relations of the aorta
- The inferior mesenteric artery arises from the left antero-lateral side of the subrenal aorta. It continues downwards in the pelvis as the superior rectal artery. It supplies blood to the large bowel. It anastomoses with branches of the superior mesenteric artery above and the middle and inferior rectal arteries below. These anastomoses can usually sustain the blood supply to the large bowel if the inferior mesenteric artery is tied off during aortic surgery.
- The inferior mesenteric vein accompanies the artery in the lower subrenal area. It then parts company and runs up to the left of the duodenum. It finally turns right to run into the portal vein. It can cause bleeding if damaged during the dissection of the aorta, but can be tied off without harming the large bowel.
- Paired gonadal arteries arise from the front of the aorta between the origins of the renal and inferior mesenteric arteries, but rapidly run laterally. The left gonadal artery runs down the left side of the aorta, behind the mesenteric vessels, but in front of the left ureter.
- The gonads obtain an adequate blood supply from local anastomoses, if the gonadal arteries are occluded by a subrenal aneurysm, as is generally the case.
- The left gonadal vein drains into the left renal vein. The damage at the junction of these vessels during dissection of the upper end of an aneurysm can cause serious bleeding.
- The left side of the subrenal aorta is related to the inferior mesenteric artery and vein, the left gonadal vessels behind and the left ureter behind them.

Surgical approach to the upper subrenal aorta
- The anatomy of the section of aorta just below the renal arteries and above the aneurysm is of particular importance.
- This is the site of the upper anastomosis with the graft.
- If this section of aorta is aneurysmal itself, it will contraindicate an operation.
- The section is surrounded on three sides, (ie on the left,
Anatomy review (continued)

Cephalically and on the right) by bowel superficially and by veins more deeply. Damage to any of these surrounding structures may lead to a fatal outcome to the operation.

- The bowel on the left is the descending colon, cephalically the transverse colon overlying the 4th part of the duodenum, and on the right, the small bowel.

- The vein on the left is the left gonadal vein, running the left renal vein cephalically, which in turn runs into the vena cava on the right side. There are also lumbar veins posteriorly and the inferior mesenteric vein anteriorly.

Autonomic nerves and plexuses

- The autonomic nerve supply to the pelvic organs (genito-urinary derivatives of the hindgut) forms a series of interconnecting plexuses related to the aorta and major arteries. The plexuses contain both parasympathetic and sympathetic fibres. The fibres also supply the lower bowel as far as the middle of the transverse colon.

- Damaging this autonomic nerve supply can cause debilitating urinary retention, loss of control of micturition, penile erection (parasympathetic) and ejaculation (sympathetic). Damage to the autonomic nerve supply to the lower bowel does not appear to be harmful.

- Most of the sympathetic nerve fibres come down to these plexuses directly from the T12, L1, L2 sympathetic ganglia on the sides of the relevant vertebral bodies, behind and lateral to the aorta and vena cave.

- Parasympathetic nerve fibres come from spinal levels S1,2,3,4 via pelvic splanchnic nerves (sacral nerves, or nervi erigentes - arousal nerves).

- The aortic plexus lies on the front of the lower aorta, connected to the coeliac plexus higher up the aorta. The aortic plexus is connected to the midline hypogastric plexus (presacral nerve or lumbar splanchnics). The hypogastric plexus lies on the front of the 5th lumbar vertebra and upper sacrum.

- The hyogastric plexus divides into left and right hypogastric nerves, which run down to the pelvic plexuses on the inner wall of the pelvis.

- The hypogastric nerves and plexuses are joined on their medial aspects by the parasympathetic pelvic splanchnic nerves.

- In aortic surgery, the aortic plexus (on the front of aorta) and the hypogastric plexus (on the front of the sacrum) and hypogastric nerves (on the lateral pelvic wall) are mainly at risk. The enlargement of the wall of the aorta may damage the aortic plexus. Incision and
Anatomy review (continued)

particularly transection may be damaging. The patient should be warned of this happening before the operation starts. At an elective operation, identification and preservation of the hypogastric plexus and nerves are usually possible. Infiltration of blood into the tissues from a leaking aneurysm usually prevents such identification.

Iliac and femoral arteries

- The vessels are prone to anatomical variation as well as to the changes of vascular disease.

- The aorta bifurcates into the left and right common iliac arteries over the 4th lumbar vertebra (behind the umbilicus).

- The common iliac arteries bifurcate into the internal and external iliac arteries over the sacro-iliac joints.

- The internal iliac arteries run into the depths of the pelvis to supply the pelvic organs, the lower bowel, the pelvic wall, soft tissues and skin of the pelvis.

- The external iliac arteries run round the pelvic brim to pass under the inguinal ligaments. There, they continue as the common femoral arteries, which, in health, are 5-6mm. diameter.

- The combined length of a common and an external iliac artery is about 15cm. The two index fingers are long enough to tunnel a path alongside the arteries for the limbs of a trouser graft. The curved course of the vessels means that the fingers meet at right angles. The fingers should keep to the lateral side of the arteries to avoid damage to the iliac and femoral veins running medially to the arteries.

- The common femoral artery continues as the superficial femoral artery, after the deep (profunda femoris) artery has branched off. This is usually 3-5 cm. below the inguinal ligament.

- The profunda artery arise from the lateral side of the common femoral artery and then runs deeply behind the superficial femoral artery into the adductor muscles on the medial side of the thigh. It is closely related to one or more deep femoral veins, which may need to be ligated for a satisfactory exposure of the deep femoral artery.

- NB Do not confuse these veins, which accompany the profunda artery, with the femoral vein which accompanies the superficial femoral artery.

- The medial and lateral circumflex arteries, running into the thigh muscles, arise from the profunda artery or sometimes directly from the common femoral artery.

- In addition to controlling the 3 main femoral arteries (common, superficial and deep) when preparing for a femoral arteriotomy, 4 minor arterial branches may need to be controlled nearby.
Anatomy review (continued)

They are the superficial epigastric, the superficial and deep external pudendal and the deep pudendal arteries.

- The superficial femoral artery runs down the medial aspect of the thigh. It passes through the adductor muscles to the back of the knee (popliteal fossa) via the adductor canal.

- The superficial femoral artery then continues as the popliteal artery. In the popliteal fossa, it divides into 3 terminal branches (trifurcation), the anterior and posterior tibial and peroneal arteries.

Iliac and femoral veins

- The iliac veins are closely related to the corresponding arteries. The veins are easily damaged during dissection of the arteries. Mass temporary clamping of the common iliac vessels is commonly performed as an alternative when controlling the iliac arteries.

- All the femoral and iliac veins are to be found medial to their corresponding arteries with one exception.

- The exception is the right common iliac vein, which passes laterally and behind the right common iliac artery.

- The right common iliac vein is joined by the left common iliac vein behind the right common iliac artery to form the inferior vena cava.

- The long saphenous vein and its tributaries (which correspond to the minor arterial branches), may need ligation for a satisfactory exposure of the femoral arteries.

- The femoral vein may be confused with the superficial femoral artery during dissection of the femoral area. The femoral vein is bluish-white and does not have vasa vasorum running across its surface.

Ureters

- The ureters run from the hila of the kidneys, behind the renal veins and arteries.

- The left ureter runs down the posterior abdominal wall 1-2cm. lateral to the aorta, behind the inferior mesenteric vessels and the gonadal vessels. It can be at risk here with an aneurysm larger than 5cm. or in a retroperitoneal haematoma.

- The left ureter runs over the left iliac vessels at the pelvic brim, covered by the sigmoid colon. It then runs down the lateral wall of the pelvis to the bladder.

- The right ureter is separated from the aorta by the vena cava.

- The ureters usually cross the common iliac arteries where they are bifurcating into the internal and external iliac arteries. They are particularly at risk at this point during aortic surgery. They then run...
Anatomy review (continued)

- round the inner wall of the pelvis to the bladder where they are related to the autonomic pelvic plexuses.

- The ureters are pale pink with longitudinal vessels. They vermiculate as they propel urine to the bladder or if gently squeezed with forceps.

Horse shoe kidney

- Horseshoe or pelvic kidney is a congenital abnormality occurring in less than 1 in 200 cases of aortic aneurysm. The diagnosis should be made on scanning during the work up.

- The left and right kidneys are fused together by their lower poles. This will usually block access to the aorta from the abdomen, necessitating a retroperitoneal approach.

- The ureters run anteriorly from horseshoe kidneys to the bladder.

- The blood supply to the kidneys dictates the operative procedure. There may be multiple renal arteries arising from abnormal sites such as the subrenal aorta or iliac arteries.

- Reimplantation of renal vessels into the aortic graft may be necessary.

- Successful stenting has been recorded.

- Sometimes the 2 halves of a horseshoe kidney just consists of a fibrous band in the midline. Simple division of the fibrous band may be all that is required to obtain access to an aortic aneurysm.

Further reading

Current optimal management of abdominal aortic aneurysms with a horseshoe kidney. Michael Horrocks MS FRCS Bath, UK

Pathology review

- The word aneurysm comes from the Greek, meaning "widening up".

- Abdominal aneurysms can be looked on as a variant of occlusive atheromatous arterial disease which is always present as well.

- **Microscopically** there is a degeneration of all three layers (intima, media and adventitia) of the aortic wall. The wall is weakened by a loss of elastin fibres. The wall thins and stretches. Stitches will tear through this weak wall.

- There is infiltration of the aneurysm wall with atheromatous and calcified plaques which may show up on straight X-rays of the abdomen.

- With loss of the intima, the aneurysm becomes lined with platelet thrombus. This is a soft, yellow jelly like mass with a central lumen along which the blood flows. An angiogram may show an apparently normal lumen without displaying the aneurysmal sac. Thrombus may embolise into the vessels of the lower limbs. This may happen before or during the surgery.

- The inferior mesenteric artery is often occluded by the thrombus long before an aneurysm presents clinically. This will encourage anastomotic pathways to the bowel. It explains the low risk of ischaemia of the bowel when this artery is tied off during aortic surgery.

- The gonadal arteries are similarly affected, but collaterals are adequate in protecting the testes from ischaemia.

- **Macroscopically**, an aneurysm is a swelling of the aorta more than 1.5 times the normal diameter (i.e. more than 30mm.). Lesser degrees of swelling are called ectasia or dilatations. Aneurysms can exceed 150mm. in diameter.

- The aneurysms are saccular (local blow-outs) or fusiform (spindle-shaped).

- The vessels will lengthen as well as dilate. This leads to distortion of the anatomy. For instance, elongation of the aorta and the iliac arteries may displace the origin of the common iliac arteries sideways and posteriorly out of sight.

- As an aortic aneurysm enlarges, it draws the relatively healthy subrenal aorta forwards from the front of the spine. This gap is an important plane of dissection and a preferred site for clamping the aorta.

- There is nearly always some degree of atheromatous disease in the aorta proximal to the aneurysm and in the vessels more distally i.e. at the sites for suturing the graft. These changes often to lead to difficult graft anastomoses.
Pathology review (continued)

- Since atheroma tends to form initially on the posterior walls of the vessels, the aortic surgeon seeks healthy sites on the anterior walls of distal vessels for placing the distal limbs of grafts.

- Atheromatous disease may cause occlusion of the arteries of the lower limb, coronary and cerebral arteries. Assessment of these vessels is a standard part in the clinical work up.

- Clinically, aneurysms expand at a rate of about 2mm. per year. The rate of expansion is more rapid in some patients and it accelerates, the greater the diameter over 5cm.

- The larger the aneurysm, the greater the chance of rupture.

- Aneurysms of the subrenal aorta are most amenable to surgery.

- 70% of subrenal aneurysms will have a 2-5cm. segment of reasonably normal aorta just below the renal arteries. This segment will usually hold sutures well enough to secure the graft. This segment becomes shorter as the aneurysm increases in diameter and length.

- Aneurysms of the renal and supra renal aorta are often inoperable due to involvement of the renal and superior mesenteric arteries and the coeliac axis,

- There may be a generalised aneurysmal disease, with aneurysms of cerebral, thoracic aorta, suprarenal abdominal aorta, iliac, femoral or popliteal arteries. These should be sought clinically and on special tests.

- In the presence of aneurysms (and occlusive disease) in the iliac and femoral vessels, aortic operations need to be planned to maintain the blood flow to pelvis and lower limbs and to minimise the chance of rupture of these secondary aneurysms.

- Dissecting aneurysms of the aorta are quite distinct from arteriosclerotic aneurysms.

- Dissecting aneurysms are caused by necrosis of just the media of the aorta. Starting in the thoracic aorta, a stream of blood dissects between the intima and the adventitia off the aortic wall, blocking the lumen. This stripping process may track may extend down as far as the abdominal aorta.

- Dissecting aneurysms are often seen in young adults with Marfan's syndrome (arachnodactyly, high arched palate, lens dislocation and dissecting aneurysm).

- Mycotic aneurysms are rare aneurysms associated with infection such as infected pancreatic cysts. Staphylococcus or Salmonella may be found in otherwise typical atheromatous aneurysms.
Pathology review (continued)

Clinical presentation

- **Enlargement** of an aneurysm, particularly when still small (under 5cm.), may not cause any symptoms. Screening for asymptomatic aneurysms is under discussion.

- Symptoms due to steady enlargement are usually related to pressure on local structures.

- An enlargement anteriorly may give chronic abdominal pain, lateral enlargement may give loin pain mimicking renal disease and posterior enlargement may give back pain mimicking chronic spinal disease.

- ** Leakage** of the aneurysm is often confined to an infiltration of local retroperitoneal tissues, particularly on the left where the aorta runs. These tissues and the abdominal wall will have a tamponading effect. Induction of anaesthesia will lead to relaxation of the abdominal wall and loss of the tamponade. The surgical team needs to be completely ready to operate before anaesthesia starts.

- There is likely to be a rapid crescendo of pain as the tissues are infiltrated with blood. Vasoconstriction and haemodilution may compensate for the loss of blood from the circulation. This may be sufficient to keep the patient normotensive for some hours and delay recognition of the diagnosis.

- The consumption of clotting factors may make the blood less likely to clot, aggravating the bleeding. Clotting factors usually need to be provided during operations for leaking aneurysms.

- **Rupture** of the aneurysm into the peritoneal cavity is likely to lead to a fatal loss of circulating blood volume.

  Rupture of the aorta into the vena cava or into the left renal vein produces a lethal arterio-venous fistula.

- **Diagnosis** of a leaking aneurysm classically depends on the presence of abdominal pain, hypovolaemia and anaemia with an expansile swelling in the upper abdomen.

- **Differential diagnosis** of a leaking aneurysm includes perforated peptic ulcer, faecal peritonitis, infarcted bowel, and pancreatitis.

- **Diagnostic pitfalls** may be encountered where an aneurysm in a shocked patient with an acute abdomen is neither palpable nor pulsatile, or where the aneurysm is an incidental finding.

Inflammatory aneurysm

- In about 2% of cases there is an intense inflammatory process in the retroperitoneal tissues surrounding the aneurysm.
Pathology review (continued)

- The fourth part of the duodenum is particularly prone to the development of an aorto-duodenal fistula. This presents usually with recurrent haematemesis and melaena. Clinically it imitates a bleeding peptic ulcer, a condition happens also to be relatively common in patients with aortic aneurysms. Ureteric obstruction may also occur.
Graft review

- There are several makes of vascular grafts using different materials and constructions.
- We find the Unigraft KDV (Knitted Double Velour) range of grafts from BBraun very satisfactory.
- These grafts are made of a single layer of knitted non absorbable polyester.
- A special type of knitting is used called warp knitting. This minimises the stretching of the fabric when the graft is full of blood under pressure.
- The grafts are made in a double velour. This means that the threads on the inner and outer surfaces of the material run in tiny loops like velvet. The threads are not tufted like carpet.
- On the inner surface, this gives a very large surface area for the migration of endothelial cells.
- On the outer surface, fibroblasts can migrate through to lay down collagen for strength.
- The cells adhere very strongly to the velour surface.
- Woven grafts are stiffer and more likely to damage viscera than knitted grafts. They are not recommended for the abdominal aorta.
- The fabric is made leak proof with a coating of gelatine on the inside. The grafts therefore do not need to be sealed by preclotted with blood before use.
- The gelatine also has an anti-thrombogenic effect.
- On the shelf the gelatine deteriorates very slowly, giving a shelf life of the grafts of 5 years.
- Once the graft is sutured in place, the body absorbs the gelatine. The absorption process is extended to 4-8 weeks by cross-linking the gelatine with an enzyme (hexamethylene-di-isocyanate).
- The tubes are knitted with transverse ridges. These ridges hold the lumen open. This allows the grafts to bend without kinking and to resist rotary motion at the anastomosis.
- To anticipate the slight lengthening of the grafts when filled with blood at systolic pressure (about 15%), the graft should be stretched by this amount before the anastomosis is started. A tension of 1000 grams on the empty graft will achieve this. A higher tension may cause the stitches to tear out of the aorta or artery.
Graft review – continued

- In a Y (trouser or bifurcation) graft, the aortic section and the limb sections are joined by integral knitting. This makes the junction very strong and leakproof.

- A line of black polyester is knitted into the fabric to mark the front surface of the graft. This allows detection of any twisting of the graft.

- The fabric is so stable that stitches can be inserted within 2mm. of the edge of the graft without tearing (high suture retention). If the graft is too short, stitches will tear out of the blood vessel wall before the graft.

- When cut across, the ends of the fabric will not fray or delaminate.

- Antibiotic impregnated or silver bonded grafts are available where the surgeon is concerned about graft infection.

- The grafts will usually last the natural life of the patient.

- A long graft does not carry a higher risk of thrombosing than a shorter graft.

- Thrombosis in the graft is usually due to:
  - Low cardiac output.
  - Stenoses at the sites of anastomoses.
  - Kinked graft.
  - Inadequate distal run off down the limb vessels.
Suturing review

The tissues
The anastomoses of the graft onto the aortic or arterial wall are dependent more on the condition of the blood vessel than on the graft.

Modern grafts do pose their own suturing problems, but they are of lesser importance. For instance, the aortic end of a graft should be sutured through an outer transverse ridge to prevent buckling. Grafts do not delaminate, so a needle can be passed through the fabric in either direction. In contrast, in blood vessels, needles passing from outside to inside run the risk of causing the intima or atheromatous plaques to detach from the vessel wall.

The blood vessel that is stitched is always affected by aneurysmal or occlusive disease to some degree. Paradoxically, a healthy vessel wall is more delicate than one with minor atheromatous disease.

Severe aneurysmal disease in the upper subrenal aorta may make the anastomosis impossible, with the sutures cutting through the weakened tissue.

Even relatively normal looking subrenal aorta is difficult to anastomose. Intermediate amounts of disease affect the wall ranging from a consistency resembling wet blotting paper to severe calcification.

However, even the most unlikely and unhealthy tissues can provide a satisfactory anastomosis, given satisfactory needles, sutures and impeccable technique.

The needles
The needles should be round bodied to minimise a cutting action on the vessel wall. Also accidental cutting of a previous stitch by a cutting needle is avoided. Remember that a round bodied needle may transfix a previous stitch.

The aortic needle should be strong enough to pass through thick atheromatous tissue. It should be long enough and strong enough to take large bites of aortic tissue and even of the anterior longitudinal ligament of the vertebrae in the case of a posterior rupture.

A 25mm. half curved round bodied needle is satisfactory.

The femoral anastomoses are more delicate, and require a smaller, less traumatic needle. A 17mm half curved round bodied needle is satisfactory.

The atheromatous and calcified plaques round the lumbar arteries are often so tough that a round bodied needle will not pass through. A strong tapercut needle is usually needed to stitch off these vessels.

The sutures
A non-absorbable suture is essential since the healing of the graft to a blood vessel is slower than the inevitable reduction in strength of an absorbable suture.
Suturing review (continued)

The strength of the suture should be high enough to withstand the stresses of pulling of the suture though the tissues and the pressure of blood in the vessel.

Monofilament sutures, such as polypropylene, have a very smooth surface, giving a low friction when passing through the tissues. The stitches of half an anastomotic line can before tightening the tissues onto the graft. A Blalock nerve hook is useful to do this.

The monofilament sutures can slip if the assistant lets go accidentally. They can snap if kinked. They need at least 6 throws for a secure knot.

Braided sutures, such as Ethibond, have a rougher surface with much higher friction in the tissues. They have largely been superceded by monofilament sutures.

The aortic anastomosis requires a suture with a knotted breaking strength of 1500 grams. This is close to the breaking strength of 3/0 polypropylene (1600 grams).

The femoral or iliac anastomoses require a knotted breaking strength of 750 grams. 4/0 polypropylene is suitable with a breaking strength of 1200 grams.

Stitching off the lumbar arteries requires a stronger suture because of tough atheroma and calcification around their orifices. Use 2/0 polypropylene with a knotted breaking strength of more than 2600 grams.

Satisfactory sutures

Every surgeon has his own preference, but we find the sutures below satisfactory.

Ethicon W89772/0 Monofilament polypropylene 90cm. long with 2 25mm. half curved tapercut needles

Ethicon W8522 3/0 Monofilament polypropylene 90 long with 2 25mm. half curved round bodied needles

Ethicon W8935 4/0 Monofilament polypropylene 90 long with 2 17mm. half curved tapercut needles.

The technique

The success of the anastomosis depends very much on the surgeon’s technical skill. He/she has to be very familiar with and completely confident in the needle and the suture. While performing an anastomosis, he/she must not be preoccupied with or be let down by these items. Any new or alternative suture should be viewed with suspicion and be thoroughly assessed before the operation starts.
**Suturing review (continued)**

There is usually just one chance to place a suture correctly. There is no room for uncertainty about placement of individual stitches or for inaccurate insertion.

There are various fail safe techniques. Eg. Tie the first knot of an anastomosis at the centre of the suture. Stitch with the first needle and that half of the suture. Keep the second needle and the second half of the suture still attached to the knot. If the first needle or suture break during an anastomosis, you can use the second needle and the second half of the suture.

Do not use dissecting forceps to hold any part of the suture that will be incorporated in the anastomosis. They can damage and weaken the suture.

If a knot appears in the suture, pulling it through the anastomosis may tear the vessel. Use the second needle and suture or a complete new stitch instead.

**On the aorta**

Place the stitches 5mm. from the edge of the graft to prevent fraying.

Place the stitches 5 – 10mm. from the edge of the aorta to prevent tearing and to encourage bunching of the tissue for a watertight anastomosis.

Place the stitches 3mm. apart on the graft. A 16mm. graft has a circumference of 50mm. (pi times the diameter, say 3 times ). This means 8 stitches on the anterior wall and 8 on the posterior wall.

Insert the suture into the graft from outside to inside. This will ensure the needle will go through the aorta from inside to outside (preventing lifting the intima or atheroma).

Pull the suture through the graft before passing the needle through the aortic wall. This will minimise the tearing stress on the aorta.

If avoidance of delaminating a blood vessel means stitching backhand, consider standing on the opposite side of the patient. You will avoid the delamination and still stitch forehand.

Adjust the distance between bites on the aorta to allow for differences in diameter compared with that of the graft.

Avoid pass the needle through the graft and the aortic wall in one go. This is often unsuccessful and has to be repeated singly, wasting time and damaging the aorta.

Take as deep a bite as you can without bending the needle.

Exit the aorta from the inside at least 10mm. distal to the entry site.

Catch the end of the needle with your dissecting forceps and then with the needle holders to prevent it popping back into the aortic tissues.

Avoid bending or breaking the tip of the needle. If you do, use a new stitch for the next bite and tie the first suture to it with 6 throws.
Suturing review (continued)

Knot tying
In these anastomoses, there is one major knot at the end, and two less major knots at the beginning of each suture.

The main dangers are:
- The suture not being tight enough.
  - The maximum strength of the tissues is about 750 grams.
  - The maximum strength of the suture is about 1200 grams or more.
  - The surgeon must be able to tighten the suture enough and to be aware that the suture is much stronger than the tissues.
- If the suture, especially a polypropylene suture, is not tight enough:
  - Use a blunt Blalock nerve hook like a crochet hook to tighten the sutures.

The suture breaking.
- Deliberately break a knotted suture before the operation to find out how strong it is.
- Make sure all first throws lie correctly in line before tightening them. i.e. the suture only changes 30 degrees in direction in the throw.
- Throws lying out of line, i.e. with a 450 degree change of direction in the throw, halve the strength of the suture.
- Be gentle, particularly when you are under extreme pressure.
- Check you have been given the correct suture.

The suture slipping.
- Use double or triple turns on the first throws, particularly if you are using a coated monofilament suture.
- Hand tie all sutures.
  - Tie the sutures without slackening the pull on the suture at any stage.
  - Keep calm.

The graft tearing.
- The graft is most unlikely to tear.
- If the graft does tear:
  - Pass the needle through the graft further away from its edge.

The blood vessel tearing
**Suturing review (continued)**
The blood vessel tissues may be extremely poor and tear easily.
Reduce the stresses on the tissues by lining all first throws up correctly.

Push the suture beyond the knot wound when tightening. This will counteract any upward pull on the stitch.

Be gentle, even when you are at extremes of pressure.

Remove any calcified plaques that may be interfering with how the suture runs.

Take a deeper bite and tie the new stitch with greater care and caution.

With a monofilament suture, take two bites and snug the tissues down with great care.

If the tissue tears:
Stitch a patch of graft into the area to bolster the tissues.
Stitch the aorta higher up in an untorn area.

You may not be able to retrieve the situation if the tissues disintegrate.

**Femoral anastomoses**
These anastomoses are much more delicate than for the aorta.

Use 4/0 polypropylene with a 15mm. 2 round ended needles.

Place the sutures 1mm. apart and 1mm. from the edges of the graft and the vessels.

**The assistant’s role**
The surgeon should control the tension, the direction of pull and the placement of the suture on the tissue and graft.

The assistant must hold the sutures with the exact tension and direction that the surgeon has used. No swaying of the suture.

The assistant should use fingers or arterial dissecting forceps (e.g. Atraugrip forceps) to hold the sutures.

The forceps should only hold that part of the suture that will not be involved in the anastomosis.
Case selection

The decision to operate is not always clear cut. The factors below should be considered.

Indications

Elective operation
- Aneurysm more than 5cm. diameter
- Symptomatic aneurysm
- Aneurysm causing distal embolism

Emergency operation
- Leaking aneurysm
- Ruptured aneurysm

Contraindications

Elective operation
- Aneurysm extending to renal arteries
- Old age eg over 80 years
- Chronic obstructive pulmonary disease
- Septic foci
- Urine infection
- MRSA positive
- Severe intercurrent disease
- Stoma – ileostomy or colostomy
- Previously turned down for elective surgery

Emergency operation
- All the above
- Failure to respond to resuscitation
Case selection (continued)

Glasgow Aneurysm Score over 80
This is an estimate of the chance of death of a patient having an operation for a ruptured abdominal aortic aneurysm.

Risk score = Age in years

Shock Add 17 points

Myocardial disease (myocardial infarct and/or angina)
Add 7 points

Cerebro-vascular disease (all grades of stroke and TIAs – transient ischaemic attacks)
Add 10 points

Renal disease (serum urea >20 mmol/L)
Add 14 points

<table>
<thead>
<tr>
<th>Glasgow Aneurysm Score</th>
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<td>90 – 97</td>
<td>62</td>
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<td>&gt;97</td>
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When to stop operating
This is a decision to be taken by the surgeon and the anaesthetist.

When there is inadequate cardiac output

When there is uncontrollable bleeding

Uncoagulating blood

Unsustainable demand for blood

Danger points in the operation
The surgeon faces the following problems which singly or together mitigate against a successful operation.

- All patients with leaking aneurysms are actively dying.
- The patient has a 25% chance of dying in the anaesthetic room or on the operating table.
- Moribund patient arriving in the anaesthetic room.

Case selection (continued)
• Cardiac arrest before induction of anaesthesia
• Deterioration on induction of anaesthesia.
• Deterioration on opening the abdomen.
• Uncontrollable bleeding on dissecting the upper end of the aneurysm.
• Failure to control the upper end of the aneurysm.
• Bleeding from a torn vena cava.
• Bleeding from the lower end of the aneurysm.
• Bleeding from the iliac vessels.
• Bleeding from the upper anastomosis.
• Bleeding from the lower anastomosis(es).
• Red ink syndrome (Bleeding due to a lack of clotting factors).
• Myocardial failure.
• The patient is likely to develop a profound bradycardia with negligible cardiac output.
• Cardiac massage is a last ditch move.
• Another 25% of patients will die from one or more of the features below:
  • Rebleeding after leaving the operating theatre.
  • Renal and other systems failures.
  • Myocardial infarction.
  • Pulmonary infarction.
  • Cerebral thrombosis and haemorrhage.
Operation choice

The choice of operation is affected by five main factors.

- The graft must be sutured distally to vessels that are healthy enough for healing and that can take the blood flow distally to the lower limb(s).
- If there is aneurysmal disease of more distal vessels, these secondary aneurysms should be bypassed and isolated.
- If there is occlusive disease of more distal vessels, these obstructions should be bypassed as for secondary aneurysms, but do not need to be isolated.
- If both internal iliac arteries are tied off, the patient is likely to die of massive ischaemia to the sacral area.
- In an elective operation where a Y graft is to be inserted, the patient’s heat loss can be reduced by dissecting out the femoral arteries before opening the abdomen.

**The most common scenario**

Elective operation for a solitary aneurysm of the subrenal aorta with satisfactory iliac and femoral arteries.

Aorto-aortic graft. No groin exposure.

**All leaking aneurysms**

The key is to stop the bleeding as soon as possible.

Aorto-aortic graft if the aortic bifurcation and iliac arteries are satisfactory.

Otherwise perform an aorto – bifemoral Y graft with additional procedures for iliac aneurysms as described below.

**All iliac artery aneurysms or occlusions/stenoses**

Aorto – bifemoral Y graft.

An aorto – iliac Y graft is more difficult and more hazardous and no more effective than an aorto – bifemoral graft. We do not recommend it.

**Aneurysm of one common iliac artery**

Tie off the affected common iliac artery above and below the aneurysm.

Blood supply to the pelvic organs will come via the limb of the graft on the same side, retrogradely up the external and internal iliac arteries.
Operation choice (continued)

- **Bilateral common iliac aneurysms**
  Tie off two common iliac arteries above and below the iliac aneurysms.

  Blood supply to the pelvic organs will come via the limbs of the graft on the each side, retrogradely up the external and internal iliac arteries.

- **Unilateral external iliac artery aneurysm**
  Tie off the external iliac artery above and below the aneurysm.

  Blood supply to the pelvic organs will come via the limbs of the graft on the opposite side, retrogradely up the external iliac arteries.

- **Bilateral external iliac artery aneurysms**
  Tie off the external iliac artery above and below the larger of the two aneurysms.

  Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the smaller aneurysm and the internal iliac artery.

  The smaller aneurysm should expand more slowly in the future.

- **Unilateral internal iliac artery aneurysm**
  Tie off the internal iliac artery proximal to the aneurysm.

- **Bilateral internal iliac artery aneurysms**
  Tie off the internal iliac artery proximal to larger the aneurysm.

  Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the opposite external iliac artery and through the internal iliac aneurysm.

  The smaller aneurysm should expand more slowly in the future.

- **Unilateral femoral aneurysm**
  Anastomose the limb of the Y graft to a non – aneurysmal section of the superficial femoral artery distal to the aneurysm.

  Tie off the femoral artery above and below the aneurysm.

  Blood supply to the thigh muscles should be adequate via anastomotic channels from the superficial femoral artery.
Operation choice (continued)

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the opposite external and internal iliac arteries.

- **Bilateral femoral aneurysms**
  Anastomose the limbs of the Y graft to non-aneurysmal section of the superficial femoral arteries distal to the aneurysm(s).

  Tie off the femoral artery above and below the larger of the aneurysms. Excision is often possible.

  Blood supply to the thigh muscles should be adequate via anastomotic channels from the superficial femoral arteries.

  Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the femoral aneurysm and the external and internal iliac arteries.

  The smaller aneurysm should expand more slowly in the future.

  Consider an extra graft from one limb of the Y graft to an iliac artery.

- **Popliteal artery aneurysms**
  Surgery on popliteal artery aneurysms can be postponed to a later date.

- **Combinations of aneurysms**
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20.17 INSERT THE FIRST STITCH OF THE ANASTOMOSIS
20.18 INSERT A 3 O’CLOCK SUTURE
20.19 PULL THE ANTERIOR LIP OF THE GRAFT CEPHALICALLY
20.20 START THE POSTERIOR HALF OF THE ANASTOMOSIS
20.21 TIE OFF THE POSTERIOR HALF OF THE ANASTOMOSIS
20.22 START THE ANTERIOR HALF OF THE ANASTOMOSIS

20.23 INSERT A LOCK STITCH
20.24 INSERT 2 LOOSE VENT BITES
20.25 WARN THE ANAESTHETIST AGAIN ABOUT POSSIBLE BLOOD
20.26 PREPARE TO CLEAR THE GRAFT OF DEBRIS AND BLOOD CLOT
20.27 REMOVE ANY SLOOPS FROM ABNORMAL ILIAC ARTERY
20.28 PARTLY OPEN THE LEFT ILIAC ARTERY CLAMP
20.29 CLEAN OUT THE GRAFT AND LEFT COMMON ILIAC ARTERY
20.30 FLUSH HEPARIN SALINE DOWN THE LEFT COMMON ILIAC ARTERY
20.31 RECLAMP THE LEFT COMMON ILIAC ARTERY
20.32 CLEAN OUT THE GRAFT AGAIN
20.33 PARTLY OPEN THE RIGHT COMMON ILIAC ARTERY CLAMP
20.34 PARTLY OPEN THE AORTIC CLAMP
20.35 RECLAMP THE AORTA
20.36 CLEAN OUT THE GRAFT AND THE COMMON ILIAC ARTERIES
20.37 FLUSH OUT THE GRAFT AND THE COMMON ILIAC
20.38 TIE OFF THE 2 SUTURES ON THE ANASTOMOTIC VENT
20.39 CHECK THE LOWER ANASTOMOSIS FOR BLEEDING
20.40 PART OPEN THE UPPER AORTIC CLAMP
20.41 FULLY OPEN THE AORTIC CLAMP
20.42 CHECK THE BLOOD FLOW
20.43 CHECK THE AORTA AND GRAFT
20.44 EXPLORING THE AORTA AND GRAFT
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Section 21.00 Lower anastomosis with inlay technique
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21.02 ADJUST THE TRAVERS SELF-RETAINING RETRACTOR
21.03 EXTEND THE OPENING IN THE ANEURYSM LONGITUDINALLY
21.04 EXTEND THE OPENING IN THE ANEURYSM TRANSVERSELY
21.05 CLEAR OUT THE AORTA AND ILIAC VESSELS
21.06 CHECK HAEMOSTASIS INSIDE THE ANEURYSMAL SAC
21.07 CHECK THE ILIAC ARTERY HAEMOSTASIS
21.08 CHECK THE INFERIOR MESENTERIC ARTERY HAEMOSTASIS
21.09 CHECK THE IliAC ARTERIES AGAIN
21.10 CHECK THE AORTIC BIFURCATION
21.11 REMOVE ANY ATHEROMATOUS PLAQUES FROM THE BIFURCATION
21.12 LAY THE GRAFT IN THE ANEURYSM SAC

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21.14 PULL THE GRAFT DISTALLY DOWN TO THE AORTA
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21.18 INSERT A 3 O’CLOCK SUTURE.
21.19 PULL THE ANTERIOR LIP OF THE GRAFT CEPHALICALLY
21.20 START THE POSTERIOR HALF OF THE LOWER ANASTOMOSIS
21.21 TIE OFF THE POSTERIOR HALF OF THE ANASTOMOSIS
21.22 CLEAN OUT THE GRAFT
21.23 FLUSH THE GRAFT WITH HEPARIN SALINE
21.24 START THE ANTERIOR HALF OF THE LOWER ANASTOMOSIS
21.25 INSERT A LOCK STITCH
21.26 INSERT 2 LOOSE VENT BITES
21.27 WARN THE ANAESTHETIST AGAIN ABOUT POSSIBLE BLOOD LOSS
21.28 PREPARE TO CLEAR THE GRAFT OF DEBRIS AND BLOOD CLOT
21.29 REMOVE ANY SLOOPS FROM ABNORMAL ILIAC ARTERY BRANCHES
21.30 PARTLY OPEN THE LEFT ILIAC ARTERY CLAMP
21.32 CLEAN OUT THE GRAFT AND LEFT COMMON ILIAC ARTERY
21.33 FLUSH HEPARIN SALINE DOWN THE LEFT COMMON ILIAC
21.34 RECLAMP THE LEFT COMMON ILIAC ARTERY
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21.36 PARTLY OPEN THE RIGHT COMMON ILIAC ARTERY CLAMP
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22.20 INSERT THE FIRST STITCH
22.21 STITCH ALONG THE RIGHT HAND SIDE OF THE ANASTOMOSIS
22.22 STITCH AROUND THE TOE OF THE ANASTOMOSIS
22.23 COME BACK 5MM. ALONG THE LEFT HAND SIDE OF THE ANASTOMOSIS
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24.10 CHECK THE SWAB, NEEDLE AND INSTRUMENT COUNTS
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26.34 CHECK THE FEMORAL ARTERY IS PULSATING
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26.36 INSERT A DRAIN
26.37 CLOSE THE SUBCUTANEOUS FAT
26.38 CLOSE THE SKIN

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26.39 CHECK THE FEMORAL PULSE AGAIN
26.40 PERFORM A FEMORAL EMBOLECTOMY ON THE OTHER SIDE
26.41 CHECK THE PULSES AND THE PERFUSION OF THE LOWER LIMBS

Section 27.00 Equipment and Materials
Section 1.00 Work up

For an elective patient
A full clinical work up is needed.
i.e.
History and Examination.
To assess the effects of the aortic aneurysm
To detect other aneurysmal and occlusive vascular disease
To detect past and intercurrent disease

Ultrasound or CT scan:
To exclude a suprarenal aneurysm.

To identify other aneurysms and occlusive disease of vessels distal to the aorta.

ECG.
Hb + Full blood count.
Clotting screen.
Urea and electrolytes.
Urine culture
Nasal and groin swabs for MRSA
Chest X-ray.
Blood glucose.
Group and save serum.
Referral for an echocardiogram and a cardiological opinion.
Admit 24 hours before operation for intravenous administration of 2 litres dextrose/saline.

For an urgent patient.
I.e. Need to operate within the next 3 hours.
Assess in the Emergency Area, where there is access to resuscitation and imaging.

Do not admit the ward. This will cause unnecessary delays.

Take a history and examine the patient.

Inform the consultant surgeon or the surgeon who will be doing the operation.

Warn the anaesthetic team.

Warn the operating theatre team.

The patient has some pain and an expansile selling.

The diagnosis is in doubt.
About 25% of patients with aneurysms have other causes for abdominal pain.
e.g. peptic ulcer, ischaemic bowel.
Section 1.02 Work up (continued)

Step number 1.02 continued

There have been no hypotensive episodes.

The systolic blood pressure is above 100mm. of mercury.
The pulse rate is less than 100 per minute.
The same investigations should be done as for an elective patient.

Cross match 4 units of blood.

The ultrasound or CT scan will indicate whether there is any leakage around the aneurysm or into the peritoneal cavity.

Some dilatation of the suprarenal aorta up to 25mm. is acceptable for grafting.

Dilatation greater than 25mm. or thrombus in a suprarenal aneurysm makes a successful operation unlikely.

** NB There is a danger of underestimating the urgency of operation.

Patients can deteriorate within minutes.

Aneurysms wait for nobody.

1.03 For a rapidly deteriorating patient

ie. need to operate as soon as possible.

The patient has pain and an expansile swelling.
The diagnosis is clear.

There is no serious intercurrent disease.

Patients over 80 years have less than 20% chance of surviving emergency surgery for aneurysms.

There have been hypotensive episodes.
The systolic blood pressure is below 100mm. of mercury.
The pulse rate is more than 100 per minute.

Take blood for:
   Cross matching 6 units of blood.
### Section 1.03 Workup (continued)

<table>
<thead>
<tr>
<th>Step Number</th>
<th>Workup Details</th>
</tr>
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<tbody>
<tr>
<td>1.03 continued</td>
<td>Hb + full blood count + clotting screen.</td>
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<tr>
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<td>Urea and electrolytes.</td>
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<td>Use a femoral vein stab if the arm veins are not accessible.</td>
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<td></td>
<td>Nasal and groin swabs for MRSA</td>
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<td>Do ECG.</td>
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<td>Insert two intravenous lines in the upper limbs.</td>
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<td>Use 14 swg. diameter cannulas eg Venflon.</td>
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<td>Use the most peripheral sites possible in the upper limbs.</td>
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<td>Scan if immediately available.</td>
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<td>Do not shave.</td>
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<td>Obtain written consent the patient if there is time.</td>
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<td>Do not hesitate.</td>
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<td>Call the anaesthetic and scrub team.</td>
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<td>***Transfer the patient to the anaesthetic room for resuscitation.</td>
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</table>
Section 2  Operation plan

By this time you should have an initial plan for the operation.

I.e. The operation itself, any special factors, any other procedures that may be needed, any variants to accommodate anatomical and pathological variants.

The plan may well need modification during the course of the operation as more information comes to hand and to accommodate predicted and unpredicted problems.
Section 3.00 Preliminaries

Step number
3.01 CHECK THE PATIENT IN THE ANAESTHETIC ROOM.

3.02 CHECK THAT SYSTEMIC HEPARIN WILL NOT BE GIVEN.

3.03 CHECK THE PERIPHERAL PULSES
   This is to be aware of pre-operative distal arterial blockage.

   The blockages may be due to thrombosis or embolism.

   In a hypotensive patient, the distal pulses may not be palpable
   because of vasoconstriction or poor cardiac output.

   You will need this information when diagnosing possible
   thrombosis or embolism, during or after the operation.

3.04 CHECK THE RELATIVES HAVE BEEN WARNED
   With an emergency grafting, the patient may only have a 25%
   chance of coming off the table alive.

   Make sure that you have made this point very clear to the
   relatives.

3.05 CHECK THAT BLOOD HAS BEEN ORDERED
   Group and save serum an elective case and 4 units or more
   may be needed for an emergency case.

   Ideally, 2 units should be present in the anaesthetic room at the
   time of induction of the anaesthesia for an urgent or emergency
   case.

3.06 CHECK THE PATIENT HAS BEEN SHAVED OR CLIPPED
   From the nipples to the knees.

   This can be ignored if the operation is very urgent.

3.07 CHECK THE PATIENT HAS A BLADDER CATHETER
   Run the drainage tubing between the patient’s feet with the
   collecting bag visible below the level of drapes.

   Empty, measure and record the urine volume on catheterisation.

   Make sure there is a volume scale on the collecting bag for
   monitoring the urine output during the operation.

   Stick the tubing to the operating table with 15cm. Elastoplast
   with a mesentery.

   Make sure the catheter tubing is slack and is not dragging on the
   patient’s bladder neck.
Section 3.07 Preliminaries (continued)

Step number
3.07 continued

Attach the drainage bag to the side of the operating table using a frame. Make sure it will be visible for inspection by the anaesthetist during the operation.

3.08 CHECK THERE ARE NO TED - ANTI THROMBOSIS STOCKINGS

These stockings can impair blood flow in the lower limbs. They make the limbs look falsely ischaemic at the end of the operation.

In any case, the lower limbs will be anticoagulated with heparin during the operation.

3.09 CHECK THE GRAFTS

Make sure there are the following grafts actually in the theatre. eg Unigraft KDV grafts (BBraun Aesculap)

Straight grafts
- 18mm. X 15cm.
- 20mm. X 15cm.
- 22mm. X 15cm.
- 24mm. X 15cm.

Trouser grafts
- 14mm. X 7mm. X 40cm.
- 16mm. X 8mm. X 40cm.
- 18mm X 9mm. X 40cm.
- 20mm. X 10mm. X 40cm.

Check the grafts are within their shelf life.

3.10 CHECK THE MATERIAL OF THE GRAFTS

Ideally use an impermeable non stretch knitted graft.

3.11 CHECK THE SUTURE FOR THE ANASTOMOSIS

eg 2/0 and 4/0 Prolene with a needle at each end (Ethicon W8577).

3.12 CHECK THE AORTIC CLAMP

Small, medium and large Satinsky clamps will be needed – 3 of each.

One to clamp the aorta and one to clamp the graft when testing the upper anastomosis.

Two 25cm. straight vascular clamps will be needed for a large aorta.
Section 3.13 Preliminaries (continued)

Step Number
3.13 CHECK THE HEPARIN SOLUTION
5000 units Heparin in 500 mls. of 0.9% Saline for local anticoagulation.

3.14 CHECK THE PATIENT HAS BEEN GIVEN ANTIBIOTICS INTRAVENOUSLY:
   Flucloxacillin 1500mg.
   Metronidazole 150mg.

3.15 CHECK THE DIATHERMY PAD
   Under the buttocks.

3.16 ANAESTHESIA
   Spend a few minutes with the anaesthetist going over the operation plan.
   Systemic anticoagulation with heparin during an elective operation is not really necessary, but you need to agree about it.

   Check that blood is available in the anaesthetic room before the anaesthetic begins.

   For elective cases.
   Endo-trachal intubation in the Anaesthetic Room.
   Central venous line.
   Arterial line.
   E.C.G.
   Epidural line
   Bair Hugger Warmer unit Model 505

   For emergency cases
   The major priority is to get a clamp on to the aorta above the aneurysm as soon as possible.

   One of the major risks is severe hypotension and bleeding on induction of anaesthesia.

   The surgical team should always be scrubbed up and ready at the time of induction.

   In severe cases the patient can be cleaned and towelled up in the Operating Theatre before induction.
Section 3.17 Preliminaries (continued)

3.17 CHECK THE SURGICAL TEAM
You will need a very experienced first assistant (Ask for a consultant if necessary).

A second and preferably a third assistant should be strong and have sufficient endurance for a possible 3-4 hour operation.

Check that the scrub nurse and particularly the runner nurse have enough experience.

Make sure all the team have eaten properly and have been to the toilet.

Go through the steps of your planned operation with them.

3.18 CHECK THERE IS NO OTHER PROCEDURE TO DO
Section 4.00 Preparing the abdomen

Step
Number
4.01 SEQUENCE OF INCISIONS

For an urgent or emergency operation:
The abdomen is opened first, since the first priority is to place a clamp on the aorta proximal to the aneurysm to stop the bleeding.

For an elective operation:
The abdomen is opened first if a straight graft is planned. The femoral arteries can be exposed second, if it then turns out that an aorto–bifemoral graft is needed.

To conserve body heat, the femoral arteries are exposed first if an aorto–bifemoral artery is planned from the start.

Go to:
Section 14.00 Dissecting out the femoral arteries

4.02 CHOICE OF ABDOMINAL INCISION

**A transverse incision** gives very good access, particularly to the upper end of the aneurysm.

It takes a few seconds longer to open and close than a midline incision, because more abdominal wall structures need to be divided. Eg The rectus muscle.

It may be less painful than a midline incision postoperatively.

There may be a higher incidence of wound herniation than after a midline incision.

The positioning, skin exposure, skin preparation and draping of the abdomen are identical with either a transverse or midline incision.

If there is a previous incision:
Ignore it and make the transverse incision. Be prepared for adhesions inside the abdomen and technical difficulties to overcome when closing the wound.

**A midline incision** is quicker than a transverse incision.

In an extreme emergency, the abdomen can be opened in the midline in less than 30 seconds.

It may need more positive retraction with self-retaining retractors than a transverse incision.

Its access to the upper limit of the aneurysm and the upper aorta may be slightly more restricted.
Section 4.02 Preparing the abdomen (continued)

4.02 continued

It may be more useful than a transverse incision in an emergency when other conditions such as infarcted bowel are the cause of an acute abdomen.

For either incision:
Read on.

4.03 POSITION - SUPINE
Protect the heels with cushioning.

Surgical access is required from the nipples to the knees.

4.04 STANCE
Stand on the patient’s left hand side.
This means that you will be closer to the aneurysm than if you stand on the right.

You will not have to reach over the small bowel to operate on the aorta.

The posterior halves of the anastomoses, which are probably more difficult than anterior halves, can be performed forehand.

However, some surgeons prefer to stand on the patient’s right hand side

Have your first assistant opposite you.

Have a second assistant on his/her left.

Have a third assistant on your left.

4.05 PLACE A SCREEN SUPPORT
Place the support, fastened to the operating table, at the level of the patient’s shoulders.

4.06 CLEAN THE SKIN
From nipples to knees.

From one posterior axillary line to the other.

Use 2 applications of aqueous Povidone Iodine (Betadine). Dry off thoroughly with a third swab on a stick.

Any residual liquid will prevent the adhesive drape sticking properly.

4.07 TOWEL UP
From the mid-sternum to the mid-thigh.
Section 4.07 Preparing the abdomen (continued)

Step Number
4.07 continued From one mid-axillary line to the other.

Place a lower drape up to the mid thigh.

Place an upper drape down to 5cm. above the lower end of the sternum.

Stick the left side drape from the lower drape to the upper drape, parallel to the anterior superior iliac spine.

Stick the right drape from the upper drape to the lower drape, parallel to the anterior superior iliac spine.

4.08 APPLY A TRANSPARENT ADHESIVE DRAPE
Use an extra-large (60 x 60cm.) iodophore impregnated drape. eg 3M Ioban

Hold the 2 left corners tightly yourself. Have your first assistant holding the 2 right hand corners tightly.

Let the scrub nurse peel the backing off the underside of the drape. Keep tight hold.

Lay the drape onto the square of skin which is exposed by the fabric drapes.

Relax the tension so that drape will tuck neatly into the groin creases and over the genitalia.

Squeeze air bubbles from under the drape by rubbing the drape with a gauze swab.

4.09 ATTACH STERILE HANDLES TO THE OVERHEAD LAMPS

4.10 CHECK THE DIATHERMY IS WORKING
Up to 50 watts cutting diathermy.

Use a finger switch (firestick) handle with a blade.

4.11 CHECK THE SUCKER IS WORKING

4.12 CHECK A STERILE BOWL IS AVAILABLE
This will be for any large volumes of intraperitoneal blood.

4.13 CHECK THE ANAESTHETIST IS READY FOR YOU TO INCISE THE SKIN.
Section 5.00 Opening the abdomen - Transverse incision

Step Number

5.01 INCISE THE SKIN
Use a scalpel with a no. 22 Swann-Morton blade.
Start at the left midclavicular line, 5cm. above the umbilicus.
Continue transversely to the right midclavicular line.

5.02 INCISE THE SUBCUTANEOUS FAT
Use a finger switch diathermy with blade (Firestick).
Coagulate vessels in this layer as needed.

5.03 RETRACT THE SUBCUTANEOUS FAT
Use large abdominal packs to expose the external oblique muscle and aponeurosis.

5.04 CUT THE EXTERNAL OBLIQUE MUSCLE ON EACH SIDE
Use the firestick.

5.05 CUT ACROSS THE ANTERIOR RECTUS SHEATH ON EACH SIDE
Use the firestick.

5.06 TUNNEL BEHIND THE LEFT RECTUS ABDOMINIS MUSCLE
Use your left index finger.

5.07 CUT ACROSS THE LEFT RECTUS MUSCLE
Use the firestick.
Identify the superior epigastric artery as it runs in the back wall of the rectus muscle.
Coagulate the artery.

5.08 CUT ACROSS THE RIGHT RECTUS MUSCLE
As for the left rectus muscle and left superior epigastric artery.

5.09 ELEVATE THE POSTERIOR RECTUS SHEATH
Use 2 pairs of artery forceps.

5.10 OPEN THE UMBILICUS
Use a scalpel with the blade held flat.

5.11 OPEN THE WHOLE ANTERIOR ABDOMINAL WOUND

5.12 CHECK THE PERITONEUM AROUND THE WOUND EDGES IS FREE FROM ADHESIONS
Free any adhesions to the inside of the peritoneum for 5cm. around the wound edge.
This will ensure that retractors do not damage adherent bowel of omentum.
Section 5.00 Opening the abdomen - Transverse incision (continued)

5.13 APPLY SKIN TOWELS
Tucking skin towels under the each lateral edge of the wound keeps the wound neat and may help sterility.
Omit this in extreme emergency cases.

Clip the towels to the ends of the wounds with towel clips.

5.14 RETRACT THE WOUND EDGES
Usually a Deaver retractor is all that is needed.

For a very obese patient, use 2 Finochietto abdominal retractors.

Place the worm gears on the opposite side of the wound.

Have your first assistant place his/her hand between the drapes and the worm drive to prevent the drapes tangling.

Open the wound as much as it will go.

5.15 CHECK FOR BLEEDING FROM THE WOUND EDGE
Coagulate minor vessels in the rectus muscle plus epigastric vessels.

Go to:
Section 7.00 Exploring the abdominal cavity
Section 6.00 Opening the abdomen – Midline incision

6.01 INCISE THE SKIN
Have the first assistant hold the umbilicus to the right with a Littlewood forcep.

Incise the skin with a scalpel with a No.22 Swann Morton blade.

Cut the skin in the mid line and around the left of the umbilicus

Start 20 cm. below the umbilicus and continue 5 cm. above and to the left of the xiphisternum to maximise access at the upper end of the wound.

Clear access to the upper end of the abdominal aorta is absolutely essential.

6.02 INCISE THE SUBCUTANEOUS FAT
Use a finger switch diathermy with blade (Firestick).

Coagulate vessels in this layer as needed.

6.03 INCISE THE LINEA ALBA
Use the firestick.

Cut the linea alba up to the left lateral side of the xiphisternum.

6.04 OBTAIN HAEMOSTASIS
The left superior epigastric artery lateral to the xiphisternum may need specific coagulation.

If the patient is very shocked, there may be little bleeding from the abdominal wound until the blood pressure rises.

This may not happen until the aorta is clamped or the operation is finished.

Be prepared to diathermy bleeders in the wound edge at these late stages.

6.05 OPEN THE PERITONEUM
Hold the peritoneum up between 2 artery forceps in the middle of the wound.

Open the peritoneum with a scalpel (blade held flat).

Tell the anaesthetist if there is free peritoneal fluid

This will alert him/her to the correct diagnosis.

Eg Blood from a ruptured aneurysm

Faecal fluid from a faecal peritonitis

Smelly bloody fluid from infarcted bowel.
Section 6.05 Opening the abdomen – Midline incision (continued)

Step
Number
6.05 continued
Prune juice fluid from pancreatitis.

6.06 OPEN THE PERITONEUM IN THE WHOLE LENGTH OF THE WOUND
Use dissecting scissors.

Extend the opening up to the left side of the xiphisternum and down to the lower end of the wound.

6.07 CHECK THE PERITONEUM AROUND THE WOUND EDGES IS FREE FROM ADHESIONS
Free any adhesions to the inside of the peritoneum for 5cm. around the wound edge.
This will ensure that retractors do not damage adherent bowel of omentum.

6.08 APPLY SKIN TOWELS
Tucking skin towels under the each lateral edge of the wound keeps the wound neat and may help sterility.
Omit this in extreme emergency cases.

Clip the towels to the ends of the wounds with towel clips.

6.09 RETRACT THE WOUND EDGES
Use 2 Finochietto abdominal retractors.

Place the worm gears on the opposite side of the wound.

Have your first assistant place his/her hand between the drapes and the worm drive to prevent the drapes tangling.

Open the wound as much as it will go.
Section 7.00 Exploring the abdominal cavity

Step number

7.01 SCOOPOUT ANY INTRAPERITONEAL BLOOD OR OTHER FLUIDS
Use a sucker, large gauze packs or your hand.

Put blood and clots into the sterile bowl.

7.02 FREE OFF ANY ADHESIONS

7.03 EXAMINE THE INTRA-ABDOMINAL CONTENTS
About 20% of suspected ruptured aneurysms are other conditions such as mesenteric infarction, massive strangulated bowel, retro-peritoneal malignancy with haemorrhage, a dissecting aneurysm or acute pancreatitis.

These and other conditions need to be treated on their own merits.

If there is an aneurysm as well, it should be left until the presenting condition has been managed.

7.04 LOOK FOR AN ANEURYSM
There is usually a very obvious swelling in the abdominal aorta more than 5cm. in diameter, visible or palpable.

A posterior saccular aneurysm or a leaking iliac aneurysm may not be so obvious.

If there is massive retroperitoneal bleeding and the patient is hypotensive, the aneurysm may also not be so obvious.

7.05 LOOK FOR A RETROPERITONEAL HAEMATOMA
If the operation is for a suspected leaking aneurysm and a minimal or no retroperitoneal haematoma is found, the operation should be much easier. The success rate should be as high as in an elective operation.

The haematoma can vary from faint blood staining alongside the aneurysm to a massive haematoma 50cm. or more in diameter consisting of blood clot and oedematous blood-infiltrated tissues filling most of the retroperitoneum.

The situation of the haematoma will give a guide to the site of the leak in the aneurysm wall.

e.g A central retroperitoneal haematoma suggests a posterior rupture. The posterior wall of the aneurysm may be formed by anterior longitudinal ligament of the lumbar vertebrae only.

A haematoma on the right side of the retroperitoneal tissues should alert the surgeon to a dangerous leak near the vena cava, or even into the vena cava.
Section 7.05 Exploring the abdominal cavity (continued)

7.05 continued

A haematoma to the left should alert the surgeon to difficulties in identifying the inferior mesenteric artery and left gonadal vein.

An anterior haematoma may infiltrate the mesentery and make the identification of the aneurysmal wall difficult.

A haematoma in the pelvis suggests a leak from an iliac aneurysm, even though there may be non-leaking abdominal aneurysm as well.

There is no need to dissect in the haematoma when making this assessment. Indeed, such attempts may damage blood – infiltrated tissues.

7.06 LOOK FOR ISCHAEMIC DAMAGE TO THE BOWEL

This is present in about 5% of leaking cases at this stage in the operation.

The large bowel is most at risk, but the small bowel can be affected.

Beware:

Bluish tinges to the bowel.

Purple patches of necrosis.

Loss of peristalsis.

Loss of sheen to the peritoneum covering the bowel.

If the whole of the bowel is involved:

Abandon the operation.

Go to Section 24.00 Closing the abdomen.

If at least three quarters of the small bowel is viable:

Continue the operation. Ischaemic bowel will need to be removed after the aortic grafting.

Secondary ischaemic damage to the bowel may occur after ligating the inferior mesenteric artery later in the operation.

7.07 LOOK FOR OTHER ANEURYSMS

Look for aneurysms of the external and iliac arteries.

There may be general dilatation of these vessels without specific saccular or fusiform aneurysms.

A localised dilatation of an artery more than 2.5 times its normal diameter, should be considered to be an aneurysm.
Section 7.07 Exploring the abdominal cavity (continued)

If aneurysms are present, a Y graft will be required.

Vessels may need to be tied off to minimise the chance of the aneurysm enlarging and rupturing.

At the same time, the blood supply to the lower limbs and the pelvis needs to be preserved.

7.08 LOOK FOR OTHER PATHOLOGY IN THE ABDOMEN AND PELVIS e.g. Peptic ulcers.

Large bowel carcinoma or diverticular disease.

Gall stones.

Assess the relevance of these conditions in relation to the aneurysm.

Eg Advanced malignancy will probably contraindicate an aortic operation.

Gallstones can be left for possible removal at a later date.

7.09 FOR AN INFLAMMATORY ANEURYSM i.e. Very tough inflammatory tissue adherent to the surrounding tissues, especially the duodenum.

An aorto-duodenal fistula may develop between the aorta and the fourth part of the duodenum, which arches over the aorta. This can lead to catastrophic terminal bleeding.

If there is no sign of bleeding:
  Consider closing the abdominal wound and giving a 2 week course of steroids and reassessing.

If there is bleeding:
  Continue with the operation.

Beware of difficult dissection, bowel perforation and graft infection.

If the anastomosis becomes infected, fatal leakage in 10 – 14 days is almost certain.

7.10 FOR A DEFINITE QUIESCENT ANEURYSM i.e. Without any signs of bleeding.

The procedure is the same as that for a leaking aneurysm, but it will be much easier.
Section 7.10 Exploring the abdominal cavity (continued)

Step Number 7.10 continued

The on-table mortality is about 1% compared with about 25% for a leaking aneurysm.

7.11 FOR A LEAKING ANEURYSM

This means that there is definite retroperitoneal bleeding or intraperitoneal bleeding.

Compared with an elective procedure, the following factors increase the difficulties and dangers:

- Unprepared patient medically.
- Patient in a dangerous hypovolaemic/ischaemic state.
- Ischaemic damage already possible to heart, kidneys, lower limbs and brain.
- Larger aneurysm with less “normal” aorta for anastomosis.
- Anatomy obscured by haematoma.
- Damage to visceral arterial supply by the haematoma.

However, if the operation is not performed, the patient is sure to die.

Consider the Glasgow aneurysm scale.

Just do your best.

Read on.
Section 8.00 Assessing the aneurysm

**Step Number**

8.01 ASSESS THE ANEURYSM

The aims are:
- To confirm that the aneurysm is the cause of the patient’s condition.
- To show that the aneurysm does not involve the renal arteries.
- To decide about using a straight graft or a trouser graft.

At the same time you will be identifying a 2-3 cm. length of relatively normal aorta above the aneurysm.

You will also be clearing the site for applying an aortic clamp here.

8.02 PALPATE THE UPPER END OF THE ANEURYSM

You need to confirm that the aneurysm is subrenal i.e below the renal arteries. This should have been suggested by the scans.

You should be able to do this within 15 seconds or so.

In more than 50% of cases, you will be able to feel a normal or acceptable aorta less than 25mm. diameter below the fourth part of the duodenum. This is a clear indication to continue.

8.03 PALPATE THE AORTA ABOVE THE TRANSVERSE COLON

If the aorta is obviously more than 50 mm. at this level:
- Consider closing the aorta off below the renal arteries and performing axillo-bifemoral grafts.

Consider abandoning the operation.

Go to Section 24.00 Closing the abdomen.

If the aorta seems to be less than 50mm.:
- You need to mobilise the 4th part of the duodenum and to see the left renal vein and the renal arteries.

This mobilisation is also needed for clamping the aorta.

Sometimes the suprarenal aorta is wider than normal, i.e more than 20mm. diameter, but less than 30cm. This does not preclude a grafting operation.

Amend the operation plan as needed.

If the aneurysm is leaking, a direct approach to the upper end of the aneurysm is the fastest way to clamping the aorta.
Section 8.03 Assessing the aneurysm (continued)

Step 8.03 continued

In an elective case, there is plenty of time to identify the rest of the aneurysm and the iliac vessels, since this may give a better access to the upper end of the aorta.
Section 9.00 Controlling the upper end of the aneurysm

Step Number
9.01 INTRODUCTION
This is normally the most difficult part of an operation for a leaking aneurysm.

Speed and accuracy are essential.

Keep calm.

Avoid damage to the venous structures that surround the aorta here.

9.02 FREE OFF ADHESIONS
For instance small bowel may be adherent to the aneurysm.

Avoid opening the bowel, which almost certainly would lead to infected graft.

9.03 BRING OUT THE SMALL BOWEL
Pull the small bowel out of the abdomen and place it on the right side of the abdominal wall.

9.04 COVER THE SMALL BOWEL
Use a large abdominal pack, soaked in saline.

The small bowel remains outside the abdominal cavity until the abdomen is closed.

Make sure that the bowel remains moist and does not slide off the abdominal wall.

Some surgeons prefer to tuck the small bowel into the right side of the abdominal cavity.
This may require two or more large saline-moistened abdominal packs held by two or more broad Kelly retractors.

Obesity or retroperitoneal haematoma will prevent this manoeuvre.

Some surgeons prefer to pack the small bowel into a plastic bag outside the abdomen.
Make sure the assistants do not compress the bag and damage the bowel.

9.05 PACK AWAY THE TRANSVERSE COLON
Use one or more large packs.

Tuck the transverse colon over the stomach.
Section 9.06 Controlling the upper end of the aneurysm (continued)

Step Number

9.06   RETRACT THE TRANSVERSE COLON CEPHALICALLY
Use a Deaver retractor held by the first assistant.

9.07   IDENTIFY THE FOURTH PART OF THE DUODENUM
This will be running laterally across the aorta.

9.08   MOBILISE THE FOURTH PART OF THE DUODENUM
Use dissecting scissors and a pledget on a sponge holder.

Cut transversely along the lower margin of the third and fourth parts of the duodenum to expose the upper end of the aneurysm.

Sweep the duodenum upwards off the aorta.
Take great care not to open the duodenum. This is particularly hazardous if there is a very adherent inflammatory type of aneurysm.

If the duodenum is opened, close it over with 2 layers of 3/0 Vicryl (Ethicon W9136).

In the rare event of opening an aorto-duodenal fistula at this site:
Close the aortic defect with 2/0 Ethibond (Ethicon W8577).
Consider suturing off the aorta above this site and performing axillo-bifemoral grafting.

The inferior mesenteric vein is also vulnerable as it runs on the left side of the duodeno–jejunal flexure.
If it is in the way, tie it off.

9.09   RETRACT THE DUODENUM UPWARDS
Use the tip of the Deaver retractor held by the second assistant.

It is difficult for the second assistant to see what he/she is retracting. Let the assistant peer into the wound from time to time, so that he/she can visualise what is being retracted.

9.10   DISSECT THROUGH THE RETROPERITONEAL FAT TO THE AORTA
Use scissor dissection.

If the tissues are infiltrated with blood and are oedematous:
Use finger dissection or dissection with the end of a sucker.

The aorta is a very definite tube, a very pale yellow, much paler than fat.
Section 9.10 Controlling the upper end of the aneurysm (continued)

Step Number
9.10 continued If the fat is very dense:

\[ \text{Clip and tie off as necessary.} \]

Continue the dissection upwards until you meet the blueness of the left renal vein running across the aorta.

If you can see or feel a 30mm. length of aorta, 25mm. diameter or less, there is enough space for applying the aortic clamp and for an anastomosis.

\[ \text{There is no need to free off the front of the aorta more than this.} \]

Go to 9.13 DISSECT OUT THE SUPRAANEURYSMAL AORTA

If less than 30mm. of the aorta is visible, continue the mobilisation below.

9.11 MOBILISE THE LEFT RENAL VEIN

Use a pledget.

The left renal vein lies under the fourth part of the duodenum.

The vein is very delicate.

Make sure that you do not damage the left testicular/ovarian vein as it runs into the left inferior surface of the left renal vein.

If you do damage the left testicular/ovarian vein, stitch it off with a 3/0 Vicryl stitch (Ethicon W9136).

If it is in the way, double clip it with 2 400 Ligaclips 10mm. apart and cut it with scissors.

Beware of damaging the lumbar veins which run behind the aorta.

If they bleed, pack a swab over the bleeding area and await spontaneous haemostasis.

Start the dissection of the lower end of the aorta while you wait 5 minutes or so for haemostasis.

The left renal vein will not be visible if it runs behind the aorta.

The junction between the left renal vein and the inferior vena cava is also vulnerable to damage by dissection or by haematoma on the right.
Section 9.11 Controlling the upper end of the aneurysm (continued)

Step Number
9.11 continued

Dissect the left renal vein so that you can identify the underlying aorta.

Retract the vein with the Deaver retractor.

If you can see a 50mm. length of aorta, 25mm. diameter or less:
There is enough space for applying the aortic clamp.

There is no need to free off the front of the aorta more than this.

Go to:

9.13 DISSECT OUT THE SUPRAANEURYSMAL AORTA

If less than 30mm. of aorta is not visible:
Divide the left renal vein.

Read on.

9.12 LIGATE AND DIVIDE THE LEFT RENAL VEIN
This is needed if the aneurysm extends higher than the renal vein.

Use a Moynihan cholecystectomy forcep.

Burrow between the aorta and the left renal vein.

Dissect out a 3cm length of left renal vein from the aorta.

Tie the left renal vein in continuity at two sites 2cm. apart using 3/0 Vicryl ties (Ethicon W9125).

Cut the left renal vein with scissors.

Cut the ends of the suture 10mm long.

9.13 DISSECT OUT THE SUPRAANEURYSMAL AORTA
Use finger dissection and dissection with a pledget on a stick, below the renal arteries.

A sucker is a useful dissection instrument if the tissues are oedematous and infiltrated with blood.

Dissect the right side of the aorta first between the aorta and the vena cava down to the vertebral body.
Section 9.13 Controlling the upper end of the aneurysm (continued)

On the left side, dissect between the aorta and the left renal vein (if not divided) and the gonadal vein. Continue down to the vertebral body.

You should find that the aorta runs forwards from the renal arteries towards the aneurysm.

There should be a gap between the aorta and the vertebral column so that you can sink your fingers around the aorta.

The renal arteries will be palpable, running out laterally from the aortic wall, or will be visible when the left renal vein is retracted.

The right renal artery is lower than the left.

Beware of abnormalities in the anatomy.

Take care that you do not damage the vena cava just to the right of the aorta.

Clamp any such tear in the vena cava with a Satinsky clamp. Close the tear with continuous vascular sutures of 4/0 polypropylene (Ethicon W8935).

End up with 30mm. of reasonably normal aorta dissected free from the vertebral column.

If this part of the dissection is involved in the haematoma or rupture, it becomes more difficult.

Persist with finger dissection to identify the aorta.

If there is excessive bleeding:

Pack this part of the wound with a large gauze pack and wait 5 minutes before retrying.

Sometimes this is the end of the operation because of intractable bleeding.

Get the first assistant to press on the supraduodenal part of the aorta to control bleeding.

Apply pressure to the supraduodenal aorta with an aortic compressor.

9.14 DISSECT BEHIND THE AORTA

This is needed for the transection technique, but not the inlay grafting technique.

Pass a finger around the back of the aorta.

Section 9.14 Controlling the upper end of the aneurysm (continued)
Step Number 9.14 continued

This part of the aorta should be 1-2cm. anterior to the spine.

If the finger will not pass:
Continue dissecting with an O’Shaughnessy until the posterior aspect of the aorta is free.

Pass the forcep into the dissection tunnel on the left side of the aorta.

Open the jaws to dissect a little more.

Remove the jaws from the aorta before closing them. Then reinsert.

Continue in this way until the anterior longitudinal ligament of the vertebrae is clearly seen.

Closing the forcep behind the aorta risks damaging the lumbar veins.

Take particular care in dissecting between the aorta and the vena cava on the right hand side.

Aim to clear 20mm. of aorta above the aneurysm.

If there is insufficient aorta:
Increase the dissection up to the renal arteries.

9.15 CLAMP THE AORTA

Check that the Deaver retractor is displaying the required length of aorta.

Place a small Satinsky clamp around the aorta.
The jaws should be perpendicular to the aorta with the concavity of the C jaws pointing caudally.

The tips of the jaws must extend behind the aorta.
Press the tips of the jaws on the vertebral bodies to make sure.

Push the clamp cephalically up the aorta to expose the maximum length of subrenal aorta for the anastomosis.

If the aorta is too large for the Satinsky clamp:
Use the medium or large clamp.

Avoid the vena cava.

Use all the clicks (10) on the ratchet on the clamp.

Section 9.15 Controlling the upper end of the aneurysm (continued)
Step
Number 9.15 continued

Slowly increase the pressure over 10 seconds or more if the aorta is calcified and brittle.

Get your second assistant to hold the clamp perfectly upright.

Make sure he/she does not let the Deaver retractor (holding the left renal vein, the duodenum and the transverse colon), press on the clamp.

The retractor will dislodge the clamp from the aorta if this is allowed to happen.

You will need to adjust the assistant's retractor and clamp from time to time to correct the assistant's "retractor creep".
This is particularly a problem with a midline incision.

Check there is no longer any pulsation in the aneurysm.

If the aneurysm is still pulsating:
Reposition the clamp to completely occlude the aorta.

If there is less than 1.5cm. of aorta distal to the clamp:
Place another Satinsky clamp just proximal to the first, but below the renal arteries.

Remove the first clamp.

If there is still insufficient aorta:
Ligate and divide the left renal vein.

If there is still insufficient aorta:
Place a clamp above the renal arteries.

If you cannot control the upper end of the aorta, and this is the site of the rupture, the operation may be impossible.
The tissues may just disintegrate as the clamp is applied.

Discuss with the anaesthetist the advisability of continuing.

Consider opening the aneurysm and inserting a Foley catheter into the aorta to tamponade the vessel. This is very much a last ditch move.

Remember to clamp the open end of the catheter with an artery clip before inserting the catheter into the aorta.

Inflate the balloon with up to 30ml. of saline from a 30ml syringe until the bleeding stops.

Section 9.15 Controlling the upper end of the aneurysm (continued)
Step Number 9.15 continued

Clip the inflation tube with an artery clip to prevent the saline in the balloon running back into the syringe.

If you cannot get enough aorta for a satisfactory posterior anastomosis:

- Compress the aorta above the duodenum with an aorta compressor.

- Cut the back wall of the aorta behind the renal arteries to obtain more aortic tissue.

Perform the anastomosis as quickly as possible to minimise renal ischaemia.

After making the anastomosis, clamp the graft just below the top of the graft as soon as possible to restore blood flow to the kidneys.

Or pass a Foley catheter up the aorta and inflate the balloon.

9.16 ANTICOAGULATE THE PROXIMAL AORTA

This will anticoagulate blood in the aorta up as far as the lowest branch, i.e. the renal arteries.

Use 120 mls. of Heparinised Saline in a 20 ml syringe with a green topped 21 SWG needle.

Inject into the aorta 1cm. above the aortic clamp.

Aspirate blood into the syringe before injecting, to confirm you are in the lumen of the aorta.

Press on the puncture site for 2 minutes with a pledget to control any bleeding after removing the needle.

9.17 CHECK THE CLOTTING STATUS OF THE BLOOD

It is sensible to order fresh plasma early since it usually takes 20 minutes to thaw in the Laboratory before it can be used.

Repeat the clotting screen hourly.

Signs of the Red Ink syndrome: i.e. lack of clotting factors.

- Failure of clot formation.

- Bleeding starting from tissues and through previously water tight suture lines.

9.18 LET THE ANAESTHETIST CATCH UP WITH BLOOD LOSS

If the bleeding has been controlled with the aortic clamp:

Section 9.18 Controlling the upper end of the aneurysm (continued)
Step
Number 9.18
continued

The anaesthetist has time to replace blood loss with blood or colloid.

If the bleeding is not controlled with the clamp: Compress the aorta with an aortic compressor in the lesser sac. The exploration has to continue very quickly.

Open the aneurysm sac and control the suprarenal aorta with a Foley catheter balloon.
Section 10.00 Controlling the lower end of the aneurysm

Step Number
10.01 INTRODUCTION
This dissection is usually easier than for the upper end of the aneurysm.

There is less urgency for speed now that the pressure in the leaking aneurysm has been controlled.

The main hazard is avoiding damage to the iliac veins.

10.02 DISPLAY THE POSTERIOR PERITONEUM
This is the peritoneum lying below the fourth part of the duodenum, with the descending colon on the left and the small bowel on the right.

This may be the site of an enormous haematoma and infiltration from blood from a leaking aneurysm.

10.03 OPEN THE POSTERIOR PERITONEUM
Use dissecting scissors and a pledget on a stick.

Start at the site of opening the peritoneum at the lower border of the duodenum.

Make a longitudinal cut into the peritoneum from the upper end of the aneurysm to the common iliac arteries.

Run the dissection down the mid line of the aorta.

Finish at the bifurcation of the aorta.
This may run to one side or another.

The origin of the iliac arteries may be hidden by the aneurysm or displaced by the tortuosity of the arteries themselves.

Avoid the ureters which run over the iliac arteries to the pelvis. They lie behind the gonadal veins. The blue of these veins is a guide to the ureters.

The ureters are pale, with longitudinal vessels.
They show peristalsis when squeezed gently with forceps.

They will usually be swept laterally, under the lateral leaf of peritoneum.

They will eventually lie lateral to an aorto-aortic graft.

They should usually be placed posterior to the limbs of an aorto-bifemoral graft.

Section 10.04 Controlling the lower end of the aneurysm (continued)
10.04 DIVIDE THE INFERIOR MESENTERIC VEIN

This will improve exposure of the aorta and prevent inadvertent damage to the vein.

The vein runs behind the posterior peritoneum on the left, usually on medial to inferior mesenteric artery.

It runs cephalically, lateral to the duodeno – jejunal flexure.

The blood drainage of the large bowel will reroute along other mesenteric veins.

Use 2/0 Vicryl. (Ethicon W9136)

10.05 RETRACT THE PELVIC STRUCTURES

Use a Deaver retractor in the lower part of the wound

Display the lower aorta and pelvic cavity.

10.06 LOOK FOR ILIAC ANEURYSMS AND STENOSES

Both aneurysms and stenoses will need to be bypassed by a Y graft.

Only aneurysms need to be isolated in addition.

For a leaking aneurysm:

Plan to isolate the aneurysms once the lower end of the aorta and the lumbar arteries have been controlled

10.07 TECHNIQUE FOR ISOLATING DISTAL ANEURYSMS

Ideally the vessel feeding blood to the aneurysm and, the vessel draining blood from the aneurysm, should be ligated.

This is not always possible due to:

The site of the aneurysm.

The direction of blood flow to aneurysm after a Y graft.

Excision of an aneurysm may be justified only in a femoral artery but not in an iliac artery.

Dissect the relevant vessel off the associated vein.

Use O’Shaughnessy forcep as for the aorta.

Pass a double 2/0 Vicryl tie around the artery.

Hold the ends in an artery forcep.

Do not tie them off until the graft has been inserted.

Section 10.08 Controlling the lower end of the aneurysm (continued)
10.08 ISOLATION OF AN ANEURYSM OF ONE COMMON ILIAC ARTERY
Plan to tie off the affected common iliac artery above and below the aneurysm.

Blood supply to the pelvic organs will come via the limb of the graft on the same side, retrogradely up the external and internal iliac arteries.

10.09 ISOLATION OF BILATERAL COMMON ILIAC ANEURYSMS
Plan to tie off both common iliac arteries above and below the iliac aneurysms.

Blood supply to the pelvic organs will come via the limbs of the graft on the each side, retrogradely up the external and internal iliac arteries.

10.10 ISOLATION OF A UNILATERAL EXTERNAL ILIAC ARTERY ANEURYSM
Plan to tie off the external iliac artery above and below the aneurysm.

Blood supply to the pelvic organs will come via the limbs of the graft on the opposite side, retrogradely up the external iliac arteries.

10.11 ISOLATION OF BILATERAL EXTERNAL ILIAC ARTERY ANEURYSMS
Plan to tie off the external iliac artery above and below the larger of the two aneurysms.

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the smaller aneurysm and the internal iliac artery.

The smaller aneurysm should expand more slowly in the future.

10.12 ISOLATION OF UNILATERAL INTERNAL ILIAC ARTERY ANEURYSM
Plan to tie off the internal iliac artery proximal to the aneurysm.

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the opposite internal iliac artery.

10.13 ISOLATION OF BILATERAL INTERNAL ILIAC ARTERY ANEURYSMS
Plan to tie off the internal iliac artery proximal to larger the aneurysm.

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the opposite external iliac artery and through the internal iliac aneurysm.

Section 10.13 Controlling the lower end of the aneurysm (continued)
Step
10.14 ISOLATION OF A UNILATERAL FEMORAL ANEURYSM
Plan to anastomose the limb of the Y graft to a non-aneurysmal section of the superficial femoral artery distal to the aneurysm.

Tie off the femoral artery above and below the aneurysm.

Blood supply to the thigh muscles should be adequate via anastomotic channels from the superficial femoral artery.

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the opposite external and internal iliac arteries.

10.15 ISOLATION OF BILATERAL FEMORAL ANEURYSMS
Plan to anastomose the limbs of the Y graft to non-aneurysmal sections of the superficial femoral arteries distal to the aneurysm.

Tie off the femoral artery above and below the larger of the aneurysms. Excision is often possible.

Blood supply to the thigh muscles should be adequate via anastomotic channels from the superficial femoral arteries.

Blood supply to the pelvic organs will come via the limb of the graft on the opposite side, retrogradely up the femoral aneurysm and the external and internal iliac arteries.

The smaller aneurysm should expand more slowly in the future.

Consider an extra graft from one limb of the Y graft to an iliac artery.

10.16 ISOLATION OF POPLITEAL ARTERY ANEURYSMS
Surgery on popliteal artery aneurysms can be postponed to a later date.

10.17 COMBINATIONS OF ANEURYSMS
Follow the above principles to create procedures that will ensure satisfactory blood flow to the pelvis and the lower limbs.

10.18 DIVIDE THE INFERIOR MESENTERIC ARTERY
Look out for the inferior mesenteric artery running downwards on the left side of the posterior peritoneum.

If you cannot find it, it may be thrombosed.

Section 10.18 Controlling the lower end of the aneurysm (continued)
Continued Make sure that you have identified the left ureter first.

Dissect out the mesenteric artery, double ligate it with 2/0 Vicryl (Ethicon W9125) and divide it. The left colon and upper rectum should obtain sufficient blood supply from anastomoses with the marginal artery and pelvis vessels.

If you cannot find the artery:
Continue with the dissection.

Be prepared to stitch the artery off from inside the aorta after opening the sac if it has not thrombosed.

10.19 DISSECT OUT THE ORIGIN OF THE LEFT COMMON ILIAC ARTERY.
Use O’Shaughnessy forceps or a mixture of finger and blunt dissection.

The common, the external and internal iliac arteries may be displaced from their usual positions and directions.

This can be caused by the aneurysm and/or a large haematoma.

Also, any dilatation of the iliacs is usually associated with lengthening and tortuosity of the vessels.

Make sure you have dissected the common iliac arteries, and not the others.

If the iliac veins are adherent to the arteries
Only display the front and the sides of the iliac arteries ready for a right angled De Bakey clamp to occlude the vein as well as the artery later.

***This method is preferred by many surgeons instead of attempting a potentially hazardous complete dissection of the arteries.

Control abnormal branches of the iliac arteries with sloops, double wrapped around and clipped with artery forceps.

If the iliac veins bleed:
Control them with 5 minutes of pressure.

If this fails:
Repair the defects with 4/0 Prolene (Ethicon W8935).

If this fails:
Tie the veins off using 2/0 Vicryl (W9025).

Section 10.20 Controlling the lower end of the aneurysm (continued)

Step Number
10.20 DISSECT OUT THE ORIGIN OF THE RIGHT COMMON ILIAC ARTERY.
   As for the left common iliac artery.

10.21 DISSECT OUT THE ORIGIN OF THE LEFT EXTERNAL ILIAC ARTERY
   As for the left common iliac artery.

10.22 IDENTIFY THE ORIGIN OF THE RIGHT EXTERNAL ILIAC ARTERY
   As for the left common iliac artery.

10.23 CLAMP THE LEFT COMMON ILIAC ARTERY
   Use a right angled De Bakey clamp (3 clicks).
   Arrange the handles to lie down towards the thigh so as to
   be out of the way of the anastomoses.

   If the vessel is too deep:
   Use a straight De Bakey clamp. Beware of knocking it
   during the anastomosis.

10.24 LOCALLY ANTICOAGULATE THE DISTAL LEFT ILIAC ARTERY
   Use 120 ml. of Heparinised Saline, a 20 ml. syringe and a green
topped 21 SWG needle.

   Check the needle is pressed onto the syringe until it has
   stopped creaking.

   Angle the needle on the syringe to 30 degrees to avoid passing
   the needle through the back wall of the artery.

   Squeeze the artery distal to the clamp to find an uncalcified area
   of wall.

   This squeezing will also help detect whether the artery is
   thrombosed.

   Push the needle into the anterior wall at 30 degrees to the
   vessel.

   Avoid pushing the needle through the posterior wall.

   Aspirate blood into the syringe before injecting, to confirm you
   are in the lumen of the artery.
     If bubbles aspirate:
       You have gone through the back wall.
       Reposition the needle.

   If blood does not aspirate:
     You may have gone through the posterior wall.
     Reposition the needle.

---

Section 10.24 Controlling the lower end of the aneurysm (continued)
Step
Number
10.24
If blood still does not aspirate:

The artery may contain blood clot, aneurysmal debris or be blocked by atheroma.

(Your initial clinical examination of the patient should have suggested any arterial blockage).

Continue with the operation, but be prepared to perform an embolectomy or to eventually use a straight graft.

If saline fills the wound:

You have gone through the back wall of the artery.

Reposition the needle.

10.25 CLAMP THE RIGHT COMMON ILIAC ARTERY

As for the left common iliac artery.

10.26 LOCALLY ANTICOAGULATE THE DISTAL RIGHT ILIAC ARTERY

As for the left common iliac artery.

You have now stopped flow of blood into the aneurysm form above and from below.

The next step is to stop blood flow into the back of the aneurysm from the lumbar arteries.

The aneurysm has to be opened to do this.
Section 11.00 Opening the aneurysm

11.01 INTRODUCTION
The aneurysm is opened initially to gain control of the lumbar arteries.

The aneurysm may contain thrombus which needs to be removed.

The surgeon needs to be ready to control bleeding into the aneurysm from vessels probably in the following order:
- Incompletely clamped aorta and iliac arteries.
- Rare sources such as an aorto-caval fistula.
- Lumbar arteries.

11.02 GO TO THE UPPER END OF THE AORTA
Use the Deaver retractor to expose the aorta and the upper end of the aneurysm.

11.03 CHECKS BEFORE OPENING THE ANEURYSM
Check there is a large bowl available for the blood clot and platelet thrombus from the aneurysm.

Check the scrub nurse has:
- A 16 FG Foley catheter:
  - Balloon checked by inflating to 30ml. with saline.
- Arterial clamp for the distal end of the catheter.
- A 50ml. Luer lock syringe of saline.
- Two spare Foley catheters, in case the balloon on the first one bursts, or the iliac vessels need control with the catheters.
- Three stitches of 3/0 Vicryl (Ethicon W9136) on the scrub table, one mounted on a long needle holder.
  - These stitches will be to underrun any bleeding lumbar arteries in the back wall of the aneurysm.
  - There may be as many as six or more.
  - They may bleed very near the planned anastomosis at the upper end of the aneurysm.
  - Be prepared to underrun the rarer median sacral artery.

Check the anaesthetist is happy that the patient can stand some blood loss.

Section 11.14 Opening the aneurysm
Step
Number
11.04 OPEN THE ANEURYSM LONGITUINALLY
   Use a scalpel with a No. 15 Swann Morton blade.
   Make a longitudinal incision into the front wall of the aorta.
   Start 5 cm. above the bifurcation.
   Finish 5 cm. below the aortic clamp.

11.05 REMOVE THE ANEURYSM CONTENTS
   Scoop out blood clots, yellow platelet thrombus and blood with
   your hand.
   Have a large pack available to pack into the lower part of the
   aneurysm while you deal with any serious bleeding from above.

11.06 CONTROL ANY AORTIC BLEEDING
   If there is aortic bleeding:
   The aortic clamp is not tight or not properly positioned.
   Try putting more clicks on the aortic clamp.
   If this controls the bleeding:
      Continue the operation.
   If not:
      Place a second clamp proximal to the first.
      Press the second clamp even more firmly
      onto the vertebral column than the first,
      before closing the jaws.
   If the second clamp has controlled the bleeding:
      Remove the first clamp.
   If control is still inadequate:
      Clamp the aorta above the renal arteries
      and reposition the subrenal clamp.
   If this does not control the bleeding:
      Compress the aorta in the lesser sac with an
      aorta compressor.
      Insert a Foley catheter 10cm. up the aorta
      through the aneurysmal incision.
      Inflate the balloon with up to 30ml. of saline to
      control the bleeding.
      Clip off the filling tube with an artery forcep.
      Make sure the main catheter tube is clamped
      with the extra arterial clamp.

Section 11.07 Opening the aneurysm (continued)
11.07 CONTROL ANY ILIAC ARTERY BACK BLEEDING
Localise the site of bleeding using swabs, packs and the sucker.

Tighten the responsible iliac clamp(s).
Check that they are clamping the common iliac arteries completely.

Check that they are not just clamping the internal or external iliac arteries only.

Check that the iliac arteries are not torn.
If they are torn:
Double clamp the artery and repair the tear with a continuous suture of 4/0 Polypropylene (Ethicon W8935).

If that does not work:
Consider tying the iliac arteries off and using a Y graft

11.08 CLEAN OUT THE ANEURYSM
Remove platelet thrombus, blood clot and atheromatous debris.

11.09 LOOK FOR AN AORTO-CAVAL SHUNT
This will be on the right hand side of the aorta.

Stitch the defect in the caval wall with 4/0 Prolene.

Clamp the defect with a Satinsky clamp to obtain control if it is too large for 2-3 free stitches.

11.10 CONTROL LUMBAR ARTERIES
The lumbar arteries, if not blocked, will be bleeding from the back wall of the aneurysm.

The vessels are arranged in pairs – up to 6 pairs, corresponding to the vertebrae. The aortic clamp may compress the lining of the aorta and hide the uppermost two.

Complete control of bleeding is essential to prevent blood obscuring the suturing of the anastomoses as well as causing hypovolaemia.

11.11 UNDER-RUN ANY LUMBAR ARTERIES
Excise flaps of atheroma holding the arterial orifices open, before stitching the vessels off.

Use criss-cross stitches of 3/0 Vicryl (Ethicon W1936).

Section 11.11 Opening the aneurysm (continued)
11.11 continued You should now have a relatively bloodless field inside the aneurysm sac.

A minute of two controlling minor bleeders at this point is well worth the extra effort.

11.12 EXTEND THE AORTIC INCISION
Use Metzenbaum scissors.

Cut the aneurysm wall distally down to 2cm. from the bifurcation of the aorta.

Remove thrombus from here.

11.13 INSERT A RETRACTOR INTO THE ANEURYSM
Use a Travers self-retaining retractor.

Place the handles distally, so that they do not impede the upper anastomosis.

Open the jaws to display the inside of the aneurysm.

Stitch off any residual lumbar arteries.

11.14 ANTICOAGULATE THE ILIAC ARTERIES AGAIN
Use the 20ml. syringe with a bulb adaptor (blob) containing heparin saline.

Temporarily open the iliac clamps in turn to flush 3 syringefuls of heparin saline down each common iliac artery.

11.15 PROGRESS SO FAR
You should now have control of bleeding and a cleaned out aneurysmal sac.

There is always some seepage of blood from retroperitoneal haematomas.

11.16 WAIT UNTIL THE ANAESTHETIST HAS CAUGHT UP WITH ANY BLOOD LOSS

11.17 THE NEXT STEP
Checking the iliac arteries.

Read on.
Section 12.00 Checking the iliac arteries

Step number
12.01 INTRODUCTION
The iliac arteries and more distal vessels may be occluded by atheroma, thrombus or embolus.

Thrombosis and embolism may have occurred before the operation or since the operation started.

Thrombus and emboli can usually be cleared with a balloon catheter.

Atheroma may indicate a modification to the operation plan or additional surgery, immediately or later.

12.02 CHECK THE ILIAC ARTERIES ARE PATENT
Part open the iliac artery clamp on each side in turn to confirm that there is back bleeding.

The peripheral vessels are usually patent, and even larger than normal, since the aneurysmal condition often affects all arteries to some degree

If there is back bleeding from each iliac artery:
Anticoagulate the iliac arteries again.
Use the 20ml. syringe with a bulb adapter (blob) containing heparin saline.

Temporarily open each iliac clamp in turn to flush 3 syringefuls of heparin saline down each iliac artery.

Go to Section 14.00 Choosing a straight or Y graft.

If there is no back bleeding from one or both iliac arteries:
Squeeze the quadriceps to force blood from branches of the external iliac back up the common iliac artery into the aorta.

If there is no back flow from quadriceps compression:
Pass a Fogarty catheters down the blocked iliac artery from inside the aneurysm.

12.03 CHECK THE FOGARTY CATHETER
Check it is a No 4 French Gauge catheter. i.e Balloon 4mm. in circumference.

Check you have a spare No 4 catheter available.
**Section 12.03 Checking the iliac arteries (continued)**

Step number 12.03 continued

Have the catheter brought to the operating table.

Make sure it does not flip onto unsterile areas.

Remove the central wire.

Test the balloon at the tip of the catheter.

Have 0.75ml of heparin saline inserted into a 2ml syringe.

Check that there is no air in the syringe, which would upset the feel of the catheterisation.

Push the syringe onto the catheter until any creaking at the joint stops.

Inflate the balloon with the 0.75ml of the heparin solution.

Check that the balloon does not burst and the balloon is a regular sphere shape.

Replace the catheter if substandard.

12.04 PASS THE FOGARTY CATHETER DOWN THE LEFT COMMON ILIAC ARTERY

Open the left iliac artery clamp fully, but leave it in place.

Pass the Fogarty catheter down the artery.

The catheter usually passes easily down to about 40cm, i.e down the superficial femoral artery and its extension, the popliteal artery, to the popliteal trifurcation.

The catheter will pass through thrombus and embolus material.

If it meets an obstruction at less than 20cm:

This may be due to a kink in a tortuous vessel.

Bend the distal 2cm of the catheter.

Repass the catheter and rotate it to negotiate any kink.

Try to pass a narrower catheter.

If the catheter will still not pass:

The iliac arteries are probably blocked with atheroma.

You will need to perform a Y aorto-bifemoral graft.

**Section 12.04 Checking the iliac arteries (continued)**
Step number
12.04 continued

If the catheter encounters a blockage at 40cm. or so:

There is probably atheroma at the femoropopliteal junction.

Concentrate on clearing the femoral artery of any thrombus or embolus more proximally.

Reassess the blood flow to the limb at the end of the aortic operation.
   A femoro-popliteal bypass may be needed immediately or later.

If the catheter passes to more than 40cm.:

There is probably no atheromatous blockage of the femoral or popliteal artery.

There may be a poor run off more distally.
   This may not be amenable to further surgery.

Assess this in the recovery period.

12.05 CLEAR OUT ANY THROMBUS OR EMBOLUS
At best, this will be from the iliac, femoral and popliteal arteries.

Push the heparin saline into the balloon until you feel a resistance.
   The resistance is the wall of the artery.

If you push too hard, you can rupture the arterial wall, especially when it is healthy. This will most likely be in the vessels below the inguinal ligament.
   The balloon will suddenly inflate easily.

This sudden inflation can happen also if the balloon bursts.
   Withdraw the balloon.

   If it has burst:
      Replace it. Be more gentle with the new balloon.

   If you think you have ruptured the vessel:
      Plan to examine the limb at the end of the operation.
      Explore and repair the vessel as needed.

Pull the catheter steadily out of the artery with your left hand.

Section 12.05 Checking the iliac arteries (continued)
At the same time, with your right hand, increase or decrease the amount of liquid in the balloon to match the diameter of the vessel being swept clear of the thrombus or embolus.

You will probably feel the narrowing of the superficial femoral artery at the adductor hiatus (about 35cm. from the aortic bifurcation).

You will feel the roughness of atheromatous plaques on the arterial wall.

As the balloon of the catheter approaches the mouth of the common iliac artery, get the first assistant ready with a vascular sucker to remove thrombus or emboli.

If you bring up thrombus or emboli:
  Repeat passing the catheter until no more material is obtained.

  You should have a steady stream of back bleeding if the blockage is relieved.

  Flush 60ml of heparin saline down the left iliac artery.

  Reclamp the left iliac artery.

  If there is no back bleeding and the catheter pass to 40cm. or more, the limb may not be viable below the knee.

  Flush 60ml of heparin saline down the left iliac artery as above.

  Reclamp the left iliac artery.

  Continue the operation with a straight graft in anticipation of improvement in the distal limb when the aortic flow is reestablished.

  However, the patient may eventually lose part of the left limb from ischaemia.

12.06 REPEAT THE CATHETERISATION PROCEDURE ON THE RIGHT ILIAC ARTERY
  Use the same technique as for the left iliac artery
Section 13.00 Choosing a straight or Y graft

13.01 INTRODUCTION
A straight graft involves only 2 anastomoses, upper and lower, compared with the 3 anastomoses of a Y graft.

However the 2 femoral anastomoses are quicker and easier to perform. After including the time to explore the groins and to make the vascular tunnels, inserting a Y graft usually takes longer than a straight graft.

A straight graft can be anastomosed to the bifurcation of the aorta in about 70% of cases, using an inlay technique (see section 17).

Where the anastomosis is to be made using a transection technique, the proportion of suitable cases for a straight graft falls to about 50%.

Where there is aneurysmal or occlusive disease of the iliac arteries, a Y graft is mandatory. If there is, Some surgeons prefer a Y graft even if there is only minor dilatation of the iliac arteries.

13.02 CHOOSE A GRAFT
For a straight graft, match the diameter of the graft to the aorta. Usually a 16mm. diameter graft is adequate.

For a trouser graft, usually a 16mm. diameter aortic section graft with 8mm. diameter iliac limbs is adequate (90%).
Section 14.00 Dissecting out the femoral arteries

Step
Number
14.01 CLEAR THE GROIN AREA ON EACH SIDE
Clear a space 8cm. above the groin crease (more for a fat patient), 10cm. below the groin and 20cm. wide.

Centre the space on the midinguinal point, ie the surface marking of the femoral artery.

Make sure the retractors are not interfering with this area.

Resterilise the skin with Chlorhexidine, if the adhesive plastic drape has torn or become unstuck.

14.02 INCISE THE SKIN IN THE LEFT GROIN
Use a No 22 blade on a large scalpel handle to incise the cutis.

Make a vertical incision in the midinguinal line, from 5cm. above the groin to 8cm. below it.

14.03 DEEPEN THE INCISION
Use the firestick to incise into the subcutaneous fat down to the fascia lata.

14.04 INSERT A SELF RETAINING RETRACTOR
Use a Cones self retaining retractor with the handle pointing towards the knee.

Retract the subcutaneous fat by prising the jaws open.

14.05 PALPATE THE FEMORAL ARTERY
This is easier to find when the artery is:
- Pulsating.
- Aneurysmal.
- Atheromatous.

14.06 DEAL WITH OTHER STRUCTURES IF IN THE WAY
Coagulate or ligate veins running into the sapheno-femoral junction.

Elevate the inguinal ligament and the abdominal wall with a Langenbeck retractor in a fat patient.

Make sure there is no femoral hernia in the fatty tissue in the femoral triangle.

Avoid damaging lymph nodes and lymphatic vessels to prevent lymphoceles postoperatively.

Excise inguinal lymph nodes only if they are obstructing the exposure of the blood vessels.
Section 14.06 Dissecting out the femoral arteries (continued)

Step
Number
14.06
continued Beware of lymphoceles postoperatively if nodes are removed.

Avoid the femoral vein medially.
The vein may be confused with a nonpulsating femoral artery.

Avoid the femoral nerve laterally.

14.07 READJUST THE RETRACTOR
This will give a better view of the arteries.

14.08 START TUNNELLING UNDER THE INGUINAL LIGAMENT
This will give a good exposure of the common femoral artery as it emerges from under the inguinal ligament, as an extension of the external iliac artery.

Use finger dissection for 2cm. on the lateral side of the external iliac artery.
This will avoid damage to the femoral and external iliac veins which run medially.

14.09 CONFIRM THAT AN AORTO-FEMORAL GRAFT IS TO BE USED
If this exposure is being made before the abdomen is opened in anticipation of an aorto-femoral graft being used:
Place a gauze swab in each groin wound.
This will protect the wound from contamination and absorb any oozing of blood.

Open the abdomen for confirmation of the use of a Y graft.

If the abdomen is already open and the Y graft is certain:
Read on.

14.10 EXPOSE THE THREE FEMORAL ARTERIES
These are:

1 The common femoral artery coming from under the inguinal ligament as a continuation of the external iliac artery.

It bifurcates into the superficial and deep femoral arteries at some point between the inguinal ligament and up to 10cm. more distally.

2 The superficial femoral artery running down as a continuation of the common femoral artery at its bifurcation.
Section 14.10 Dissecting out the femoral arteries (continued)

3 The deep (profunda) femoral artery running initially medially and then behind the superficial artery to run into muscles laterally.
   Variations with early branchings are common.

Use dissecting scissors.

The arteries have characteristic transverse vasa vasorum on their surface.

Mistaking the long saphenous vein or the femoral vein for the arteries is more likely if the arteries are not pulsating.

Dissect in a plane close to the artery, so that the surface is shiny.

14.11 DISSECT OUT THE ARTERIES

The aim is to clear all sides of the three vessels and every one of their branches.
   They can then be controlled with bulldog clamps and plastic threads (sloops).

The bifurcation of the common femoral artery should be the central point of this dissection.

Clear 4cm. of each femoral artery and 2cm. of their minor branches.

The profunda artery may be obscured by a tributary of a profunda vein, which should be double ligated and divided for access.
   NB The profunda vein must not be confused with the femoral vein

Make sure you have found all the vessels.

Look under and behind all the vessels to make absolutely certain.

Use a small cholecystectomy forceps.

Hints for trainees:
   Use a Jaws in – Jaws open – Jaws out technique to open up the tissues behind the vessels.
   Avoid a Jaws in – open – shut – open – shut method which can damage the vessels.)

14.12 CONTROL MINOR BRANCHES
Section 14.12 Dissecting out the femoral arteries (continued)

Step Number
14.12 continued

Use sloops.

Double loop a sloop around each vessel.

Hold each sloop with an artery forcep.

14.13 PASS SLOOPS AROUND EACH FEMORAL ARTERY

Pass a small cholecystectomy forcep behind each vessel in turn.

Grasp a sloop in the jaws and pull it half way through.

Clip the two end of each sloop with an artery forcep.

14.14 DISSECT OUT THE RIGHT HAND FEMORAL ARTERIES

Use the same technique as for the left femoral arteries.

Go to Section 15.00 Making the vascular tunnels
Section 15.00 Making the vascular tunnels

Step Number 15.01 INTRODUCTION

These are retroperitoneal tunnels along which the limbs of the trouser graft will run.

The peritoneal cover should prevent:
- Adhesions forming between the graft and omentum or bowel.
- Erosion of the limbs of the graft into the bowel.

The tunnels run from the origins of the internal iliac arteries, round the pelvic brim to the common femoral arteries.

The tunnels run lateral to the iliac arteries and veins.

The ureter will run superficial to the tunnels.

15.02 START MAKING THE LEFT VASCULAR TUNNEL

Have access to the groins and the abdominal cavity.

Use index fingers of both hands.
- The right index finger tunnels along the lateral side of the left common iliac artery.
- The left index tunnels up from the lateral side of the common femoral artery.

The tunnel passes behind the sigmoid colon and the ureter.

The fingers will meet at right angles due to the curvature of the rim of the pelvis.

Make sure there are no strands of tissue in the tunnel.

Using finger dissection will ensure that the diameter of the tunnel is more than 1cm.

You may not feel or see the ureter during this dissection.

If the peritoneum tears:
- Repair the defect with 3/0 Vicryl once the graft limb is in situ.

15.03 PASS AN O’SHAUGHNESSY FORCEP UP THE LEFT TUNNEL

Pass the O’Shaughnessy up the tunnel, pressing on the tip of the forcep on the tip of the index finger inside the tunnel as a guide.

The closed jaws on the forcep should appear in the pelvic opening of the tunnel.

Remove the forcep.
Step
Number
15.04 MAKE THE RIGHT VASCULAR TUNNEL
   Same technique as on the left.
   
   You may need to stand on the patient’s right to do this.
Section 16.00 Choosing a transection or inlay technique for anastomosis

Step Number
16.01 INTRODUCTION

With the transection technique, the aorta is cut completely across and the graft is sutured to it, end to end. Since the posterior wall is cut through, the graft is sutured posteriorly to end of the aorta.

With the inlay technique, the aorta is only opened anteriorly. Here, the posterior wall is not cut through. The graft is sutured posteriorly, not to the end of the aorta, but to the inside of its posterior wall.

Surgeons tend to favour one technique or another, often depending on the method used in their training. Overall, the inlay technique is the commoner, but either technique is satisfactory when performed correctly.

16.02 PROS AND CONS OF THE TRANSECTION TECHNIQUE

The dissection behind the aorta may lead to serious bleeding from lumbar veins.

The anastomosis is quicker than the inlay technique, particularly the posterior walls.

A reinforcing tube of graft can be slid over the anastomosis to reduce leakage.

The middle of the posterior wall of the aorta is usually well exposed for accurate suturing.

Make sure that the lower aorta can be dissected free before committing yourself to a transection technique.

16.03 PROS AND CONS OF THE INLAY TECHNIQUE

At the upper anastomosis, there is no dissection behind the aorta with danger of bleeding from lumbar veins.

Insertion of sutures into the middle of the posterior wall of the aorta may be obscured by compression of the side walls by the aortic clamp. This is a danger area and difficult to correct if there is bleeding here.

The amount of aorta available for suture posteriorly may be larger with the inlay technique, particularly for a high aneurysm.

At the lower end of the straight graft, the inlay technique allows an anastomosis onto the aortic bifurcation.

The transection technique may be limited to anastomoses with the aorta 1 - 2cm. higher. Disease of the aorta nearer the bifurcation would necessitate a Y graft or an inlay graft.
Step 16.04 FEMORAL GRAFTS

These anastomoses are invariably end to side to preserve the blood supply to the pelvis.
Section 17.00 Cutting the graft

Step
Number
17.01  FOR A STRAIGHT GRAFT
The graft supplied by the manufacturers is longer than is needed for convenient handling.

A shorter length should be cut from the whole graft.

17.02  CUT ONE CM. OFF ONE END OF THE WHOLE GRAFT
Use stitch scissors.

Cut across the apex of a crimp, to help the graft to stay open during suturing.

Use this end for stitching to the subrenal aorta.

17.03  CUT OFF A SUITABLE LENGTH OF GRAFT
Measure the distance between the subrenal aorta and the bifurcation of the aorta.

Choose a site on the graft 5cm. longer than this.

Cut across the graft at this site with a 30 degree backward slant. This angle will fit best onto the aorta at its bifurcation.

Use stitch scissors.

The graft will be shortened to fit later.

Go to Section 19 Upper anastomosis with aortic transection.

17.04  FOR A Y GRAFT
There is a danger of the limbs of a Y graft kinking as they bifurcate from the main trunk of the graft.

To minimise the abduction of the limbs of the graft, the site of bifurcation should be higher than in normal anatomy.

This is done by shortening the main trunk of the graft to 2cm.

The limbs of the graft will lie parallel in the aneurysm sac without abduction.

Use stitch scissors.

Make a cut transversely across the trunk of the graft.

Make the cut 1cm. (3 or 4 crimps), above the bifurcation.

Cut across the apex of a crimp, to help the graft to stay open during suturing.

Section 17.04 Cutting the graft (continued)
Step 17.04 continued
Keep a 6cm. length of the aortic section of the graft to cover and reinforce the upper anastomosis later.

Do not shorten the limbs of the Y graft at this stage

Go to Section 18.00 Upper anastomosis with aortic transection

Or Section 19.00 Upper anastomosis with inlay technique
Section 18.00 Upper anastomosis with aortic transection

Step Number
18.01 INTRODUCTION
The upper anastomosis may take an hour or more.

The procedure consists of:
Insertion of a mattress suture at 3 o’clock and one at 9 o’clock.
Making the posterior wall of the anastomosis, followed by the anterior wall.
Using two sutures with two needles on each suture.

18.02 CHECK THE SUBRENAL AORTA IS MOBILISED POSTERORLY
Pass an O’shaughnessy forcep round the back of the aorta.

If not completely free:
Complete the dissection with the forceps.

If there is bleeding from lumbar veins:
Control this with 5 minutes packing with a swab.

If bleeding continues:
Maintain the packing for longer
Consider an inlay technique.

18.03 CHECK HAEMOSTASIS
You must have control of all bleeding from inside the aneurysm before starting the anastomosis. If left, any bleeding here is likely to get worse and obscure the anastomoses.

Readjust the clamps and oversew lumbar vessels as needed.

There is often some minor overspill from the haematoma or minor vessels outside the aneurysm. Control this by tucking in gauze swabs and with the sucker as needed.

If necessary, tie off or repair bleeding vessels.

18.04 TRANSECT THE AORTA
Use long Metzenbaum scissors.

Choose a site 2cm. distal to the Satinsky clamp.
Cut the aorta perpendicular to its long axis.
Beware of the lumbar veins behind the aorta.

18.05 CHECK THE GRAFT
These checks apply to straight and Y grafts.

Section 18.05 Upper anastomosis with aortic transection (continued)
Step Number
18.05 continued

Check that the orientation lines on the graft are in line with the aorta and distal vessels.

Identify the 3 and 9 o’clock positions on both the graft and the aorta.

This will prevent any mismatching between the lengths of the posterior walls of the graft and that of the aorta.

It will also ensure that the limbs of a Y graft are not rotated relative to the femoral or iliac arteries.

Use the orientation lines on the graft to assist.

18.06 INSERT THE FIRST STITCH

Start the anastomosis at nine o’clock
ie On the right lateral wall of the aorta.

Insert a double needled 3/0 Prolene stitch.
Make a mattress stitch between the aorta and the graft.

The knot will lie on the outside of the aorta.

Mattress stitches are less likely to cut through the aorta than simple stitches.

Where the aorta is very diseased, insert the needles so as to avoid delaminating the aortic intima.
ie Pass the needles should pass through the aorta from inside to outside.

Insert the first needle into the right side of the graft from outside to inside.

Take a 2mm. bite on the graft to include the widest part of the crimping .
Use the anterior black line to choose the correct 9 o’clock position.

Pull the needle and half the suture through the graft to minimise cheese wiring the aorta with the next part of the stitch.

Insert the first needle through the right lateral wall of the aorta 10mm. proximal to its cut end, from inside to out.
Avoid the vena cava laterally.

Remove calcified atheroma as needed.

To maximise the length of available aorta, push the needle holder laterally against the Satinsky clamp as you insert the suture. Do this on all subsequent bites.

Section 18.06 - Upper anastomosis with aortic transection (continued)
Number
18.06 continued
Pull the first needle and half the suture through the aortic wall.
Half the mattress stitch is finished.
Insert the second needle through the graft 2mm. from the first, from outside to inside.
Pull the second needle and second half of suture through the graft.
Insert the second needle through the aortic wall 3mm. from the first, 7mm. away from the cut end of aorta, from inside to out.
Pull the second needle and second half of the suture through the aorta.
Snug the graft onto the aorta.
End up with equal lengths of suture so that the knot will be in the middle of the suture.
Use a Blalock nerve hook to snug the line of polypropylene sutures down.
   Pick out any loops of obviously loose stitches.
   Polypropylene sutures do not need to be tight since they will bed into the aorta and graft once the vessels are filled with blood.
Tie the mattress stitch on the outside of the aorta.
   Use a double throw with a 750grams. pull to start.
   Follow with 4 throws to lock the stitch (1500 grams. pulls).
   Check the knot has not slipped.
   Lay the sutures with the 2 needles on the drapes.
   The 2 needles ensures that there is a spare suture if needed.

18.07 INSERT A 3 O’CLOCK SUTURE.
   Insert on the left lateral wall of the aorta.
   Insert and tie a mattress suture as for the 9 o’clock stitch.
   Lay the sutures lie with the 2 needles on the drapes.
   The 9 and 3 o’clock sutures, each with 2 needles, means that 3 spare sutures are immediately available for the posterior half of the anastomosis if the first one breaks.

Section 18.07 Upper anastomosis with aortic transection (continued)
18.07 continued These sutures will flare open the upper end of the graft to fit the lower end of the aorta.

18.08 FLIP THE GRAFT UPWARDS
The graft should lie on the blade of the Deaver retractor with some tension from the assistant to prevent it falling back into the wound.

This will lift up the anterior lip of the graft out of danger and display the posterior lip lying conveniently close to the posterior lip of the aorta.

Adjust the distance between bites on the aorta to allow for differences in diameter compared with that of the graft.

18.09 START THE POSTERIOR HALF OF THE ANASTOMOSIS
Use the right hand (9 o’clock) suture.

Take bites 2mm. apart, 2mm. deep on the graft and 7mm. deep on the aorta.
   This is a forehand stitch, outside to inside on the graft and then inside to out on the aorta.

To minimise cheese wiring the aorta:
   Pull the suture through the graft before passing it through the aorta.

   Do not pass the needle through the graft and the aorta at the same time.

   The bites in this part of the posterior wall must be close enough together to keep the anastomosis watertight.

   This is the most likely part of the anastomosis to be leaky, and is probably the most difficult to correct.

Get it right first time.

Continue stitching until you reach the left hand stitch.

Add an extra stitch rather take a risk of leaving a gap between the last stitch and the left hand stitch.

Avoid including the anterior wall of the aorta in the posterior aorta wall stitches.

Continue until you reach the 3 o’clock suture.

Use a Blalock nerve hook to snug the line of polypropylene sutures down.

Section 18.09 Upper anastomosis with aortic transection (continued)
continued

Pick out any loops of obviously loose stitches.

The polypropylene sutures do not need to be tight since they will bed into the aorta and graft once the vessels are filled with blood.

18.10 TIE OFF THE POSTERIOR WALL OF THE ANASTOMOSIS

Remove the needle from the posterior wall suture.

Remove one needle from the left hand suture.

Tie the posterior suture to the needle free end of the left suture.

Five throws.

Cut the free ends one cm. long.

18.11 START THE ANTERIOR HALF OF THE ANASTOMOSIS

Flip the graft downwards.

This will display the anterior lips of the graft and of the aneurysm.

The anterior aortic wall is usually more healthy than the back wall. It is also more accessible.

Unless the aorta is very diseased, a forehand stitch passing through the aorta from outside to inside should not delaminate the aorta.

Use the second suture from the right side mattress stitch.

Take bites as for the posterior half of the anastomosis.

Use forehand to pass the needle from inside to outside on the aortic wall and then outside to inside on the graft.

To obtain more exposure to the aorta:

Push the retractor upwards with the needle holder as you insert the stitches.

If the aorta may delaminate:

Move to the right hand side of the patient and use a forehand stitch, outside to inside on the graft and inside to outside on the aorta.

Avoid narrowing the iliac limbs of a Y graft by taking too deep bites on the graft.

Adjust the distance between bites so that a dog ear does not develop towards the end of the anastomotic line.

Section 18.11 Upper anastomosis with aortic transection (continued)

Step Number
18.11

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continued  Insert an extra stitch at the end of the anastomosis if needed to ensure a watertight anastomosis.
   The anterior aortic wall is likely to be less thickened by atheroma than the posterior wall, so moderate the tension a little to prevent tearing.

   If the aorta tears:
      Take more proximal bites and be even more careful with tensioning.

   If there is still tearing:
      Use patches of graft to bolster the tissues.

18.12 FINISH THE UPPER ANASTOMOSIS
There is no need to vent the anastomosis to remove debris from the aorta. Any such material will pass below the anastomosis when the aortic clamp is released momentarily.

After the last stitch is inserted:
   Remove the needle from the anterior suture line and the needle from the left suture.

   To avoid needle stick injuries, make sure the nurse takes hold of the loose ends of suture 5cm. away from the needles. She should cut the sutures off together with the 2 needles.

Tie the ends of the left and right hand sutures on the outside of the graft and the outside of the aorta.

   Use a double first throw with a 750grams pull.

   Finish off with 4 locking throws (1500 grams.).

   Cut the free ends 10mm. long.

18.13 SLIDE A 6CM. SLEEVE OF EXTRA GRAFT OVER THE ANASTOMOSIS.
This will prevent the bowel adhering to the suture material of the upper anastomosis.

   Slide the sleeve over an O’Shaughnessy forcep.

   Hold the ends of the limbs of the graft or the distal end of a straight graft with the forcep.

   Slide the sleeve down the forcep and graft to fit over the upper anastomosis.

18.14 TEST THE UPPER ANASTOMOSIS
Warn the anaesthetist that there may be some blood loss.
The anaesthetist will be prepared to increase blood replacement to compensate for this.

18.15 CLAMP OFF THE GRAFT
To avoid blood loss:
Place a second Satinsky clamp 2cm. below the anastomosis on a straight graft.

Place O’Shaughnessy forceps on the limbs of a Y graft 5cm. from the trunk.

18.16 PART OPEN THE AORTIC CLAMP
Cautiously partly open the aortic clamp the proximal graft fills with blood.

Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state.

18.17 CHECK FOR BLEEDING
There will be MINOR, MODERATE, SERIOUS or ZERO bleeding from the anastomotic line or from tears in the aortic wall.

MINOR bleeding is the most common situation for an elective operation.
Place a gauze swab around accessible parts of the anastomosis.

Cover the swabs with large gauze packs.
Press on the packs for 3 minutes.
Remove the packs and swabs slowly, and inspect the anastomosis.

If there is continued minor bleeding, or less bleeding:
Place a cellulose gauze on the bleeding area.

Recover the area with a swab and a pack.
Press on the area for a further 3 minutes.
Repeat until the anastomosis is dry.

Even rather vigorous bleeding will stop using swabs and gauzes, a little pressure, and waiting for blood clotting to close defects in the anastomotic lines.

Section 18.17 Upper anastomosis with aortic transection (continued)
Step Number 18.17 continued MODERATE bleeding from minute gaps in the anastomotic line is the most common when operating on a leaking aneurysm.
It amounts to blood welling up to the level of the top of the anastomosis within 5-10 seconds. This will stop as the gaps block with thrombus in 2 or 3 minutes.

Close off the clamp.

Tuck 2 pieces of surgical cellulose around the anastomosis and a gauze swab on top. Wait 3 minutes.

Partly open the clamp.

If the bleeding is less:
Repeat the reclamping and packing until the anastomosis is dry.

Open the aortic clamp completely.
If the bleeding is less:
Repeat the reclamping and packing until the anastomosis is dry.

If there is no bleeding:
Go to Step 18.18 Reapply the aortic clamp

If there is the same or more bleeding:
Repeat the packing.

When the anastomosis is dry.
Go to Step 18.18 Reapply the aortic clamp

If the bleeding continues:
Check the patient's clotting status.
Correct deficiencies with fresh frozen plasma and, if necessary, platelets.
Look for anatomical causes as below.

SERIOUS bleeding will be lethal if allowed to continue. This amounts to blood welling up to the level of the top of the anastomosis within 1-2 seconds.

Look for blood spurting through a larger anastomotic gap or a tear in the aorta.

Section 18.17 Upper anastomosis with aortic transection (continued)

Step
Number
18.17 continued
Close the clamp.

Stitch the gap or tear with vascular stitches.
Reopen the clamp partly
If the bleeding is less:
    Reclamp and tuck surgical cellulose around the anastomosis.

Repeat the reclamping and packing until the anastomosis is dry.

Fully open the aortic clamp.
If there is no bleeding:
Go to Step 18.18 Reapply the aortic clamp
    If the bleeding is the same or worse:
        Suspect a major gap or tear.

        Reapply the clamp.

        Find out where the bleeding is coming from.

        Elevate the graft to examine the posterior and lateral parts of the anastomosis.

        Insert vascular stitches to seal off leaking areas.

        Stitch beyond the first suture line to avoid needle damage to the first line.

        Use mattress stitches if the aortic tissues are cutting out.

        Bolster mattress stitches with spare patches of graft to prevent the suture cutting through the aorta.

        Keep calm.

        These stitches have to pass through the aorta and the graft in one bite, so they are more difficult to do than those in the first anastomotic line.

        Part release the aortic clamp

Section 18.17 Upper anastomosis with aortic transection (continued)
Step Number 18.17 continued

If there is still major bleeding:
    Reapply the clamp.
Apply a higher aortic clamp and remove the lower one to obtain a longer length of acceptable aorta.

Restitch the leaking site(s).

Consider taking down the anastomosis and starting anew.

Insert a Foley balloon into the lumen to obtain higher and healthier aorta for a reanastomosis.

Your stitching ability will be tested to the limits.

In 15-20% of leaking aneurysms, the extent of the disease, the effects of blood loss, clotting failure and general frailty of the patient may prove too much for any surgical technique.

The same applies for 1-2% of elective aneurysms.

You can only do your best.

The patient may develop a severe bradycardia or other dysrhythmia at any stage in the operation and die on the table.

In the presence of continued severe bleeding at this point, a joint decision with the anaesthetist may be needed at this stage about stopping the operation.

ZERO bleeding is uncommon.

If there is no leakage of blood:

Open the aortic clamp fully, but do not move it out of position.

Check that the patient’s blood pressure is over 100mm. mercury.

If not:

Wait for the anaesthetist to raise the blood pressure.

Section 18.17 Upper anastomosis with aortic transection (continued)

Step

Number

18.17 continued

Check that the squeezed aortic walls have opened after the clamp has been part opened.

Massage the walls to open any adhesive effect.
Be ready to reapply the clamp.

Check the blood in the aorta has not clotted.
Massage any blood clot out.

Be ready to reapply the clamp.

If there is still no leakage:
Continue the next step.

18.18 FULLY OPEN THE AORTIC CLAMP

Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state

If there is bleeding:
Manage bleeding as for a partly open aortic clamp.

Go to Step 18.17 Check for bleeding.

When there is no more bleeding:
Read on.

18.19 REAPPLY THE AORTIC CLAMP

18.20 REMOVE THE GRAFT CLAMP(S)

18.21 SUCK OUT BLOOD CLOT AND DEBRIS FROM INSIDE THE AORTA
Use a Yankauer sucker.

18.22 FLUSH THE GRAFT
Use heparin/saline to remove any fragments of blood clot.

18.23 REAPPLY THE AORTIC CLAMP
You are now ready to start the lower anastomosis.

Go to Section 20.00 Lower anastomosis with aortic transection

Or Section 21.00 Lower anastomosis with Y graft
Section 19.00 Upper anastomosis with inlay technique

19.01 INTRODUCTION

The main difference from the transection technique is that the posterior wall of the aorta is preserved.

The posterior half of the graft is sutured into the inside of the posterior wall of the aorta, and not sutured end to end.

The anterior halves of the aorta and the graft are sutured end to end as in the transection technique.

The procedure consists of:

- Insertion of one mattress suture at 3 o’clock and one at 9 o’clock (as in the transection technique).

- Taking bites of the inside of the posterior wall of the aorta, not the whole thickness of the aorta.
  - To minimise delamination of the posterior wall, the needle is inserted proximally into the aorta and exits distally.

- Making the posterior half of the anastomosis, followed by the anterior half.

- Using two sutures with two needles on each suture.

Although the many details of the inlay technique are the same as the transection technique, they are repeated in full below.

This is because many surgeons use solely the inlay technique.

19.02 START THE UPPER ANASTOMOSIS

This may take an hour or more.

19.03 CHECK THE HAEMOSTASIS

You must have control of all bleeding from inside the aneurysm before starting the anastomosis. If left, any bleeding here is likely to get worse and obscure the anastomoses.

Readjust the clamps and oversew lumbar vessels as needed.

There is often some minor overspill from the haematoma or minor vessels outside the aneurysm. Control this by tucking in gauze swabs and with suction as needed.

If necessary, tie off or repair bleeding vessels.

19.04 TRIM THE UPPER END OF THE OPENING IN THE ANEURYSM

The anterior half of the upper end needs to be cut transversely so that the graft can be anastomosed easily.
A Pantogen Operative Script – Grafting of abdominal aortic aneurysm

Step Number
19.04 continued Use Pott’s scissors to make the cut 30mm. below the aortic clamp from 3 o’clock to 9 o’clock.

19.05 CHECK THE INSIDE OF THE AORTA AT THE LEVEL OF THE ANASTOMOSIS
Ideally, there should be relatively healthy aorta above the aneurysm. It should be of relatively normal diameter (16 – 20mm.).

There should be at least 20mm. of aorta visible below the aortic clamp.

Often the aortic wall is very atheromatous, ranging from resembling wet blotting paper to being severely calcified.

If the aneurysm has ruptured at this site posteriorly:
   The anterior longitudinal ligament of the lumbar vertebrae may be exposed. This will need to be incorporated in the posterior part of the anastomosis.

The most unlikely and unhealthy tissues can provide a satisfactory anastomosis.

Remove any calcified patches of atheroma at the anastomosis site.

The keys to a successful posterior wall anastomosis are:
   Take large, deep bites of all available tissue using a strong needle.
   Bunch the tissue onto the graft to make a watertight contact using a strong suture.

19.06 CHECK THE GRAFT
These checks apply to straight and Y grafts.

Check that the orientation lines on the graft are in line with the aorta and distal vessels.

Identify the 3 and 9 o’clock positions on both the graft and the aorta.
   This will prevent any mismatching between the lengths of the posterior walls of the graft and that of the aorta.
   It will also ensure that the limbs of a Y graft are not rotated relative to the femoral or iliac arteries.
   Use the orientation lines on the graft to assist.

19.07 INSERT THE FIRST STITCH
Start the anastomosis at nine o’clock

Section 19.07 Upper anastomosis with inlay technique (continued)
Number 19.07 continued

ie On the right lateral wall of the aorta.

Make a mattress stitch between the inside wall of the aorta and the end of the graft.

Use a double needled 3/0 Polypropylene stitch (eg Ethicon W8522).

The knot will lie on the outside of the graft.

Insert the first needle deeply into the interior of the right lateral wall of the aorta 5mm. proximal to the aortic anastomosis line.

Remove calcified atheroma as needed.

To maximise the length of available aorta, push the needle holder laterally against the Satinsky clamp as you insert the suture. Do this on all subsequent bites.

Bring the first needle out of the interior of the aortic wall 5mm. distal to the anastomosis line.

Pull the needle and half the suture through the aorta to minimise cheese wiring the aorta.

Insert the first needle through the right side of the graft from inside to out.

Take the 2mm. bite on the graft to include the widest part of the transverse ridge.

Use the anterior black line to choose the correct 9 o’clock position (right lateral wall).

Pull the first needle and half the suture through the graft wall.

Half the suture has now been inserted

Insert the second needle 5mm. from the first stitch.

ie Also from proximal to distal aorta, forehand.

Insert the second needle through the graft 3mm. from the first, from inside to outside.

Pull the second needle and half of the suture through the graft.

Snug the graft onto the aorta.

End up with equal lengths of suture so that the knot will be in the middle of the suture.

Tie the mattress stitch on the outside of the graft.

Section 19.07 Upper anastomosis with inlay technique (continued)
19.07 continued Use a double throw with a 750gm. pull to start.

Follow with 4 throws to lock the stitch (1500 gm. pulls).

Check the knot has not slipped.

Lay the 2 halves of the suture with the 2 needles on the drapes.

The 2 needles ensure that there is a spare suture if needed.

19.08 INSERT A 3 O’CLOCK SUTURE.

Insert a suture as for the 9 o’clock stitch.

Lay the 2 halves of the suture with the 2 needles on the drapes.

The 9 and 3 o’clock sutures, each with 2 needles, means that 3 spare sutures are immediately available for the posterior half of the anastomosis if the first one breaks.

These sutures will flare open the upper end of the graft to fit the lower end of the aorta.

19.09 RETURN TO THE RIGHT SIDE OF THE ANASTOMOSIS

19.10 FLIP THE GRAFT UPWARDS

The graft should lie on the blade of the Deaver retractor with some tension from the assistant to prevent it falling back into the wound.

This will lift up the anterior lip of the graft out of danger and display the posterior lip lying conveniently close to the posterior wall of the aorta.

19.11 INSERT THE NEXT STITCH

Insert the next stitch into the end of the posterior wall of the graft wall from outside to inside.

Place it 3mm. from the first bite and 5mm. from the edge of the graft.

Pull the needle and suture through the graft.

Pass the needle into the posterior wall of the aorta 5mm. proximal to the anastomotic line and about 3mm. from the right hand stitch.

Section 19.11 Upper anastomosis with inlay technique (continued)
continued Adjust the distance between bites on the aorta to allow for
differences in diameter compared with that of the graft.

This will prevent a dog ear developing towards the end of the
anastomotic line.

Take as deep a bite as possible into the posterior wall of the
aorta without bending the needle.

Bring the needle out of the inside of the aortic wall 5mm. distal to
the anastomotic line.

Pull the needle and suture through the aortic wall with the
dissecting forceps and needle holder, until the suture is
750gm.tight.

Have the suture held at this tension in this ideal direction by the
first assistant's dissecting forceps.

19.12 CONTINUE INSERTING THE STITCHES INTO THE POSTERIOR
HALF OF THE ANASTOMOSIS
Make the stitches 3mm. apart on the graft and correspondingly
far apart on the aortic wall to accommodate some bunching of
the aorta.

Maintain the 750gm. pull by the assistant.

The middle of the posterior wall is very deep due to lateral
pressure from the aortic clamp.

The bites in this part of the posterior wall must be close enough
together to keep the anastomosis watertight.

This is the most likely part of the anastomosis to be leaky, and is
probably the most difficult to correct.

Get it right first time.

Continue stitching until you reach the left hand stitch.

Add an extra stitch rather take a risk of leaving a gap between
the last stitch and the left hand stitch.

Tie the left and right hand stitches together, on the outside of the
graft, but on the inside of the aorta.
  Use a double first throw with a 750gm.pull.
  Finish off with 4 more throws.
  Cut the free ends 10mm. long.

Section 19.13 Upper anastomosis with inlay technique (continued)

Step Number
19.13 START THE ANTERIOR HALF OF THE ANASTOMOSIS
This is the same as for the transection technique.
The junction between the inlay posterior suturing and the end-to-end anterior suturing requires special attention. It is a special source of leakage. This is described in detail in the text.

19.14 LAY THE GRAFT IN THE ANEURYSM SAC
This will bring the anterior walls of the graft and aorta into view.

19.15 BEGIN THE ANTERIOR HALF OF THE ANASTOMOSIS
Use the second half of the 9 o'clock suture.

You will be stitching the anastomosis from the far side towards yourself.

The anterior aortic wall is usually more healthy than the back wall.

It is usually safe to pass the needle through the aortic wall from outside to inside, without delaminating the intima.

If the wall is very diseased and calcified:
Pass the needle in the opposite direction.

Move to the right hand side of the patient to stitch forehand

Load the needle on to a needle holder forehand.

Tension the suture to 750gm.

Have the suture held with a dissecting forcep well away from the part of the suture that will be incorporated into the anastomosis.

19.16 INSERT THE FIRST STITCH
Pass the stitch forehand through the aorta from outside to inside 3mm. from the right mattress stitch and 5mm. from the edge of the aorta.

Note that the mattress stitch takes a bite of the wall of the aorta, but the anterior stitches are inserted right through the wall of the aorta.

Make sure that there are no gaps at the junction between the mattress stitch and the anterior anastomosis.

Pull the stitch and needle through the aorta.

Section 19.16 Upper anastomosis with inlay technique (continued)

Step Number
19.16 continued Pass the needle through the graft from the inside to outside, 3mm. from the right lateral tie, 5mm. from the edge of the graft.
Pull the needle and suture through the graft.

Tension the suture to 750gm.

Have the suture held by the first assistant with a dissecting forcep.

Check the suture is holding the anastomosis firmly closed.

19.17 CONTINUE THE ANTERIOR HALF OF THE ANASTOMOSIS
As with the posterior half of the anastomosis, make the stitches 3mm. apart on the graft and correspondingly far apart on the aortic wall to accommodate some bunching of the aorta.

Maintain the 750gm. pull by the assistant. The anastomosis must be firmly closed and watertight.

The anterior aortic wall is likely to be less thickened by atheroma than the posterior wall, so moderate the tension a little to prevent tearing.

If the aorta tears:
   Take more proximal bites and be even more careful with tensioning.

If there is still tearing:
   Use patches of graft to bolster the tissues.

19.18 FINISH THE UPPER ANASTOMOSIS
There is no need to vent the anastomosis to remove debris from the aorta. Any such material will pass below the anastomosis when the aortic clamp is released momentarily.

After the last stitch is inserted:
   Remove the needle from the anterior suture line and the needle from the left suture.

   To avoid needle stick injuries, make sure the nurse takes hold of the loose ends of suture with an artery forcep, 5cm. away from the needles.

   She/he should cut the sutures off together with the 2 needles.

   Tie the ends of the left and right hand sutures on the outside of the graft and the outside of the aorta.

   Use a double first throw with a 750gm. pull.

Section 19.18 Upper anastomosis with inlay technique (continued)

Step
Number 19.18 continued

Finish off with 4 locking throws (1500 gm.).

Cut the free ends 10mm. long.
Insert an extra stitch at the end of the anastomosis if needed to ensure a watertight anastomosis.

19.19 TEST THE UPPER ANASTOMOSIS
This is the same procedure as for a transection technique.
Warn the anaesthetist that there may be some blood loss.
The anaesthetist will be prepared to increase blood replacement to compensate for this.

19.20 CLAMP OFF THE GRAFT
To avoid blood loss:
Place a second Satinsky clamp 2cm. below the anastomosis on a straight graft.
Place O’Shaughnessy forceps on the limbs of a Y graft 5cm. from the trunk.

19.21 PART OPEN THE AORTIC CLAMP
Cautiously partly open the aortic clamp so that the proximal graft fills with blood.
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.
Release the clamp later in stages according to the cardiac state.

19.22 CONTROL ANY BLEEDING
The procedures described below apply to all anastomotic bleeds in this operation.
There will be MINOR, MODERATE, SERIOUS or ZERO bleeding from the anastomotic line or from tears in the aortic wall.
MINOR bleeding is the most common situation for an elective operation.
Place a gauze swab around accessible parts of the anastomosis.
Cover the swabs with large gauze packs.
Press on the packs for 3 minutes.

Section 19.22 Upper anastomosis with inlay technique (continued)
Step Number 19.22 continued
Remove the packs and swabs slowly, and inspect the anastomosis.
If there is continued minor bleeding, or less bleeding:
Place a cellulose gauze on the bleeding area.

Recover the area with a swab and a pack.

Press on the area for a further 3 minutes.

Repeat until the anastomosis is dry.

Even rather vigorous bleeding will stop using swabs and gauzes, a little pressure, and waiting for blood clotting to close defects in the anastomotic lines

MODERATE bleeding from minute gaps in the anastomotic line is the most common when operating on a leaking aneurysm.

It amounts to blood welling up to the level of the top of the anastomosis within 5-10 seconds.

This will stop as the gaps block with thrombus in 2 or 3 minutes.

Close off the clamp.

Tuck 2 pieces of surgical cellulose around the anastomosis and press a gauze swab on top.

Wait 3 minutes.

Partly open the clamp.

If the bleeding is less:

Repeat the reclamping and packing until the anastomosis is dry.

Open the aortic clamp completely.

If the bleeding is less:

Repeat the reclamping and packing until the anastomosis is dry.

If there is no bleeding:

Go to Step 19.23 Reapply the aortic clamp

If there is the same or more bleeding:

Repeat the packing.

Section 19.22 Upper anastomosis with inlay technique (continued)

Step Number 19.22 continued

When the anastomosis is dry.

Go to Step 19.23 Reapply the aortic clamp

If the bleeding continues:
Check the patient’s clotting status.

Correct deficiencies with fresh frozen plasma and, if necessary, platelets.

Look for anatomical causes as below.

SERIOUS bleeding will be lethal if allowed to continue. This amounts to blood welling up to the level of the top of the anastomosis within 1-2 seconds.

Look for blood spurting through a larger anastomotic gap or a tear in the aorta.

Close the clamp.

Stitch the gap or tear with vascular stitches of 3/0 polypropylene (eg Ethicon W8522).

Reopen the clamp partly
   If the bleeding is less:
      Reclamp and tuck surgical cellulose around the anastomosis.

Repeat the reclamping and packing until the anastomosis is dry.

Fully open the aortic clamp.
   If there is no bleeding:
      Go to Step 19.23 Reapply the aortic clamp

   If the bleeding is the same or worse:
      Suspect a major gap or tear.

Reapply the clamp.

Find out where the bleeding is coming from.

Elevate the graft to examine the posterior and lateral parts of the anastomosis.

Insert vascular stitches to seal off leaking areas.

Section 19.22 Upper anastomosis with inlay technique (continued)

Step Number 19.22 continued

Stitch beyond the first suture line to avoid needle damage to the first line.
Use mattress stitches if the aortic tissues are cutting out.

Bolster mattress stitches with spare patches of graft to prevent the suture cutting through the aorta.

Keep calm.

These stitches have to pass through the aorta and the graft in one bite, so they are more difficult to do than those in the first anastomotic line.

Part release the aortic clamp
If there is still major bleeding:
Reapply the clamp.

Apply a higher aortic clamp and remove the lower one to obtain a longer length of acceptable aorta.
Restitch the leaking site(s).

Consider taking down the anastomosis and starting anew.

Insert a Foley balloon into the lumen to obtain higher and healthier aorta for a reanastomosis.

Your stitching ability will be tested to the limits.

Consider stitching the aorta off and performing an axillo-bifemoral graft.

Consider packing the bleeding area with a 6 metre pack, led out of the abdomen via a separate stab incision. If the patient survives, removal of the pack at a second look operation at 24-48 hours is feasible.

Section 19.22 Upper anastomosis with inlay technique (continued)

In 15-20% of leaking aneurysms, the extent of the disease, the effects of blood loss, clotting failure and general frailty of the patient may prove too much for any surgical technique.
The same applies for 1-2% of elective aneurysms.

You can only do your best.

The patient may develop a severe bradycardia or other dysrhythmia at any stage in the operation and die on the table.

In the presence of continued severe bleeding at this point, a joint decision with the anaesthetist may be needed at this stage about stopping the operation.

**ZERO bleeding** is uncommon.

If there is no leakage of blood:

- Open the aortic clamp fully, but do not move it out of position.
- Check that the patient’s blood pressure is over 100 mm. mercury.
  - If not:
    - Wait for the anaesthetist to raise the blood pressure.
- Check that the squeezed aortic walls have not stuck together after the clamp has been part opened.
  - Massage the walls to open any adhesive effect.
- Be ready to reapply the clamp.
- Check the blood in the aorta has not clotted.
  - Massage any blood clot out.
- Be ready to reapply the clamp.
- If there is still no leakage:
  - Continue the next step.

19.23 **FULLY OPEN THE AORTIC CLAMP**

Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state.

**Section 19.23 Upper anastomosis with inlay technique (continued)**

Step Number
19.23 continued If there is bleeding:
Manage bleeding as for a partly open aortic clamp.

Go to Step 18.17 Check for bleeding.
When there is no more bleeding:
Read on.

19.24 REAPPLY THE AORTIC CLAMP

19.25 REMOVE THE GRAFT CLAMP(S)

19.26 SUCK OUT BLOOD CLOT AND DEBRIS FROM INSIDE THE AORTA
Use a Yankauer sucker.

19.27 FLUSH THE GRAFT
Use heparin/saline to remove any fragments of blood clot.

You are now ready to start the lower anastomosis.

Go to Section 20.00 Lower anastomosis with aortic transection

Or to Section 21.00 Lower anastomosis with inlay technique graft

Or to Section 22.00 Lower anastomosis with Y graft
Section 20.00 Lower anastomosis with aortic transection

Step Number

20.01 INTRODUCTION

The lower anastomosis may take an hour or more.

The technique is very similar to the aortic transection for the upper anastomosis.

The lower aorta is dissected free and is transected just above the bifurcation.

An end-to-end anastomosis is made between the lower end of the graft and the lower end of the aorta.

As in the upper anastomosis, the procedure in principle consists of:

- Insertion of a mattress suture at 3 o’clock and one at 9 o’clock.

- Making the posterior half of the anastomosis, followed by the anterior half.

- Using two sutures with two needles on each suture.

- Differences in the detail from the transection technique for the upper anastomosis will be described in the text.

  Eg Obtaining access when the graft cannot be flipped up.

  Suturing technique with the aorta lying distally and the graft proximally.

  Making a vent in the anastomosis.

  Venting will remove thrombus and debris from the graft, aorta and iliac vessels before the lower anastomosis is closed.

20.02 DISSECT THE LOWER AORTA FREE

Use dissecting scissors, an O’Shaughnessey forcep, or the tip of a sucker.

Free 20mm. of the lowest part of the aorta.

Dissect the section of aorta off:

  - The vena cava on the right.

  - The lumbar veins posteriorly.

  - The left ureter on the left.

  - Preserve the autonomic nerves of the aortic plexus and the hypogastric plexus/ presacral nerves, if possible.

Section 20.03 Lower anastomosis with aortic transection (continued)
Step Number

20.03 CHECK THE LOWER AORTA IS MOBILISED POSTERIORLY
Pass an O’Shaughnessy forcep round the back of the aorta.

If not completely free:
Complete the dissection with the forcep.

If there is bleeding from lumbar veins:
Control this with 5 minutes packing with a swab.

If bleeding continues:
Maintain the packing for longer

Consider an inlay technique.
Go to Section 21.00 Upper anastomosis with inlay technique

If the aorta cannot be freed off sufficiently:
Consider an inlay technique if the distal aorta only has minor atheromatous disease.
Go to Section 21.00 Lower anastomosis with inlay technique.

Consider an aorto-bifemoral graft if the distal aorta has moderate to severe atheromatous disease.
Go to Section 22.00 Lower anastomosis with Y graft.

20.04 EXTEND THE OPENING IN THE ANEURYSM
Use Metzenbaum scissors.

Extend the opening in the aneurysm down to the lower aorta 2cm. above the bifurcation.

This is where the aorta will be transected.

20.05 TRANSECT THE AORTA
Use long Metzenbaum scissors.

Use the lower end of the longitudinal opening in the aneurysm and aorta.

Cut right through the aorta transversely and perpendicular to its long axis.

Beware of residual lumbar veins behind the aorta.

20.06 CLEAR OUT THE AORTA AND ILIAC VESSELS
Remove thrombus and debris from inside the vessels as far as the iliac clamps.
Use swabs, heparinised saline and a sucker.

Section 20.07 Lower anastomosis with aortic transection (continued)
Step
Number
20.07 CHECK HAEMOSTASIS INSIDE THE ANEURYSMAL SAC
You must have control of all bleeding from inside the aneurysm before starting the anastomosis. If left, any bleeding here is likely to get worse and obscure the anastomoses.

Readjust the clamps and oversew lumbar vessels as needed.

There is often some minor overspill from any retroperitoneal haematoma or minor vessels outside the aneurysm. Control this by tucking in gauze swabs and with the sucker as needed.

If necessary, tie off or repair bleeding vessels.

20.08 CHECK THE INFERIOR MESENTERIC ARTERY HAEMOSTASIS
Sometimes this artery does not bleed until this point in the operation, when the blood volume has been restored.

If the artery bleeds now:
Ligate the vessel with 2/0 Vicryl (eg Ethicon W9125).

20.09 CHECK THE ILIAC ARTERIES AGAIN
Part open the iliac artery clamp on each side in turn to confirm that there is back bleeding.

If there is back bleeding from each iliac artery:
Anticoagulate the iliac arteries again.
Use the 20ml. syringe with a bulb adapter (blob) containing heparin saline.

Temporarily open each iliac clamp in turn to flush 3 syringefuls of heparin saline down each iliac artery.

If there is no back bleeding from one or both iliac arteries:
Go back to Section 12.00 Checking the iliac arteries.

20.10 CHECK THE AORTIC BIFURCATION
Make sure your decision to insert a straight graft was correct.

The bifurcation should be between 18 and 25mm. in diameter for anastomosis with a straight graft.
If not:
Consider using a trouser graft.
This will mean anastomosing a Y graft end-to-end onto the uppermost 5cm. of the inserted straight graft.

Section 20.11 Lower anastomosis with aortic transection (continued)
Step
Number

20.11 REMOVE ANY ATHEROMATOUS PLAQUES FROM THE AORTIC BIFURCATION

Use dissecting scissors and artery forceps.

Any residual plaques may prevent a watertight joint between the graft and the aorta.

20.12 LAY THE GRAFT IN THE ANEURYSM SAC

This is in preparation for cutting the graft to a correct length.

The site of cutting the graft has to make allowance for the lengthening that happens when the graft is filled with arterial blood.

20.13 PULL THE GRAFT DISTALLY DOWN TO THE AORTA

Use vascular dissecting forceps.

Pull the graft distally at 1000gm.

The graft will lengthen 1 – 2 cm., which is an estimate of the lengthening when full of blood at arterial pressure.

20.14 CHECK THE ORIENTATION OF THE GRAFT

Check that the trunk of the graft is not twisted.

A twist in a graft will obstruct the blood flow.

A graft sutured in place with a twist in it will have to be cut, derotated, and resutured.

Check the orientation lines on the graft are in line with the aorta and distal vessels.

Identify the 3 and 9 o’clock positions on both the graft and the aorta.

20.15 CUT THE GRAFT

Use stitch scissors.

With the traction maintained, cut the graft straight across at the site of a transverse ridge.

20.16 CHECK THE LENGTH OF THE CUT GRAFT

Pull the graft distally to reach the end of the aorta.

Use a 1000gm. pull.

If the graft seems slack:

Cut off redundant graft.

If the graft needs a 1500gm. pull:

Have it held distally with a right angled De Bakey clamp until the lower anastomosis is complete.

Section 20.16 Lower anastomosis with aortic transection (continued)

Step
This will prevent the excess traction on the first sutures of the distal anastomosis.

If the graft needs more than a 1500gm. pull:
Suture in an extra section of graft.

20.17 INSERT THE FIRST STITCH OF THE ANASTOMOSIS
This is the same as for the upper anastomosis with aortic transection.

Start the anastomosis with a 9 o’clock mattress stitch.
   ie On the right lateral wall of the aorta.

Insert a double needleed 3/0 Polypropylene stitch (eg Ethicon W8522.

Insert the first needle into the right side of the graft from the outside to the inside.
   Take a 2mm. bite on the graft.
   Use the anterior black line to choose the correct 9 o’clock position.

Pull the first needle and half the suture through the graft to minimise cheese wiring the aorta with the next part of the stitch.

Insert the same needle through the right lateral wall of the aorta 10mm. proximal to its cut end, from inside to out.
   Avoid the vena cava laterally.
   Remove calcified atheroma as needed.

Pull the needle and half the suture through the aortic wall.

Half the stitch is now completed.

Insert the second needle through the graft 2mm. from the first.

Pull the second needle and second half of suture through the graft.

Insert the second needle through the aortic wall 3mm. from the first, 7mm. away from the cut end of aorta, from inside to out.

Pull the second needle and second half of the suture through the aorta.

End up with equal lengths of suture so that the knot is in the middle of the suture.

Snug the graft onto the aorta.
20.17 continued
Tie the mattress stitch on the outside of the aorta.

Use a double throw with a 750gm. pull to start.

Follow with 4 throws to lock the stitch (1500 gm. pulls).

Check the knot has not slipped.

Lay the sutures with the 2 needles on the drapes.

| The 2 needles ensures that there is a spare suture if needed. |

20.18 INSERT A 3 O’CLOCK SUTURE
This is the same as for the upper anastomosis.
Ie on the left lateral wall of the aorta.

Insert a mattress suture as for the 9 o’clock stitch.

Lay the sutures lie with the 2 needles on the drapes.

As for the upper anastomosis, the 9 and 3 o’clock sutures, each with 2 needles, means that 3 spare sutures are immediately available for the posterior half of the anastomosis if the first one breaks.

These sutures will flare open the upper end of the graft to fit the lower end of the aorta.

20.19 PULL THE ANTERIOR LIP OF THE GRAFT CEPHALICALLY
Use a vascular forcep held by the first assistant.

This will display the posterior walls of the graft and the aorta.

20.20 START THE POSTERIOR HALF OF THE ANASTOMOSIS
This is the same as for the upper anastomosis.

Use one of the right hand (9 o’clock) sutures and needles.
Keep the others in reserve on the drapes.

Take bites 2mm. apart, 2mm. deep on the graft and 7mm. deep on the aorta.

Insert the stitch backhand from outside to inside on the graft and then inside to out on the aorta.
To stitch forehand, stand on the patient’s right.

Adjust the distance between bites on the aorta to allow for differences in diameter compared with that of the graft.

Section 20.20 Lower anastomosis with aortic transection (continued)
continued  To minimise cheese wiring the aorta:
   Pull the suture through the graft before passing it through the aorta.

Do not pass the needle through the graft and the aorta at the same time.

The bites in this part of the posterior wall must be close enough together to keep the anastomosis watertight.

As in the upper anastomosis, this is the most likely part of the anastomosis to be leaky, and is difficult to correct.

Get it right first time.

Continue stitching until you reach the left hand stitch.

Add an extra stitch rather take a risk of leaving a gap between the last stitch and the left hand stitch.

Avoid including the anterior wall of the aorta in the posterior aortic wall stitches.

Continue until you reach the 3 o’clock suture.

Use a Blalock nerve hook to snug the line of polypropylene sutures down.

Pick out any loops of obviously loose stitches.

Polypropylene sutures do not need to be tight since they will bed into the aorta and graft once the vessels are filled with blood.

20.21 TIE OFF THE POSTERIOR HALF OF THE ANASTOMOSIS
   Remove the needle from the posterior wall suture.

   Remove one needle from the left suture.

   Tie the posterior suture to the needle - free end of the left suture. Five throws.

   Cut the free ends one cm. long.

20.22 START THE ANTERIOR Half OF THE ANASTOMOSIS
   This differs from the upper anastomosis in that a vent is needed for removal of clot and debris.

   Release the forceps holding the anterior wall of the graft.

Section 20.22  Lower anastomosis with aortic transection (continued)
Step number
20.22
continued The anterior walls of the graft and aorta will be lying together.

The anterior aortic wall is likely to be less thickened by atheroma than the posterior wall, and therefore be more delicate.

Moderate the tension a little when suturing, to prevent tearing the aortic wall.

Stand on the patient’s left.

Use the second suture from the right side mattress stitch.

Take bites as for the posterior half of the anastomosis.

Use forehand to pass the needle from outside to inside on the graft and inside to outside on the aortic wall.

If the aorta tears:

Take more distal bites and be even more careful with tensioning.

If there is still tearing:

Use patches of graft to bolster the tissues.

Avoid encroaching on the bifurcation of the aorta.

Adjust the distance between bites so that a dog ear does not develop towards the end of the anastomotic line.

If a dog ear does develop:

Insert extra sutures between the aorta and the graft to close any gaps.

Continue until you are 10mm. from the 3 o’clock stitch.

This will allow a 10mm. gap for venting the graft.

Tighten up the suture line

Use a nerve hook.

20.23 INSERT A LOCK STITCH

The aim is to lock the suture line here so that the suture line made so far remains watertight.

You will be using looser stitches in the final 10mm. of the anastomosis as a vent when releasing the iliac and graft clamps.

To make the lock stitch:

Bring out the needle and suture from the last aortic exit site.

Section 20.23 Lower anastomosis with aortic transection (continued)
Form a loop of suture between the last exit site on the graft site and the last entrance site on the aorta.

Pass the needle and suture through this loop

Snug the lock stitch with a 750gm. pull.

20.24 INSERT 2 LOOSE VENT BITES
Insert them into the last 10mm. of the anastomosis.

These will eventually close the last 10mm. of the anterior wall of the anastomosis.

Keep these bites loose to allow venting of the inside of the graft.

Put one throw on the final knot.
The final knot is between this end of the suture and the end of the 3 o’clock suture.
Keep the ends ready for tying the final suture when the graft has been vented.

20.25 WARN THE ANAESTHETIST AGAIN ABOUT POSSIBLE BLOOD LOSS
This will give the anaesthetist time to provide a reserve of blood volume as blood passes into the lower limbs and to compensate for any blood loss.

Keep the anaesthetist informed of your progress.

Close relevant clamps if the anaesthetist needs more time to correct hypovolaemia or dysrhythmias.

20.26 PREPARE TO CLEAR THE GRAFT OF DEBRIS AND BLOOD CLOT
The aim is to flush out any blood clot, platelet thrombus, atheromatous debris and air out of the graft, the aorta and iliac arteries.

This will prevent their causing emboli when the circulation is fully restored.

This is done by letting such matter flow out of the iliac arteries and out of the subrenal aorta through a partly open lower anastomosis.

20.27 REMOVE ANY SLOOPS FROM ABNORMAL ILIAC ARTERY BRANCHES

20.28 PARTLY OPEN THE LEFT ILIAC ARTERY CLAMP
Do this slowly in case there is bleeding from iliac arterial tears.
continued

Watch blood filling the left iliac artery and the graft, spilling out of the loose part of the lower anastomosis.

If there is no flow up the left iliac artery:
- Check the artery has not remained squashed flat despite the clamp being opened.
- Massage the artery with your fingers to open it up.

Squeeze the left thigh muscles to force blood from branches of the iliac artery up the main vessel.

If there is still no flow:
- The left iliac artery is probably thrombosed or blocked by an embolus.

You need to pass a Fogarty catheter as you did before starting the upper anastomosis.

Use the vent in the anastomosis to pass the Fogarty catheter.

Go to Step 12.03 Check the Fogarty catheter

20.29 CLEAN OUT THE GRAFT AND LEFT COMMON ILIAC ARTERY
   Use a sucker

20.30 FLUSH HEPARIN SALINE DOWN THE LEFT COMMON ILIAC ARTERY
   Do this once back flow is established up the left common iliac artery.
   Use 60ml. heparin saline on a 20ml. syringe plus a bulb ended adaptor.

20.31 RECLAMP THE LEFT COMMON ILIAC ARTERY

20.32 CLEAN OUT THE GRAFT AGAIN
   Use a sucker.

20.33 PARTLY OPEN THE RIGHT COMMON ILIAC ARTERY CLAMP
   Manage the right vessels as you have done for the left vessels above.

   When the right common iliac artery has backflow and has been reheparinised:
   Read on.

20.34 PARTLY OPEN THE AORTIC CLAMP
   Let 20ml. or so of blood run into the graft.

Section 20.35 Lower anastomosis with aortic transection (continued)
20.36 CLEAN OUT THE GRAFT AND THE COMMON ILIAC ARTERIES
Use a sucker.

20.37 FLUSH OUT THE GRAFT AND THE COMMON ILIAC ARTERIES
Use 20ml. heparin saline.

20.38 TIE OFF THE 2 SUTURES ON THE ANASTOMOTIC VENT
Remove the needle from the anterior suture line and the needle from the left suture.

To avoid needle stick injuries, make sure the nurse takes hold of the loose ends of suture with an artery forcep, 5cm. away from the needles.

He/she should cut the sutures off together with the 2 needles.

Tie the ends of the left and right hand sutures on the outside of the graft and the outside of the aorta.
Use a double first throw with a 750gm.pull.

Finish off with 4 locking throws (1500 gm.).
Cut the free ends 10mm. long.

20.39 CHECK THE LOWER ANASTOMOSIS FOR BLEEDING
The pressure in the graft is low because the upper end is still clamped off.

Low pressure blood will be flowing retrogradely up the common iliac arteries.

It is unlikely that there will be more than minor oozing.
Use sutures of 3/0 polypropylene (eg Ethicon W8522) if there is serious bleeding.

The low pressure allows the graft to be retracted sideways for access to the posterior halves of the anastomoses.

Expect more serious bleeding when the upper aortic clamp is opened.

20.40 PART OPEN THE UPPER AORTIC CLAMP
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.
Release the clamp later in stages according to the cardiac state
If there is bleeding:
Manage bleeding as for a partly open aortic clamp.

Section 20.40 Lower anastomosis with aortic transection (continued)
Step Number 20.40 continued
Go to Step 18.17 Check for bleeding.
When there is no more bleeding:
   Read on.

There are two anastomotic lines that may bleed – the upper and the lower.

Keep your hand in the handles of the aortic clamp.

Be ready to close the clamp if there is serious bleeding from either anastomosis.

Tackle bleeding from the upper anastomotic line before the lower anastomosis.
   If the upper aortic clamp has to be reapplied while correcting leakage from the upper anastomotic line:
      The blood in the graft and more distal vessels may clot.

      Clearance of blood clot in this event is usually performed best through a new opening in the middle of the graft.

   If a graft clamp had to be applied while correcting bleeding from the lower anastomosis:
      Again, the blood in the graft and more distal vessels may clot.

      Clear blood clot through a new opening in the middle of the graft.

As the aortic clamp is slowly released:
   The graft will become tense and may bow forwards a little.

   If the graft bows forwards right out of the sac:
      Shorten it by cutting out a section and reanastomosing it.

      Complete the haemostasis of the anastomotic lines before shortening the graft.

As for the upper anastomosis alone, there will be MINOR, MODERATE, SERIOUS or ZERO bleeding from either anastomosis.

For details of procedures to deal with bleeding:
   Go to Step 18.17 Check for bleeding.

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Section 20.40 Lower anastomosis with aortic transection (continued)
Step
Number
20.40
continued

If there is moderate or serious bleeding from the lower anastomosis:
The iliac arteries will need to be clamped off temporarily as well as the aorta.

When reopening the clamps:
Reopen the iliac clamps first.
This will confirm that the lower anastomosis to low pressure blood.

Bleeding from the posterior halves of the anastomoses is particularly dangerous.

Access is very difficult with the graft lying in the aneurysmal sac.

Clamping the aorta will reduce the tenseness in the graft.
This will allow some access to the backs of the anastomoses for vascular stitches.

When there is no longer any bleeding:
Read on.

20.41 FULLY OPEN THE AORTIC CLAMP
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state

If there is bleeding:
Manage bleeding as for a partly open aortic clamp.

Go to Step 18.17 Check for bleeding.

20.42 CHECK THE BLOOD FLOW
A satisfactory blood flow is present if:
The graft, the distal aorta, the iliac arteries and the femoral arteries are all tense and pulsating.

The feet are pink and warm.

The foot veins are full (no guttering).

If all these signs are present and there is zero or minimal bleeding from the anastomoses:
You are well on the way to a successful operation.

Leave any packing of the anastomoses for ten minutes.

Leave one member of the surgical team guarding the operation site.

Section 20.42 Lower anastomosis with aortic transection (continued)

Step Number
20.42 continued Have a cup of coffee.
After 10 minutes:
Go to Section 23.00 Checking for haemostasis

If any of these signs are absent:
There may simply some hypovolaemia or cardiac depression.

If they persist despite correction of blood volume and cardiac function:
Thrombosis or embolism are the most likely causes. Immediate removal of thrombus or emboli is required.

20.43 CHECK THE AORTA AND GRAFT
If there is no expansile pulsation of the aorta or graft:
The blood in the aorta or graft may have clotted. Clotted blood feels semi-solid through the vessel wall.

Aspirate the graft with a 21 SWG needle to check that the blood whether the aorta or graft have clotted.
If the blood is liquid:
Press on the puncture wound until it stops bleeding.
Use a pledget on a stick.

Go to Step 20.45 Check the iliac artery pulses.

If the graft seems to be clotted:
Read on.

20.44 EXPLORING THE AORTA AND GRAFT
Clamp the graft with a small Satinsky clamp.
Open the clamped piece of graft.
Make a 10mm. transverse incision into the graft.
Use a No15 blade on a long handle.
Partly open the clamp.
If there is only liquid blood:
Go to Step 20.45 Check the iliac artery pulses

If there is blood clot:
Clamp the aorta above the upper anastomosis. Ie Where there should be liquid blood running into the renal arteries.

Release the Satinsky clamp.

Section 20.44 Lower anastomosis with aortic transection (continued)
Step Number 20.44 continued
Part open the aortic clamp to flush 20ml. blood down from the subrenal aorta.

Reclose the clamp.
Inject 20ml. of heparin saline into the aorta above the clamp to prevent clotting in the aorta there.

Clear out the graft and aorta with a sucker.

Perform an embolectomy to clear the vessels distally to the popliteal trifurcation.

See Step 12.03 Check a Fogarty catheter

Close the incision in the graft.

Use continuous 2/0 polypropylene (eg Ethicon W8577).

Open the Satinsky clamp.

If there is minor bleeding:
Place a swab on the closure site for 3 minutes until there is no more bleeding.

If there is spurting of blood:
Insert another suture to close the defect.

Place a swab on the closure site for 3 minutes until there is no more bleeding.

Release the aortic clamp.

20.45 CHECK THE ILIAC ARTERY PULSES
This also suggests clotting in the aorta or graft.

Repeat Step 20.43 Exploring the aorta and graft.

20.46 CHECK THE FEMORAL ARTERY PULSES
If they are present:
Go To Section 23.00 Haemostasis

If they are absent:
This suggests clotting or embolism into the iliac arteries.

Perform an embolectomy via the common femoral artery on the same side.
This procedure includes a clearance of the common and external iliac arteries.

Section 20.46 Lower anastomosis with aortic transection (continued)
Step Number
20.46 continued

See Section 26.00 Femoral Embolectomy

20.47 CHECK THE POPLITEAL ARTERY PULSES
Have a skilled non-scrubbed person do this procedure under the drapes.

If they are present:
   Go to Step 20.48 Check the foot warmth, pulses and veins.

If they are not present:
   This may be due to observer error or vasoconstriction.

   Continue the operation, but be prepared to perform femoral embolectomies later in the operation.

   Go To Section 23.00 Haemostasis

20.48 CHECK THE FOOT WARMTH, PULSES AND VEINS
   If the feet are pink and warm (room temperature + 5 degrees or more), dorsalis pedis and posterior tibial arteries are present and the foot veins are filled:
      Go To Section 23.00 Haemostasis

   If not:
      This may be due to observer error or vasoconstriction.

      Continue the operation, but be prepared to perform femoral embolectomies later in the operation.

      Go To Section 23.00 Haemostasis
Section 21.00 Lower anastomosis with inlay technique

21.01 INTRODUCTION

The lower anastomosis may take an hour or more.

The technique is very similar to the inlay technique for the upper anastomosis. See Section 19.00 Upper anastomosis with inlay technique.

The posterior wall of the aorta is maintained. The graft is anastomosed to the inside of posterior wall.

As in the upper anastomosis, the procedure in principle consists of:
- Insertion of a mattress suture at 3 o’clock and one at 9 o’clock.
- Making the posterior half of the anastomosis, followed by the anterior half.
- Using two sutures with two needles on each suture.

Differences in the detail from the transection technique for the upper anastomosis will be described in the text. Eg Obtaining access when the graft cannot be flipped up.

Suturing technique for the aorta lying distally and the graft proximally.

Making a vent in the anastomosis.

21.02 ADJUST THE TRAVERS SELF-RETAINING RETRACTOR

Move the retractor distally to display the lower end of the aneurysm.

Keep the handles distal, to prevent them interfering with the positioning of the graft in the next few steps.

21.03 EXTEND THE OPENING IN THE ANEURYSM LONGITUDINALLY

Use Metzenbaum scissors.

Extend the opening in the aneurysm down to the lower aorta 2cm. above the bifurcation.

This is where the aorta will be transected.

21.04 EXTEND THE OPENING IN THE ANEURYSM TRANSVERSELY

Use Pott’s scissors.

Make a cut across the lowest part of the aneurysm, 20mm. above the bifurcation from 3 o’clock to 9 o’clock.
Section 21.04 Lower anastomosis with aortic transection (continued)

Step Number
21.04 continued This will give access to the “healthy” tissue of the lower aorta for the anastomosis.

21.05 CLEAR OUT THE AORTA AND ILIAC VESSELS
Remove thrombus and debris from inside the vessels as far as the iliac clamps.
Use swabs, heparinised saline and a sucker.

21.06 CHECK HAEMOSTASIS INSIDE THE ANEURYSMAL SAC
As always, you must have control of all bleeding from inside the aneurysm before starting the anastomosis. If left, any bleeding here is likely to get worse and obscure the anastomoses.

Readjust the iliac clamps and oversew lumbar vessels as needed.

There is often some minor overspill from any retroperitoneal haematoma or minor vessels outside the aneurysm. Control this by tucking in gauze swabs and with the sucker as needed.

If necessary, tie off or repair bleeding vessels.

21.07 CHECK THE IliAC ARTERY HAEMOSTASIS
Retighten or reposition the iliac clamps to make sure there is no leakage.
Any bleeding from the iliac arteries will flood the anastomosis, making it very difficult.

21.08 CHECK THE INFERIOR MESENTERIC ARTERY HAEMOSTASIS
Sometimes this artery does not bleed until this point in the operation, when the blood volume has been restored.
Ligate the vessel with 2/0 Vicryl (eg Ethicon W9125) if it bleeds now.

21.09 CHECK THE ILIAC ARTERIES AGAIN
Part open the iliac artery clamp on each side in turn to confirm that there is back bleeding.

If there is back bleeding from each iliac artery:
Anticoagulate the iliac arteries again.
Use the 20ml syringe with a bulb adapter (blob) containing heparin saline.

Temporarily open each iliac clamp in turn to flush 3 syringefuls of heparin saline down each iliac artery.

If there is no back bleeding from one or both iliac arteries:
Go back to Section 13.00 Checking the iliac arteries

Section 21.09 Lower anastomosis with inlay technique(continued)
Step Number

21.10 CHECK THE AORTIC BIFURCATION
Make sure your decision to insert a straight graft was correct.

The bifurcation should be between 16 - 22mm. in diameter for anastomosis with a straight graft.

If not:

Consider using a trouser graft.
This will mean anastomosing a Y graft end-to-end onto the uppermost 5cm. of the inserted straight graft.

21.11 REMOVE ANY ATHEROMATOUS PLAQUES FROM THE BIFURCATION
Use dissecting scissors and artery forceps.

Any residual plaques may prevent a watertight joint between the graft and the aorta.

21.12 LAY THE GRAFT IN THE ANEURYSM SAC
This is in preparation for cutting the graft to a correct length.

21.13 CHECK THE ORIENTATION OF THE GRAFT
Check that the trunk of the graft is not twisted.
A twist in a graft will obstruct the blood flow.

A graft sutured in place with a twist in it will have to be cut, derotated, and resutured.

Check the orientation lines on the graft are in line with the aorta and distal vessels.

Identify the 3 and 9 o’clock positions on both the graft and the aorta.

21.14 PULL THE GRAFT DISTALLY DOWN TO THE AORTA
Use vascular dissecting forceps.

The graft will lengthen 1 – 2 cm., which is an estimate of the lengthening when full of blood at arterial pressure.

21.15 CUT THE GRAFT
Use stitch scissors.

With the traction maintained, cut the graft straight across at the site of a transverse ridge.

21.16 CHECK THE LENGTH OF THE GRAFT
Pull the graft distally to reach the end of the aorta.
Use a 1000 gm. pull.

Section 21.16 Lower anastomosis with inlay technique(continued)
Step Number
21.16 continued

Cut the graft shorter if it seems slack.

If the graft needs a 1500 gm. pull:
   Have it held distally with a right angled De Bakey clamp until the lower anastomosis is complete.
   This will prevent the excess traction on the first sutures of the distal anastomosis.

If the graft needs more than a 1500 gm. pull:
   Suture in an extra section of graft.

Section 21.17 Lower anastomosis with inlay technique

21.17 INSERT THE FIRST STITCH OF THE LOWER ANASTOMOSIS

This is the same as for the upper anastomosis.

To minimise the risk of delaminating the aorta:
   Take bites of the aorta before inserting stitches through the graft.
   This will require backhand stitching if the surgeon is standing on the patient’s left.
   The stitches can be inserted forehand if the surgeon moves to the patient’s right hand side.

Start with a 9 o’clock mattress stitch.
   ie Into the right lateral wall of the aorta.

Choose a site 5mm. posterior to the transverse cut across the anterior aortic wall.

Insert the first needle deeply into the interior of the right lateral wall of the aorta, 5mm. proximal to its bifurcation.

Bring the needle out of the interior of the aorta 15mm. proximal to its bifurcation.
   Remove calcified atheroma as needed.

Pull the needle and half the suture through the aorta to minimise cheese wiring the aorta.

Insert the first needle into the right side of the graft from inside to outside.

Take a 2mm. bite on the graft to include the widest part of the transverse ridges.
   Use the anterior black line to choose the correct 9 o’clock position.
   Pull the needle and half the suture through the graft.

Half the mattress stitch is finished.
Insert the second needle into the aorta 5mm. from the first bite, 5mm. proximal to the bifurcation.

Bring out the second needle 15mm. proximal to the bifurcation line.

Pull this needle and half of the suture through the aorta.

With this second needle, take a 2mm. bite through the graft 2mm. from the first half of the stitch from inside to outside.

Pull the needle and half of the suture through the graft.

End up with equal lengths of suture so that the knot will be in the middle of the suture.

Snug the graft onto the aorta.

Tie the mattress stitch on the outside of the graft. Use a double throw with a 750gm. pull to start.

Follow with 4 throws to lock the stitch (1500 gm. pulls).

Check the knot has not slipped.

Lay the sutures with the 2 needles on the drapes.

**21.18 INSERT A 3 O’CLOCK SUTURE.**

This is the same as for the upper anastomosis. Ie on the left lateral wall of the aorta.

As for the 9 o’clock stitch, use the intact aortic wall, 2mm. posterior to the anterior cut in the aorta.

Insert a mattress suture as for the 9 o’clock stitch.

Lay the suture with the 2 needles on the drapes.

As for the upper anastomosis, the 9 and 3 o’clock sutures, each with 2 needles, means that 3 spare sutures are immediately available for the posterior half of the anastomosis if the first one breaks.

These sutures will flare open the upper end of the graft to fit the lower end of the aorta.

**21.19 PULL THE ANTERIOR LIP OF THE GRAFT CEPHALICALLY**

Use a vascular forcep held by the first assistant. This will display the posterior walls of the graft and the aorta.

---

Section 21.20 Lower anastomosis with inlay technique(continued)
21.20 START THE POSTERIOR HALF OF THE LOWER ANASTOMOSIS

This is largely the same as for the upper anastomosis.

Use one of the right hand (9 o’clock) sutures and needles.
Keep the others in reserve on the drapes.

This is a backhand stitch.
To stitch forehand, stand on the patient’s right.

Place bites through the graft from outside to inside, and into the inside of the aorta.

Place bites 2mm. apart on the graft.

Adjust the distance between bites on the aorta to allow for differences in diameter compared with that of the graft.

Place the bites 10mm. deep on the aorta and 2mm. from the edge of the graft.

To minimise cheese wiring the aorta:
Pull the suture through the aorta before passing it through the graft.

Do not pass the needle through the graft and the aorta at the same time.

If the aorta tears:
Take deeper bites more distally.

Use patches of graft material to bolster the aorta.

The bites in this part of the posterior wall must be close enough together to keep the anastomosis watertight.

As in the upper anastomosis, this is the most likely part of the anastomosis to be leaky, and is difficult to correct.

Get it right first time.

Continue stitching until you reach the left hand stitch.

Add an extra stitch rather take a risk of leaving a gap between the last stitch and the left hand stitch.

Use a Blalock nerve hook to snug the line of polypropylene sutures down.
Pick out any loops of obviously loose stitches.

Section 21.20 Lower anastomosis with inlay technique(continued)
continued Polypropylene sutures do not need to be tight since they will bed into the aorta and graft once the vessels are filled with blood.

21.21 TIE OFF THE POSTERIOR HALF OF THE ANASTOMOSIS
Remove the needle from the posterior wall suture.
Remove one needle from the left suture.
Tie the posterior suture to the needle - free end of the left suture.
Five throws.
Cut the free ends one cm. long.

21.22 CLEAN OUT THE GRAFT
Use a sucker to remove any blood clot and debris that may have gathered in the graft, iliac arteries and the aortic stump during this half of the anastomosis.

21.23 FLUSH THE GRAFT WITH HEPARIN SALINE
Use 20 ml. of heparin saline to prevent clotting of any blood seeping into the graft during the second half of the anastomosis.
Suck out the heparin saline.

21.24 START THE ANTERIOR HALF OF THE LOWER ANASTOMOSIS
This is the same as the anterior half of the upper anastomosis.

It is an end-to-end technique, whereas the posterior half is the inlay technique.

As with the upper anastomosis, make sure that there are no gaps at the junction between the inlay posterior half and the end to end anterior half of the anastomosis.

Release the forceps holding the anterior wall of the graft.
The anterior walls of the graft and aorta will be lying together.
The anterior aortic wall is likely to be less thickened by atheroma than the posterior wall, and therefore be more delicate.
Moderate the tension a little when suturing, to prevent tearing the aortic wall.

Use the 9 o’clock right hand needle and suture.
Bite into the graft from the outside, 5mm. from the graft edge and 7mm. from the 9 o’clock stitch.
Pull the needle and suture through the inside of the graft.

Section 21.24 Lower anastomosis with inlay technique(continued)
continued  Stitch through the anterior wall of the aorta 10mm. proximal to the bifurcation from inside to outside.

Bring the needle out of the outside of the bifurcation.
If the outside wall of the aorta is not accessible for the needle to emerge:
Use internal stitches until the outside was is accessible.

Continue suturing until you are 10mm. from the left hand stitch.

21.25 INSERT A LOCK STITCH
The aim is to lock the suture line here so that the suture line made so far remains watertight.

You will be using looser stitches in the final 10mm. of the anastomosis as a vent when releasing the iliac and graft clamps.

To make the lock stitch:
Bring out the needle and suture from the last aortic exit site.

Form a loop of suture between the last exit site on the graft site and the last entrance site on the aorta.
Pass the needle and suture through this loop

Snug the lock stitch with a 750gm. pull.

21.26 INSERT 2 LOOSE VENT BITES
Insert them into the last 10mm. of the anastomosis.

These will eventually close the last 10mm. of the anterior wall of the anastomosis.

Keep these bites loose to allow venting of the inside of the graft.

Put one throw on the final knot.
The final knot is between this end of the suture and the end of the 3 o’clock suture.

Keep the ends ready for tying the final suture when the graft has been vented.

21.27 WARN THE ANAESTHETIST AGAIN ABOUT POSSIBLE BLOOD LOSS
This will give the anaesthetist time to provide a reserve of blood volume as blood passes into the lower limbs and to compensate for any blood loss.

Keep the anaesthetist informed of your progress.

Section 21.27  Lower anastomosis with aortic transection (continued)
continued Close relevant clamps if the anaesthetist needs more time to correct hypovolaemia or dysrhythmias.

21.28 PREPARE TO CLEAR THE GRAFT OF DEBRIS AND BLOOD CLOT
The aim is to flush out any blood clot, platelet thrombus, atheromatous debris and air out of the graft, the aorta and iliac arteries.

This will prevent their causing emboli when the circulation is fully restored.

This is done by letting such matter flow out of the iliac arteries and out of the subrenal aorta through a partly open lower anastomosis.

21.29 REMOVE ANY SLOOPS FROM ABNORMAL ILIAC ARTERY BRANCHES

21.30 PARTLY OPEN THE LEFT ILIAC ARTERY CLAMP
Do this slowly in case there is bleeding from iliac arterial tears.

Watch blood filling the left iliac artery and the graft, spilling out of the loose part of the lower anastomosis.

If there is no flow up the left iliac artery:
Check the artery has not remained squashed flat despite the clamp being opened.

Massage the artery with your fingers to open it up.

Squeeze the left thigh muscles to force blood from branches of the iliac artery up the main vessel.

If there is still no flow:
The left iliac artery is probably thrombosed or blocked by an embolus.

You need to pass a Fogarty catheter as you did before starting the upper anastomosis.

Use the vent in the anastomosis to pass the Fogarty catheter.
Go to Step 12.03 Check the Fogarty catheter

21.32 CLEAN OUT THE GRAFT AND LEFT COMMON ILIAC ARTERY
Use a sucker

21.33 FLUSH HEPARIN SALINE DOWN THE LEFT COMMON ILIAC ARTERY

Section 21.33 Lower anastomosis with aortic transection (continued)
continued Do this once back flow is established up the left common iliac artery.
Use 60ml. heparin saline on a 20ml. syringe plus a bulb ended adaptor.

21.34 RECLAMP THE LEFT COMMON ILIAC ARTERY

21.35 CLEAN OUT THE GRAFT AGAIN
Use a sucker.

21.36 PARTLY OPEN THE RIGHT COMMON ILIAC ARTERY CLAMP
Manage the right vessels as you have done for the left vessels above.

When the right common iliac artery has backflow and has been reheparinised:
Read on.

21.37 PARTLY OPEN THE AORTIC CLAMP
Let 20ml. or so of blood run into the graft.

21.38 RECLAMP THE AORTA

21.39 CLEAN OUT THE GRAFT AND THE COMMON ILIAC ARTERIES
Use a sucker.

21.40 FLUSH OUT THE GRAFT AND THE COMMON ILIAC ARTERIES
Use 20ml. heparin saline.

21.41 TIE OFF THE 2 SUTURES ON THE ANASTOMOTIC VENT
Remove the needle from the anterior suture line and the needle from the left suture.

To avoid needle stick injuries, make sure the nurse takes hold of the loose ends of suture with an artery forcep, 5cm. away from the needles.
He/she should cut the sutures off together with the 2 needles.

Tie the ends of the left and right hand sutures on the outside of the graft and the outside of the aorta.
Use a double first throw with a 750gm pull.

Finish off with 4 locking throws (1500 gm.).

Cut the free ends 10mm. long.

21.42 CHECK THE LOWER ANASTOMOSIS FOR BLEEDING
The pressure in the graft is low because the upper end is still clamped off.

Section 21.42 Lower anastomosis with aortic transection (continued)
continued

Low pressure blood will be flowing retrogradely up the common iliac arteries.

It is unlikely that there will be more than minor oozing. Use sutures of 3/0 polypropylene (eg Ethicon W8522) if there is serious bleeding.

The low pressure allows the graft to be retracted sideways for access to the posterior halves of the anastomoses.

Expect more serious bleeding when the upper aortic clamp is opened.

21.43 PART OPEN THE UPPER AORTIC CLAMP
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state.

There are two anastomotic lines that may bleed – the upper and the lower.

Keep your hand in the handles of the aortic clamp.

Be ready to close the clamp if there is serious bleeding from either anastomosis.

Tackle bleeding from the upper anastomotic line before the lower anastomosis.

If the upper aortic clamp has to be reapplied while correcting leakage from the upper anastomotic line:

The blood in the graft and more distal vessels may clot.

Clearance of blood clot in this event is usually performed best through a new opening in the middle of the graft.

If a graft clamp had to be applied while correcting bleeding from the lower anastomosis:

Again, the blood in the graft and more distal vessels may clot.

Clear blood clot through a new opening in the middle of the graft.

As the aortic clamp is slowly released:

The graft will become tense and may bow forwards a little.

Section 21.43 Lower anastomosis with aortic transection (continued)

If the graft bows forwards right out of the sac:
Shorten it by cutting out a section and reanastomosing it.

Complete the haemostasis of the anastomotic lines before shortening the graft.

As for the upper anastomosis alone, there will be MINOR, MODERATE, SERIOUS or ZERO bleeding from either anastomosis.

For details of procedures to deal with bleeding: Go to Step 18.17 Check for bleeding.

If there is moderate or serious bleeding from the lower anastomosis:
The iliac arteries will need to be clamped off temporarily as well as the aorta.

When reopening the clamps:
Reopen the iliac clamps first.
This will confirm that the lower anastomosis to low pressure blood.

Bleeding from the posterior halves of the anastomoses is particularly dangerous.

Access is very difficult with the graft lying in the aneurysmal sac.

Clamping the aorta will reduce the tenseness in the graft.
This will allow some access to the backs of the anastomoses for vascular stitches.

When there is no longer any bleeding:
Read on.

21.44 FULLY OPEN THE AORTIC CLAMP
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state

If there is bleeding:
Manage bleeding as for a partly open aortic clamp.

Go to Step 18.17 Check for bleeding.

When there is no more bleeding:
Read on.

Section 21.45 Lower anastomosis with aortic transection (continued)
Step Number
21.45 CHECK THE BLOOD FLOW
A satisfactory blood flow is present if:
The graft, the distal aorta, the iliac arteries and the femoral arteries are all tense and pulsating.

The feet are pink and warm.

The foot veins are full (no guttering).

If all these signs are present and there is zero or minimal bleeding from the anastomoses:
You are well on the way to a successful operation.

Leave any packing of the anastomoses for ten minutes.

Leave one member of the surgical team guarding the operation site.

Have a cup of coffee.

After 10 minutes:
Go to Section 23.00 Checking for haemostasis

If any of these signs are absent:
There may simply some hypovolaemia or cardiac depression.

If they persist despite correction of blood volume and cardiac function:
Thrombosis or embolism are the most likely causes.

Immediate removal of thrombus or emboli is required.

21.46 CHECK THE AORTA AND GRAFT
If there is no expansile pulsation of the aorta or graft:
The blood in the aorta or graft may have clotted.
Clotted blood feels semi-solid through the vessel wall.

Aspirate the graft with a 21 SWG needle to check that the blood whether the aorta or graft have clotted.
If the blood is liquid:
Press on the puncture wound until it stops bleeding.
Use a pledget on a stick.

Go to Step 21.44 Check the iliac artery pulses.

If the graft seems to be clotted:
Read on.

Section 21.47 Lower anastomosis with aortic transection (continued)
Step Number
21.47 EXPLORING THE AORTA AND GRAFT
Clamp the graft with a small Satinsky clamp.
Open the clamped piece of graft.
Make a 10mm. transverse incision into the graft.
Use a No15 blade on a long handle.

Partly open the clamp.
If there is only liquid blood:
Go to **Step 20.45 Check the iliac artery pulses**

If there is blood clot:
Clamp the aorta above the upper anastomosis.
Ie Where there should be liquid blood running into the renal arteries.

Release the Satinsky clamp.
Part open the aortic clamp to flush 20ml. blood down from the subrenal aorta.
Reclose the clamp.

Inject 20ml. of heparin saline into the aorta above the clamp to prevent clotting in the aorta there.

Clear out the graft and aorta with a sucker.
Perform an embolectomy to clear the vessels distally to the popliteal trifurcation.
**See Step 12.03 Check a Fogarty catheter**

Close the incision in the graft.
Use continuous 2/0 polypropylene (eg Ethicon W8577).

Open the Satinsky clamp.
If there is minor bleeding:
Place a swab on the closure site for 3 minutes until there is no more bleeding.
If there is spurting of blood:
Insert another suture to close the defect.
Place a swab on the closure site for 3 minutes until there is no more bleeding.
Release the aortic clamp.

**Section 21.48 Lower anastomosis with aortic transection (continued)**
Step Number
21.48 **CHECK THE ILIAC ARTERY PULSES**
This also suggests clotting in the aorta or graft.

**Repeat Step 21.47 Exploring the aorta and graft.**
21.49  CHECK THE FEMORAL ARTERY PULSES
   If they are present:
       Go To Section 23.00 Haemostasis
   If they are absent:
       This suggests clotting or embolism into the iliac arteries.
       Perform an embolectomy via the common femoral artery on the
       same side.
       This procedure includes a clearance of the common and
       external iliac arteries.
       See Section 26.00 Femoral Embolectomy

21.50  CHECK THE POPLITEAL ARTERY PULSES
   Have a skilled non-scrubbed person do this procedure under the
   drapes.
   If they are present:
       Go to Step 21.51 Check the foot warmth, pulses and
       veins.
   If they are not present:
       This may be due to observer error or vasoconstriction.
       Continue the operation, but be prepared to perform
       femoral embolectomies later in the operation.
       Go To Section 23.00 Haemostasis

21.51  CHECK THE FOOT WARMTH, PULSES AND VEINS
   If the feet are pink and warm (room temperature + 5 degrees or
   more), dorsalis pedis and posterior tibial arteries are present and
   the foot veins are filled:
       Go To Section 23.00 Haemostasis
   If not:
       This may be due to observer error or vasoconstriction.
       Continue the operation, but be prepared to perform
       femoral embolectomies later in the operation.
       Go To Section 23.00 Haemostasis
Section 22.00 – Lower anastomoses with bifemoral grafts

22.01 INTRODUCTION
The lower anastomoses may take an hour or more.

Ties may need to be placed around vessels associated with other more distal aneurysms.

See Step 10.07 Technique for isolating distal aneurysms.

The femoral arteries have been exposed and the vascular tunnels have been made.

A Y graft has been inserted successfully into the upper aorta.

The Y graft is lying in the aneurysm sac together with the upper parts of the two limbs of the graft.

The next steps are to feed the limbs of the grafts down the vascular tunnels for anastomosis to the femoral arteries.

These procedures are usually much less difficult than the operation so far.

22.02 CLEAR OUT THE AORTA AND ILIAC VESSELS
Remove thrombus and debris from inside the vessels as far as the iliac clamps.
Use swabs, heparinised saline and a sucker.

22.03 CHECK HAEMOSTASIS INSIDE THE ANEURYSMAL SAC
You must have control of all bleeding from inside the aneurysm before starting the anastomosis. If left, any bleeding here is likely to get worse and obscure the anastomoses.

Readjust the clamps and oversew lumbar vessels as needed.

There is often some minor overspill from any retroperitoneal haematoma or minor vessels outside the aneurysm. Control this by tucking in gauze swabs and with the sucker as needed.

If necessary, tie off or repair bleeding vessels.

22.04 CHECK THE INFERIOR MESENTERIC ARTERY HAEMOSTASIS
Sometimes this artery does not bleed until this point in the operation, when the blood volume has been restored.

If the artery bleeds now:
Ligate the vessel with 2/0 Vicryl (eg Ethicon W9125).

22.05 CHECK THE ILIAC ARTERIES AGAIN
Part open the iliac artery clamp on each side in turn to confirm that there is back bleeding.

If there is back bleeding from each iliac artery:
Section 22.05 – Lower anastomoses with bifemoral grafts

Step Number 22.05 continued

Anticoagulate the iliac arteries again.

Use the 20ml. syringe with a bulb adapter (blob) containing heparin saline.

Temporarily open each iliac clamp in turn to flush 3 syringefuls of heparin saline down each iliac artery.

If there is no back bleeding from one or both iliac arteries:

Go back to Section 12.00 Checking the iliac arteries

22.06 PASS THE LEFT LIMB OF THE GRAFT THROUGH THE LEFT TUNNEL

Pass an O’Shaughnessy forcep up the left iliac tunnel.

Pass your right index finger down the tunnel to touch the tip of the forcep as a guide.

Have the forcep emerge at the upper end of the tunnel.

Grasp the end of the left limb of the graft with the O’Shaughnessy forcep.

Avoid rotation of the graft by seeing that the anterior longitudinal markings on the limb of the graft stay in line.

Pull the limb through the tunnel and out into the groin wound.

Check again that there is no rotation of the graft.

Pull on the limb of the graft to tension the limb in the tunnel. This will prevent the limb looping into the abdomen when full of blood under arterial pressure.

It will also relieve the distal anastomosis of tension as it is stitched.

Use a 1000 gm. pull.

Hold the tension by clamping the limb as it emerges from under the inguinal ligament into the groin wound.

Use an O’Shaughnessy forcep with the handles lying on the abdominal wall.

22.07 REPEAT ON THE RIGHT HAND SIDE.

22.08 CLAMP OFF THE RIGHT LIMB OF THE GRAFT

Place an O’Shaughnessy forcep across the origin of the right graft limb.
Section 22.08 – Lower anastomoses with bifemoral grafts

Step
Number
22.08 continued

This will prevent blood passing down the right limb of the graft when the left limb is being flushed through later.

22.09 RETURN TO THE LEFT GROIN.

22.10 CLAMP OFF THE LEFT COMMON FEMORAL ARTERY
Use an angled De Bakey clamp.

Place the handles on the abdomen.

22.11 CLAMP OFF THE LEFT PROFUNDA FEMORIS ARTERY
Use a bulldog clamp.

22.12 CLAMP OFF THE LEFT SUPERFICIAL FEMORAL ARTERY
Use an angled De Bakey clamp with the handles lying down the thigh.

22.13 TIGHTEN ANY SLOOPS AROUND MINOR ARTERIES

22.14 CHOOSE A GRAFTING SITE ON THE COMMON FEMORAL ARTERY
Find a 15mm. long site on the anterior surface which is free from atheroma ie soft and thin.

If one is not present:
Find one on the superficial femoral or on the lowest part of the external iliac artery under the inguinal ligament.

22.15 OPEN THE COMMON FEMORAL ARTERY
Use a No 15 blade on a Swann Morton handle.

Make a longitudinal incision 12mm.long.

This will fit the obliquely – cut S shaped end of a 6mm. graft limb.

22.16. INSPECT THE INSIDE OF THE ARTERY
Suck out any clot.

If there is bleeding:
Check the clamps and sloops are tight.

Check for any minor arteries that may have been overlooked.

22.17 CHECK THE HOLDING CLAMP ON THE GRAFT AT THE INGUINAL LIGAMENT
Check that it is tensioning the limb of graft to 1000 gm.

Section 22.18  Lower anastomoses with bifemoral grafts (continued)
Step Number
22.18 PLACE THE DISTAL GRAFT OVER THE CHOSEN ANASTOMOSIS SITE

22.19 CUT THE LIMB OF THE GRAFT
Use stitch scissors.

Flatten the graft in the anterior-posterior plane.

Make an oblique cut across the flattened graft so that the anterior wall wall is longer than the posterior anterior wall by 10mm. This cut should lie over the arteriotomy site.

This will produce an oblique end to side anastomosis on the anterior wall of the artery.

Do not make a straight cut, which will produce an ellipse opening in the graft with pointed ends. This is difficult to anastomose.

Instead, curve the cut in an S shape, starting and finishing perpendicular to the graft wall.

This will make an ellipse opening in the end of the graft with a broad heel and a broad toe for easier anastomosis.

If the S shape is cut tangentially to the graft wall, the ellipse will have very pointed ends. This make the anastomosis even more difficult than a straight cut.

Practise on a piece of graft that will not be used in the patient to get it right.

22.20 INSERT THE FIRST STITCH
Get your assistant to pull the distal end of the graft distally with a vascular forcep.

Use 4/0 Polypropylene with 2 tapercut needles (eg Ethicon W8557).

Start at the heel of the graft.

Stitch from inside to out on the graft and on the artery.

Use both needles.

Make a mattress suture with equal free ends of suture. Lie in the middle of the suture.

Tie with 4 throws on the outside of the graft and the artery.
22.21 STITCH ALONG THE RIGHT HAND SIDE OF THE ANASTOMOSIS
Place stitches 1mm. apart with 1mm. bites.

Use a forehand stitch.

Pass the needle from inside the artery to outside.

Pass the needle perpendicularly through the artery wall.
  Do not pass it obliquely.
  This may lead to the suture tearing through the artery when the stitch is tightened.

22.22 STITCH AROUND THE TOE OF THE ANASTOMOSIS
You will appreciate the benefit of a wide toe to the graft here.

Continue stitching from inside the artery to the outside.

22.23 COME BACK 5MM. ALONG THE LEFT HAND SIDE OF THE ANASTOMOSIS
Lie the suture distally, held in a bulldog clip.

22.24 RETURN TO THE HEEL OF THE ANASTOMOSIS
Use the other length of suture with its needle.

Run stitches down the left hand side of the anastomosis towards the toe of the anastomosis.
  As before, 1mm. apart, 1mm. bites, forehand, running inside to outside on the artery.

End up 1mm. from the first suture line.

Keep the last 3 throws slack.
  This will give a 3mm. defect for flushing the graft limb and the artery.

22.25 WARN THE ANAESTHETIST
There may be some blood loss at this point.

The anaesthetist will want to increase the patient’s blood volume in anticipation.

22.26 OPEN THE CLAMPS ON THE DEEP FEMORAL ARTERY
This will confirm backflow.

Squeeze the thigh to confirm backflow.

If there is no back flow:
  Pass Fogarty catheters.
  See Step 26.26 Passing the Fogarty catheter.

22.27 OPEN THE CLAMP ON THE SUPERFICIAL FEMORAL ARTERY
This will confirm back flow.

Section 22.27 Lower anastomoses with bifemoral grafts (continued)
22.27 continued Squeeze the thigh to confirm backflow.

If there is no backflow:
Pass Fogarty catheters.
See **Step 26.26 Passing the Fogarty catheter.**

22.28 RELEASE SLOOPS ON MINOR GROIN ARTERIES

22.29 FLUSH THE COMMON FEMORAL ARTERY
Use 60ml. heparin saline on a 20ml. syringe plus a bulb ended adaptor.

22.30 RELEASE THE O’SHAUGHNESSY FORCEP TENSIONING THE LEFT LIMB OF THE GRAFT.

22.31 PART OPEN THE AORTIC SATINSKY CLAMP FOR 2 SECONDS
Blood will run from the aorta down the left limb of the graft.
Any recent thrombus, platelet thrombus and atheromatous debris will flush into the groin wound.
Let the debris gather in a swab in the wound to minimise trauma to the artery.

22.32 SUCK OUT THE FEMORAL ARTERY

22.33 TIE OFF THE ANASTOMOSIS SUTURES
Use 4 throws.
Cut the ends 5mm. long.

22.34 CHECK FOR BLEEDING FROM THE FEMORAL ANASTOMOSES
If there is bleeding:
It is likely to be minor.
Go back to **Step 19.17 Check for bleeding.**

22.35 PART OPEN THE SATINSKY CLAMP ON THE AORTA AGAIN
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.
Release the clamp later in stages according to the cardiac state
Check that there is no bleeding from the upper anastomosis.
If there is bleeding:
Go back to **Step 19.17 Check for bleeding.**
continued When there is no bleeding from the upper anastomosis:

22.36 FULLY OPEN THE AORTIC CLAMP
Close the clamp at the anaesthetist’s request if the increased circulation is too much for the patient’s heart.

Release the clamp later in stages according to the cardiac state.

If there is bleeding:
Go back to Step 19.17 Check for bleeding

When there is no bleeding:
Read on

22.37 CHECK THERE IS BLOOD FLOW INTO THE LEFT LIMB
Usually the blood flow is satisfactory as shown by the presence of a pulsating graft and distal arteries and warm pink feet.

If the flow is not satisfactory, the causes will be:
Poor cardiac output.
Check the blood pressure and cardiac output with the anaesthetist.

Thrombosis.
Emboli smg into distal vessels.
Compressed graft in the vascular tunnel.
Kinked or twisted graft.
Obstruction at anastomoses.
Occlusive disease in distal vessels.

Check the femoral artery is pulsating.
If not:
Check the trunk of the graft is pulsating.
If the trunk is not pulsating:
The sides of the graft may have stuck together.
Release them by squeezing.

The trunk may have clotted.
Consider a thrombectomy through the trunk of the graft.

If the trunk is pulsating, but not the limb of the graft:

Section 22.37 Lower anastomoses with bifemoral grafts (continued)
continued

Check the limb of the graft is not compressed in the vascular tunnel.

Enlarge the tunnel with the finger.

Release any tight bands.

Check the limb of the graft is not kinked or twisted.

Correct by cutting and reanastomosing the limb of the graft.

There is thrombus in the limb of the graft.

Perform a thrombectomy through the limb of the graft using a Fogarty catheter.

If the limb of the graft is pulsating but not the femoral arteries:

There is clot or embolus in the femoral arteries.

Perform a thrombectomy/embolectomy through limb of the graft.

Or, there is obstruction at the anastomosis.

Consider exploring and redoing the anastomosis.

If the femoral artery is pulsating, but the foot is white and cold with guttering of the veins:

There is embolism, clotting or occlusive disease below the femoral arteries in the groin.

Go to Section 12.00 Checking the iliac arteries

Check the foot is pink and warm.

22.38 MAKE THE ANASTOMOSIS ON THE RIGHT HAND SIDE

Do the same as for the left side

See Step 22.19 Clamp off the left common femoral artery.

Except:
continued

Release the O’Shaughnessy clamp on the right limb of the graft instead of the aortic Satinsky clamp (which has already been opened).

You should now have a functioning aorto-bifemoral graft.

22.39 TIE OFF RELEVANT VESSELS FOR OTHER ANEURYSMS
See Step 10.07 Technique for isolating distal aneurysms.
Section 23.00 Haemostasis

23.01 CHECK HAEMOSTASIS
Check:
The anastomotic lines.
If there is bleeding:
Manage bleeding as before.

See Step 18.17 Check for bleeding.

The vessels around the upper anastomosis.
The inferior mesenteric artery.
The lumbar arteries.
The vena cava and iliac veins.
Bleeding vessels in the abdominal wound edges.
Anywhere else.
The ideal of a bloodless field can usually be obtained with an elective operation.
Accept a moderate amount of oozing of blood from the retroperitoneal haematoma in an emergency case.
Do not accept bleeding from anastomoses. Persevere with efforts to obtain haemostasis.

23.02 INSERT A DRAIN
This is often omitted.
Use a medium Portovac drain.
Pass the spike introducer through the abdominal wall from inside out in the left iliac fossa.

Check that the drain:
Does not damage the sigmoid colon.
Does not pass through the loops of a Finocietto retractor.
Pull the drain through the abdominal wall until the black localising mark appears at skin level.

Cut the drain at the end of the perforations.
Tuck the drain into the aneurysm sac.
Suture the drain in place in the skin.
Section 23.02 Haemostasis (continued)

Step 23.02 continued

Use No 1 silk on a hand needle (Ethicon W9173).

Make a bite into the nearby skin.

Tie the suture with 4 throws.

Wrap the silk 4 times round the drain.

Tighten the suture to make a waist in the tubing.

Tie the suture with 4 throws.

Cut the ends 4cm. long.
Section 24.00 Closing the abdomen

Step Number
24.01 REMOVE THE ANEURYSM RETRACITOR

24.02 CLOSE THE ANEURYSM SAC
   This will prevent the graft coming into direct contact with the bowel and omentum.

   This should prevent the graft eroding through the bowel wall or forming adhesions with the omentum.

   Use continuous No1 Vicryl (eg Ethicon W9125).

   Start at the top of the incision in the aneurysm.

   Close the transverse incision.

   Close the longitudinal incision.

   Close the lower transverse incision.

   Overlap the sac over the graft to provide minor compression to lessen minor bleeding.

   Have the drain passing out of the lower end of the aneurysm wound.

24.03 REMOVE ALL CLAMPS AND FORCEPS

24.04 REMOVE THE ABDOMINAL PACKS

24.05 CHECK HAEMOSTASIS AGAIN

24.06 SUCK OUT ANY INTRAPERITONEAL BLOOD

24.07 WASH OUT THE PERITONEAL CAVITY
   Use 1000ml. saline.

   Check that it is at blood heat by putting your hand in the liquid.

24.08 CHECK FOR ISCHAEMIC DAMAGE TO THE BOWEL
   Look for:
   Dark blue and black patches.
   Lack of sheen.
   Lack of peristalsis.

   Resect the affected bowel as needed.

24.09 CHECK THAT THERE IS NO EXTRA PROCEDURE TO DO IN THE ABDOMEN
   Eg Hernia repair.
Section 24.10 Closing the abdomen (continued)

24.10 CHECK THE SWAB, NEEDLE AND INSTRUMENT COUNTS

24.11 CHECK FOR BLEEDING FROM THE ABDOMINAL WOUND EDGE

24.12 PLACE FORCEPS ON THE EDGE OF THE LINEA ALBA
   Use 2 large cholecystectomy forceps on the middle of the linea
   alba on each side.

24.13 CLOSE THE PERITONEUM AND LINEA ALBA FOR A MIDLINE
   INCISION
   Close the peritoneum and the muscle and fascial layers for a
   transverse incision.

   Use double No.1 PDS with a blunt needle (eg Ethicon W 9966).
   All layers closure.

   Use 2 lengths, starting at each end and tying together in the
   centre of the wound.

   Eight throws on the central knot.

24.14 CLOSE THE SUBCUTANEOUS FAT
   Use continuous 2/0 Vicryl (eg Ethicon W9125)

24.15 CLOSE THE SKIN
   Use continuous 4/0 Vicryl (eg Ethicon W9890).

24.16 CHECK THE FEMORAL PULSES AGAIN
   If one or both are absent:
   Perform one or bilateral femoral embolectomies.
   See Section 26.00 Femoral Embolectomy

24.17 CHECK THE FOOT COLOUR AND PULSES
   If either foot is mottled blue or white:

   And the popliteal artery is not pulsating:

   And the subcutaneous veins are empty (guttering):
   Perform a femoral embolecotmy on the affected side.
   See Section 26.00 Femoral Embolectomy

   If the feet are pink, warm and show capillary refilling:
   Continue below.

24.18 CONNECT THE SUCTION TUBING FROM THE DRAIN
Section 25.00 Final Touches

Step
Number
25.01 OPEN THE SUCTION TAPS

25.02 CHECK THE URINE OUTPUT
   An absence of urine at this stage is a sign of a poor prognosis.

25.03 DISCUSS THE FURTHER MANAGEMENT WITH THE ANAESTHETIST

25.04 WRITE OPERATION NOTES

25.05 WRITE TO THE GENERAL PRACTITIONER AND REFERRING PHYSICIAN

25.06 HAVE A CUP OF TEA

25.07 REASSESS THE PATIENT
   If bleeding or showing signs of graft failure:
       Continue observation.
       Consider reoperating.
   If in a satisfactory condition:
       Transfer to the Intensive Care Unit.

**End of operation.**
Section 26.00 Femoral Embolectomy

Step Number
26.01 INTRODUCTION

This is procedure may be needed at the end of an aortic aneurysm graft.

It consists largely of:

Section 14.00 Dissecting out the femoral arteries

Section 12.00 Checking the iliac arteries

Plus a proximal embolectomy of the aorta.

The procedure is described at length because of important differences in detail and because it may need to be performed in isolation.

26.02 CLEAR THE GROIN AREA

Clear a space 8cm. above the groin crease (more for a fat patient), 10cm. below the groin and 20cm. wide, centered on the midinguinal point. ie the surface marking of the femoral artery.

Make sure the retractors are not interfering with this area.

If the adhesive plastic drape has torn or become unstuck:

Resterilise the skin with Povidone iodine,

26.03 INCISE THE SKIN

Use a No 22 blade on a large scalpel handle to incise the cutis.

Make a vertical incision in the midinguinal line, from 5cm. above the groin to 8cm. below it.

26.04 DEEPEN THE INCISION

Use the firestick to incise into the subcutaneous fat down to the fascia lata.

26.05 INSERT A SELF RETAINING RETRACTOR

Use a Cones self retaining retractor with the handle pointing towards the knee.

Retract the subcutaneous fat by prising the jaws open.

26.06 PALPATE THE FEMORAL ARTERY

This is easier to find when the artery is:

Pulsating.
Aneurysmal.
Atheromatous.

26.07 DEAL WITH OTHER STRUCTURES IF IN THE WAY

Coagulate or ligate veins running into the sapheno-femoral junction.

Section 26.07 Femoral Embolectomy (continued)
Step Number
26.07 continued Elevate the inguinal ligament and the abdominal wall with a Langenbeck retractor in a fat patient.

Make sure there is no femoral hernia in the fatty tissue in the femoral triangle.

Avoid damaging lymph nodes and lymphatic vessels to prevent lymphoceles postoperatively.
   Excise inguinal lymph nodes only if they are obstructing the exposure of the blood vessels.
   Beware of lymphoceles postoperatively if nodes are removed.

Avoid the femoral vein medially. The vein may be confused with a nonpulsating femoral artery.

Avoid the femoral nerve laterally.

26.08 READJUST THE RETRACTORS
   This will give a better view of the arteries.

26.09 START TUNNELLING UNDER THE INGUINAL LIGAMENT
   This will give a good exposure of the common femoral artery as it emerges from under the inguinal ligament as a continuation of the external iliac artery.
   Use finger dissection for 2cm. on the lateral side of the external iliac artery.
   This will avoid damage to the femoral and external iliac veins which run medially.

26.10 EXPOSE THE THREE FEMORAL ARTERIES
   These are:
   The common femoral artery coming from under the inguinal ligament as a continuation of the external iliac artery.
      It bifurcates into the superficial and deep femoral arteries at some point between the inguinal ligament and up to 10cm. more distally.
   The superficial femoral artery running down as a continuation of the common femoral artery at its bifurcation.
   The deep (profunda) femoral artery running initially medially and then behind the superficial artery to run into muscles laterally.

Section 26.10 Femoral Embolectomy (continued)
Variations with early branchings are common.

Use dissecting scissors.

The arteries have characteristic transverse vasa vasorum on their surfaces.

Dissect in a plane close to the artery, where the surface is shiny.

**26.11 DISSECT OUT THE ARTERIES**

The aim is to clear all sides of the three vessels and every one of their branches so that they can be controlled with bulldog clamps and plastic threads (sloops).

The site of the incision in the bifurcation of the common femoral artery should be central to this dissection.

Clear 4cm. of each main artery and 2cm. of each branch.

The profunda artery may be obscured by a tributary of a profunda vein, which should be double ligated and divided for access.

Make sure you have found all the vessels.

Look under and behind all the vessels to make absolutely certain.

Use a small cholecystectomy forceps.

(HINT FOR TRAINEES: Use a JAWS IN – JAWS OPEN – JAWS OUT – JAWS SHUT technique to open the tissues behind the vessels. Avoid a JAWS IN – OPEN – SHUT – OPEN – SHUT method which can damage the vessels.)

**26.12 CONTROL MINOR BRANCHES**

Use sloops.

Double loop a sloop around each vessel.

Hold the end of each sloop with an artery forcep.

**26.13 PASS SLOOPS AROUND EACH FEMORAL ARTERY**

Pass a small cholecystectomy forcep behind each vessel in turn.

Grasp a sloop in the jaws and pull it half way through.
26.13 continued   Clip the two end of each sloop with an artery forcep.

26.14 CLAMPING AND ANTICOAGULATING EACH FEMORAL ARTERY
Read on.

26.15 START BY CLAMPING THE SUPERFICIAL FEMORAL ARTERY
Choose a bulldog clamp which is long enough and has a sufficiently strong spring to compress the artery.

Open the jaws of the clamp as wide as they will go.

Place the open clamp carefully across the artery at right angles.

Have 2mm.of each jaw protruding beyond the artery.

Let the jaws close on the artery.

26.16 ANTICOAGULATE THE SUPERFICIAL FEMORAL ARTERY
Use 20ml. of heparin saline in a syringe with a green topped 21SWG needle.

Push the needle through the anterior wall of the superficial femoral artery 10mm. distal to the clamp.
Make sure the needle does not go through the back wall.

Withdraw on the piston to check that blood aspirates back into the syringe.

If blood cannot be aspirated
   Pull the needle out of the artery and try to aspirate again.
   Push the needle further in and reaspirate.
   Insert the needle through a different site.

If you still cannot aspirate blood:
   The vessel may be thrombosed or blocked with an embolus.

Continue anticoagulating the other vessels.

If you aspirate blood:
   Inject the 20ml. of heparin saline into the vessel.

26.17 CLAMP THE DEEP FEMORAL ARTERY
Apply a clamp as for the superficial femoral artery.

The artery is often less accessible than the superficial artery.

Take care that the clamp crosses the artery completely.

Section 26.18 Femoral Embolectomy (continued)
Inject 20ml. heparin saline distal to the clamp, as for the superficial femoral artery.

26.19 CLAMP THE COMMON FEMORAL ARTERY
Apply a clamp as for the superficial femoral artery.

   Place it 4cm. proximal to the superficial femoral clamp to make enough space for the arteriotomy.

   Use a De Bakey clamp if a bulldog is not long or strong enough.

26.20 ANTICOAGULATE THE COMMON FEMORAL ARTERY
Inject 20ml. heparin saline as for the superficial femoral artery.

   Hold a pledget on a sponge holder onto the injection site for 1 minute to control any bleeding.

26.21 CHECK THE CATHETER
Check it is a No 4 French Gauge catheter. I.e. 4mm. in circumference.

   Check you have a spare No 4 catheter available.

   Have the catheter brought to the operating table.

   Make sure it does not flip onto unsterile areas.

   Remove the central wire.

   Test the balloon at the tip of the catheter.

   Have 0.75ml of heparin saline inserted into a 2ml. syringe.

   Check that there is no air in the syringe, which will upset the feel of the procedure.

   Push the syringe onto the catheter until any creaking on the joint stops.

   Inflate the balloon with the 0.75ml. of liquid.

   Check that the balloon does not burst and the balloon is a regular sphere shape.

   Check the balloon deflates on release of the syringe.

   Replace the catheter if substandard.

Section 26.22 Femoral Embolectomy (continued)

Step

Number

26.22 MAKE THE ARTERIOTOMY
Use a No 28 blade on a long handle.

Choose a site:
  On the front of the distal common femoral artery.

  On a healthy piece of artery if possible, 20mm. long.

  Avoid dense calcified patches.

Make a transverse 28mm. cut.
  This will be big enough for the inflated balloon to pass through.

  Make sure the ends are cut cleanly to give the maximum length.

  Avoid peeling the intima off the subintima, especially distally.

26.23 ASPIRATE BLOOD CLOT AND BLOOD
  Use a vascular sucker.

  Avoid suction on the inside wall to prevent damage to the endothelium.

26.24 CHECK HAEMOSTASIS
  Check the clamps are properly positioned and tightly closed.

  Check you have not missed any branches.

26.25 PART OPEN THE CLAMP ON THE SUPERFICIAL FEMORAL ARTERY

26.26 PASSING THE FOGARTY CATHETER
  Use the same technique as for the iliac artery.

  As a reminder:
    Follow these steps.

26.27 PASS THE FOGARTY CATHETER DOWN THE SUPERFICIAL FEMORAL ARTERY
  Use your fingers to hold the catheter.

  Use vascular forceps to hold the catheter in any awkward angle to pass down the artery.

  Open the clamp a little more to let the catheter pass through.

  Pass the catheter down ideally to beyond the popliteal trifurcation.

Section 26.27 Femoral Embolectomy (continued)

The catheter will pass through thrombus and embolus material.
If it meets an obstruction at about 20 cm. i.e. at the adductor hiatus:

This may be due to a kink in a tortuous vessel,
Bend the distal 2 cm. of the catheter.

Repass the catheter and rotate it to negotiate any kink.

Try to passing a narrower catheter.

If the catheter will still not pass:
The superficial femoral artery is probably blocked with atheroma.
Accept this situation and continue the embolectomy.

If the catheter passes to 30 cm. or more:
Push the heparin saline into the balloon until resistance is felt.

The resistance is the wall of the artery.

If you push too hard:
You can rupture the arterial wall, especially when it is healthy. This will most likely be in the vessels below the trifurcation.

The balloon will suddenly inflate easily.

This sudden inflation can happen also if the balloon bursts.
Withdraw the balloon.

If it has burst:
Replace it.

Be more gentle with the new balloon.

If you think you have ruptured the vessel:
Plan to examine the limb at the end of the operation.
Explore and repair the vessel as needed.

Pull the catheter steadily out of the artery with your left hand.

**Section 26.27 Femoral Embolectomy (continued)**

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<th>Step Number</th>
<th>At the same time, with your right hand, increase or decrease the amount of liquid in the balloon.</th>
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The aim is to match the diameter of the balloon with that of vessel being swept clear of the thrombus or embolus.

You will probably feel the narrowing of the superficial femoral artery at the adductor hiatus (about 30cm. from the arteriotomy).

You will feel the roughness of atheromatous plaques on the arterial wall.

As the balloon of the catheter approaches the arteriotomy:
Get the first assistant ready with a vascular sucker to remove thrombus or emboli.

If you bring up thrombus or emboli:
Repeat passing the catheter until no more material is obtained.

You should have a steady stream of back bleeding if the blockage is relieved.

Flush 60ml of heparin saline down the superficial femoral artery.
Reclamp the superficial femoral artery.

If there is no back bleeding and the catheter pass to 30cm. or more
The limb may not be viable below the knee.

However, the patient may eventually lose part of the left limb from ischaemia.

Flush 60ml of heparin saline down the superficial femoral artery anyway.

Reclamp the superficial femoral artery.

26.28 EMBOLECTOMISING THE DEEP FEMORAL ARTERY
This is the same technique as for the superficial femoral artery.

The catheter needs careful fiddling round the turns in the deep artery.

The deep femoral artery is rarely thrombosed or embolised and is usually healthier than the two other femoral arteries.

Section 26.29 Femoral Embolectomy (continued)

Step Number
26.29 EMBOLECTOMISING THE VESSELS PROXIMAL TO THE COMMON FEMORAL ARTERY
Use the same technique as above.
There is likely to be more blood loss due to higher pressures proximally.

The catheter should pass into the graft.

Release of thrombus and emboli is likely to cause a whoosh of blood. 
Warn your assistants to keep out of the way of the blood.

Be very quick to close the common femoral clamp to minimise blood loss and loss of heparin saline.

If there is no vigorous flow of blood down from the iliac artery:
Try passing the catheter higher up above the graft.
Consider reexploring the graft and anastomoses.

26.30 CLOSING THE FEMORAL ARTERIOTOMY
Flush out the isolated section of common femoral artery with 20ml. of heparin saline.

Use a 4/0 polypropylene vascular suture with one needle removed (eg Ethicon W8953).

Place a first stitch 1mm. from the distal end.

Pass the needle though the upper edge of the artery 1mm. from one lateral end.
Pass the needle from outside to inside.
Pass the needle though the corresponding edge of the lower edge from inside to outside.
This should prevent intimal delamination.

Tie the first stitch with 4 throws.
Cut the end 10mm. long.
Continue the closure with continuous stitches 2mm. apart.
Maintain a 250gm. tension.
Insert the final stitch 1mm from the proximal end.
Tie off the stitch.
Use 4 throws.

Section 26.30 Femoral Embolectomy (continued)

Step Number
26.30 continued Cut the ends 10mm. long.

26.31 OPEN THE SUPERFICIAL FEMORAL ARTERY CLAMP
26.32 OPEN THE DEEP FEMORAL CLAMP

26.33 PART OPEN THE COMMON FEMORAL CLAMP
   If there is spurting:
      Insert extra 4/0 vascular stitches.
   If there is minor bleeding:
      Cover the arteriotomy with a swab and wait 3 minutes.
      Continue until the arteriotomy is dry.

26.34 CHECK THE FEMORAL ARTERY IS PULSATING
   If not:
      Consider a recatheterisation.

26.35 CHECK HAEMOSTASIS IN THE REST OF THE FEMORAL WOUND

26.36 INSERT A DRAIN
   This is often omitted.
   Use a medium Portovac drain.
      Pass the spike introducer through the lateral wall of the
      wound from inside out.
   Check that the drain:
      Does not damage the arteries.
      Pull the drain through the wound edge until the black localising
      mark appears at skin level.
      Cut the drain to include 5cm. of perforations.
      Tuck the drain into the wound.
      Suture the drain in place in the skin.
      Use No 1 silk on a hand needle (eg Ethicon W9173).
      Make a bite into the nearby skin.
      Tie the suture with 4 throws.
      Wrap the silk 4 times round the drain.
      Tighten the suture to make a waist in the tubing.

Section 26.36 Femoral Embolectomy (continued)

Step
Number
26.36
continued
Tie the suture with 4 throws.
Cut the ends 4cm. long.

26.37 CLOSE THE SUBCUTANEOUS FAT
Use continuous 2/0 vicryl (eg Ethicon W9125)

26.38 CLOSE THE SKIN
   Use continuous 3/0 Vicryl (eg Ethicon W9890).

26.39 CHECK THE FEMORAL PULSE AGAIN
   If the pulse is absent:
   Consider repeating the embolectomy.

26.40 PERFORM A FEMORAL EMBOLLECTOMY ON THE OTHER SIDE
   If needed.
   Use the same technique as for the first side.

26.40 CHECK THE PULSES AND THE PERFUSION OF THE LOWER LIMBS
   If blood flow is poor and there is evidence of a distal occlusive disease:
   Consider further assessment with angiography.

End of operation.

Section 27.00 Equipment and Materials

AORTIC ANEURYSM/AORTO-ILIAC GRAFT
AORTO-FEMORAL GRAFT

READ CODE:
Elective Straight Graft:  7A143
Emergency Straight Graft:  7A133

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**RESECTION EXTRAS**

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<td>DOYEN CLAMPS CURVED</td>
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**CHECK LIST**

PACKED BY: 

DATE: 

NURSE 

TAKING: 

RUNNER: 

PATIENT No. 

PRE. OP. 

CHECK: 

POST. OP. 

CHECK: 

| REVISION No. 04 | SHEET 06A | |
|-----------------|----------||
| DATE 26/03/99   |          | |

**THEATRE SERVICES**

X 3 TRAYS

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<td>1</td>
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©M H Edwards 2006
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<tr>
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CHECK LIST
PACKED BY
DATE:
NURSE
TAKING
RUNNER
PATIENT No.
PRE OP
CHECK:
POST OP
CHECK:

REVISION No. 03
SHEET No. 50

DATE 13/05/99
9

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ARTERIAL INSTRUMENTS

DRAPES

REINFORCED MAJOR ABDOMINAL

EXTRAS

DIATHERMY POUCH
18 X 24 SUPER IOBAN
20ML SYRINGE X 2 22ML SYRINGE X 1
SUCTION TUBING 500ML IV NORMAL SALINE
5ML HEPARIN (1000 unit per ml)
GREEN NEEDLE X 1 10 X JOLLS
WHITE TAPE 2 END TETRAS
LONG DIATHERMY FORCEPS
FINE SUCTION NOZZLES
MCDONALDS DISSECTORS X 2
ARTERIAL EXTRAS (IN A PACKET)
ARTERIAL GRAFT BOX (straight -
16,18,20,22,24mm trouser

16x8, 18x9, 20x10, 22x11, 24x12)

? CATHETER BITS - see urology file

LARGE WEST RETRACTORS X 2 (For Y-Graft Only)

THIN SIGMOIDOSCOPE BIOPSY FORCEPS X 2

FOR Y-Graft)

(For Y-Graft)

BROAD KELLY x 1 JOSEPH SCISSORS (For Y

Graft Only)
## FEMORAL EMBOLECTOMY EQUIPMENT  -  See Operation 29

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<thead>
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<td>W768</td>
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<td>SKIN</td>
<td>W9890</td>
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