

Vascular Skills Lab One

I. OBJECTIVES

By the end of this laboratory session participants should be able to . . .

- 1) Demonstrate proper use of vascular instruments
- 2) Dissect and gain distal and proximal control of the aorta
- 3) Sew a dacron patch onto an arteriotomy
- 4) Resect a segment of aorta and repair with Gortex graft

II. ASSUMPTIONS

The resident has reviewed vascular anastomosis technique and anatomy. The resident has practiced the art of sewing vascular anastomosis using the graft and suture material provided to them.

III. SUGGESTED READING

Chapters 182, 190, and 196 in Mastery of Surgery, 5th edition. Editor, Fischer, J. Lippincott William & Wilkins. Philadelphia 2007.

IV. ANATOMICAL CONSIDERATION

Although the approach to the human aorta is through the peritoneum centrally with the small bowel on the right, in the swine model, the best approach is by mobilizing the intestines to the left. This is best accomplished by incising the right flank attachments of the small and large intestines. The entire bowel is then mobilized to the left, exposing the aorta quite nicely. There are usually one to two spinal arteries off of the posterior of the aorta. One should be cognizant of this when trying to obtain distal and proximal control.

V. DESCRIPTION OF LABORATORY MODULE

Two pigs will be set up for two to three residents per pig. Residents are to dissect out the aorta, obtain distal and proximal control, and make an arteriotomy. A Fogarty thrombectomy balloon is then passed proximally and the balloon inflated. Proximal control is then released. Each resident will practice passing the balloon and inflating it.

The aortotomy is then increased longitudinally and dacron patch sewn in place. This segment is then excised and the aorta repaired with a gortex graft.

VI. DESCRIPTION OF TECHNIQUE/PROCEDURE

Vessel handling

Blood vessels are far less forgiving than other tissues commonly handled in general surgical practice. The vessel wall is made up of three layers, all of which are delicate and easy to traumatise. This is even more the case when the vessel is diseased. As a rule, the

vessel wall should never be grasped between forceps. During dissection, the surgeon should endeavor to 'dissect the vessel off the patient'. If touching the vessel is truly unavoidable, only grasp the adventitia and, even then, only lightly. Often the closed forceps can be used to deflect the vessel or traction on a suture or neighboring structure can afford the exposure required.

After circumferential vessel dissection, to obtain control of the vessel, slings are carefully placed. This should be done using a right-angled forceps, but resist the temptation to push the instrument through remaining tissue on the invisible surface of the vessel. The tangible resistance is often due to the presence of a significant branch artery or venous tributary and it is all too easy to avulse these by the clumsy use of the right-angled forceps. When this situation arises, patiently return to scissor dissection until all intervening tissue is cleared. Traditionally, right-angled forceps are passed around arteries in a direction away from the neighboring vein to minimize the risk of venous trauma.

Vascular clamps are potentially dangerous. They should be applied with care and only as tight as is necessary to arrest blood flow. Try to place clamps to aid the subsequent procedure rather than hinder it. Select a clamp of appropriate size and strength for the vessel being treated.

Vascular sutures and needles

Vascular sutures are non-absorbable and monofilament. They pass smoothly through the vessel wall causing minimal disruption to the component layers. The size of suture used will depend largely on the size of vessel in question and the extent of disease. Generally speaking, 2/0 and 3/0 sutures are used for the aorta, 3/0 and 4/0 for the iliac arteries, 5/0 and 6/0 for the femoral and popliteal arteries and 7/0 for the crural and brachial arteries. For the direct suture of veins, size again relates to vessel caliber, although often, relatively smaller sutures will be used due to the relatively thin venous wall.

The needles used in vascular surgery are curved but not semi-circular. This configuration ensures that when they are used correctly and enter the vessel wall perpendicular to its longitudinal and transverse axes, the smallest needle hole is created. Often, so-called 'calcium cutting' or specially-strengthened needles are needed to traverse calcified arterial wall.

Suture technique

The needle should be mounted on the needle-holder approximately one-third to half-way along its length from the point. Try to create an 'open' angle between the needle and holder. This approach allows for the maximum possible maneuverability for the operator. As a rule, sutures should be passed from within the vessel lumen outwards. This guarantees that the intima is tacked down and cannot be raised as a flap after blood flow is restored. This latter event is disastrous as vessel occlusion and thrombosis can occur. The object of all vascular suture lines is to create an everted anastomosis with even tension that is completely haemostatic. In order to minimize damage to the vessel wall during suturing and to guarantee precise suture placement, it is recommended that the suture is passed through the vessel wall by a number of short pushes of the needle. Do not grasp the needle by its point after it has passed through the vessel, as this will blunt it and compromise the safe performance of the remainder of the anastomosis. Avoid ripping the needle through the vessel wall as this leads to the creation of slits instead of needle holes. These will inevitably leak and cause you problems.

When tying knots with vascular sutures, it is important to have all vessels clamped to avoid the knot being tied loose. A useful tip for snugging down the first throw is to tie a double throw or to tie the first two throws as a 'granny knot' followed by carefully squared reef knots. Six to eight throws in total should ensure against knot slippage.

Arteriotomy

After obtaining exposure and control of the artery, the next stage in all procedures is opening the vessel. The length of the arteriotomy and whether it is performed transversely or longitudinally depends principally on which procedure is being carried out. If an embolectomy is being performed, a transverse arteriotomy usually suffices and can be closed primarily. However, if it is anticipated that an endarterectomy or graft anastomosis will be necessary, a longitudinal arteriotomy is used. Except where the artery is very large, it is not possible to close such an arteriotomy primarily and a patch will be required. The danger with primary closure of a longitudinal arteriotomy is the creation of a significant stenosis with all the expected hemodynamic consequences.

Technique

- Most surgeons use either a number 11 or 15 blade. The vessel should be steadied (but not grasped) so that it is stabilized whilst the arteriotomy is being fashioned. Make the incision in the centre of the surface of the artery facing you.
- With the blade pointing away from you, a short stabbing technique should be used. Sudden movements and excess pressure can lead to the posterior wall of the vessel being either traumatized or incised. In the real-life situation, remember that the opposite wall of the artery may be diseased and, therefore, more vulnerable to this kind of inadvertent injury.
- On entering the lumen proper a 'flash' of blood will be seen. At this point use Potts' angled scissors to complete the arteriotomy. The lower blade of the scissors should be placed in the lumen of the artery with care. By lifting this blade towards you, damage to the opposite side of the vessel will be avoided. Then, cut the desired length of arteriotomy with even cuts (Figure 1.1).
- For a transverse arteriotomy, open between one-third and a half of the circumference of the vessel. At this stage, all blood should be aspirated away with a sucker and then the luminal surface can be inspected by using closed forceps to distract the walls of the vessel.

Transverse arteriotomy: primary closure

- Begin this exercise by using a double-ended polypropylene suture (you will be provided with 5/0) starting in the corner of the arteriotomy. Both needles should be inserted from inside the vessel lumen to outside and then a knot tied.
- Next, a continuous suture is placed to close the vessel. So that distal intimal flaps are secured and arterial dissection avoided, it is important to complete the vessel closure by placing the needle from outside to in on the 'upstream side' of the arteriotomy and from inside to out on the 'downstream' side.
- The suture line should be comprised of evenly spaced bites of adequate depth in the vessel wall to achieve a haemostatic anastomosis. If the bites are uneven or too

deep, leak points will develop. Equally, if the bites are too superficial the suture will cut out.

- In the real-life situation, temporary release of the clamps is necessary followed by generous lavage with heparinized saline, to flush out any thrombus or atheromatous debris.
- Finally, tie the suture with at least six throws in your knot. If extra sutures are required at leak points, they should be inserted after clamps have been re-applied and attempts to place sutures without clamps resisted.

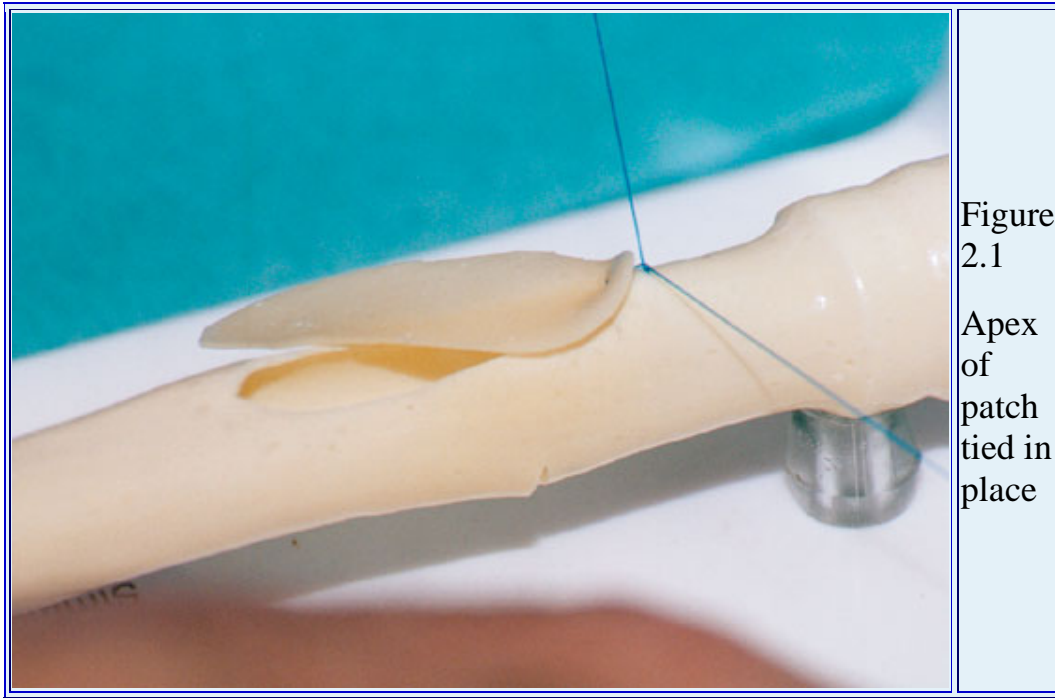
LONGITUDINAL ARTERIOTOMY: PATCH ANGIOPLASTY

The placement of a patch to close an artery prevents primary closure leading to a significant stenosis. In the real-life situation, the choice of material lies between autogenous vein and one of the many commercially available patches. Generally speaking, if a segment of vein is available from the same operative wound or if there is any risk of infection, vein should be used. In an elective operation, for example carotid endarterectomy, a prosthetic patch will serve just as well.

When preparing a vein patch, remember to remove as much of the adventitial tissue as possible from the edge of the patch. This will avoid the risk of this layer becoming involved in the suture line and acting as a possible nidus for thrombosis formation. When cutting the patch, bear in mind the size of the artery being patched. The aim is to close the vessel without stenosis, not to create a focal dilatation.

Technique

- In general, the length of arteriotomy will be two to three times the diameter of the vessel. Clearly, if a very long endarterectomy or other similar intervention has been performed, a longer incision will be needed. For this exercise open the model artery for 3 cm and excise a small ellipse of the 'vessel' wall.
- Cut the patch so that the apex is rounded rather than pointed. This will avoid stenosis at the apex of the patch closure. Do not cut the patch to match the length of the arteriotomy: leave it long as this will facilitate handling during suturing.
- A double-ended 5/0 Prolene suture is inserted as a single stitch at the apex of the patch from outside to in on the patch and then from inside to out at the distal end of the arteriotomy. Tie this suture with three throws in your knot and tether one end with a rubber-shod forcep (Figure 2.1).
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- Next, pass the needle on the non-shod end through the patch and pull this tight. Once this suture has been passed through the vessel wall and again tightened, traction on the patch will lead to eversion of the edges and align the patch and artery walls for subsequent suturing.
- The first two or three stitches should be inserted separately through the patch and artery to guarantee precise placement. However, once away from the apex if it can be done safely the suture can be passed through both in one pass of the needle. So that the operator gets into a rhythm which not only makes the process faster but also more precise, keep reminding yourself to push the heel of the needle through and grasp the needle ready for the next bite. Avoid unnecessary delays repositioning the needle with fingers.
- As the heel of the arteriotomy is reached, cut the patch to shape. The easiest way to do this is to cut it straight across and then trim the corners off. Be careful not to cut the suture inadvertently. After passing the heel place a further two or three sutures and then put the shod on the suture and turn your attention to the other suture (Figure 2.2).

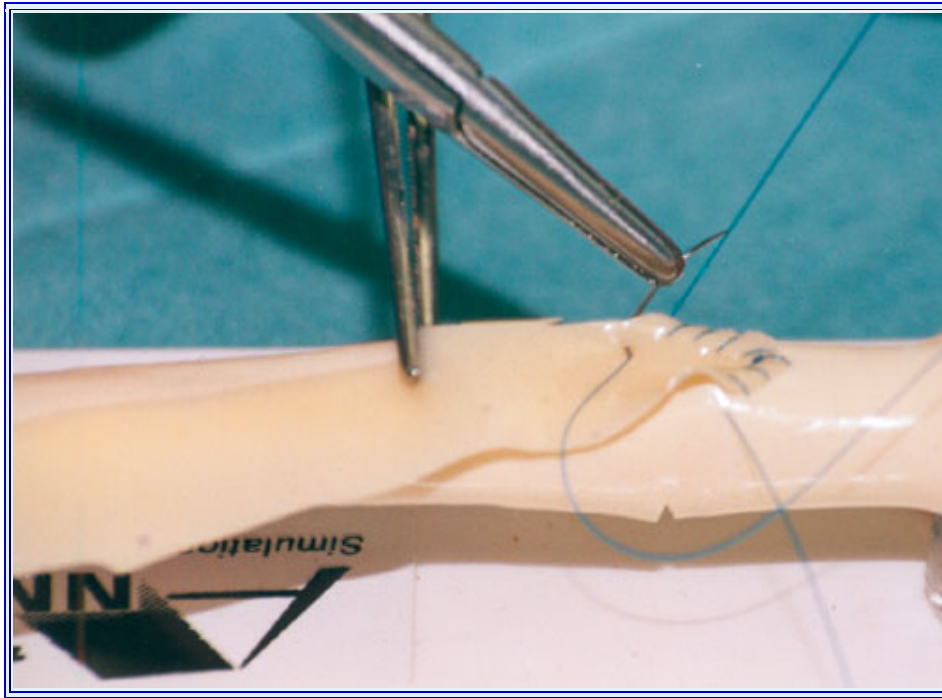


Figure 2.2

After placing a few sutures on one side, commence suturing on opposite side of the patch

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- Repeat the process from the toe again, taking separate bites until away from the toe and complete the suture line towards the other stitch. Tie the two ends with six to eight throws.
- On completion of this exercise, it is worthwhile cutting open your patch angioplasty and inspecting it from the inside. There should be complete eversion of the patch and artery walls and no irregular surface on the luminal aspect.

End to end vascular graft anastomosis

The technique of inlay end-end anastomosis is most commonly used when replacing an aneurysmal or injured segment of artery with a graft. The essence of the method is that the native artery is not completely transected and, therefore, when performing an anastomosis to the intact part of the vessel wall circumference, it is necessary to take bites of two wall thicknesses of the artery.

For this exercise, we shall use a model of an aortic aneurysm. This section is designed to teach the principles of inlay anastomosis, not aneurysm repair.

Technique

- This technique depends upon the fact that the graft is sutured to normal artery both proximally and distally. Incise the aneurysm model longitudinally and extend this proximally until normal-looking vessel is reached.
- Extend the arteriotomy transversely around the vessel for about half of the circumference, equally on both sides. Branch vessel back bleeding can be controlled by either slinging the vessels which may be reimplemented later (for example the inferior mesenteric artery) or overseeing them from inside with a

figure-of-eight Prolene suture (as is the case for lumbar arteries) (Figures 3.1 and 3.2).



Figures 3.1 and 3.2
Incising the neck of the aneurysm



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- You will be supplied with an appropriately-sized Dacron tube graft for the exercise. In real life, graft sizers can be used if you are in doubt. Commence the suture line in the middle of the back wall and using a double-ended Prolene suture (3/0 in this case), insert a suture from outside to inside on the graft. Next, pass the needle from inside to out and back in to the vessel lumen. Thus the needle will emerge in the middle of the back wall having traversed two thicknesses of aortic wall (Figure 3.3). Now, making sure that the two needles are on equal lengths of the suture, snug the graft down and tie the suture tightly with three throws on your knot (Figure 3.4).

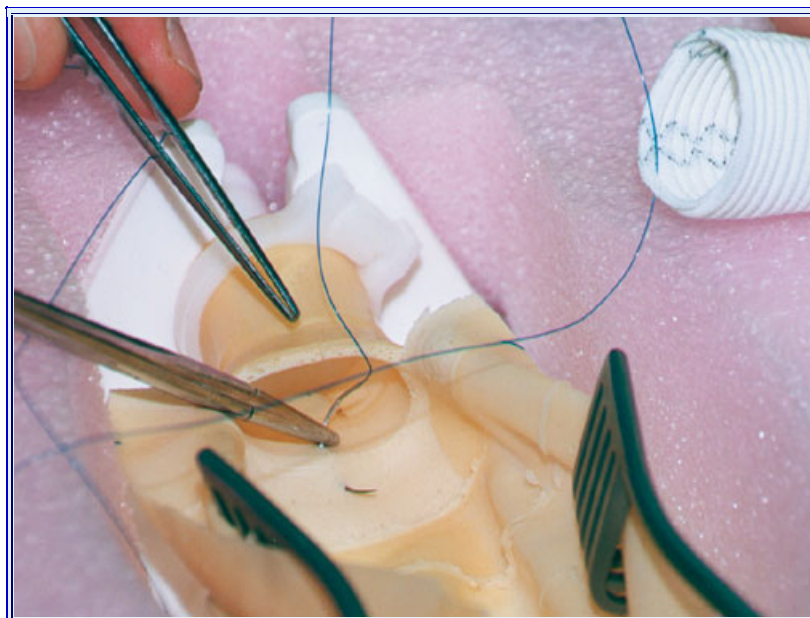


Figure 3.3
Needle passes through two thicknesses of the aortic wall

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- When you inspect the graft now, the knot will lie on the outside, within the lumen of the part of the aneurysm that will be excluded (Figure 3.4).



Figure
3.4

Knot
lies
'outside'
the
graft

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- Select the suture that you wish to bring towards the right side and secure the other needle with a rubber-shod forcep. Pass the needle back into the graft and then from inside to out on the aorta again taking two wall thicknesses with the needle emerging about 3 mm along the artery wall.
- Continue this process until you reach the corner which marks the deepest aspect of the transverse extension of your arteriotomy. At this stage, pass the needle outside the aorta and then back inside deep to the corner. By doing this carefully, you will exclude one of the commonest sites of anastomotic leakage (Figure 3.5).

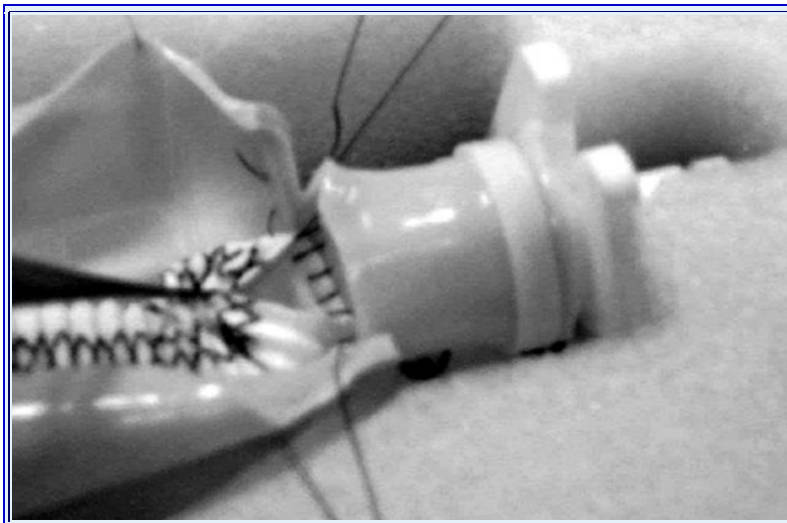


Figure 3.5

Technique
for
excluding
corners
during inlay
anastomosis

- Shod this needle and start in the centre of the back wall with the other suture. Continue with this in a similar manner until just beyond the 'corner' and then shod this suture, again maintaining adequate tension so that it does not loosen. Complete the anterior wall with the first stitch. A knot comprised of eight throws should be tied (Figure 3.6).

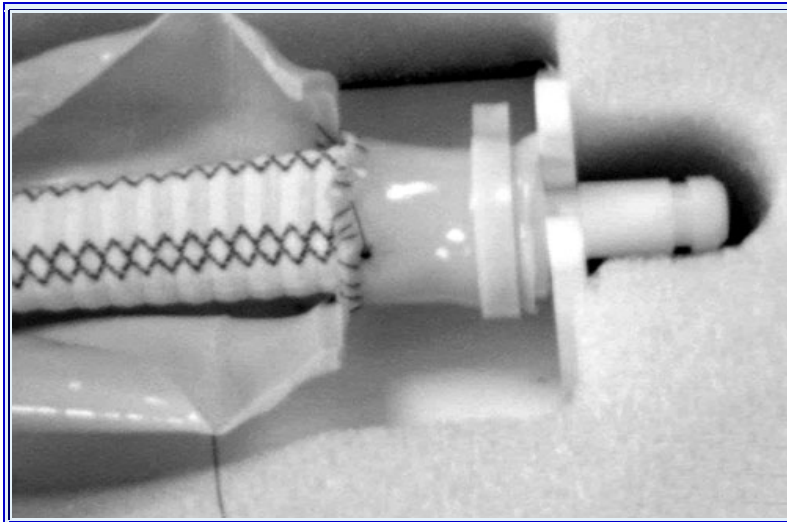


Figure 3.6
Completed
inlay end-
end
anastomosis

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- The distal anastomosis is then completed in exactly the same manner, after cutting the graft to the required length. Prior to completing the suture line and tying the suture, do not forget that in the real-life situation care is taken to remove clamps temporarily and irrigate with heparinised saline so that all thrombus and atheromatous debris are expelled.

*borrowed from the Royal College of Surgeons of Edinburgh Surgical knowledge and skills web site. <http://www.edu.rcsed.ac.uk/index.htm>

VII. EQUIPMENT NEEDED

- 1) 5mm gortex grafts of 15cm length x6
- 2) Dacron gafts to be cut up for patches
- 3) 5-0 prolene on vascular needle (RB-1 or RB-2)
- 4) Satinsky vascular clamps
- 5) Bulldog Vascular clamps
- 6) Castro-viejo needle drivers x2
- 7) Debakey forceps
- 8) Metzenbaum scissors x2
- 9) Potts scissors x2
- 10) Suction
- 11) weitlaner retractors
- 12) Gloves

VIII. REFERENCES

Chapters 182, 190, and 196 in Mastery of Surgery, 5th edition. Editor, Fischer, J. Lippincott William & Wilkins. Philadelphia 2007

The Royal College of Surgeons of Edinburgh Surgical Knowledge and Skills Web Site. <http://www.edu.rcsed.ac.uk/index.htm>

