Vascular Anastomosis

**Objective:**
To understand the basic principles and techniques involved in the creation of end to end and end to side vascular anastomoses.

**Outline:**
- Instruments
- Graft and Suture Material
- Basic Principles
  - Exposure
  - Vascular Control
  - Arteriotomy and Graft Preparation
  - Anastomosis / Repair
  - Unclamping / Reperfusion
- End to End Anastomosis
- End to Side Anastomosis

**Instruments**
A vascular anastomosis requires the use of basic surgical instruments, a pair (or two) of hands and specific vascular instruments which typically include:
- Scissors for vascular dissection – eg Metzenbaum (or similar) scissors.
- Vascular forceps – atraumatic, non-toothed (DeBakey, Crawford etc)
- Vascular clamps or alternatives (vessel loops, occlusion catheters)
- Fine-tipped needle driver
- Number 11 blade for arteriotomy
- Pott’s scissors
- Other – irrigation catheter and syringe, vascular pledgets, suture boots

**Graft and Suture Material**
Grafts are either synthetic or biological. Synthetic grafts are readily available and work well on large vessels (aorta, iliacs, supra-aortic trunks). Biologic grafts, especially autologous vein are preferred for smaller vessels (groin and below) and are resistant to infection.

**Synthetic Grafts**
- Polyester – either knitted or woven (commonly known as Dacron)
- Polytetrafluorethylene (PTFE) commonly called “Gortex”

**Biologic Grafts**
- Autologous vein graft
- Allogenic materials – treated biologic grafts from cadavers (vein, aorta etc)
- Other – treated bovine pericardium

Sutures most commonly used are monofilament and non-absorbable (polypropylene, PTFE). In rare instances an absorbable synthetic, monofilament suture such as polyglyconate (Maxon) may be used – eg vascular repair in children. Absorbable suture must never be used with synthetic grafts.
**Basic Principles**

**Exposure**
- Know the anatomy and widely prep the area in the event that proximal or distal control is difficult.
- Sufficient vessel must be exposed to allow control (room for clamps), and comfortable space for the repair.
- The dissection plane should be directly on the vessels (but leaving the adventitia intact).
- Sharp dissection with scissors is preferred (versus blunt traction, pulling).
- Preserve all side branches of arteries where possible as they may represent important collaterals.

**Vascular Control**
- Vascular surgery should ideally take place in a bloodless field. In addition to the proximal and distal vessels one must identify and control any side branches in the area of the proposed arteriotomy.
- Anticoagulation is given before clamping.
- Atraumatic vascular clamps should be applied in a way that minimizes trauma and embolization of debris. Clamps typically have multiple locks – apply just enough pressure to occlude flow. Atherosclerotic plaque is often on the posterior wall – clamping anterior-posterior rather than side to side may reduce the risk of embolization.
- The clamp handles should be positioned as to not interfere with the anastomosis.
- Vessel loops may be used to control low-pressure outflow vessels.
- Occlusion balloons offer an alternative to clamps where exposure may be difficult.

**Arteriotomy and Graft Preparation**
- The artery should be opened with a #11 (pointed tip) blade. The remainder of the artery may be opened with angled (Potts) scissors or continuing with the blade.
- Care must be taken to traverse all three layers of the artery wall to avoid dissection during arteriotomy. At the same time one must avoid injury to the back wall (for end to side anastomoses).
- The arteriotomy length should be a minimum of 1.5 times the graft diameter for end to side anastomoses.
- The graft is then cut to match the arteriotomy. Dacron grafts may be cut with scissors, PTFE grafts must be cut with the #11 blade to avoid fraying the edges. Vein grafts should be cut with sharp scissors to minimize trauma.

**Anastomosis / Repair**
- Specific details of end to side and end to end techniques are discussed below.
- The forceps must not traumatize the vessel wall by crushing the intima and media. The forceps may lightly grasp the adventitia or be used simply as counter-pressure when the needle is passed through the wall.
• Plan the anastomosis to maximize the number of “forehand” bites.
• In most instances the bites are inside-out artery and outside-in graft.
• Running sutures (one or two) are typically used. Interrupted sutures may be preferred if there is a risk of tearing or purse-stringing a vessel.
• The suture should traverse all three layers – smaller on intima and larger on media/adventitia.
• The suture bites should be evenly spaced to allow distribution of tension on the anastomosis.
• The suture should be pulled in a direction that avoids cutting across the artery wall.
• The edges of the anastomosis should be everted to minimize the amount of foreign body in the artery lumen and maximize the opening of the anastomosis.
• The inflow and outflow should be flushed and checked prior to the completion of the anastomosis.
• A minimum of 6 throws are required for synthetic monofilament suture knots.

Unclamping
• The vessel clamps should be gently released but not removed.
• If more than one outflow vessel the first vessel released should be the one where embolism is less of a problem (e.g., the external carotid rather than the internal).
• Needle-hole bleeding will stop with gentle pressure and time. Pulsatile bleeding may require a repair suture – clamp inflow and use a suture one size smaller than that used for the anastomosis.
• Check flow by pulses and Doppler signals.
• Remove clamps and reverse anticoagulation only when happy with flow and hemostasis.
Types of Anastomoses
(If you are still reading this don’t worry – the following will be best understood in the lab.)

End to Side Anastomosis
Common uses include bypass procedures for occlusive disease and the creation of arterio-venous fistulas.

- Review the basic principles as outlined above.
- After exposure and control the arteriotomy is made. Usually this is a longitudinal arteriotomy with a minimum length of 1.5 times the graft diameter.
- The graft is cut to match the length of the arteriotomy. The heel and toe of the graft are cut in a beveled fashion so that these ends are blunt / wider to avoid narrowing the ends of the anastomosis.
- Two common techniques are used – the “open” (or parachute) method or “closed” approach.
  - In the open technique the heel of the graft is sewn first – the suture is started 2 or 3 bites from the apex of the heel. Sewing outside – in graft then inside-out artery, the bites are placed (2 or 3 on one side, at the apex, and then 2 or 3 down the other side) before the heel of the graft is brought down to the artery. The anastomosis is then completed by continuing the running suture down the side, around the toe and then the contralateral side until it meets the starting point. The open technique is excellent for small vessels.
  - The closed technique is somewhat easier and can be used on larger vessels. The heel and toe are secured with a “box stitch”. The anastomosis is then completed in quadrants, bringing the suture from heel and toe respectively down either side to meet at the midpoint of the arteriotomy.
- The heel and toe of an end to side anastomosis are the most critical points – poorly placed sutures may narrow the inflow or outflow or alternatively result in bleeding that is difficult to repair once unclamped.

End to End Anastomosis
Common uses include repair or replacement of arteries with aneurysmal disease or damage due to trauma.

- Review the basic principles as above.
- After exposure and control the artery is transected at a point where it is clearly healthy. In “inlay” repairs for aneurysms the posterior wall is left intact.
- An appropriate sized graft is selected. If there is size discrepancy, either the artery or graft is beveled to achieve a better size match.
- For very small vessels both ends are beveled to enlarge the diameter of the anastomosis and avoid “purse-stringing” or creating a stenosis.
- The posterior wall is sewn first. Running sutures are most common but in difficult areas interrupted sutures are often used.
- Bites are generally placed outside-in graft and inside-out artery. Where two arteries are being sewn together the bites are placed inside-out in the direction of flow.