Vascular Surgery

An artery is composed of three layers called *tunics*.

1. Tunica externa or tunica adventitia. It is composed of connective tissue fibroblasts and collagen and should be dissected from the cut end of vessels involved in reconstruction to avoid inadvertent infolding of the adventitia into the lumen of the anastomosis.
2. Tunica media (smooth muscle cells and elastic tissue).
3. Tunica intima (endothelial cells). It is quite fragile and must be handled carefully by the surgeon to avoid intimal damage, which may lead to activation of the clotting cascade and thrombosis

Veins are more thin walled and collapsible than arteries and are also composed of three main layers, or tunics.

1. the tunica externa, or adventitia (connective tissue fibroblasts and collagen).
2. The tunica media of a vein is thinner than that of an artery and, although composed chiefly of smooth muscle cells, generally does not act to function in a contractile manner.
3. The tunica intima (endothelial cells). Most veins, although not contractile, contain infoldings of the tunica intima. These valves prevent backflow and pooling of blood from the effects of gravity.

Venous dissection and reconstruction should proceed with caution, because the venous wall is thin and its intima also readily damaged with overly aggressive or careless handling.

Pulmonary veins and the umbilical vein carry oxygenated blood as they traverse from the lungs to the heart or from the dam to the fetus.

GENERAL VASCULAR AND MICROVASCULAR SURGERY

Instruments, Suture, and Graft Materials

Instruments

An assortment of instruments used commonly in general vascular surgery. From left to right: a diamond-jawed needle holder, DeBakey atraumatic forceps, Metzenbaum and Potts scissors, and small and large right-angled forceps.

Microvascular surgical instrumentation. From left to right: microvascular needle holders, without catch, curved Vannas microvascular dissecting scissors, straight adventitial scissors, jeweler's forceps, and curved and straight mosquito hemostats.

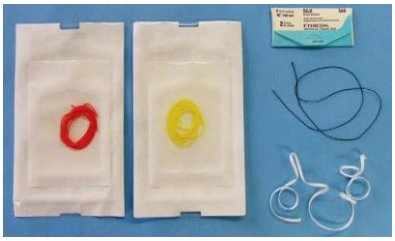
A variety of atraumatic vascular clamps in differing configurations and sizes. From left to right: a DeBakey atraumatic angled vascular clamp, DeBakey atraumatic tangential clamps, a DeBakey-Satinsky atraumatic tangential clamp, a Cooley atraumatic clamp, a DeBakey atraumatic multipurpose curved clamp, and a Castaneda atraumatic neonatal clamp.

a standard bulldog clamp can be used. These clamps do not have handles

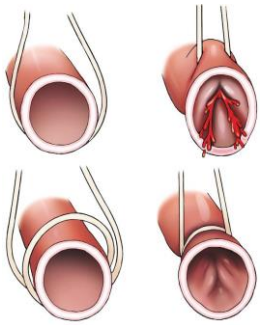
Arteriotomy clamp. The open tip allows for accurate assessment of the depth of the arteriotomy

An operating microscope offering 10× magnification is mandatory for many delicate microvascular procedures, such as anastomoses of small vessels. Surgical loupes providing magnification from 2.5× to 4.5× are readily available.

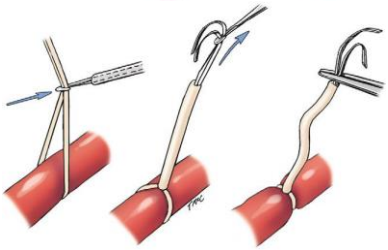
loops of Silastic, heavy-gauge suture, rubber catheters, and moistened umbilical tapes can be used to facilitate manipulation, exposure, and dissection of vessels



Silk suture, umbilical tape, or Silastic tubing may be looped around vessels to aid in retraction or as part of a tourniquet.



A single loop around a vessel, when placed under traction, will not prevent hemorrhage from the lumen of a cut vessel**,** but traction on a double (Potts) loop will control the vessel.



Application of a Rumel tourniquet: Hooking the two ends of the suture, umbilical tape, or Silastic tubing. **,** Pulling the ends through the short segment of catheter. **,** Cinching down the tourniquet and securing it with a hemostat.

Sutures

Vascular suture should be swaged onto a ½ or 3/8 circular, round, taper-point needle end. Caliber of the needle and suture should be as small as possible to minimize hemorrhage through suture holes, a range of 3-0 to 8-0 suture is typically used, progressing from larger to smaller vessels.

Generally, vessels with an internal diameter of 4 to 6 mm can be sutured with 4-0 to 5-0 suture, vessels of 2 to 3 mm with 6-0 suture, and vessels of less than 2 mm with 7-0 to 8-0 suture

3-0 suture might be chosen for a mitral valve surgery in a small-breed dog, and 7-0 to 8-0 suture is typically chosen for vascular anastomosis in feline renal transplant procedures.

Monofilament suture such as nylon orpolypropylene is preferred for arterial work because of greater strength and durability and decreased tissue reactivity,

Braided multifilament sutures have excellent knot-holding capabilities and, when passed through mineral oil or bone wax, have improved ease of handling and exhibit less drag. These soft multifilament sutures are commonly used in the more delicate venous tissues.

Prosthetic vascular grafts and patches

Prosthetic vascular grafts and patches can be categorized as

1. biologic or
2. synthetic.

Biologic grafts include those derived from native tissues such as jugular veins and other expendable vessels, of which there are few in small animal patients.

Synthetic grafts can be further classified into

1. textile and
2. nontextile varieties.

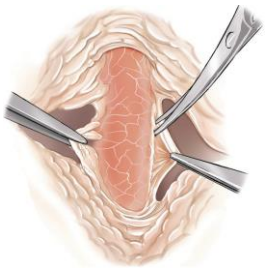
Textile grafts, such as knitted Dacron, were used commonly in the past but have been supplanted largely by the nontextile grafts because of problems associated with thrombogenicity and infectivity.

Nontextile grafts are predominantly made from expanded polytetrafluoroethylene, a linear, thermoplastic polymer of carbon, oxygen, and fluorine. They are not knitted or woven but are made by an extrusion process into porous tubes or sheets. PTFE grafts are strong, conformable, and easy to handle; can be cut to various sizes and configurations; and may be customized based on the needs of the patient.

Vascular Exposure and Control

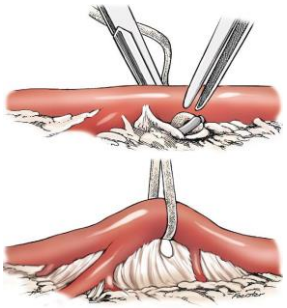
The surgeon may be able to locate the course of a vessel by palpation, and intraoperative Doppler colorflow ultrasonography may be helpful in locating an aberrant or difficult-to-detect vessel.

After incising overlying skin, subcutaneous fat, and fascia, hand-held or self-retaining retractors may be helpful in exposing the vessel of interest. The surgeon should dissect as closely to the adventitia as possible, generally with a blunt-tipped, rightangled forceps or blunt-tipped fine Metzenbaum scissors.



The adventitial surface of the artery is marked by a characteristic vaso vasorum pattern of perfusing vessels. Dissection of a normal artery showing the characteristic vaso vasorum pattern of perfusion. Perpendicular countertraction draws air into the areolar tissues surrounding the adventitia, creating the "white line" that delineates the proper plane of dissection.

Veins are generally recognizable by their white and bluish color and a ballotable sensation noted on direct finger pressure over the vessel.



Dissection of a vessel is facilitated by passage of suture, tape, or Silastic tubing underneath the vessel as traction on the loop reveals the location of various intervening branching vessels.

Hemostasis and Anticoagulation

A variety of hemostatic tools are available to vascular surgeons to

1. permanently interrupt blood flow, including: Kelly, Crile, and mosquito hemostatic forceps; clips; sutures; staples; monopolar and bipolar cautery devices; and hemostatic sponges, gels, powders, textiles, and waxes.
2. Temporary occlusion of blood flow can be accomplished with use of atraumatic vascular clamps, sutures, tapes, polymeric silicone tubing, and specialty tourniquets as described above.

One must carefully weigh the risk of systemic administration of anticoagulant compounds to the patient presented. Additionally, many anticoagulant medications commonly used in human patients, such as aspirin, present dangers other than hemorrhage to small animal patients, including hepatic, gastrointestinal, and renal compromise.

To prevent clot formation in vessels undergoing simple incision or arterial or venous anastomosis, the authors have used with great success an icecold solution of 2% lidocaine, heparin, and 0.9% saline to thoroughly flush the isolated vessel segment via the arteriotomy or venotomy site.

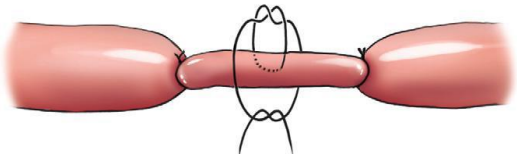
Vascular Incisions and Closures

Permanent vascular interruption by ligation or use of another hemostatic device is the simplest of all vascular procedures.

For veins and smaller arteries, single or double ligation using silk or absorbable suture or single ligation with the addition of a distal hemostatic clip should suffice.

Vascular clips for stapling devices may be used for patent ductus arteriosus and also which offer secure closure of large arterial vessels supplying organs such as lung or liver lobes.

For patent ductus arteriosus, a ligature placed at each end of the intervening vessel with a transfixation suture placed between obliterates the vessel lumen, decreases the risk of recanalization, and permits safe ligation in continuity.



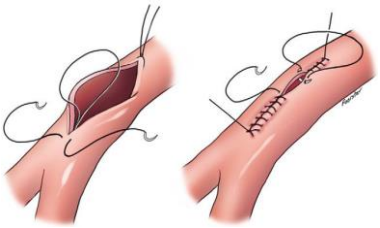
Simple incision into a vessel may be used to

1. introduce catheters for interventional procedures or
2. cannulas for bypass procedures,
3. to remove thrombi, or
4. for treatment of specific vascular conditions.

Vessel incisions may be longitudinal or transverse. In vessels smaller than 4 mm in diameter, a transverse incision is recommended.

Upon closure of a longitudinal vascular incision, a horizontal mattress suture is placed at either end using double-armed suture**.** Closure is performed by running a simple continuous pattern from each end toward the middle, where the sutures are tied. The continuous suture line must be pulled and held taut throughout placement to avoid hemorrhage in areas that are slack.

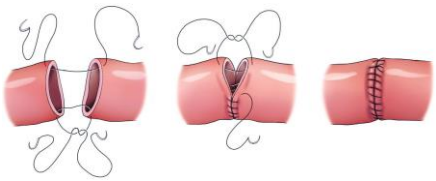
Sutures are generally placed 1 mm apart and 1 mm from the cut edge of the vessel except when vessels are enlarged, thickened, or diseased.



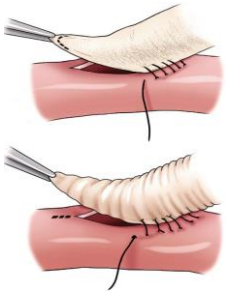
Vascular Anastomoses

The vascular anastomosis is performed most commonly. In veterinary surgery, simple end-to-end, end-to-side, and side-to-side anastomoses are performed.

A simple perpendicular end-to-end anastomosis is begun with two double-armed sutures placed 180 degrees apart and run continuously toward each other on either side



End-to-Side Anastomosis



Its described uses include feline and canine renal transplantation, grafting of free vascularized segments of skin and muscle, and palliation of tetralogy of Fallot.

End-to-side anastomosis may be used to suture artery to vein, artery to artery, vein to vein, or prosthetic graft to artery or vein.

Side-to-Side Anastomosis

Side-to-side anastomosis is not commonly performed in clinical veterinary vascular surgery