LEARNING OBJECTIVES:
1. Review the historical development of vascular and cardiovascular surgeries
2. Identify special instruments used by vascular and cardiovascular surgeons

Vascular surgery is a multi-disciplinary specialty involving the diagnosis and management of vascular diseases: those affecting the body's blood vessels (veins, arteries and capillaries). Procedures range from traditional and invasive open surgeries to minimally invasive procedures, including those performed in catheterization laboratories (cath labs) to examine blood flow to the heart and to test how well the heart is pumping. Conditions treated by vascular surgeons include peripheral diseases that involve veins and arteries located outside the heart and brain.

Cardiovascular conditions involve both the heart and blood vessels, and are treated by cardiovascular surgeons. Vascular and cardiovascular surgeries share some of a wide range of vascular instruments and operative techniques, and there is a vast wealth of parallel technological development and shared research. These surgeries and the instruments used to perform them are the topic of this lesson.

History of Vascular and Cardiovascular Surgeries

The golden era of vascular surgery began in the mid-1940s. At the outset, vascular surgery depended almost entirely on the development of specialized clamps, instruments and other tools to permit surgical intervention. The development of tangential holding vascular clamps (side clamps) to partially occlude (close) vessels and partially reduce blood flow allowed for reconstruction or side-to-side anastomosis (cross connection) of large vessels. These procedures began after atraumatic clamps (those that did not cause damage or injury) were developed by Friedrich Trendelenburg (1844–1924), and his invention was later improved upon by renowned surgeons like DeBakey, Cooley, Satinsky, and others.

Arterial homografts (artery transplants) were introduced, followed by the development of synthetic vascular suture materials and surgery-specific instruments. The introduction of devices, such as embolectomy catheters used for the surgical removal of emboli (clots or other material that travel through the bloodstream and lodge in and block a blood vessel), have progressed at an exponential rate. Cath-lab procedures opened new horizons in vascular and cardiovascular intervention, and one modern trend is a hybrid operation theatre that combines a cath lab with a traditional operating room.

Vascular and Cardiovascular Instruments

Handle shapes of vascular instruments may be flat or rounded, and some instruments have a knurled pattern in the metal surface to increase the friction and grip. The choice of handle shape and grip pattern is a personal preference of the surgeon who typically selects a shape that provides the best possible control. The length of the instrument handle determines comfortable working distance, and the weight of the instrument determines its use. For example, some vascular interventions, especially micro-surgery, require lightweight instruments.

Clamps

Vessel clamps are used to temporarily interrupt blood flow. Common vascular clamps have fine widthwise or longitudinal serrations. Special vascular clamps and forceps used for cardiac and vascular surgery are non-traumatic (also referred to as atraumatic), and have two types of jaw patterns:

- DeBakey-type jaws have two rows of finely-serrated teeth on one blade and one row on the opposing blade to provide a triangular grip.
- Cooley-type jaws have a double row of finely-serrated teeth arranged in opposing rows.
Vascular surgery clamps have angled jaws of various sizes. Because the clamps remain on the blood vessel for a specified time during the surgery, they should be selected for size to fit the operative site. Each size and angle is designed to clamp at a different region and to allow as wide an operative access as possible. Vascular clamp jaws require careful cleaning and inspection to avoid the accumulation of debris.

A Fogarty clamp has rubber-shod serrated blades to provide an atraumatic grip on tissues and blood vessels. The rubber-shod is disposable and should be replaced after each patient use.

Bulldog clamps are spring-loaded crossover clamps used to shut off small arteries. They open when squeezed, and the serrated-face clamp blades shut when squeeze pressure is relaxed. These clamps vary in sizes, curves, and angles, and the force that is applied by each type is measured in grams applied to the artery. These clamps present a reprocessing challenge because it is difficult to keep them open, and repeated openings decrease the strength of the spring and alter the force that is subsequently applied on the blood vessel. Gentle manual cleaning is most effective to provide and maintain a clean and properly functioning clamp.

Tubing clamps are used during open heart surgery to clamp off and control the heart bypass machine tubes.

**Cutting Devices**

Potts and Dittriech vascular scissors are very delicate and very sharp, and are used on delicate soft tissues, such as blood vessels. The scissors’ tips are available in angles varying from 25 to 135 degrees. Some versions have a spring mechanism, and others are held with rings. Those with a spring mechanism allow the scissors to have a very fine cutting motion and a delicate, quick grip.

The tension of spring-loaded instruments is an important concern. If the tension is too weak, it will be difficult to secure the tool between the surgeon’s fingertips without closing it excessively or dropping it from the hand grip. If the tension is too strong, it will require excessive effort that, over repeated use, can prompt premature hand muscle fatigue. To test for correct tension, place the instrument between the fingers and partially close the tips. Then, while holding this position, turn your hand over. If the instrument tip rotates out of position, the spring tension is too weak. Testing for excessive tension is more difficult and is defined by the level of hand muscle fatigue after a period of prolonged use.

An aortic punch is used by heart surgeons to create a hole in the wall of the aorta (the main artery leaving the left side of the heart) to attach another blood vessel in a bypass grafting surgery. The aortic punch is critical to the success of a bypass operation, and it must be sturdy yet sharp to maximize its effectiveness. Aorta and vessel-cut edges must be smooth to provide a smooth anastomosis (interconnection) and a seal that is fluid-tight.

Vein harvesting is necessary to obtain a vein for use as the bypass vessel. The saphenous or radial veins can be used, and the procedure can be performed by a direct traditional method that involves cutting the leg the length of the vein segment, or with an endoscopic surgical technique that leaves a minimal scar. After harvesting, a valvulotome (an instrument used to section a valve) is passed through the vessel to destroy the vein’s valves.

**Needle Holders**

Castroviejo and Jacobson needle holders are used for passing 5/0 to 7/0 swedged-on sutures. They are spring-loaded, and the jaw pattern may be smooth or serrated with straight or curved tips. Some surgeons prefer needle holders with locks, and others choose to grasp the needle without a lock. When closed, the jaws should close in a parallel fashion, so the needle will be securely grasped. Needle holders should be opened by releasing their distal (farthest) latch to allow thorough cleaning.

**Retractors**

Self-retaining retractors, like Gelpi with single-point tips and Wietlaner with blunt or sharp rake-style tips, are used to retract shallow incisions. In open heart surgery procedures, the sternum is held open with a sternal retractor designed to apply an opening force evenly along the patient’s sternum. This instrument is comprised of a rack with hinged arms mounted to it, a cog mechanism to force one of the arms to move along the rack, and retractor blades pivotally mounted to the arms. When the surgery involves using a mammary artery, a special retractor is required for artery visualization.

Other retractor models are available for various approaches and procedures. All self-retaining retractors should be opened or disassembled before reprocessing. Some retractors contain screws and require special attention of both operating room and CIS technicians to ensure that the screws are present before and after surgery. Self-retaining retractors tend to lose their retracting force over time, so it is important to check device resistance by applying force to the retractor blades.

**Vascular Dilators**

Vascular dilators assist the dilation of vessels for coronary and vascular surgery. Their tip size typically ranges from 0.5 mm to 5.0 mm. Dilators are malleable (capable of being shaped or bent) and tend to bend. While it is possible to smooth the dilators somewhat, if the instrument is too twisted it may not be suitable for use, and the surgical team may assist in this decision. When in doubt, simply sit the instrument on a platform (a slightly-elevated surface near the tip of the forceps) that is used to assist with suturing by catching the suture to help make a knot. A needle pulling forceps enables suturing procedures because the surgeon is able to pull the suture needle out of the tissue quickly and easily with the same thumb forceps used to manipulate the incision edges. A Gerald forceps has slender and tapered tips used for grasping...
fine tissue, and a ring tip micro forceps allows for a more secure grip on the tissue and is specially designed to grasp various arteries.

To inspect forceps, CIS technicians should hold the forceps as they are used in surgery, close the tip slowly, and ensure that the distal part closes prior to the center of the jaws. The spring action should be resistant, but not hard, and the two jaws should perfectly face each other. Ensure that the serrations are sharp enough and that the teeth mesh perfectly.

**Powered Instruments**

Powered instruments are used to access the thoracic (chest) cavity. The traditional full sternotomy, with its benefit of full exposure, requires making an incision in the middle of the chest from the top to the bottom of the sternum. A sternal saw (sternostome) is used to cut the sternum bone. This powered tool may be operated by batteries, electricity or compressed air power. A sternotome used for primary heart surgery has a reciprocating saw blade that moves back and forth, and it is more powerful than a saw used for re-operation. Note: re-operations require less powerful saws because, after sternotomy, the sternum is fragile and should be approached very carefully. CIS technicians should always carefully follow the manufacturer's instructions regarding handling and reprocessing of powered instruments.

**Internal Defibrillator Paddles**

These devices may be used during open heart surgery for resuscitation (restoring) of cardiac function if the procedure required the heart to be non-beating during the repair. Some open heart procedures can safely be performed on a beating heart, making resuscitation unnecessary. The paddles have a limited number of recommended reuses and require periodic electric conductivity and resistance tests by qualified medical device technicians. Therefore, a tracking system is needed to best assure the safety and functionality of these instruments.

**Valve Surgery Instruments**

Examples of these devices include:

- Hooks that may be round-ended, straight, or bent at a 90° angle and allow sharp and blunt manipulation and probing of valves during replacement operations. A small mirror is used for posterior (rear) view of the valve.
- A variety of frames with a suture holding apparatus that are used during valve replacement surgeries to keep numerous sutures properly aligned.
- Valve dilators that are used in procedures that return the valve to an earlier condition and for transventricular fracture of the valve through a small incision. These instruments have blades with an opening size controlled by a screw on the instrument's handle.
- Specialized valve handles that are typically designed for each type of valve. They help to ensure a firm grasp of the valve and to facilitate sewing ring exposure during valve replacement operations.

**In Conclusion**

Safe reprocessing of vascular and cardiovascular instruments is based on instructions provided by manufacturers, but the pillars of good practice are the knowledge and skills of CIS technicians. They must understand the purpose and use of these instruments, and consistently pay close attention to the processing details required for these challenging devices.

High quality positive patient outcomes require properly functioning and sterile vascular and cardiovascular instruments that are effectively managed by highly-trained CSSD personnel.

**Additional Reading**


CIS Self-Study Lesson Plan Quiz
(Instrument Continuing Education-ICE)

Lesson No. CIS 225: Vascular and Cardiovascular Surgical Instruments

Questions (circle correct answer):

1. Early vascular surgeries depended upon the development of:
   a. Internal defibrillator paddles
   b. Specialized clamps, instruments and other tools
   c. Valve surgery instruments
   d. Powered instruments

2. What is an “emboli?”
   a. A type of heart valve
   b. A primary vein
   c. A clot or other material that travels through the bloodstream and lodges in and blocks a blood vessel
   d. The main artery leaving the left side of the heart

3. The handle length of a vascular or cardiovascular instrument determines:
   a. Its use
   b. How it should be processed for reuse
   c. Where it should be placed in an instrument set
   d. Comfortable working distance

4. The purpose of a clamp is to:
   a. Retract shallow incisions
   b. Dilate blood vessels
   c. Assist with suturing
   d. Temporarily interrupt blood flow

5. What type of clamp is used to shut off small arteries?
   a. Jacobson clamp
   b. Bulldog clamp
   c. Tubing clamp
   d. Aortic clamp

6. Why is the tension of spring-loaded instruments important?
   a. Instruments cannot be processed if tension is too strong or too weak
   b. Weak tension will, over time, create premature hand muscle fatigue for the surgeon
   c. Strong tension makes it difficult to secure the instrument between the surgeon’s fingertips
   d. All of the above statements are correct
   e. None of the above statements is correct

7. Aorta and vessel-cut edges must be ______ to provide a smooth anastomosis.
   a. Rough cut
   b. Smooth cut
   c. Parallel cut
   d. Vertical cut
   e. Horizontal cut

8. Which type of needle holders is used for passing 5/0 to 7/0 swedged-on sutures?
   a. Castroviejo
   b. Jacobson
   c. Gelpi
   d. Weitlaner

9. All self-retaining retractors should be ______ before reprocessing.
   a. Replated
   b. Opened
   c. Disassembled
   d. All the above
   e. B and C above

10. Which can be bent during use or processing?
    a. Internal defibrillator paddles
    b. Valve dilators
    c. Vascular dilators
    d. Forceps

11. A sternostome may be operated by:
    a. Electricity
    b. Compressed air
    c. Batteries
    d. All the above

12. Which forceps has slender and tapered tips and is used to grasp fine tissue?
    a. Gerald
    b. Jacobsen
    c. Russian
    d. Adson

13. The retracting force of self-retaining retractors can be checked by:
    a. Applying force to the retractor blades
    b. Ensuring that distal parts close before the center of the jaws
    c. Assuring that all ratchets are tight
    d. A and C above

14. When should the suitability of vascular dilators for future use be determined?
    a. Before the instrument leaves the decontamination area
    b. At least once monthly
    c. Before the instrument is processed in the decontamination area
    d. After the instrument is cleaned and is being prepared for sterilization

15. Which type of forceps is specially designed for use in suturing arteries?
    a. Gerald forceps
    b. DeBakey forceps
    c. Gelp forceps
    d. Ring tip micro forceps

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