Surgical Operating Department – Part 5

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Instrumentation in the Operating Room

- History (14)
  - A surgical instrument is a device that has been designed for performance of an specific task during a surgical procedure
  - History of surgical instruments can be traced back to prehistoric times
    - During this time, the cave men made surgical instruments by sharpened stones, flints and animal teeth
    - Surgical instruments were being made using a variety of materials
      - These materials included: ivory, wood, bronze, iron, and silver

Instrumentation in the Operating Room

- Evolution of modern surgical instruments followed discovery of anaesthesia and asepsis in the 19th century and stainless steel in 20th century in Germany
- The 20th century saw many innovations in surgical instrumentation with the discoveries of electrocautery, ultrasonic and endoscopic devices
- Many new materials came into use
  - These included, titanium, Vitallium, carbides, and polymers
- In twenty-first century further development in surgical modalities took place, including: remote telesurgery, robotics
  - All these had impact on surgical instrument development

Instrumentation in the Operating Room

- Majority of surgical instruments currently are developed from stainless steel
  - Stainless steel is a combination of carbon, chromium, iron, and other alloys
- This combination makes the instrument strong and resistant to wear and corrosion
- Finishes used on stainless steel
  - During manufacturing three types of finishes can be used :
    - Mirror finish – these are highly polished, may cause glare but these are highly resistant to corrosion

Instrumentation in the Operating Room

- Satin and mat finish looks dull
- There is no glare in this type of finishes and this is the preferred finishes
- Ebony finish is a black chromium finish
  - This type of finish eliminates glare and reflection completely and is used in laser procedures to eliminate light beam deflection
- Gold plating on an instrument means that tungsten carbide was incorporated during the manufacturing process
  - Tungsten carbide is very hard, Used to laminate scissors blade to increase and maintain sharpness and inserted into the jaws of needle holders to increase strength and gripping abilities

Instrumentation in the Operating Room

- Instrument Categories (15)
  - There is no standard nomenclature for specific instruments
  - For purposes of discussion, the surgical instruments are categorised into:
    - Cutting instruments (dissectors)
    - Clamps
    - Retractors
    - Accessory or ancillary instruments
- Cutting Instruments (Dissectors)
  - These may be sharp or blunt

Instrumentation in the Operating Room

- These are used to cut or separate tissue
- The largest categories of sharp dissecting instruments are blades and scissors
- The combination of blade/knife handle is probably is probably the oldest of all surgical instruments
- Most of these instruments are handles (knife handle) with one end suitably made for the attachment of disposable blades
- During an operation the scrub person, may change the blades as and when necessary
- The blades are available in sterile pre-packaged packs and opened in sterile field

Instrumentation in the Operating Room

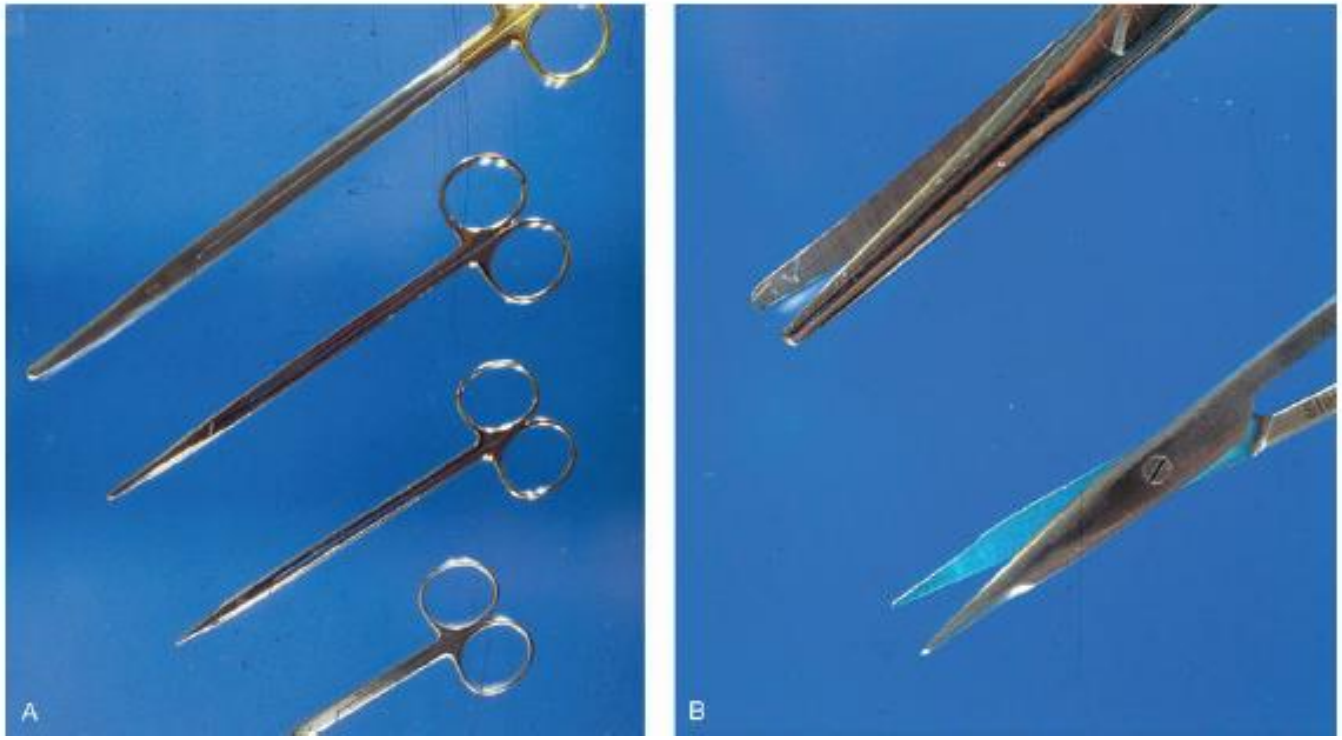
- The blades must be handled very carefully during a procedure to avoid injuries
- Scissors are designed in various shapes and sizes depending on its intended use for cutting body tissues and surgical materials
- The basic design of a scissor consists of two blades
  - Each of these blades are with chisel shaped edge with the bevel consistent with the structure to be cut
- Scissor tips may be blunt or sharp
- The blades may be straight or curved
- Conventional scissors require two movements for its use
  - One to open and another to close the jaws

Instrumentation in the Operating Room

- Some scissors may have a spring actin in the body
  - This keeps the jaws in open position
- A single movement closes the jaws to cut
- Often the scissors used in delicate plastic and eye surgery are of this type

- A basic instrument set usually includes a curved Mayo Scissors for dissection of heavy tissues, a Metzenbaum scissors for dissection of delicate tissues and a straight scissors for cutting suture
- For deep areas of the body, scissors with long handles and short blades are used

Instrumentation in the Operating Room



(A) The top two are long and standard Metzenbaum scissors. The bottom two are long and short Stevens tenotomy scissors

(B) The differences between Metzenbaum and Stevens scissors can be seen. The later are finer and are bevelled for precision cutting

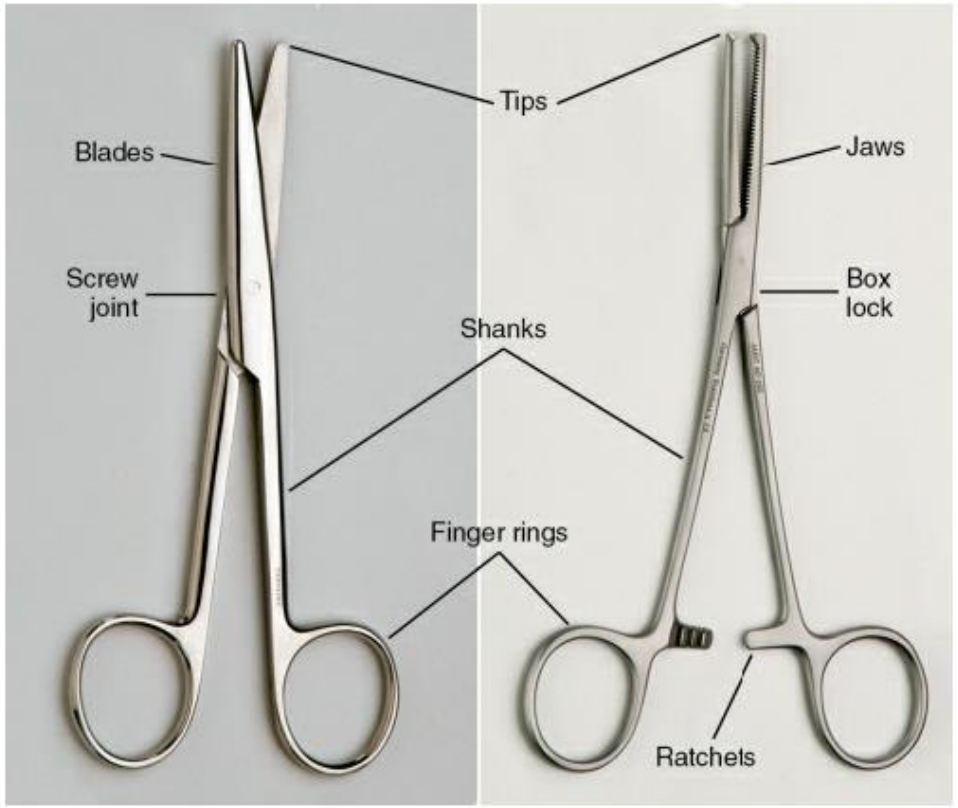
Instrumentation in the Operating Room

- Other sharp dissectors include:
  - Drills for making holes – used in neurosurgery and orthopaedics
  - Rongeurs : A rongeur is heavy-duty surgical instrument with a sharp -edged, scoop-shaped tip, used for gouging out bone. Used in maxillo-facial surgery
  - Adenotome : An adenotome may also be used rather than a curette when dissecting the adenoid
  - Dermatome : Used in skin grafting
- Some instruments in dissecting category may be sharp or blunt form

Instrumentation in the Operating Room

- Parts of an instrument
  - The design of an instrument is based on its intended function
  - All instrument has a basic standard design
    - These are modified as p[er function and type
  - The parts of the design include:
    - Handles
    - Ratchets
    - Shanks
    - Joints
    - Jaws or blades and
    - Tips

Instrumentation in the Operating Room



Mayo scissors and Kocher forceps

Source: (14)

- Finger rings are on the proximal end;
  - This is the handle area of the instrument.
- Above the rings are shanks that define the length of the instrument,
  - This is determined by the depth of the wound.
- Above the rings and attached to the shank may be ratchets that allow for the jaws to be closed and locked on tissues.
- Between the shanks and the jaw is the joint,
  - Here the two halves of the instrument are joined to permit for opening and closing.

Instrumentation in the Operating Room

- These joints are either a box lock or a screw joint
- Beyond the joint are the jaws
  - Jaws are the working portion of the instrument
- The inner jaws, tips, and shape determine its use – on what and how and on what tissues the instrument is used
- Ringed instruments are placed in the palm of the surgeon's hand
  - The working tip is kept up

❖ Tissue forceps

- These have a spring action joint at the distal end that holds the instrument open until compressed

Instrumentation in the Operating Room

- At the handle grip surgeon's fingers are placed
- The shank determine the length of the forceps
- The jaws and the tips are the working end of the forceps
  - These are determined by the tissue to be grasped
  - Tissue forceps are held between the thumb and the index finger
    - The distal joint end rests on the top of the handle like a pencil

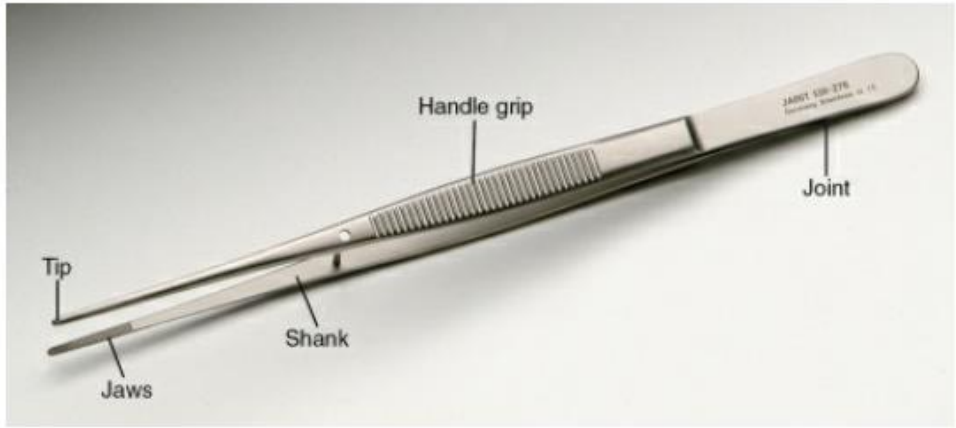


Fig: Plain tissue forceps illustrating the parts of a tissue forceps

Instrumentation in the Operating Room

- Retractors
  - These are used to hold the surgical wound open
    - Applied on the side that is worked on
  - A handled retractor is designed with a handle, a shank, a blade(s), and tips
  - At the handle the retractor is grasped
  - This may be at the middle or at one end

Richardson-Eastman double ended retractor and its part

Instrumentation in the Operating Room

- The shank determines the length of the retractor
  - It runs from the handle to the blade
  - The blade determines the depth to which the retractor is placed into the wound
  - The tip is at the end of the blade and differs depending on where and how the retractor is utilised.

Instrumentation in the Operating Room

- Instrument Categorization
  - As has been mentioned earlier (slides: 6-9), there is no standardised method of classifying surgical instruments
  - One method was presented in these slides
  - The other method is as under:
    - Instruments are designed for a specific purpose
    - The categorisation is based on its function

Instrumentation in the Operating Room

- There are nine categories. These are:
  1. Accessories
  2. Clamping and occluding
  3. Cutting and dissecting
  4. Grasping and holding
  5. Probing and dialating
  6. Retracting and exposing
  7. Suctioning and aspirating
  8. Suturing and stapling, and
  9. Viewing

Instrumentation in the Operating Room

- Instrument sets
  - Instruments are generally placed into sets according to the type of procedures that are performed at the facility
  - Typically, instruments from each category will be selected for the assembly of a set
  - These sets are then assembled, labelled, sterilised and stored for their for later use
  - Instrument sets are often labeled according to the procedure, degree of the procedure, i.e., major or minor, or
    - The specialty area

Instrumentation in the Operating Room

- For example:
  - A hysterectomy set would be used to perform a hysterectomy
  - An orthopaedic basic set would be used for a number of orthopaedic procedures

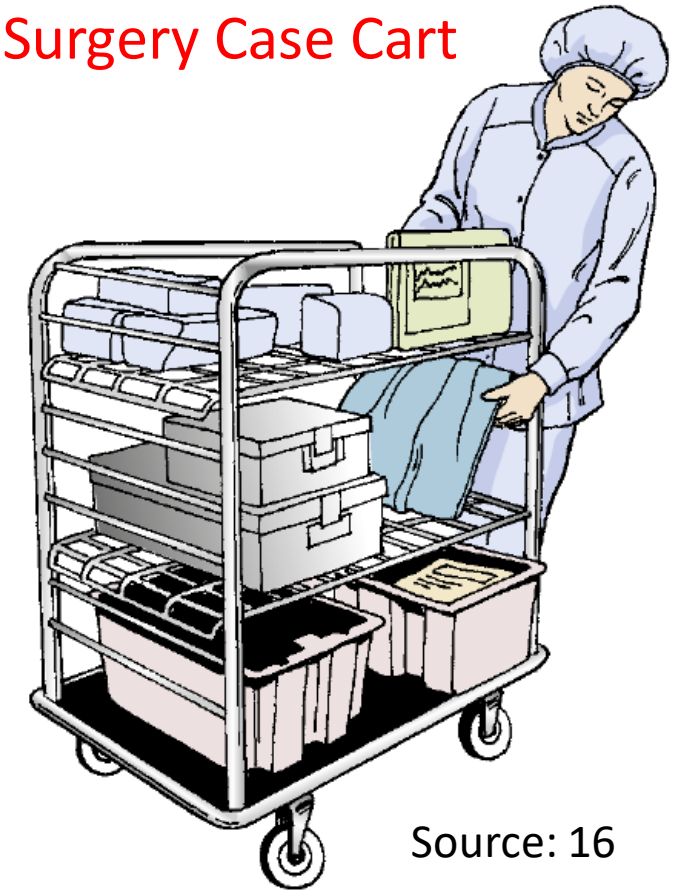
Case Cart System

- Most ORs use this system
  - The CSSD assembles a case cart and delivers all sterile instruments packs and drapes containing all required sterile supplies for a particular surgical procedure
  - The sterile and non-sterile supplies are selected as per a routine procedure and individual surgeon's preferences.

Instrumentation in the Operating Room

- Good communication system between the OR staff and that of CSSD is essential for the system to run efficiently
  - The surgeon's preference data should be up to date either in the preference card or in the computer
- The majority of the drapes and disposables will be contained within the custom pack on the case cart
- Some facilities use the items on the case cart for patient charging purposes, though not so prevalent in India
- A bar code or other computer label may be used to facilitate this function

Surgery Case Cart



Source: 16

Instrumentation in the Operating Room

- Basic Table Setups
  - Usually in most ORs instruments are set up on Mayo stands and back table
  - Though there is no fixed method of laying up the instruments, each scrub person has his or own preferences
    - However, instruments must be laid in a planned, standardised, organised and functional manner
    - This is important in case a scrub person is changed so that the new person will not have any difficulty and he/she can find the required instrument to handover to the surgeon without fumbling
    - All solutions, syringes and medication cups are to be clearly labelled

Instrumentation in the Operating Room

- It I essential that the scrub person must know the instrument inventory of the department, and
  - Instruments needed routinely for each type operation
  - The individual surgeon's preferences
  - Correct use and handling
  - Method of preparation, and
  - Post-operative care of the istruments
- Preference cards for each surgeon for a particular surgeon is the foundation of efficiently managing the daily activities of the OR

Instrumentation in the Operating Room

- Care and Handling of Surgical Instruments (17)
  - The below guidelines must be observed through all phases of handling and processing of surgical instruments
    - Know the proper name and intended use for each instrument
      - Hand the surgeon the correct item for each task
      - Most instrument damage is caused by inappropriate usage
    - Pass and place delicate instruments carefully – making sure not to drag across draping material
      - Rinse off blood and or the other debris after each use
      - A non-fibrous sponge to be used for this purpose
      - This will prevent snagging and breaking of delicate instrument tip

Instrumentation in the Operating Room

- Remove any loose instrument from the sterile field and place them on the Mayo stand or instrument table
  - This prevents extraneous from injuring the patient or falling to the floor
- After the procedure, place used instruments, except sharps and delicate items, in a tray or basin
  - Avoid carelessly throwing ordroppin
- Place reusable sharps and delicate instruments in separate containers, such as emesis basins or mesh bottom trays
- Place heavier items in the bottom of the tray, with smaller, lighter instruments on

Instrumentation in the Operating Room

- Remove defective instruments from the sterile field or processing area, decontaminate them and label them for repair
  - All instruments from the sterile field must be decontaminated before being repaired
- Protect sharp edges of instruments during handling, cleaning, sterilization and storage
- Separate sharp instruments from dull instruments

Point of Use Care

- Effective instrument processing begins at the point of use-during the surgical procedures
- Drying of blood, soil or any protein-containing material needs to be prevented
  - For this, remove gross blood and debris from instruments immediately after use by wiping with a damp gauze sponge moistened with sterile water

Instrumentation in the Operating Room

- Delicate and sharp instruments like those used in eye and microsurgical procedures are to be wiped, hinges and box locks to be opened and placed in mesh trays or baskets
  - Submerge the instruments in a soaking solution
  - The product must be safe and can be used on surgical instruments
  - **The instruments must not be soaked in saline**
    - This tends to corrode the instrument surfaces
- The soaking solution should be discarded before transport
  - Instruments may be covered with a moist towel for transportationh

Instrumentation in the Operating Room

- Electrosurgery
  - The electrosurgical unit is used to a greater or lesser extent in all surgical specialties
    - There are different types of electrosurgical equipment
  - Staff must be familiar with the manufacturers' detailed manual or operating instructions
  - Electrical current can be used to cut or coagulate most tissues
    - Large vessels are not coagulated with electrosurgery
      - Attempts to do so may cause extensive burns and necrosis

Instrumentation in the Operating Room

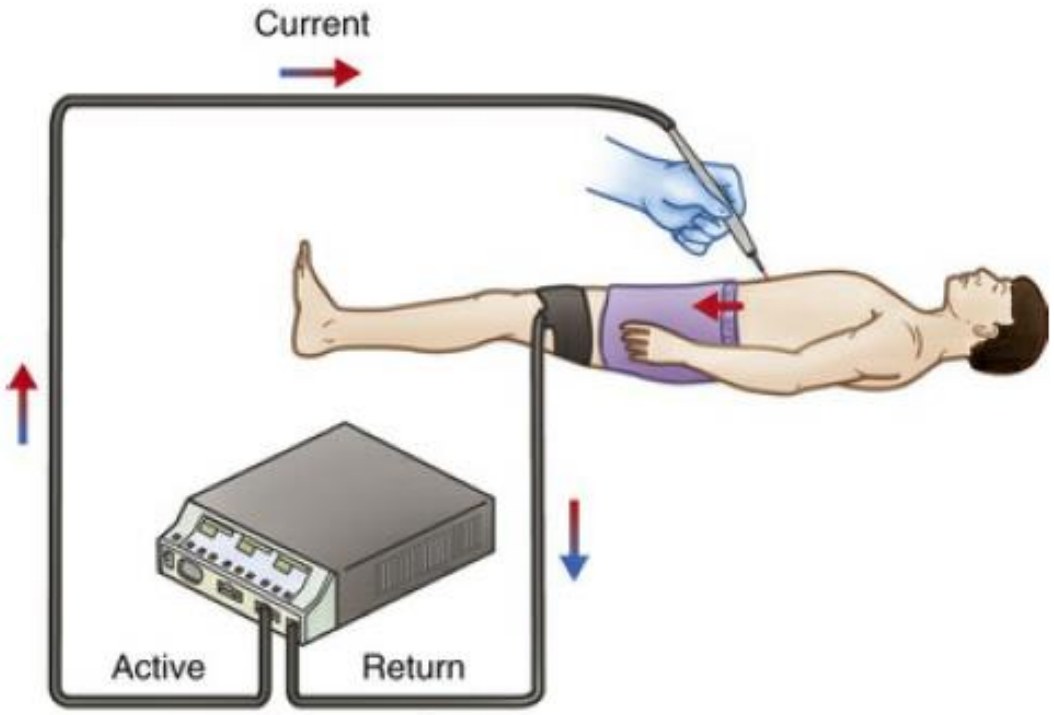
- Excess charring and devitalised tissue interferes with wound healing and may encourage infection
- Electrosurgery is not used to incise skin
  - Initial skin incision is done with scalpel
- It can be used on fat, fascia, muscle, internal organs, and vessels
- Electrosurgical unit (ESU) operate at 100,000 and 10000000 Hertz
  - This current can be passed through tissues without stimulation of muscle or nerve

Instrumentation in the Operating Room

- Difference between Electrosurgery and Electrocautery
  - Electrosurgery differs from electrocautery
  - Electrocautery is the use of unidirectional current generated by a self contained, battery operated disposable instrument with a wire at the tip
    - The wire heats when activated and coagulates the tissue
    - The energy does not enter the patient's body
  - The ESU uses an alternating current that passes through the patient's tissue and returns to the generator
  - Two forms of ESU generators are commonly used in surgery – monopolar and Bipolar

Instrumentation in the Operating Room

- Monopolar Electrosurgery
  - In this, the electric current flows from the generator to the active electrode,
    - Then, through the patient to a return electrode, and
    - Returns back to the generator
    - With concentrated electricity in a small area and with tissue impedance, heat is generated that is used for cutting or coagulating



Monopolar Electrosurgical Circuit (16)

Instrumentation in the Operating Room

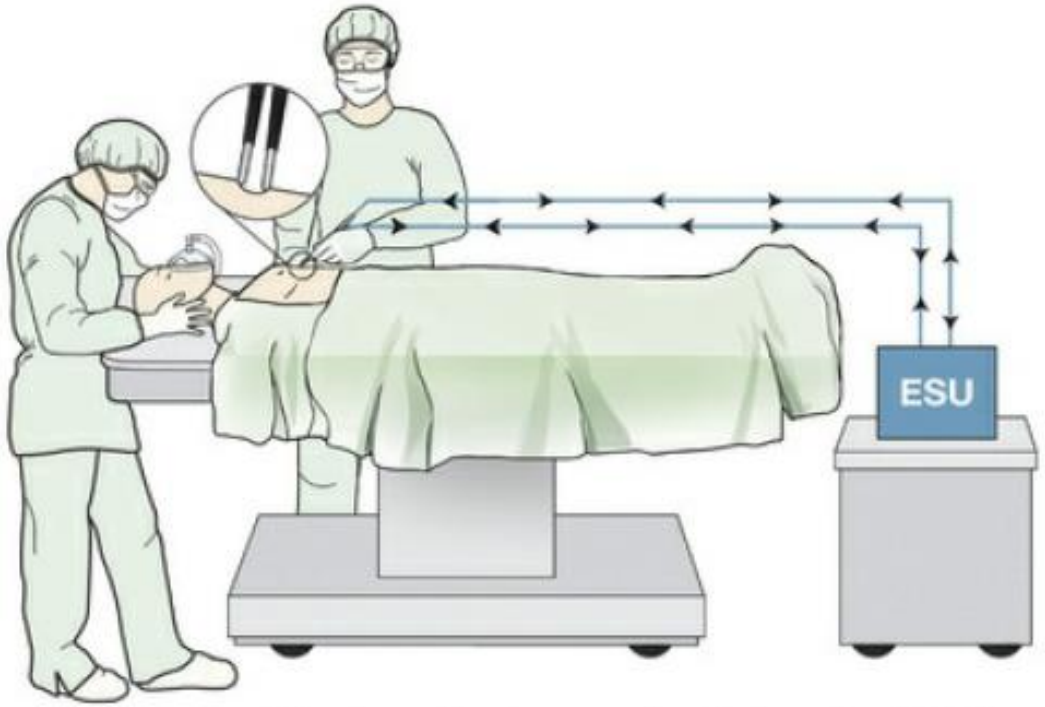
- Electrical energy passes through the patient to a dispersive pad (electrode) or patient return electrode placed on the patient's body
- The dispersive electrode surface area is large enough that energy is not concentrated to generate significant heat
  - Energy is then returned to the generator as the circuit is completed
  - If only a small part of the pad is in contact with the patient's body, electrical energy becomes concentrated, and a burn can result
- Monopolar ESU is the most common mode of electrosurgery used today

Instrumentation in the Operating Room

- The bipolar ESU system
  - In this ESU, there is no dispersive electrode
  - Electrical energy flows from on tine (or prong or blade) of the bipolar instrument to the other tine through the tissue located between the tines
  - Energy returns directly through the instrument to the generator to complete the circuit
  - There is no flow of electricity through the patent
  - During bipolar electrosurgery, the flow of electricity stops if a certain impedance level is reached
  - Often this is 100 ohms but may differ with ESU instruments

Instrumentation in the Operating Room

- At specified impedance, the flow of current significantly decreases
- Impedance meters are often used to alert the surgeon when tissue desiccation is occurring, or
  - When complete desiccation has occurred



Bipolar electrosurgical circuit. *ESU*, Electrosurgical unit.

Instrumentation in the Operating Room

- ESU Generator
  - The generator produces electrical current in three forms
    - Coagulation current
      - Intense heat is produced to seal small to moderate vessels on contact
      - The current is continuous, but diminishes for short gaps of time
    - Cutting current
      - The current is a constant flow of high energy output without gaps of time
      - The continuous flow of current causes the tissues to separate before high level heat build up

Instrumentation in the Operating Room

- Blended current
  - Both coagulating and cutting currents are produced at the same time in modified cycles
  - Small vessels are sealed at the same time as the btissue divides
  - Settings can be selected that have varied degrees of coagulation and cutting

- Active Electrode
  - This is sterile electrode
  - This electrode directs flow of current to the surgical site
  - The tip design of the electrode, i.e., blade, loop, ball, or needle is determined by the type of surgical procedure and current to be used

Instrumentation in the Operating Room

- There is an alarm system
  - The generator emits a buzzing sound when in use
  - Depending on the type of current used, whether it is cutting current or coagulating current, the pitch of the sound varies
  - The alarm has a volume control
    - The alarm should never be set to off position
- Vessels are coagulated when any metal object part is touched with the active electrode
  - A bleeding vessel is first secured with a haemostat and the tip is applied to it rather than applying the tip directly on tissue
  - This is called buzzing

Instrumentation in the Operating Room

- Electric arcing may take place between the tip and a metal instrument if there is a gap between the tip and the instrument when current is applied
- To avoid, the tip should first touch the metal instrument then current is applied
- No part other than the intended tissue part of the patient should be touched by the tip
  - To avoid touching any part of the patient, a firm grip of the handle is necessary
- Current should not be applied for more than 3 seconds
- Patient may receive burn injury, if the metal instrument touches instrument such as retractor in the surgical field

Instrumentation in the Operating Room

- The active electrode handpiece and cord are disposable
- Reusable active monocular forceps should be inspected for damage before reprocessing and also before they are brought into use in the surgical field
- It is attached to a conductor cord
  - The cord is connected to the generator
- The tip may have a pencil shaped handpiece
  - The tip of the handpiece is operated by a rocker switch
- The tip may also be incorporated into a tissue forceps or suction tip operated by a foot pedal
- For safety, only the surgeon should operate the foot pedal
- No metal instrument should be used to secure the sterile part of the cord to the field
  - Any leakage may cause electricity conduction and may cause fire

Instrumentation in the Operating Room

- When the ESU is not being used, the handpiece and active tip should be kept clean and put into the holder designed for this purpose

- Patient Return Electrode
  - This is the Inactive Dispersive Electrode
  - This is used in monopolar ESU, through which the current is returned to the ESU
  - The active tip sends the current through the patient tissue
  - To complete the circuit, current from generator to patient – through the patient tissue – through return electrode – to the ESU
  - If the path is broken, current finds an alternate path back to the ground
    - Isolated generator is used sometime where if the circuit is broken the generator shuts down

Instrumentation in the Operating Room

- One type of return electrode adhesive pad is placed in direct contact with patient skin
- The contact area must exceed 100 mm^2 and have a diameter greater than 1.2 cm
- The adhesive return electrode can be moulded to the appropriate body surface

- MEGNADYNE manufactures a reusable return electrode
  - This measures 720 in^2 and does not adhere to the patient's body
  - The gel pad is large
  - It is placed in a plastic sheath below the bed sheet on the OR bed

Instrumentation in the Operating Room

- The patient makes contact with the pad over most of the contact surface through the bed sheet
- This type of return electrode is useful when there is no suitable site for a disposable return electrode, e.g., burn patients
- In lithotomy, with this type of electrode, positioning is difficult
- Fluoroscopy imaging may be distorted if used under the patient
- The cord attaches to the generator in the patient return electrode socket

❖ Patient safety in electrosurgery

- Electrosurgery causes more patient injury than any other electrical devices used in the OR

Instrumentation in the Operating Room

- Most incidents are caused by user error

- Irrespective of the type of electrode used, the safeguards to avoid injury must be followed
- These are as under:
  - The return electrode should be as close to the site where active electrode is being used
    - This way minimum current will flow through the body
  - The patient should be positioned appropriately for the surgery before the adhesive return electrode is applied
  - This will prevent its dislodgement or buckled during patient positioing

Instrumentation in the Operating Room

- The return electrode should not be cut for the purposes of fitting
- The return area should cover as large area of the patient's body surface as possible
  - The patient's body surface area should be free from insulating effect of hair and scar tissue
  - If required the surface area may be dry shaved
  - The surface area affects heat build up if the heat cannot be dissipated quickly
  - Pressure point areas to be avoided
    - Otherwise heat build-up takes place

Instrumentation in the Operating Room

- A clean dry area of body surface may be chosen
- Body surface over a large muscle mass area is preferable
- The gel that is applied for conduction is sticky and cold
- In an awake patient if this is applied without forewarning, it may startle the patient

- The return electrode should not be placed over an implant from a previous surgery
  - The surgical scar tissue may prevent current dispersion
  - Also, the current could be diverted to the metal implant (such as hip prosthesis) and generate excessive heat

Instrumentation in the Operating Room

- Before use, the return electrode package should be checked for its integrity
  - The electrode should not be used if the package is previously opened or damaged
- Specifically, it should be ensured that the cord does not become dislodged
  - No safety belt should be used to prevent dislodgement
  - It may create excessive pressure point on the patient's skin
- The connection of the cord with the generator should be secure with compatible attachment

Instrumentation in the Operating Room

- A faulty connection may complete the circuit through an alternative pathway due to an unintentional contact with the metal operating table
- In case the return pad surface area is too small, the current passing through an exposed area of skin contacting metal will create intense heat
  - This can happen, for example, in a lithotomy position, the thigh touching a leg stirrup
  - A full thickness burn can result
- It is necessary to document:
  - the type and/or location of the dispersive return electrode

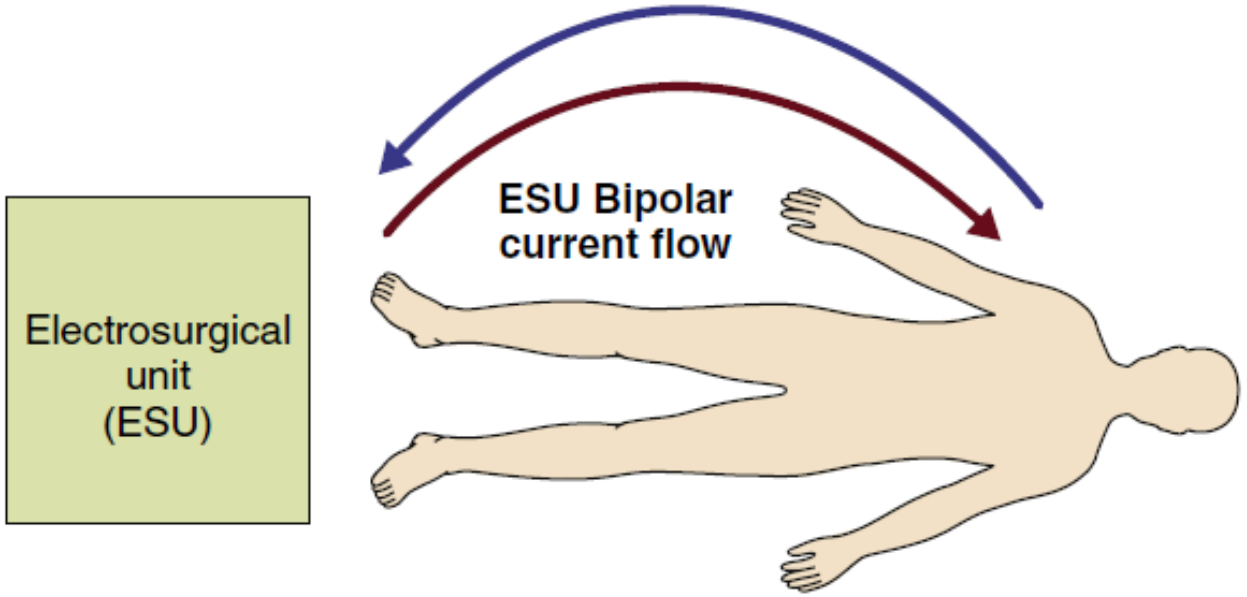
Instrumentation in the Operating Room

- Condition of patient's skin before and after electrosurgery
- The generator identification number, and settings use
- Optionally, the return electrode lot number may also be documented

- Bipolar Electrosurgery
  - In this type, current takes the path from the generator to a special forceps
    - These forceps have one active tip and one inactive tip
  - Current from the generator flows to the active tip and returns to the generator through the inactive tip

Instrumentation in the Operating Room

- The energy does not flow through the patient's body as in monopolar ESU
- Output voltage is low
- Precise control of coagulation area may be achieved
- It is safe to use in case of implantable device such as pacemaker



Bipolar current path. No return electrode is used

Instrumentation in the Operating Room

- Generalised safety consideration in Electrosurgery
  - Electrical burns is the greatest hazard of electrosurgery
  - All deep thermal burn is immediately noticeable
  - Electrosurgery should not be used in the mouth, trachea, around the head, or in the pleural cavity
    - In these areas there are high concentration of oxygen is present and fire can be caused
  - ECG should be placed as far away from the surgical site as possible, otherwise burn can be caused
  - Rings and other jewellery should be removed

Instrumentation in the Operating Room

- Flammable liquid antiseptics should used with caution
  - If at all used, the skin surface should be completely dry before draping, else flammable vapour can build up
- In case another piece of electrical equipment is used simultaneously as the ESU is in direct contact with the patient, a different source of current should be used when possible
- The cutting current of the ESU may not work, if another piece of electrical equipment is on the same circuit
- If bipolar active electrode to a monopolar receptacle may activate current causing short circuit
- Plugs on cords should be differentiated to avoid misconnections of active and inactive electrodes

Instrumentation in the Operating Room

- Moist sponges only should be used in surgical field to prevent fire when the ESU is in use
  - The same precaution should be taken in diathermy and battery operated electrocautery as well
- If the surgeon is asking for more current repeatedly, check the connections and the dispersive electrode and then the handpiece connection
  - If patient is touched, shock may result to those touching the patient
- For safety, manufacturers' instruction should be followed
- Avoid inhaling plume by patient and staff during electrosurgery

Instrumentation in the Operating Room

- Ultrasonic Blade and Scissors
  - Harmonic Scalpel
    - This is a handpiece that receives electrical energy from a generator
    - The generator is activated by foot pedal or finger control
    - This however does not function as an ESU
    - The bipolar energy is converted into mechanical vibration at a rate of 55000 waves per minute
    - The effect is that at this vibration, the instrument cuts spot coagulates protein molecules
    - The tissue dissolves on contact and coagulates in response to the protein denaturation

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End of Part 5