Surgical Operating Department

Prof (Col) Dr RN Basu

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Content

- MIS Overview

Operating Department

- Objectives of the operating department (1)
  - The primary objectives are:
    - Patient-focussed care
    - Successful surgical or diagnostic procedures for the patient
    - Preservation of patient dignity
    - Maximising efficiency in terms of throughput and outcomes
    - Keeping patient safe
    - Saving cost

Surgical Modalities

- LASER Technology (2)
  - The term LASER stands for *Light Amplification by Simulated Emission of Radiation*
  - In LASER, light is the energy source
  - LASER is produced by stimulating the electrons of many materials like solid, liquid, tunable dye, or gas with electricity
  - Stimulation can also be done by using a xenon flash lamp or another LASER
  - The light energy reaches a high energy state

LASER

- This energy then releases photons
  - A photon is a tiny particle that comprises waves of electromagnetic radiation.
  - Photons are electric fields traveling through space.
  - Photons have no charge, no resting mass, and travel at the speed of light
- The photons collide within the LASER chamber between mirrors
  - This collisions produces more energy
- The energy escapes in the form of the LASER beam
  - A constant diameter is maintained by collimation (made parallel) over a great distance
    - Ordinary light expands and is not parallel

LASER

- The beam is monochromatic (one colour) and of a single optical frequency
  - The photons travel in in a coordinated fashion with the light waves in phase with each other in an orderly fashion
- This property of LASER makes it to travel over a great distance with highly concentrated energy
  - The energy is focused on a tiny spot
    - This is the focal pint
- Each stimulated material emits energy of different wavelength
- Thus the energy is absorbed in a selective manner

LASER

- Body tissues are affected by LASER beam by the heat produced or sound that is produced
- The tissue reacts by
  - Vaporization
  - Fragmentation
  - Cutting, or
  - Coagulation
- The effect of the LASER beam is determined by:
  - Its power (wattage)
  - Its duration of the contact time with the target tissue

LASER

- The use of continuous or pulse mode
- The cooling action of blood
- Pigmentation
- Translucency of the target, and adjacent tissue

- Types of Laser
  - In the operating room several LASERs of different wavelength are used
    - The wavelength is measured in nanometers (nm)
    - These LASERs have different clinical capabilities
  - CO_2 (carbon dioxide)
    - LASERs of 10600 nm wavelength is used in a non-contact mode for cutting and vaporization of tissues
    - Welding of certain tissues, e.g., vascular anastomoses is also done

LASER

- Nd:YAG
  - Uses neodymium, yttrium aluminium garnet
  - Wavelength is 1064 nm
  - This LASER can pass through clear fluid
    - Thus, darker tissue beyond the clear fluid can be targeted
  - It can also be transmitted by a flexible probe (fiber) through an endoscope for the destruction of gastrointestinal, urinary, and respiratory tract lesion
  - For contact mode, this LASER with a sapphire tip can be used
- The Argon LASER
  - Wavelength is 488 nm – this emits blue LASER
  - Wavelength up to 515 nm emitting green LASER is used in ophthalmology

LASER

- The blue-green LASER is absorbed by melanin and haemoglobin
- In ophthalmology, it is used for photocoagulation of retinal vessels and for bleeding points
- In plastic surgery, it is used for ablating haemangiomas
- It also has various applications in dermatology

➢ KTP (Potassium Titanyl Phosphate) 532 nm LASER

- It is a variant of the Nd:YAG LASER
- In this, the beam is passed through a potassium titanyl phosphate crystal
- By this, frequency is doubled, and wavelength is halved
- By this process, the property of this LASER becomes similar to the argon LASER but tissue destruction capability is increased

LASER

- Ho:YAG (holmium) LASER
  - Wavelength 2100 nm
  - It can penetrate to 0.4 to 0.6 nm
  - It is absorbed by water like CO_2 LASER energy
  - It can be applied directly or via a fibre
  - It can be used for its acoustical effect to fragment biliary or urinary tract calculi
- Er:YAG (erbium) LASER
  - Wavelength 2940 nm
  - It is absorbed by water with shallow tissue penetration
  - It is useful in local ablation and skin resurfacing

LASER

- Tunable dye LASERs
  - Various dyes are exposed to intense light such as argon LASER
  - Wavelength 400 to 1000 nm modified by tuning crystals
  - This group of LASERs include pulse dye LASERs of various frequencies
    - Frequency depends on the particular liquid dye medium and a pulsed light source. For example:
      - This LASER with a frequency of 504 nm as conducted through a fine (0.2 nm) quartz fibre
      - it can be passed through a ureteroscope immediately adjacent to or in direct application to a calculus causing it to shatter
    - A 530 nm wavelength yellow dye LASER will also fragment urinary tract calculi

LASER

- Other tunable dye LASERs include:
  - Flashlamp pumped pulse dye LASER
  - Candela LASER
- An additional application tunable dye LASER is photodynamic therapy
  - A photosensitive dye is injected
  - The dye is selectively retained by malignant (and other) tissues
  - These tissues are exposed to appropriate wavelength (400 to 1000 nm)
  - The LASER produces a photochemical reaction destroying the tumour
- Ruby LASER is used for tattoo removal

Technical Adjuncts to Surgery - LASER

- The excimer (excited dimeric medium) LASER
  - This LASER utilizes an inert gas halide system
    - These include: argon fluoride (193 nm), krypton fluoride (248 nm), xenon chloride (308 nm), and xenon fluoride (351 nm)
  - These can be incorporated in a fine catheter
    - The catheter can include a video system and irrigating mechanism
    - This can be used to open occluded coronary arteries (pulsed 308 nm) by direct contact destruction of intimal plaque
  - An additional excimer LASER use
    - It is used for optical contouring of cornea
  - These gases are toxic so measures for housing structures and exhaust systems are inherent in their use

LASER

- Diode LASER
  - Wavelength 750 to 950 nm (Gallium arsenide 840 to 910 nm)
  - This has been introduced in a compact system
  - Used in ophthalmology for photocoagulation
  - It can be delivered directly by fibre or introduced through a slit lamp
- This LASER can also be used for urological applications
- Modified for use with an operating microscope, the LASER is very useful in microlaryngeal and ophthalmological procedures
- There are many advantages of using various types of LASERs in surgery

LASER

- In general, the benefits for using LASER are:
  - Less blood loss – most small vessels are sealed
  - Working in a relatively dry field
  - Minimal tissue trauma
  - Faster wound healing
  - Decreased chance of malignant cells spreading – being spread through lymphatics
  - Decreased scarring due to precision
  - Faster recovery time in most cases
  - Treatment of areas otherwise inaccessible via catheters and endoscopes

LASER

- Safety Precautions
  - Any time a LASER procedure is performed, a scrub person, a circulator, and a LASER safety officer (LSO) should be present
  - The LSO should have adequate training, knowledge, and experience in evaluation and control of LASER hazards
  - All LASER team members need continuing in-service education regarding their expanded responsibilities
  - Windows must be appropriately covered
  - All equipment must be checked prior to the procedure
    - the checking should include but not limited to testing the beam focus, electrical connections and suction apparatus

LASER

- Only personnel trained in LASER safety should participate
- A master key enabling operation of the LASER must be obtained and then returned at the completion of the procedure
  - The key should be kept in a locked box
  - A "sign out" log may be maintained for the key
- The pedal (when used) is identified as it is placed in front in front of the operating surgeon to avoid accidental activation
- The LASER is set at "standby" or "stop" mode during significant interruptions in its use
- Eye protection for patients and all personnel in the room is mandatory for most LASERs except when the conditions of minimum permissible exposure exists

LASER

- Flammable preparatory solutions and other flammable liquids should not be used in the are where the LASER is used
- A large amount of wtrer or saline , a fire extinguisher, and a fire blanket must be in the room for use in case of fire
- All dry materials in or near the operative field must be dampened with saline or water
- Nonflammable endotracheal tube must be used
  - Or, traditional tubes should be wrapped with commercially available tape prepared specifically for this purpose
  - The cuff should be inflated with saline
  - The tube is wrapped in wet sponges around the lips

LASER

- All instrumentation should be ebonised, or in case of large retractors being used, covered with wet towel
- Everything around the impact site, excluding the target site, must be moistened
  - The sterile field must be monitored for strike-through wetness contamination
- Special surgical masks should be worn when the LASER is in use to filter out microscopic particulate matter that has hazardous potential concerning the respiratory tract.
- A smoke evacuator must be used, held close with itsto the target to evacuate the plume with its toxic by-products and odour
- Small amounts of plume can be evacuated with the in-line room extraction
- For large amount of plume, an individual smoke evacuatorand ultra-low penetration air-filters is recommended

LASER

- Smoke evacuation filters must be changed as per manufacturers recommendations
- Disposal of “used” evacuation filers is controversial regarding whether they should be considered general waste or biomedical waste
- Treating the used filters as “biohazard” will eliminate the possibility of contamination of environment
- A nominal hazard zone can be calculated regarding wherein the operating room LASER hazard to eye, skin, and fire considerations exists
- For practical considerations, appropriate maximal protection should be employed for all procedures
- Ordinary eyeglasses and contact lenses are inadequate for protection

LASER

- Lens filters for endoscopes are necessary to avoid scatter
- When using CO_2 LASER , clear glasses with side wings are worn by everyone in the room, including the patient, if he or she is awake
- Under general anaesthesia, the patient's eyes are taped shut and covered with wet pads and the face is covered with a wet towel
- If the area to be operated is on the face, wet pads are placed about the site
- All flammable materials near the area of LASER should be covered with wet towels
- Goggles use
  - The Nd: YAG LASER requires blue-green safety goggles
  - Argon LASER requires orange goggles

LASER

- Fire is a realistic hazard, particularly when the CO_2 LASER is used in or near the airway
- Only non-flammable anaesthetics are permitted
- Conventional endotracheal tubes must be wrapped with a specific LASER retardant protective (wrap) tape
- A polyvinyl chloride (PVC) tube is highly flammable and should never be employed when the LASER is used in the oropharynx or in procedures about the head
- Insulated silicone endotracheal tubes (ET), if available, should be used
  - The cuff of the ET should be filled with saline
- The protocol for an ET fire should be rehearsed to minimise fire's untoward effect

LASER

- In case of ET fire:
  - First remove the ET
  - Turn off the flow of oxygen
  - Assist the anaesthetist in the reintubation of the patient
  - Open the oxygen supply
  - Shut down the LASER
- The mucous membrane becomes oedematous very rapidly, so reintubation of the patient is of great importance
- Only the operating surgeon should operate the LASER
  - Operation of other electrosurgical unit may be delegated to the assistant
- Use of LASER should be documented in the intraoperative record

LASER

- Regulatory Authority for Laser in India
  - In India, AERB provides the safety regulations for LASER use in all types of applications (3)
  - Unlike USA, there is no separate standards for use of LASER in health care
    - The same AERB regulation needs to be used in health care as well
  - In USA, ANSI has laid down safety standard for LASER in health care (ANSI Z-136.3-2005)
  - For LASER hazard evaluation the concept[t of safe exposure limit or MPE is taken into consideration
  - Exposure limits for LASER radiation for eye and skin are developed by International Commission on Non-Ionizing Radiation Protection (ICNIRP)

TABLE 4.1: OUTLINE OF LASER HAZARD CLASSES

Class	Description
Class 1 LASER System	• Very low power LASER, enclosed, encapsulated or embedded LASER of higher Class with adequate engineering control measures, to ensure that access to the higher Class LASER beam is not reasonably likely. • Safe under reasonably foreseeable conditions of operation and use, including intra-beam viewing, with or without optical aids. • The LASER systems in this class are not capable of causing damage to the eye or skin, and, therefore, exempted from any control or surveillance.
Class 1M LASER System	Low power, large size collimated beam, or highly divergent LASER • Safe under reasonably foreseeable conditions of operation and use, excluding optically-aided intra-beam viewing. • Compared to Class 1 sources, Class 1M sources may carry higher powers, but low intensities, as they are either diverging or collimated with a large diameter, so that the energy carried through the area of a pupil is lower than Class 1 limits. • Like any Class 1 source, these are harmless in standard conditions of use, but can present a danger when an optical instrument is used in the beam trajectory which may collimate a diverging beam, or focus a collimated source, so that the intensity at the eye increases. • This classification would be applicable for emission wavelengths between 302.5 and 4000 nm, outside which the commonly used optical components have negligible transmission.
Class 2 LASER System	Visible region (0.4 to 0.7 μm), low power LASER • Eye protection is generally provided by aversion response including blink reflex, even with optical instruments in the beam trajectory. • The exposure is considered to be hazardous, if viewed for more than 0.25 s, or repeatedly.
Class 2M LASER System	• Visible region (0.4 to 0.7 μm), low power LASER, with larger collimated beam, or divergent beam, as compared to Class-2 LASER. • Eye protection is generally provided by the aversion response, including blink reflex, only for unaided viewing. • Unsafe if viewed using optical aids, or if optical instruments are inserted in the beam trajectory.
Class 3 LASER System	Medium power LASER potentially hazardous when viewed directly or after specular reflection (intra-beam viewing). • The Class 3 systems are further divided into two sub classes as given below.

Class	Description
Class 3R	Potentially hazardous for intra-beam viewing either directly or after specular reflection, particularly when the eye is sufficiently focused and stable. However, the probability of injury upon exposure as defined above, is small. • The LASER beam does not pose any fire hazard, or hazard due to diffuse reflection. • The LASER beam is not hazardous to skin.
Class 3B	• Normally hazardous for intra-beam viewing either directly or after specular reflection. (Power is greater than the Class 3R LASER), but is not a diffuse reflection hazard or fire hazard. • For Class 3B visible LASER viewing of diffuse reflections is considered safe for a minimum viewing distance of 13 cm between the screen and the cornea and a maximum viewing time of 10 s, else the diffuse reflection exposure needs to be compared with the applicable MPE. • It is also not a hazard to skin, except at the focus.
Class 4 LASER System	High Power LASER hazardous for direct, specular and diffuse reflection, and pose Fire Hazard • The direct and specularly reflected beam is hazardous to the eye and skin, and constitute fire hazard. • The diffuse reflection is also potentially hazardous to the eye and skin, and may also initiate fire in certain conditions. • Additionally, the beam may produce LASER-generated air contaminants (LGAC) and dangerous plasma radiation

AERB Hazard Classification of LASER

LASER SAFETY SIGNS

Sample LASER Warning Signs / Equipment Label as per AERB

Surgical Modalities- LASER

Minimally Invasive Surgery

- Surgical Modalities (4)
  - Surgery continues to evolve as less invasive procedures and instrumentation are adopted
  - Various modalities of surgical techniques have evolved with the availability of advanced instrumentation and visualisation techniques
  - Some frequently used surgical modalities are:
    - Laparoscopy
    - Minimally invasive surgery technologies (MIS)
    - Robotic assisted surgery
    - Video technology

Minimally Invasive Surgery

- MIS Overview
  - In 1980's general surgeons started performing surgeries using laparoscopes
    - This technique obviated need for large incisions
  - The surgical industry also kept pace with the new age surgeries by developing newer instrumentation to accommodate the evolving knowledge and information
  - The MIS was complex but offered patients certain benefits:
    - Potentially shorter hospital stay, reduced postoperative pain, lower rates of surgical site infections, decreased intraoperative blood loss, and faster recuperation

Minimally Invasive Surgery

- Endoscopes
  - It is a long tubular shaped instrument that is inserted into the body through small incision
    - The internal structures or organs can be visualised and assessed
  - There are three types of endoscopes:
    - These are flexible, rigid, or semirigid
    - Flexible endoscopes include:
      - angioscopes,
      - Bronchoscopes
      - choledochoscopes

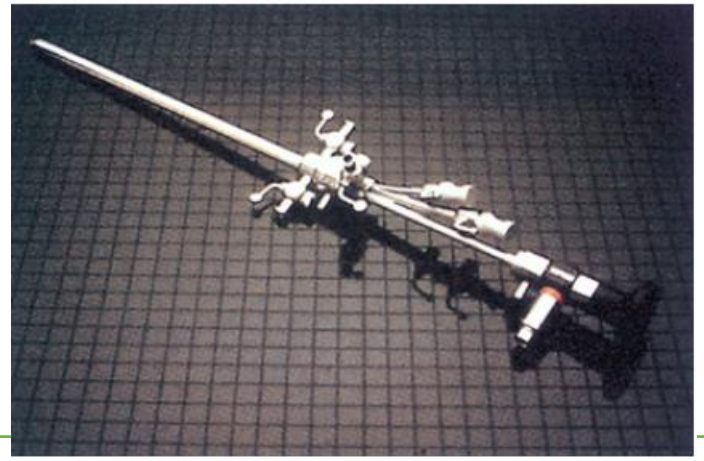
Minimally Invasive Surgery

- Colonoscopes,
- Cystonephroscopes,
- Hysteroscopes,
- Mediastinoscope,
- Ureteroscopes, and
- Ureteropyeloscopes.

❖ Rigid endoscopes include:

- Cystoscopes,
- Laryngoscopes,
- Sinuscopes,
- Arthroscopes,

Flexible Endoscope



Rigid Endoscope

Minimally Invasive Surgery

- Some endoscopes have both flexible and rigid components
- A semirigid ureteroscopes
  - Looks as a rigid endoscopes
  - It has a deflectable tip to provide a complete field of view from different angles

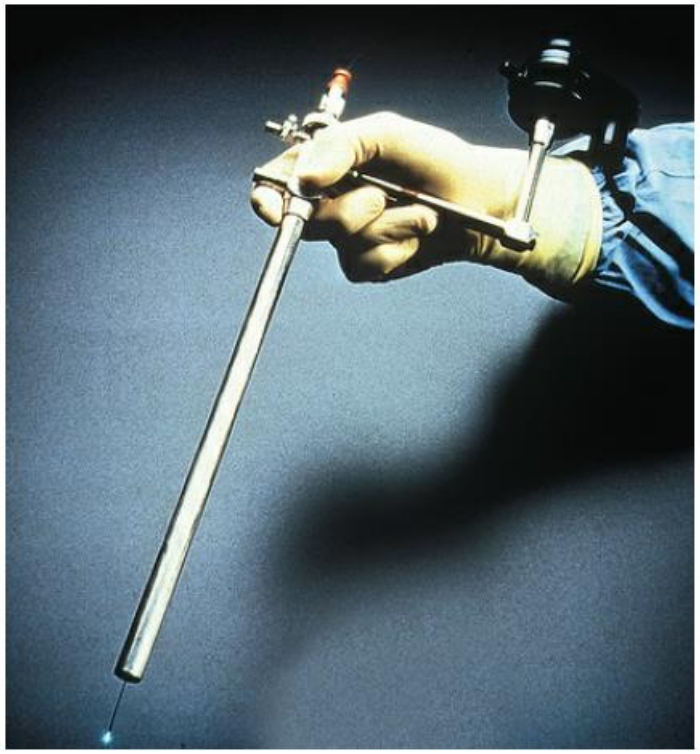
Minimally Invasive Surgery

- Hybrid endoscopes
  - These are combination of some reusable and some disposable components
  - Reusable component include
    - The eyepiece
  - Disposable part
    - Shaft and deflection tip
  - During assembly of these two components, proper alignment and proper focussing needs to be ensured
    - This is necessary for image clarity

Minimally Invasive Surgery

- Endoscopes can be either diagnostic or operative
  - Diagnostic scopes
    - They are for only observation and have no operating channels
    - The system is sealed at both ends
    - During an operative procedure, a diagnostic scope can be used when multiple access sites are planned for introducing other instrumentations
  - Operative scopes
    - These scopes are channelled to irrigate, suction, insert, and connect accessory instrumentation
    - For example, when a KTP laser is used, the laser fibres is introduced into the operating port

Minimally Invasive Surgery



Operative Laparoscope

- Advanced laparoscopic techniques may include use of a flexible endoscope to check for anastomotic leaks, identify bleeding sites, or detect other problems
- This may be required before, during, or immediately after the laparoscopic procedure
- Endoscopes are available in various diameters and lengths
  - This is dependent upon the area being visualised and the requirement of the procedure

Minimally Invasive Surgery

- Optical capability
  - For a rigid endoscopes, the optical capability is controlled by a lens system
    - It can be direct or angled
      - Direct is 0-degree
      - Angled e.g., 30,70,120 degrees
  - Some rigid endoscopes may have a distally mounted camera chip inside the scope with a rotation dial
    - This helps in proper orientation of the target site
  - Flexible endoscopes allow for a panoramic view

Minimally Invasive Surgery

- Flexible scopes
  - Two types
    - Fibreoptic endoscopes
    - Video endoscopes
  - Fibreoptic endoscopes have an eyepiece with a lens for visualisation
    - The image is carried through a bundle of fibreoptic tiny fibres made of glass
    - Video scopes have a video chip at their distal end
    - The video chip captures an image
    - The image is viewed on a monitor

Minimally Invasive Surgery

- Flexible endoscopes components
  - Has four distinct components
    1. Control body
       - Angulation knobs
       - Air-water channels
       - Biopsy port
       - Eyepiece for fibreoptic endoscopes
    2. Insertion tube
       - Flexible tube containing channels for suction, biopsy, irrigation, air and water, image bundles for the fiberscope, light bundles

Minimally Invasive Surgery

3. Bending section at the distal tip
   - Bending rubber
   - Lenses
   - Air-water nozzle
   - C-cover
   - Charge-coupled device (CCD) chip for videoscopes
4. Light-guide connector unit
   - Suction
   - Air-water channel

❖ Flexible endoscopes also have three different systems that contain some of the various components within the endoscopes:

Minimally Invasive Surgery

1. Mechanical system
   - This system provides various ports to introduce accessories to perform treatment and procedures
2. Angulation system
   - Allows the endoscope's distal tip to be moved in different directions
3. Illumination system
   - Provides light to view internal structures

- Rigid endoscopes
  - Like the flexible endoescopes, rigid endoscopes also have four distinct components
    1. Eyepiece
       - Ocular lenses
       - Some rigid videoscopes may not need an eyepiece

Minimally Invasive Surgery

1. Body
   - Light guide connector
   - Valve
2. Shaft
   - Rod lenses
   - Spacers
3. Distal end
   - Objective lens
   - Negative lens

- It is important to understand the different parts of an endoscope
  - It helps assessing any technical problem that may arise during a procedure
  - Scopes must be handled with care

Minimally Invasive Surgery

- Light source and Fibreoptic Cables
  - The light is often referred to as cold light
    - The heat from light is not transmitted through the length of scope
    - Tissue damage at the distal end is minimum
    - However, when the fibreoptic cable is disconnected from the scope during surgery, they may be very hot
      - Therefore care should be taken that the ends do not touch patient's skin or any flammable material
      - It should be held away from drapes or placed on a moist towel
      - Ideally, the light should be turned off whenever disconnected from the scope

Minimally Invasive Surgery

- ECRI Institute recommends labelling all fibreoptic light sources with a warning to prevent fire
- To prevent fire all cable connections must be completed before activating the light source
- The light source must be placed on standby when the cables are disconnected
- Light sources should have adjustable manual and automatic brightness
- The automatic mode adjusts brightness according to video image
- When set in this mode, it does not need continuous adjustment

❖ Selecting a light source certain considerations are required

- A light source that can adapt to several rigid endoscopes is preferable
- These light sources may have universal light cable adapter

Minimally Invasive Surgery

- Fibreoptic light cable needs careful handling as the cable consists of hundreds of glass fibres
  - These glass fibres may break when kinked or dropped
  - The cables are loosely coiled and it should never be bent
  - After multiple use the fibres can break, therefore cables must be checked after each use
- Three popular types of light sources are:
  - Xenon
  - Metal halide
  - Halogen

Technical Adjuncts to Surgery – Minimally Invasive Surgery

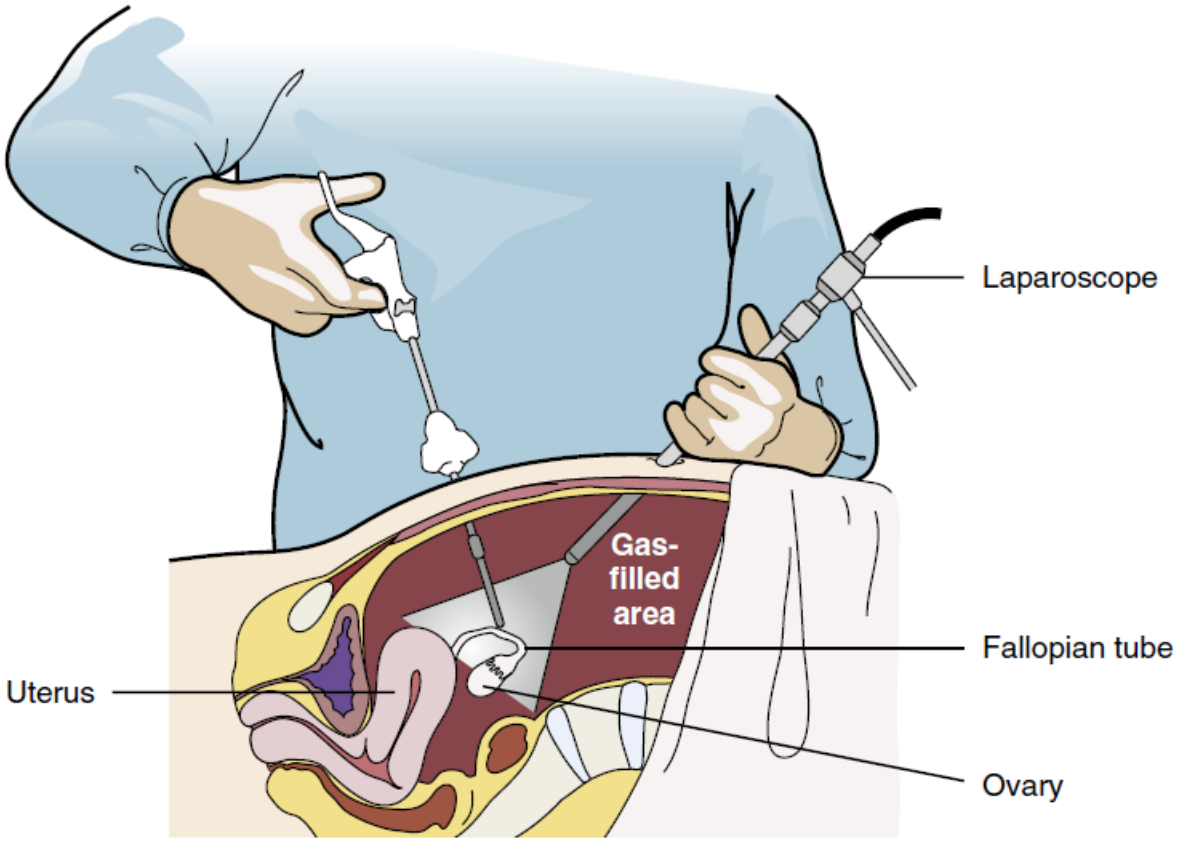
- Key terms and definitions in Endoscopy (5)
  - Endoscopy:
    - Examination of a body part or cavity with an optical system in a tubular structure
  - Insufflation:
    - Act of filling with gas. Laparoscopy is performed with carbon dioxide (CO_2)
  - Laparoscopy:
    - Endoscopic examination of the peritoneal body cavity through percutaneous access portal, placement of expansion mediu to create working space, and manipulation of intraabdominal organs

Minimally Invasive Surgery

- Percutaneous:
  - Puncture through the skin
- Pneumoperitoneum:
  - The peritoneal cavity filled with gas
- Trocar:
  - Surgical instrument that consists of a sheath with a sharp conical or pyramidal obturator used to puncture or penetrate multiple layers of tissue
  - The sheath remains in place as the obturator is removed
  - Additional instrumentation is passed through the sheath
  - Blunt styles are available

Minimally Invasive Surgery

- Veress needle:
  - Spring-loaded needle that delivers CO_2 for the creation of pneumoperitoneum
  - This is an access device for insufflation
  - The needle is inserted through a tiny 1-2 mm nick at the inferior edge of the umbilicus



Surgeon working with laparoscopic instruments within a CO2 filled pneumoperitoneum

Source (5)

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End of Part 3
(To be continued)