CHAPTER 4:

Laparoscopic Instruments in Gynaecology

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LAPAROSCOPY INSTRUMENTS

INSUFFLATOR

A laparoscopic insufflator is a medical device used in laparoscopic surgery to create a safe and working space within the abdominal cavity Function:

- **Creates Pneumoperitoneum:**

The insufflator delivers gas (usually CO2) into the abdominal cavity, creating space by lifting the abdominal wall and pushing aside internal organs.

- **Provides Visualization:**

This space allows the surgeon to see the surgical site clearly through the laparoscope (a camera inserted through a trocar).

- **Enables instrument manipulation:**

The pneumoperitoneum allows for the insertion and movement of surgical instruments, enabling complex procedures to be performed minimally invasively.

Key Features

- **Gas Source:**

The device is connected to a source of pressurized gas, most commonly carbon dioxide.

- **Pressure Regulation:**

The insufflator regulates the flow rate and pressure of the gas to maintain a safe and stable working pressure within the abdomen.

- **Safety Features:**

Many insufflators include safety mechanisms such as alarms and automatic pressure adjustments to prevent over-inflation or sudden pressure drops.

- **Monitoring:**

Devices often have displays showing preset pressure(a), actual pressure(b), flow rate(c), and total gas used(d). See figure. This setting is prior to creation of pneumoperitoneum.

Fig: 4.1: Insufflator

Fig.4.2: Gas tubing

4.3: HIGH DEFINITION(HD) ENDOSCOPIC CAMERA

An HD endoscopy camera is a high-definition imaging device used in endoscopic procedures to provide clear and detailed visuals of internal organs and structures. All cameras are based upon CMOS TECHNOLOGY .CMOS camera can be either HD (1920*1080) , /4K (3840*2160)resolution. CMOS can use either one or 3 image sensor each for red, green and blue light spectrum respectively. However ,due to technological improvements, most CMOS cameras come with single image sensor. In addition, these CMOS chip can have capacity to perceive near infra-red light (NIR) useful in Indocyanine Green (ICG) imaging .

Fig.4.3: High Definition(Hd) Endoscopic Camera Unit

Fig 4.4 Light source (left) and light cable (right)

4.4 LIGHT SOURCE AND CABLE

Laparoscopic light source cables are an essential component of the visualization system used in minimally invasive surgery. They transmit light from an external light source to the laparoscope, illuminating the surgical field for the surgeon. Now days most of light source are LED.

Types of cables

- **Fiber optic cables:** These are the most common type, composed of bundles of glass fibers that transmit light via internal reflection. They are known for their high quality of optical transmission but can be fragile and prone to fiber breakage over time.

- **Liquid crystal gel cables:** These cables utilize a clear optical gel to transmit light, offering potentially higher light transmission than traditional fiber optic cables, up to 30% more theoretically. However, they are more susceptible to damage from heat and can be more rigid due to a metal sheath.

Function

- **Illumination:** The primary role is to provide bright, clear illumination of the internal organs and tissues during laparoscopic procedures.

- **Enhanced Visualization:** High-intensity light transmitted by the cable improves the surgeon's ability to see and perform precise manoeuvres.

- **Minimal Heat Production:** Fiber optic cables are designed to transmit light with minimal heat generation, reducing the risk of thermal injury to tissues.

Safety precautions

- **Heat Generation:** The cables can generate heat, and prolonged contact with skin or drapes can lead to burns. Always ensure the light source is turned off or the cable is placed in a designated holder when not in use.

- **Eye Protection:** Avoid direct eye exposure to the intense light emitted by the cable.

- **Cable Integrity:** Regularly inspect cables for signs of damage or wear, such as kinks, fraying, or broken fibres.

VERESS NEEDLE

This is a specially designed needle with a blunt-tipped, spring-loaded inner stylet and a sharp outer needle, used to achieve pneumoperitoneum while performing closed laparoscopy. It is available in both disposable and reusable form, with 12cm or a 15cm length.

Used in closed entry technique of creating pneumoperitoneum, prior to primary port insertion.

The most recent Cochrane review concluded there is a lower risk of vascular injury with the direct entry in comparison to use of Veress needle.

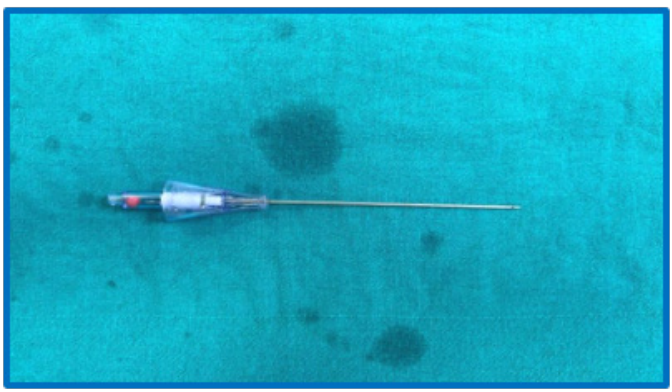

Fig 4.5 Veress needle

TROCAR AND CANNULA

Disposable and reusable trocars are available in various sizes and generally consist of the following common components:

- **Tip**: Trocars feature either sharp or blunt tips. Sharp tips cut through the abdominal wall to create an entry path, while blunt tips separate and stretch the tissues to access the peritoneal cavity without cutting.

- **Sleeve (Cannula)**: This is the working channel through which instruments are passed. Some trocar sleeves have textured outer surfaces to help anchor them to the abdominal wall. Others include an internal inflatable balloon or a plastic/rubber ring at the tip to enhance stability and prevent dislodgment.

- **Valve System**: Various valve mechanisms are used to prevent gas leakage during procedures while still allowing the passage of surgical instruments.

Side Port: Many trocars include a side port that facilitates gas insufflation or smoke evacuation during laparoscopic procedures.

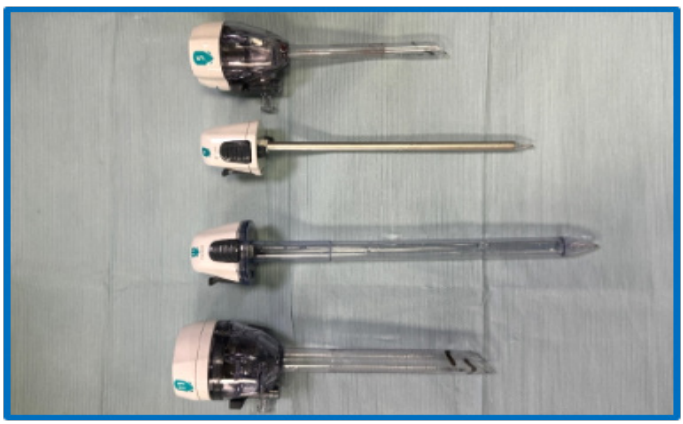

Fig 4.6 Trocar and cannula

LAPAROSCOPIC TELESCOPES AND INSTRUMENT DIMENSIONS

Telescopes used in laparoscopy are available in diameters ranging from 2 mm to 12 mm, with the 10 mm scope being the most commonly used in gynaecology. Instruments with diameters less than 5 mm offer reduced shaft rigidity, making them more flexible and fragile .Standard instrument lengths range from 34 cm to 37 cm, while longer 45 cm instruments are preferred in bariatric cases or single-port procedures.

They have various viewing angles—0°, 30°, or 45°. Each laparoscope is marked near the eyepiece with its corresponding viewing angle.

- In angled-view scopes, the direction of vision diverges from the axis of the light source.

- The 0° telescope provides a straight-ahead view and is preferred by most gynaecologists for its alignment with the natural approach, especially when assisted by less-experienced personnel.

- The 30° scope allows rotational adjustment to expand the field of view, proving advantageous in complex procedures.

- The 45° telescope is primarily used in single-incision laparoscopy but is less commonly available.

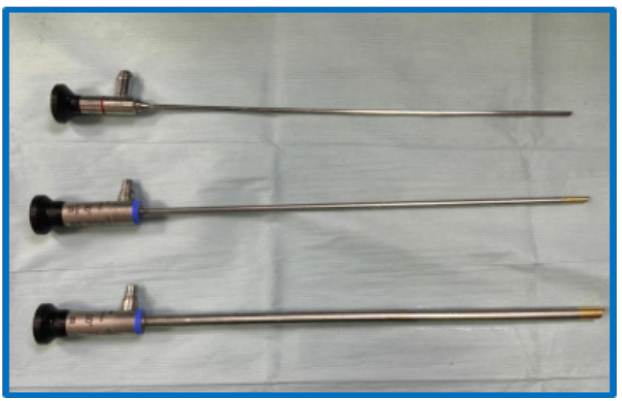

Fig 4.7 Telescopes (0,30,45 degree telescopes from top to bottom)

LAPAROSCOPY ACCESSORY INSTRUMENTS

Most laparoscopic instruments provide four primary degrees of freedom of movement: insertion/retraction, up/down, left/right, and axial rotation.

Graspers and scissors -They consist of an insulated sheath, a central working shaft, a handle, and a rotating mechanism at the working end. Handles may be variable. Ring handles resemble the conventional design used in open surgery needle holders and may be aligned in line with, or positioned at 90°

to, the working axis. A pistol grip handle enables integration of multiple functions, while a co-axial handle aligns directly with the instrument's axis. Handles may feature different types of ratchet mechanisms for secure locking.

-Grasper jaws can be single-action, with one fixed and one movable jaw, or double-action, with both jaws articulated. Single-action jaws provide greater closing force, making them ideal for instruments such as needle drivers, whereas double-action jaws allow a wider opening, which is more suitable for dissection. Grasper's jaw surfaces are of commonly of two types:

- **Traumatic:** deep serrations or toothed tips for secure grasping of tough tissue.
- **Atraumatic:** fine serrations for delicate tissue handling.

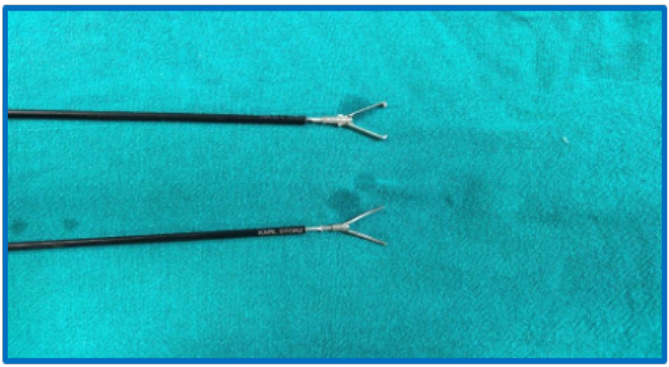

Fig 4.8 A laparoscopic graspers

Scissors with curved tip analogous to Metzenbaum scissors are commonly used, and can be connected to an electrosurgical unit.

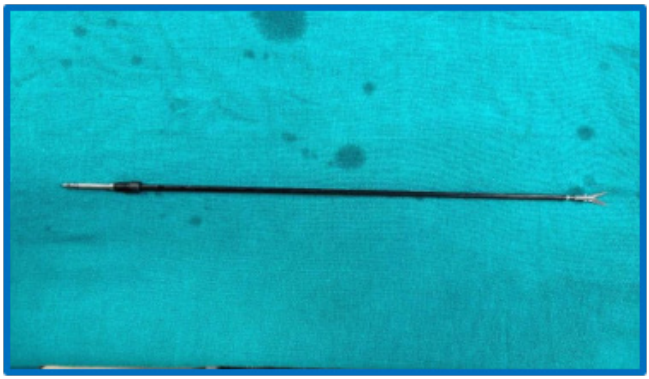

Fig 4.8 B Laparoscopic scissors

Laparoscopic Needle Holder -Various styles of needle drivers are available.The jaws may be straight or curved, with flat or finely serrated surfaces to securely hold the needle in multiple orientations. Needle drivers may have finger grip, palm grip, or pistol grip handles, as previously described.

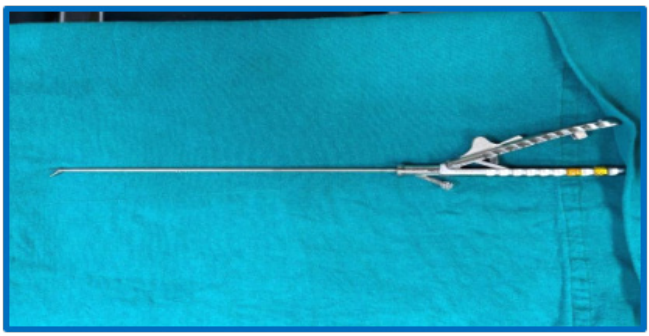

Fig 4.9 laparoscopic Needle holder

-Myoma screws, shaped like a probe with a corkscrew tip, are commonly used during myomectomy to manipulate fibroids.

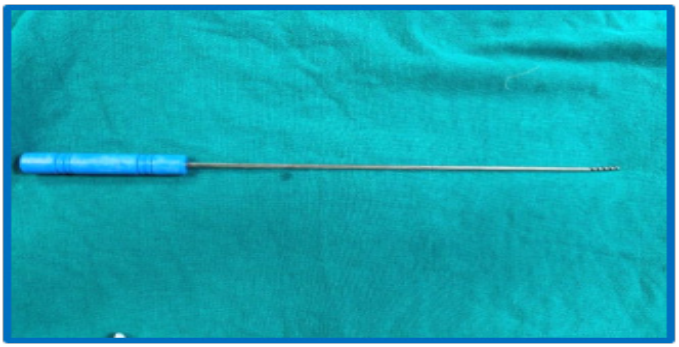

Fig 4.10 myoma screw

-The suction–irrigation device is operated via a trumpet valve, although some models use a sliding valve. Irrigation may be driven by a pressure bag or pump system.

Care must be taken during suctioning to avoid drawing in structures such as the omentum, fallopian tube, or bowel; any tissue caught must be released gently to prevent injury.

Fig 4.11 Suction irrigation device

Aspiration needles, usually 16- or 22-gauge, are used for aspirating or injecting fluids intraoperatively.

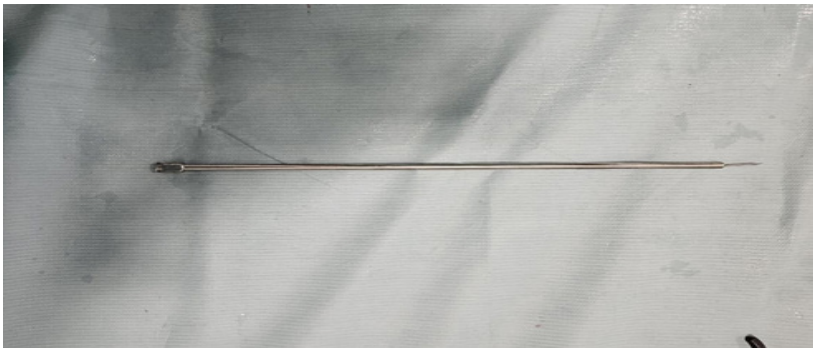

Fig 4,12 Aspoiration needle

ENERGY DEVICES

Energy sources in laparoscopy include monopolar, bipolar, advanced bipolar, ultrasonic(harmonic), combination devices, and morcellators.

- **MONOPOLAR DEVICES** are widely used for tasks such as endometriosis excision and vaginal cuff incision during hysterectomy. Various monopolar hooks and spatulas are available, and most laparoscopic scissors can connect to a monopolar lead.

Fig 4.13 monopolar hook

• **BIPOLAR DEVICES** pass electrical current between the forceps jaws, minimizing collateral tissue damage. They achieve haemostasis by thermal coagulation but generally do not cut tissue.

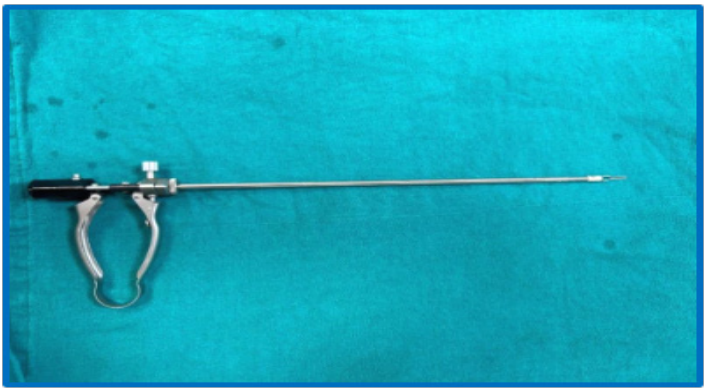

Fig 4.14 bipolar cautery

• **ADVANCED BIPOLAR INSTRUMENTS** (e.g., LigaSure, Gyrus PKS™, EnSeal®,bipolar shearer's) seal vessels up to 7 mm by delivering low-voltage energy with real-time feedback to control tissue temperature, usually below 100 °C. Advanced bipolar systems denatures collagen and elastin, sealing vessels through coaptive coagulation while reducing thermal spread, charring, and sticking. Some advanced bipolar devices also cut tissue, but they may require dedicated electrosurgical units and are relatively expensive.

LigaSure (Covidien): continuous bipolar waveform with integrated cutting.

Gyrus PKS: pulsed bipolar waveform to allow cooling but does not cut.

- **ENSEAL (Ethicon):** uses nanometer-sized conductive particles to direct energy and temperature; includes an I-Blade™ for cutting.

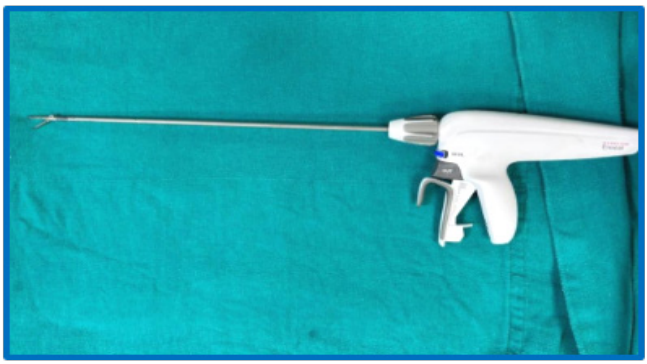

Fig 4.15 Enseal device

• **HARMONIC DEVICES** convert electrical energy to ultrasonic vibrations (around 55 kHz) via a piezoelectric crystal. The vibrating blade cuts tissue mechanically with some thermal coagulation for haemostasis. Compared to other energy sources, they generate lower temperatures (<80 °C), minimizing thermal spread and charring. They are FDA approved for sealing vessels up to 5 mm. The blade tip can remain hot after activation, so care is needed to avoid injury to adjacent structures.

Fig 4.16 Harmonic device

- **THUNDERBEAT (OLYMPUS)** combines ultrasonic and advanced bipolar energy in a single instrument, potentially reducing operative time.

- **MORCELLATORS** facilitate removal of bulky tissue specimens, such as fibroids during myomectomy. The morcellator tip should remain close to the abdominal wall, pulling tissue in rather than pushing the device forward, to minimize injury. Ports larger than 5 mm are required. Concerns about tissue dissemination led the FDA to recommend in-bag morcellation to reduce this risk.

ENDOBAG

A laparoscopic endobag, also known as a specimen retrieval bag, is a sterile, disposable bag used in laparoscopic surgery to safely contain and remove tissue or organs from the patient's body. It helps prevent contamination of the abdominal cavity during the removal process and ensures the specimen is retrieved intact.

Fig 4.17 A and B Laparoscopic tissue retrival system with Endobag