HANDBOOK OF LAPAROSCOPY INSTRUMENTS

Editor:
Lamture Yeshwant Ramrao

Bentham Books

Handbook of Laparoscopy Instruments

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Editor: Lamture Yeshwant Ramrao

ISBN (Online): 978-981-5179-90-3

ISBN (Print): 978-981-5179-91-0

ISBN (Paperback): 978-981-5179-92-7

First published in 2023.

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FOREWORD

I am pleased to know the "Handbook of Laparoscopy Instrument" will be published under the inspiring leadership of Dr. Y. R. Lamture Professor, Department of Surgery, Jawaharlal Nehru Medical College (constituent unit of Datta Meghe Institute of Medical Sciences (deemed to be university). Sawangi (Meghe) Wardha. I also present my appreciation to the team of faculty members for their support to him in this successful publication.

I compliment Dr. Y. R. Lamture and his team for their hard work and earnest efforts for the successful publication of this book. The purpose of this book is to help students develop deep insights into the subjects and build their concepts from the beginning. I hope this Handbook reaches all the students and becomes a popular tool amongst them.

I again congratulate Dr. Y. R. Lamture who led this entire worthwhile exercise in a meticulous and insightful manner.

Dr. Lalitbhushan Waghmare
Vice Chancellor
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PREFACE

Nowadays, most patients want to get operated on by minimally invasive surgery. One of these is laparoscopic surgery. The main advantage of laparoscopic surgery is that instead of operating patients through large incisions, patients get operated on through small incisions with less trauma to the tissue. There is less postoperative pain, faster recovery, and shorter hospital stays with sooner return to work. The chances of wound infection are less because of less handling of tissue and better and acceptable cosmetic scar than traditional open surgery. Also, there are fewer chances of postoperative adhesions and incisional hernia than in traditional open surgeries. Laparoscopy is the word derived from the Greek word lapara, which means "the soft part of the body between ribs and hip, loin, and flank" and scope means to "look': Laparoscopic surgery, also called minimally invasive surgery (MIS) or keyhole surgery, is a modern surgical technique in which operations are performed far from their location through small incisions (usually 0.5–1.5 cm) elsewhere in the body.

- Three Main Components include:
  - Image production
  - Pneumoperitoneum
  - Laparoscopic instruments

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CHAPTER 1

Ergonomics in Laparoscopy

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Abstract: Ergonomics studies aptly fitting a worker to his job or how the environment is more conducive to a laparoscopic surgeon. In 1949, the phrase was fully defined and benefited and protected many aspects of human activity [1]. In the context of laparoscopy, the importance of ergonomics cannot be overstated. Suturing time can be reduced by using proper ergonomics, according to studies [2]. Ergonomically designed items have been found to alleviate pressure-related chronic discomfort in surgeons [3]. This article discusses fundamental principles and procedures such as triangulation, ideal coaxial alignment, doctor-patient drawbacks, and how to forego these challenges with recent technological breakthroughs.

Keywords: Ergonomics, Hawthorne effect, Ideal position, Posture, Sectorisation, Tactile sensation, Table height, Triangulation.

INTRODUCTION

Over the last 20 years, the use of laparoscopy has grown dramatically. Compared to laparotomies, the advantages of laparoscopic surgeries are a smaller incision, fewer post-operative complications and pain, a reduced hospital stay, a speedy recovery, and, sometimes, better access. The latter differs from the former in terms of the required tools, instruments, and psychomotor abilities.

This ergonomics essay covers the fundamental principles and methodologies, such as triangulation, ideal coaxial arrangement, surgeon and patient disadvantages, and how to solve these obstacles using the most recent technological advances.

What is Ergonomics?

- The term comes from the Greek terms “ergon,” which means “labour,” and “nomos,” which means “natural laws or organization.” [1].

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Lamture Yeshwant Ramrao (Ed.)

- “The scientific study of people at work in terms of equipment design, workplace layout, the working environment, safety, productivity, and training,” according to ergonomics [1].

In layperson's terms, it's the science of matching the right specialist to the right job or creating the optimum atmosphere and environment for a doctor. The term was initially mentioned in 1949, and it has benefited and protected a broad spectrum of endeavours [1].

Ergonomics Significance

- Reduction of suture time [2].
- Chronic pain with pressure relieved [3].

The Hawthorne Effect

- It is a well-known fact that when an individual is aware that he is being observed and assessed, he does a task better and with more extraordinary precautions. This tends to distort the results in favour of better scores than would be received if the candidate being assessed was uninformed about the examination.
- This is the “Hawthorne effect,” which has been shown to apply to most scientific evaluations of human functioning. Hence, a grasp of it is crucial for ergonomic purposes [4].
- Surgeons can use ergonomic metrics to assess laparoscopy as a surgical skill that requires dexterity and coordination. Although private assessments are needed to avoid the Hawthorne effect's bias, doing so would bring many ethical and analytical concerns.

Lack of Tactile Sensation

- As learners, we are taught to “see” with our hands and eyes while acquiring those skills, as in laparotomies [1].
- The tactile feedback is sorely lost while transitioning from open to laparoscopic procedures.
- The surgeon's hands are replaced by long graspers manoeuvred through trocars, which significantly diminishes efficiency and lengthens the dissection time [5].

The Reduced Degree of Freedom of Movement

- During surgical intervention, doctors have a lot of freedom and can operate together linearly with the visible polarity. There's still direct three-dimensional vision as well as immediate tactile feedback.
- At the time, just four degrees of freedom are available. Increasing the degree from 4 to 6 enhances dexterity by 1.5 times, according to Falk *et al.* [6].

- Tremor augmentation also has a fulcrum effect. The main disadvantage is that the surgeon has no control over the vision [7].

Decoupling of the Visual (Monitor) & Motor axis

- The 'failure of spatial awareness' caused by inadvertent visual stimuli is explored, as is the 'failure of surrounding field of vision' or 'Binocular effect' caused by the limited browsing spectrum.
- Overcoming the spatial separation of the axial direction of eyesight and the axis of the process's physical element is among the significant cognitive obstacles for the practitioner in his metamorphosis into a minimally invasive surgeon.
- Working in different coordinate systems has been proven in studies to reduce performance, resulting in increased technique mistakes [8].

Assuming A Relatively Stable Posture

•While staring at the surgical field, the surgeon cannot direct his sight straight at the instruments or his hands. Working in multiple coordinate systems has been shown in studies to lower performance and increase the rate of technique errors Fig. (**1.1**) [8].

• Greatconcentrationandskillisutmost required for performing the complex laparo scopic surgeries.

• Hence, it has been observed that as compared to the open approach,the operating surgeon assumes a more static posture during laparoscopic procedures.

• These static postures have been demonstrated to bemore disabling and harmful than dynamic postures are as muscles and tendons build up lactic acid and toxins when held for prolonged periods in same postures [9 - 11].

• Sensorial ergonomics (manipulations and visualization) improve precision, dexterity, and confidence, while physical ergonomics provide comfort for surgeon. Together, these two element sofergonomics increase safety, have better outcome, and reduce the stressof the operating surgeon (Fig. **1.1**) [12].

More Crowd

• Overcrowding operating room (OR) [13] due to increased equipment may pose a physical danger to the staff in OR.

• The abundance of equipment in the operational field forms a “Spaghetti” of connections that reduces the efficiency [14].

• A ceiling-mounted system helps eliminate chaos on the floor.

CHAPTER 2

Sterilization

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Abstract: Laparoscopic instruments should be sterilized by high-level disinfection (H.L.D.). Sterilization is any process that removes or kills all microbial organisms, such as fungi, bacteria, viruses, spore forms, *etc*., present on a surface, contained in a fluid, or a compound such as biological culture media. Sterilization can be achieved by applying heat, chemicals, and irradiation; high-pressure sterilization is a process that destroys or eliminates all forms of microorganisms. Disinfection is a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. Decontamination is the removal of all pathogenic microorganisms from objects to make them safe to handle / use/ discard.

Keywords: Autoclave, Bacteria, Cleaning, Disinfection, Decontamination, Fungi, Microbial life, Spore, Viruses.

INTRODUCTION

Laparoscopic instruments should be sterilized by high-level disinfection (H.L.D.). Sterilization is any process that removes or kills all microbial organisms, such as fungi, bacteria, viruses, spore forms, *etc*., present on a surface, contained in a fluid, or a compound such as biological culture media. Sterilization can be achieved by applying heat, chemicals, and irradiation; high-pressure sterilisation is a process that destroys or eliminates all forms of microbial life. Disinfection is a process that eliminates many or all pathogenic microorganisms, except bacterial spores, on inanimate objects. Decontamination is the removal of all pathogenic microorganisms from objects to make them safe to handle / use/ discard.

Microbial Life and Sterilization

Laparoscopic instruments cannot be easily dismantled Fig. (**2.1**), used to harbour blood/tissue within their shafts. With a sterile sponge, visible blood and tissue should be wiped off. All contaminated instruments should be placed and soaked for 10 minutes in a container containing a disinfectant solution. Because of the

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fear of damage, devices should not be left in this solution for longer. Laparoscopic instruments are best rinsed in running water to clear the particulate matter and residues of chemicals used for cleaning. The instruments should be dried at the end of the cleaning process before they are packed for sterlisation.

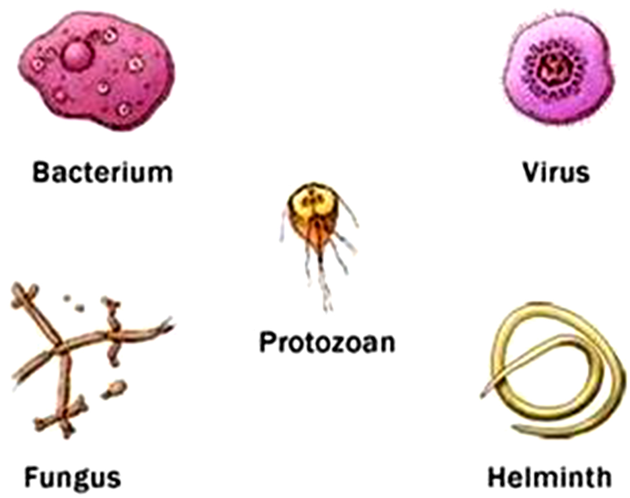

Fig. (2.1). Organisms to be destroyed in Sterilization.

Three sterilization processes are available: steam, ethylene oxide, and peracetic acid.

Steam Sterilization

Steam sterilization is one of the most common forms of sterilization in general practice. Autoclaving at 121°C for 15 minutes is ideal for all reusable metal instruments. It is a cheap alternative and effective too. Before sterilization, all the devices, tubing, and cords should be wrapped doubly in a cloth to prevent contact with the hot metallic container, which is then placed in the autoclave [1].

The autoclave is the equipment used to remove microorganisms (Viruses, Bacteria, fungi, *etc*.) and spores using high-pressure and high-temperature steam sterilization.

History of Autoclave

A French-born physicist Denis Papin invented a prototype of the autoclave called the steam digester, also known as the pressure cooker, in 1679.1 An autoclave is another term for the steam sterilizer. After Papin's steam cooker Fig (**2.2**), Charles Chamberland modified it in 1887 as the Colleague of Pasteur.

Fig. (2.2). Papin's steam cooker.

Principle of Autoclave

Liquid Water cannot be heated above 100°C in an open vessel at 100°C. If water is heated in a sealed vessel, pressure rises, and the boiling point of water is raised. The boiling point of water is directly proportional to the pressure when the volume is constant.

When pressure is increased in a closed vessel, the temperature increases proportionately. *i.e*. for about 15 pounds of pressure per square inch (Psi), the temperature rises to 121ºC. This pressure and temperature are kept constant for 20 minutes during autoclaving. It is sufficient to kill all the vegetative forms and spores of the organism [2].

Mechanism

- By coagulating and denaturing enzymes and structural proteins.
- Resistant spores generally require 121 °C for 15-30 minutes.
- Moist heat is more effective than dry heat.

The gas used for gas sterilization is ethylene oxide. It is suitable for all disposable instruments, insulated hand instruments, and tubing. Gas sterilization with ethylene oxide causes no damage to instruments, and it is non-corrosive to optics but costly (Fig. **2.3**).

CHAPTER 3

Operation Theatre Layout, Equipment Setup and Troubleshooting

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Abstract: The surgical theatre is a vital and intricate setting where time and resources are typically limited. Laparoscopic surgical procedures demand specific technical and analytical skills from operating room personnel, as there is a high chance of mistakes leading to potentially fatal repercussions in laparoscopic surgery [1]. The acquisition of complete, precise, and appropriate knowledge about linkage and interaction between human beings and laparoscopic equipment in operation theatre must be considered of utmost importance. To avoid difficulties during surgery, a surgeon must become familiar with this equipment and instruments [2].

Keywords: Anaesthetic equipments, CO_2 cylinder, Electrocautery, Laparoscopic surgery, Location of doors, Operating table, Operation theatre, Patient safety, Room layout, Room size, Troubleshooting, Video monitors.

INTRODUCTION

In laparoscopic surgery, appropriate training of operating room personnel about the operating theatre setup, usage and troubleshooting of equipment is crucial [3].

OPERATING THEATRE LAYOUT AND EQUIPMENT POSITION [4]

General Considerations

The size of the operating theatre, position of doors, electrical sockets, anaesthesia

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trolley, and the laparoscopic procedure to be performed are all important factors. It is critical to enter in the operating room early enough to ensure proper setup and that all instruments are available andin good working order. One must allow sufficient time for an appropriate set of equipment and operating table.

Establishing the Orientation and Appropriate Position of the Operating Table

If the room is spacious enough, the standard operating table position will suffice for laparoscopy.

In a small operating room, the operating table must be placed diagonally, and the laparoscopic accessory tools must be arranged appropriately around the operating table.

Optimal Position and Orientation of the Surgical Team

Establish the best position and orientation for the surgical team based on the Laparoscopic procedure. In conventional operation, it is only left or right for the operating surgeon. Unlike traditional laparoscopic surgery, the following factors must be considered (Figs. **3.1 and 3.2):**

a. Surgeon's position.
b. Number of assistants (1 or 2).
c. Staff nurse.
d. Monitors - video images must be in line with the ports and the surgeon.
e. Equipment trolley *etc.*

Robotic System and Its Effect on Operating Theatre Space

The use of da Vinci robot requires a lot of space

o Surgeon console

o Slave cathode ray tube monitor screen for operating theatre team viewing

o Robotic arm cart.

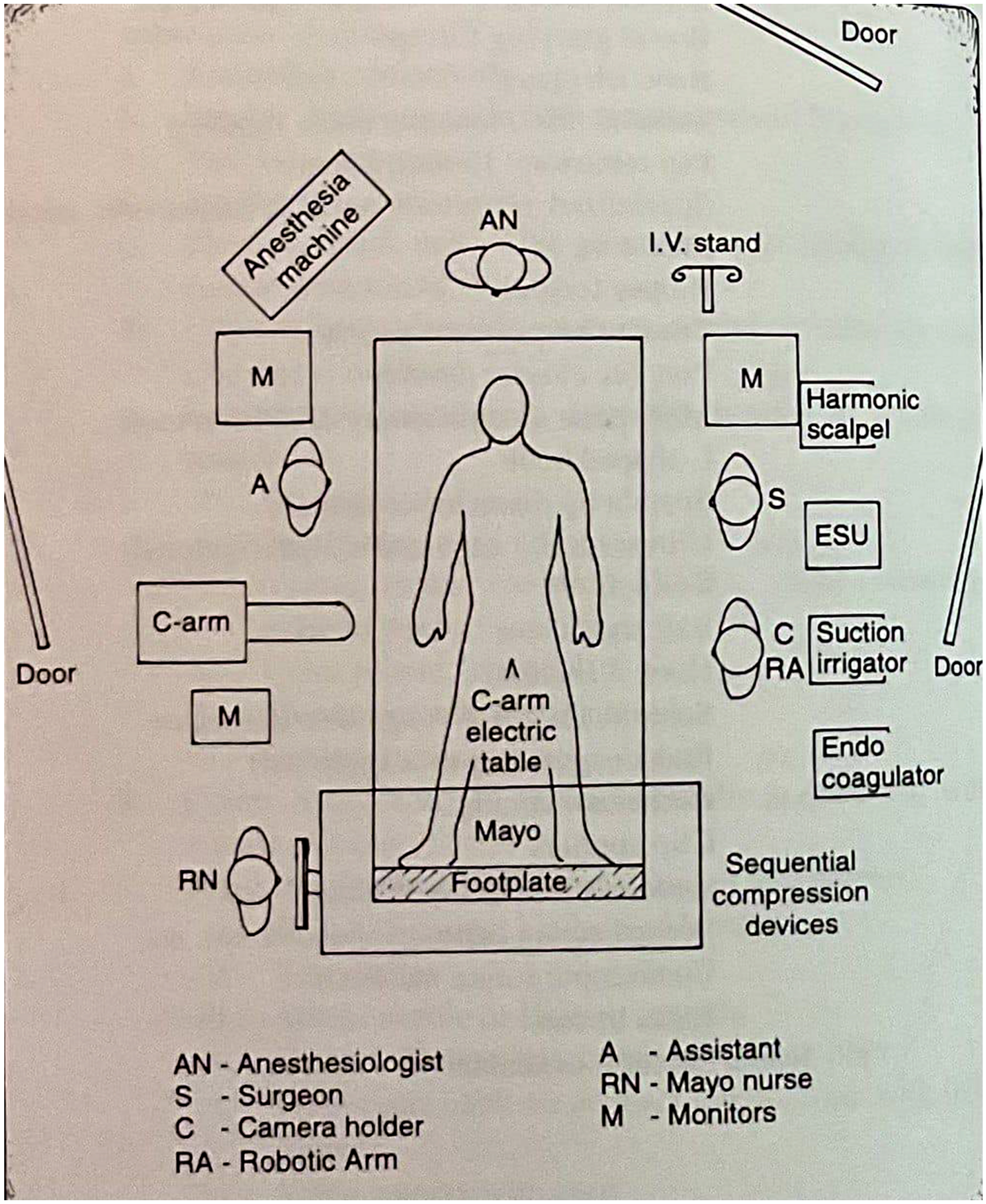

Fig. (3.1). Basic Laparoscopic Theatre Setup. Source - Soper NJ, Scott-Conner CE, editors. The SAGES Manual: Volume 1 Basic Laparoscopy and Endoscopy. Springer Science & Business Media; 2012 Jun 2 [2].

CHAPTER 4

Optical Devices

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Abstract: Optical devices in laparoscopic surgery comprised a telescope (0-30-45 degree telescopes), a light source, a light cable, a camera, and a monitor. All play an essential role from the beginning to the end of the procedure. The outcome of a suitable laparoscopic procedure depends on optical devices. The telescope used may have 0-3--45 degree view. The light source can be Helium or xenon. Xenon is costly but resembles natural light more, giving a good *in vivo* view.

Optical fibers carry light into the abdomen, and the rod lens mechanism moves images to the camera and then to monitor, to result in a successful procedure.

This chapter will go through the mechanism and working of light cables, cameras and light sources used in laparoscopy.

Keywords: Camera, Halogen bulb, Light source, Monitor, Telescope.

INTRODUCTION

Minimally invasive surgery has undergone significant advances and has changed the way operations are performed. Technological advances have produced progressively smaller laparoscopic instruments and higher-quality imaging that allow laparoscopic surgeons to perform precise dissection with minimal bleeding through most dissection planes, even those that are highly vascular.

Illumination of the peritoneal cavity is essential in laparoscopic and hysteroscopic surgery. There are a variety of light sources with varying spectral emissions and illumination power. Light originates from an object when both bulbs are illuminating that should be inspected to confirm for heated sufficiently, and the color (wavelength) of the light emitted varies with the temperature of the source. This property of color temperature is measured in degrees Kelvin (KO). Light sources with higher KO contain more high frequency (blue) wavelengths, resulting in a brighter and more accurate image. As light loses heat (lower KO),

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its spectral emission shifts from blue to red, causing the image to assume a reddish tint. Until the mids-1960s, endoscopic lighting was less expensive, it emit relatively little blue colour light, consisted of the traditional incandescent lightbulb. Output was generally between 75 and 250 W, although light sources of less than 150W were generally avoided in gynecological endoscopy. An incandescent light bulb transforms approximately 97% of electrical energy into heat, while 2% to 3% is converted into visible light. This is particularly crucial in operative endoscopy where the loss of the light source during dissecting or haemostatic procedures would pose a significant risk to the patient.

Hence, it is essential that we have the understanding about the light cables, cameras and light sources used in laparoscopy.

Imaging System

The imaging system consists of a laparoscope, *i.e*. telescope, a camera, a light source, a light cable, and a monitor.

Laparoscopes

In 1952, British physicist Hopkins invented the telescope. Laparoscopes may be developed optics (Figs. **1** and **2a and b**). Surgical stainless steel is the main component of these Laparoscopes. An optical lens encompassing spacers and glass lenses that are perfectly aligned. Commonly used are rigid ones having angles of 0°, 30°, and 45°. The diameter of the telescope varies. It may be 10 mm, 5 mm, or 3 mm. 10 mm scope is routinely used in adult practice, while a 3 mm scope is used in pediatric practice. The scope provides an attachment to a light cable. Fogging of the lens occurs intraoperatively due to increased temperature in the abdomen, which is prevented or cleared by dipping the tip in warm water. It should always be adequately cleaned after use, mainly the light cable slot, telescope eyepiece and patient end. It is sterilized with chemical sterilizers.

Light Source

Luminescence of white light is obtained by a high-intensity halogen lamp, mercury or xenon. Bundles of Fiberoptics deliver this irradiation [1]. Laparoscopic light sources comparable and similar to natural light are considered good sources of light. Three types of light sources are routinely used: halide, halogen, and xenon. The most common type of light source used is the halogen bulb. The halogen lamp comes with a condenser system.

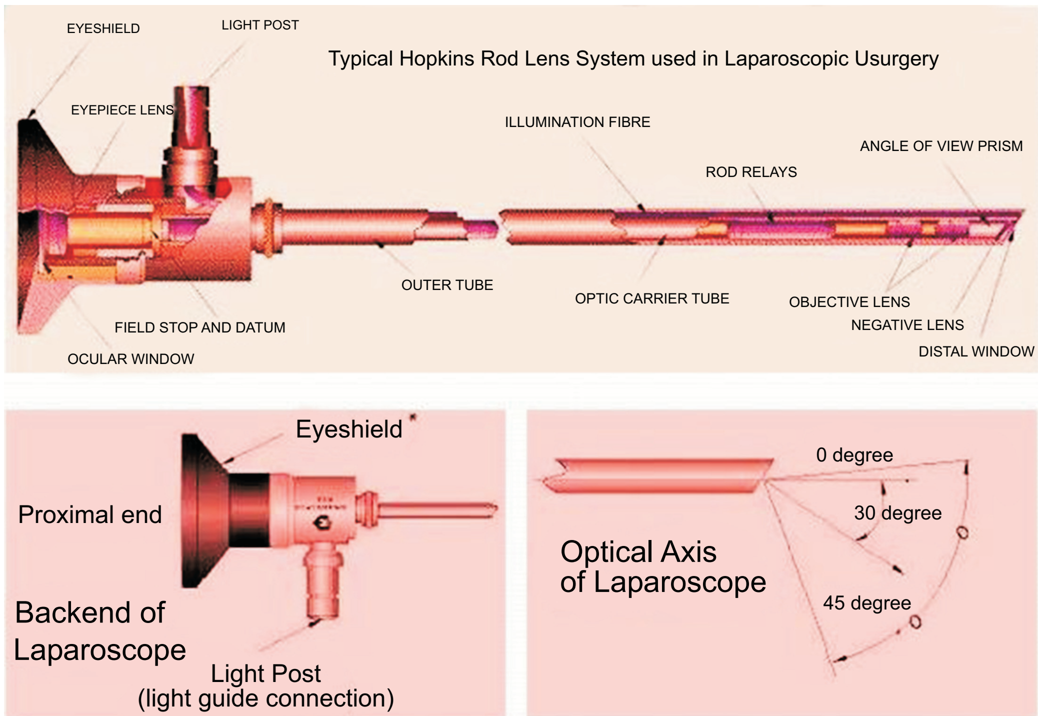

Fig. (1). Diagrammatic representation of the telescope.

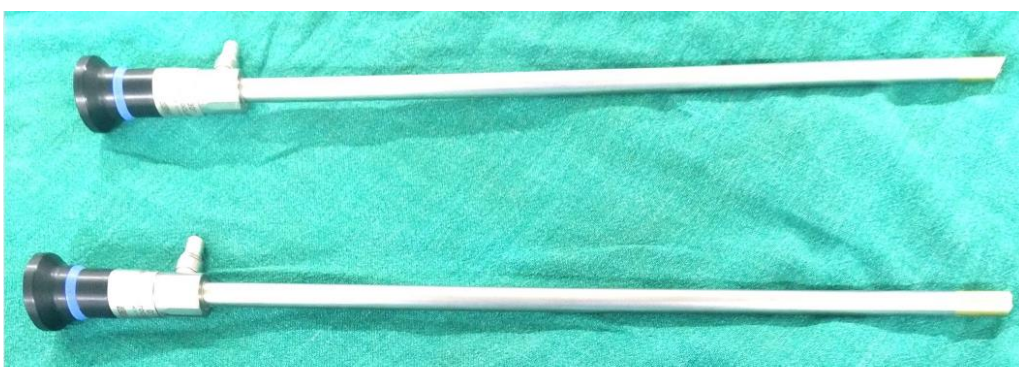

Fig. (2a). 0-degree and 45-degree telescopes.

CHAPTER 5

Equipment for Creating And Maintaining the Pneumoperitoneum

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Abstract: Creating and maintaining a pneumoperitoneum is a vital laparoscopy procedure. A set of instruments, including an insufflator, are used to achieve pneumoperitoneum. Despite having a critical role in laparoscopy, it is the least understood of all laparoscopic devices and appliances. Co_2 insufflator, also known as an endoflator, and laproflator is the most intelligent laparoscopy device as it has to work under control, considering physiology. In addition, gas cylinders, connector tubing, dual valves and gas tubing are also utilized for creating pneumoperitoneum.

Keywords: Insufflator, Mano-Meter, Pneumoperitoneum, Suction irrigator.

INTRODUCTION

Creating and maintaining a pneumoperitoneum is a vital laparoscopy procedure. A set of instruments, including an insufflator, are used to achieve pneumoperitoneum. Despite having a critical role in laparoscopy, it is the least understood of all laparoscopic devices and appliances. An insufflator, also known as an endoflator, and laproflator is the most intelligent laparoscopy device as it has to work under control, considering physiology. In addition, gas cylinders, connector tubing, dual valve and gas tubing are also utilized for creating pneumoperitoneum.

Insufflator

The insufflator, also known as Endoflator, Laproflator [1, 2], is the device used to deliver gas inside the layers of the body to create a workspace to inspect or perform surgery [3]. Initially, manual insufflators were used to create pneumoperitoneum, gradually evolving into automatic insufflators [4, 5]. Insuffla-

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tors are available depending on the maximum gas flow rate and pressure they can deliver. Insufflators providing six litres per minute to a maximum of 45 litres per minute are available [6]. An automatic insufflator is the most intelligent device for laparoscopy. The device does multiple assessments and projects it over the screen or pressure meters. After gathering the data, it creates the pneumoperitoneum and maintains it [4]. Furthermore, it has a protective mechanism to stop or modulate the gas flow and pressure because of patients' safety. In addition, it has an alarm system that warns the surgeon about an erroneous step during surgery [7, 8] (Fig. **1**).

Fig. (1). Laparoscopic Insufflator.

Lapro-Manometers

The automatic insufflators measure six numerical valves and project them over the screen [9].

1. Settings

 a. Maximum Gas flow rate
 b. Intraperitoneal pressure setting

Actual measured values

 a. Actual flow rate

b. Actual Pressure
c. The total volume of gas utilized
d. The volume of gas in the cylinder (Fig. **2**)

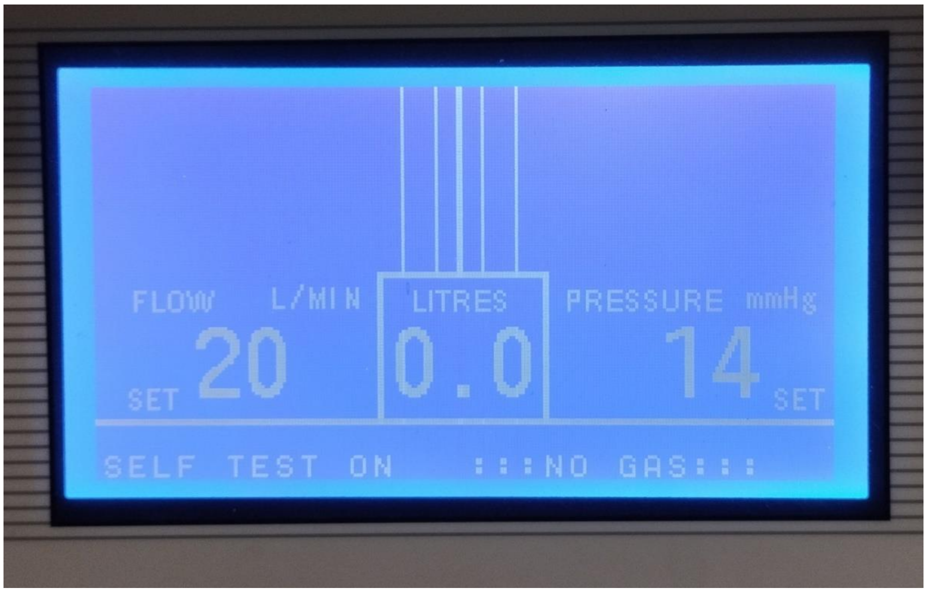

Fig. (2). Laparoscopic Insufflator Screen.

when insufflator swtich on, it calibrates itself to provide excellent pressure values. Then, it notifies the volume of gas in the cylinder, and the operating team can assess the need for an additional gas cylinder during the surgery. To begin with, two parameters are set, the maximum gas flow rate and pressure [10].

Maximum gas flow rate is a value to be set manually before starting the surgery. The device cannot override the upper level of the set value. Instead, the device automatically variates the flow rate between zero to the preset value to create and maintain the pressure without going above the set value. The flow rate is lower to avoid vasovagal episodes and hemodynamic complications [11]. The flow rate gradually increases to six ml per hour for intraperitoneal surgeries, and the pressure is kept between 10 to 14mm of Hg. Most authors recommend a 12 mm Hg pressure for decent space creation and safe laparoscopic surgery [12]. Most of the surgeries can be performed at 6litres per minute. Nevertheless, high flow rates are required to maintain the pressure during surgery requiring high-pressure suction; for instance, continuous suction is required during bleeding [13, 14]. Different pressures are necessary for various surgeries depending upon the plane of surgery (Table **1**).

CHAPTER 6

Instruments for Access

Deepak Lamture[1], **Lamture Yeshwant Ramrao**[1,*] and **Varsha P. Gajbhiye**[1]

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Abstract: Laparoscopy has emerged as a spin-off to technological advancement in the field of general surgery that not only aims to minimize the operative trauma to the patient but also to consummate the surgical endpoint. It has succeeded in curtailing the length of scars over the patient thus being able to bring less disfigurement to the patient. It has proven frugal to the patients as it reduces the operative period, and stay in the hospital and eases comparatively early resumption of the work. It has taken the edge off the psychological trauma the patient undergoes, thus adding to better surgical outputs. The long learning curve and the intraoperative complications including bleeding have proven arduous but the adoption of new technology has succeeded to master these complications.

Keywords: Pneumoperitoneum, CO_2, Gas Insufflator, Hassan cannula, trocar, Veress needle.

INTRODUCTION

Laparoscopy has today emerged as one of the latest trends in medicine for safe and effective surgery. Establishing a pneumoperitoneum is an important step in laparoscopic surgery. Many different devices and techniques have developed over the years claiming a safe approach for creating pneumoperitoneum. This can be *via* closed entry using the Veress needle and CO_2 insufflation, open non-insufflated method (Hasson), and optical entry methods using optical trocars. Following are the commonly used instruments for the creation of pneumoperitoneum.

Veress Needle

Veress needle consists of an outer cannula with a bevelled needlepoint for cutting through tissues (see Figs. **1a** and **1b**). Inside the cannula, there is an inner stylet,

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which is loaded with a spring. This spring moves forward in response to a sudden decrease in pressure encountered during crossing the anterior abdominal wall and entering the peritoneal cavity. The lateral hole on this stylet enables $C0_2$ gas to be delivered intra-abdominally. Veress needle [1, 2] is used for creating initial pneumoperitoneum so the trocar can enter safely and the distance of the abdominal wall from the abdominal viscera should increase. Veress needle technique is the most widely practised way of intra-abdominal access. It is important to check its potency and spring action every time before using it. It is available in three lengths: 80 mm, 100 mm, and 120 mm. In an obese patient, 120 mm is preferred and in a very thin patient with a scaphoid abdomen 80 mm, a Veress needle is preferred. Disposable needles can also be used.

Fig. (1). A and B veres needle.

Hassan Cannula

It is less commonly used than a Veress needle. It carries less risk of hollow visceral and vascular injury. It is safer than a Veress needle to enter the abdomen, especially in those patients having a previous history of intraabdominal operations. It consists of three pieces: a cone-shaped sleeve, a metal or plastic sheath with a flap valve, and a blunt-tipped obturator. On the sheath, there are two struts for affixing fascial sutures. The sutures are then wrapped tightly around the struts, which creates an effective seal to maintain pneumoperitoneum [3] (see Fig. **2**).

Fig. (2). Blunt end of hassan canula.

Optical Trocar

Allows visualization of the tissues as the blade cuts through the layers of the abdominal wall, see (Fig. **3**).

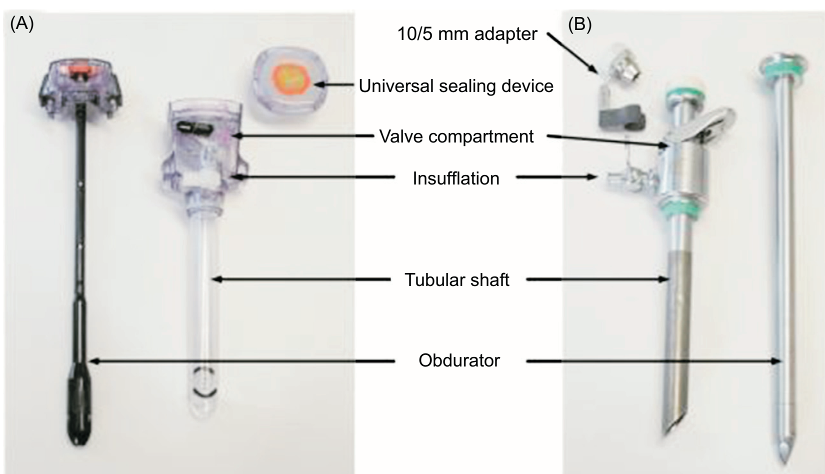

Fig. (3). An optical trocar.

Trocars

Trocars and cannulas are used to pierce the anterior abdominal wall for the placement of laparoscope and surgical instruments [4]. A trocar is a stylet that is introduced through the cannula. The trocars are available with different types of tips and sizes (Figs. **4a-d**). Tips can be pyramidal, conical, blunt-tipped, or may have optical access. Conical-tipped trocars are less traumatic to the tissue. The

CHAPTER 7

Hand Instruments

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Abstract: Operative hand instruments play a pivotal role in Laparoscopic surgeries. They are either disposable or reusable. Most instruments are made up of three parts mainly; Handle, Outer covering sheath and working insert. Instruments are broadly categorized based on the type of dissection they are used for. Instruments for Blunt dissection are Graspers and dissectors. Graspers can be of traumatic or atraumatic variety. Bipolar and Maryland are the two essential dissectors used widely. Instruments used for sharp dissection are scissors, knives, needle holders, coagulation devices, electrosurgery hooks and a spatula. All the reusable instruments have to be sterilized before each use. A few instruments have to be dissembled before sterilizing. Hence, basic knowledge regarding the various instruments is vital for a laparoscopic surgeon to operate flawlessly.

Keywords: Bullet nose grasper, Bipolar dissector, Bowel & lung clamps, Crocodile grasper, Dorsey intestinal grasper, Hunter bowel grasper, Hook and spatula, Insulated outer tube, Maryland dissector, Needle holders, Reducing sleeve, Raptor grasper, Scissors, Suture passer devices.

INTRODUCTION

These instruments may be reusable or disposable. Disposable instruments have better performance and higher safety in single-use. Some surgeons reuse disposable instruments after sterilization. Most reusable devices are expensive but cost-effective in the long-run use and need proper cleaning and maintenance. They are dismountable, so they are easy to wash and clean properly. The disposable instruments are difficult to sterilize appropriately as they do not get dismantled.

Hand instruments vary in length from 18 cm to 45 cm. Mostly, it is 36 cm in length in adults and 28 cm in pediatric practice. Their diameter varies between 18

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mm and 12 mm, but most of them pass through 10 mm and 5 mm of cannulas. The main parts of hand instruments are the handle, shaft with insulation, and tip. Many laparoscopic tools like graspers and scissors have opening and closing functions. Some instruments have ratchet for locking.

Before a new instrument is used, the surgeon should know and test it. It is always better to try a device before a procedure than during it. Before a new instrument is used, the surgeon should know and test it. It is always better to test a device before a procedure than during the procedure [1].

Operative Hand Instruments

They may be reusable or disposable. Relating to sterility issues, better execution and security is observed in single use than reusable instruments. Some surgeons reuse disposable instruments after sterilization. Reusable devices are high priced but efficient and need proper cleaning and maintenance in the long run. They are dismountable Fig. (**7.1**), making them easy to wash and clean. The disposable instruments are difficult to sterilize correctly as they are not made to get dismantled.

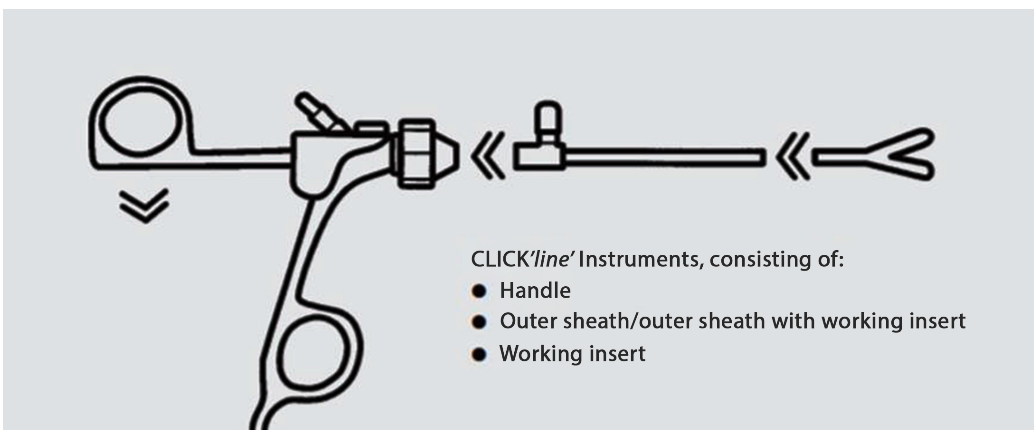

Fig. (7.1). Disamontable instrument parts of the grasper.

Hand instruments vary in length from 18 cm to 45 cm. Mostly, it is 36 cm in length for adults and 28 cm for pediatric practice. Their diameter varies between 18 mm and 12 mm, but most of them pass through 10 mm and 5 mm of cannulas. The main parts of hand instruments are the handle, shaft with insulation, and tip. Opening and closing function is seen in most of the laparoscopic instruments, including scissors and graspers [2]. Some instruments have ratchet for locking.

Handles

Locking of the jaw is facilitated in some instruments due to lock-in handles. Locking plays an important role when there is a need to hold the tissue dynamically for the long run. The handle is embraced with a locking mechanism commonly existing in instruments, so it is easy for the surgeon to lock or release the jaws. The locking instruments have a ratchet, which allows jaws to be closed in different positions. Many of the handles have attachments for unipolar cautery. The degree of freedom is maximum in the instruments due to the rotating ability of the tip at a 360° angle, which is controlled by a rotator present near the handle in most instruments. Some handles have an attachment for suction and irrigation too.

Insulated Outer Tube

The outer sheath is covered either by silicon or plastic, which provide insulation property to the instruments, making them less prone to unexpected burns to intra-abdominal viscera, mainly the bowel.

Reducing Sleeve

When the time comes, surgeons must alter their instruments from larger to smaller diameters to maintain the pneumoperitoneum. This is achieved by using reducing sleeves which reduce the diameter of the port from 10mm to 5mm or 5mm to 3mm Fig. (**7.2**).

Fig. (7.2). Reducing sleeve to maintain pneumoperitoneum.

CHAPTER 8

Energy Devices: Working Principles, Uses And Complications

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Abstract: In ancient times, a hot iron rod was used for charring at the bleeding site to stop bleeding. The earliest significant contribution to a sophisticated method of generating heat to cauterize tissue from electrical current is by Bovie. Energy sources are classified as radiofrequency electrosurgery, laser, ultrasonic, and argon beam coagulation. The majority (85%) of surgeons use monopolar electrosurgery. The electrosurgical effect on the tissue causes cutting, coagulation, fulguration, and desiccation. It uses ultrasonic technology, the unique energy form that allows both cutting and clotting at the precise point of impact, resulting in minimal lateral thermal tissue damage. Cutting and coagulation are done at lower temperatures than those used by electrosurgery or lasers. The Harmonic Scalpel has five power levels. Increasing the power level increases cutting speed and decreases coagulation.

In contrast, less power reduces cutting speed and increases clotting. Argon-enhanced electrosurgery incorporates a stream of argon gas to improve the surgical effectiveness of the electrosurgical current. Argon gas is inert and non-combustible, making it a safe medium to pass electrosurgical current.

Keywords: Argon gas coagulation electrosurgery, Bipolar cautery, Coagulation, Cutting, Desiccation, Evaporation, Fulguration, Harmonic cautery, Laser energy, Monopolar cautery, Ultrasonic cautery.

INTRODUCTION

In ancient times, hot iron rod was used for charring at the bleeding site to stop bleeding while performing surgeries on breast, and neck tumors, which was very painful and horrible; cautery is a term used when direct current (D.C.) is used for controlling the bleeding. In modern science, alternating electric current (A.C.) is used in higher frequency waveforms to produce different degrees of heat to achieve the desired effect over tissue in the form of cutting, coagulation, desicca-

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Lamture Yeshwant Ramrao (Ed.)

tion or fulguration in a safe way without any pain or electric shock. The earliest significant contribution to a sophisticated method of generating heat to cauterize tissue from electrical current is by Bovie.

There are different types of energies like electric current energy (alternate or direct) or laser, ultrasonic waves, gases like Argon, or radiofrequency unit, which are used to produce a varying degree of heat to achieve the desired temperature at the operative site to have the expected type of tissue effect to control bleeding, depending on the degree and duration of contact with tissue.

Up to 40 degrees centigrade, there is no irreversible damage to the cell, but as temperature increases, there are different effects on living cells (Fig. **1**). A limited duration of heat between 40-500C will lead to local hyperemia and oedema; longer contact time may cause cell death and devitalization. Temperature between 60-800C causes desiccation (drying), denaturation of cellular protein and membrane destruction, whereas temperature above 1000C leads to vaporization of the intracellular fluid. Vapour pressure causes the busting of tissue, and if it is slow vaporization, then there is desiccation (drying), and a further rise in heat causes tissue burn, *i.e.*, carbonization [1].

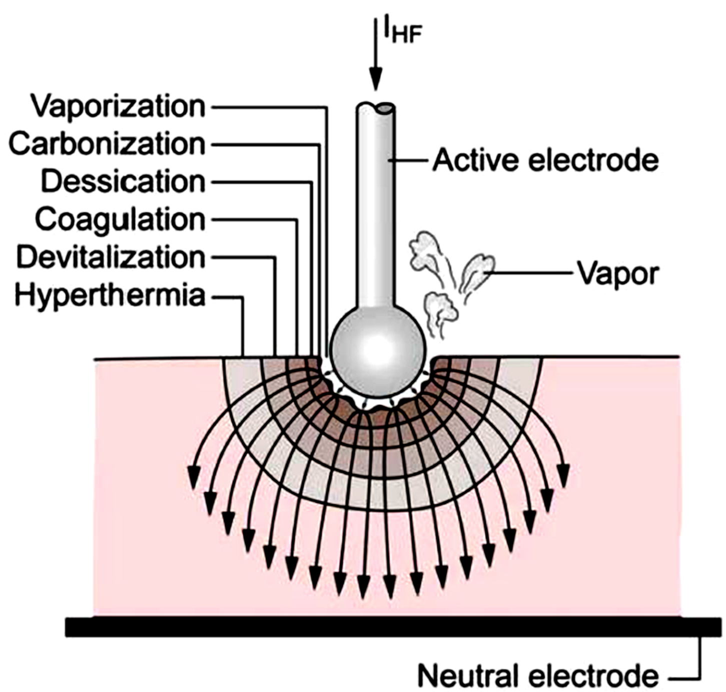

Fig. (1). Effects of the active electrode in the tissue.

Depending on the degree of temperature, the contact time required for cell death is as follows [2].

Temperature Time required for cell death

450C 15 Minutes

500C 20 Seconds

550C 2 Seconds

1000C Less than 1 Second

Waveform over 100 kHz does not produce pain or electric shock. Hence higher frequencies are used in different cautery devices to achieve desired tissue effects. Different waveforms have different tissue effects (Figs. **2a** - **c**); low voltage, continuous waves are used for cutting the tissue, whereas low voltage intermittent waveforms lead to reduced heat production that causes coagulation in the tissue and percentage in intermittency in waves is called blending. There are three blending modes. (Blend-1=50%, Blend-2= 60% and Blend-3=75% off cycles). High voltage intermittent waveform is used to produce coagulation only where there is 94% intermittency. An increase in off time will produce less heat and a higher coagulation effect, whereas reducing off time will have a more cutting effect than coagulation in the tissue.

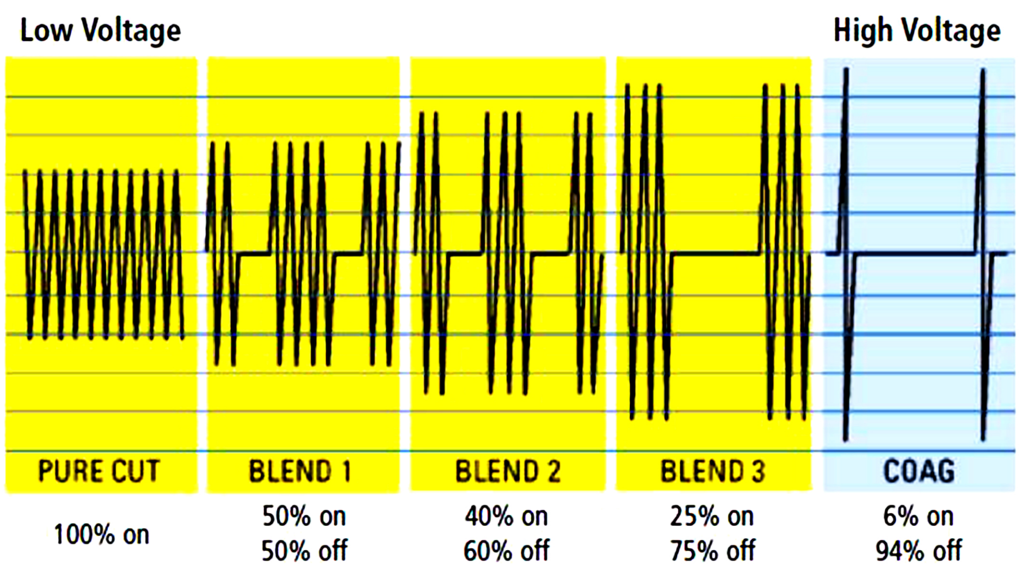

Fig. (2a). Percentage of frequency, its relation to voltage and effects.

CHAPTER 9

Basic Endoscopic Accessories

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Abstract: Early endoscope was developed about 50 years ago. It was initially developed as a diagnostic tool. Since then, several modifications in endoscopes have been made with many developments in endoscopic accessories. In the current era, endoscopy is used for both diagnostic and therapeutic procedures. Endoscopic accessories are essential tools for therapeutic endoscopic procedures. Endoscopic accessories are specially designed devices that pass through accessory channel of the endoscope & therapeutic endoscopic procedures. Routinely encountered endoscopic endoscopy needs commonly available endoscopic accessories. Common clinical problems in day to day practice are gastrointestinal tract bleeding, gastrointestinal tract foreign bodies, gastrointestinal tract strictures and the requirement of enteral access for enteral feeding. These procedures can be carried out in a day-to-day practice after gaining adequate experience and knowledge about the procedures. Commonly used endoscopic accessories can be divided into hemostatic devices, foreign Body (FB) removal devices, feeding tubes, biopsy forceps and dilators. Hemostatic devices are endoscopic accessories to control bleeding from the GI tract. Bleeding from the GI tract may be of variceal or non-variceal origin and accordingly different devices may be required. Various types of foreign body ingested can be encountered during clinical practice which can be dealt with different endoscopic accessories. Enteral feeding is a safe, effective and physiological means of providing enteral nutrition. Depending on the clinical situation, gastric or naso-jejunal enteral access may be required for enteral nutrition. Feeding tubes can be placed endoscopically for enteral access. Different types of feeding tubes are available. Biopsy forceps are tissue acquisition devices for diagnostic purposes.

Keywords: Achalasia cardia, APC, Dilator, Endoscopy, Endoscopic accessories, Esophageal stricture, Enteral feeding, Endoscopic band ligation, Feeding tubes, Epinephrine, Foreign Body, Gold probe, Hemostasis, Hemoclips, Heater probe, Injection needles, Non-variceal bleed, Pneumatic balloon, Protein coagulation, Variceal bleed.

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INTRODUCTION

The first flexible endoscope was developed about 50 years ago. It was initially developed as a diagnostic tool. Since then there were several modifications in endoscope and in the development of endoscopic accessories. In the current era, endoscopy is used for both diagnostic and therapeutic procedures. Endoscopic accessories are required tool for therapeutic endoscopic procedures. Endoscopic accessories are specially designed devices that passes through through the accessory channel of the endoscope and therapeutic endoscopic overs procedures. Routinely encountered endoscopic procedures can deal with commonly available endoscopic accessories. Common clinical problems in a day-to-day practice include gastrointestinal tract bleeding, gastrointestinal tract foreign bodies, gastrointestinal tract strictures and the requirement of enteral access for enteral feeding.

Common Endoscopic Accessories

Endoscopic accessories are specially designed devices that can be passed through the working channel of the endoscope for various diagnostic and therapeutic endoscopic procedures.

Commonly used endoscopic accessories are as follows:

1. Hemostatic devices

2. Foreign Body(FB) removal

3. Feeding tubes

4. Biopsy forceps

5. Dilators

Hemostatic Devices

These devices are used for controlling of bleeding from the gastrointestinal tract. Bleeding from gastrointestinal tract can be of variceal or non-variceal origin. The control of variceal and non-variceal bleed is achieved by different endoscopic accessory devices [1, 2] (Chart **1**).

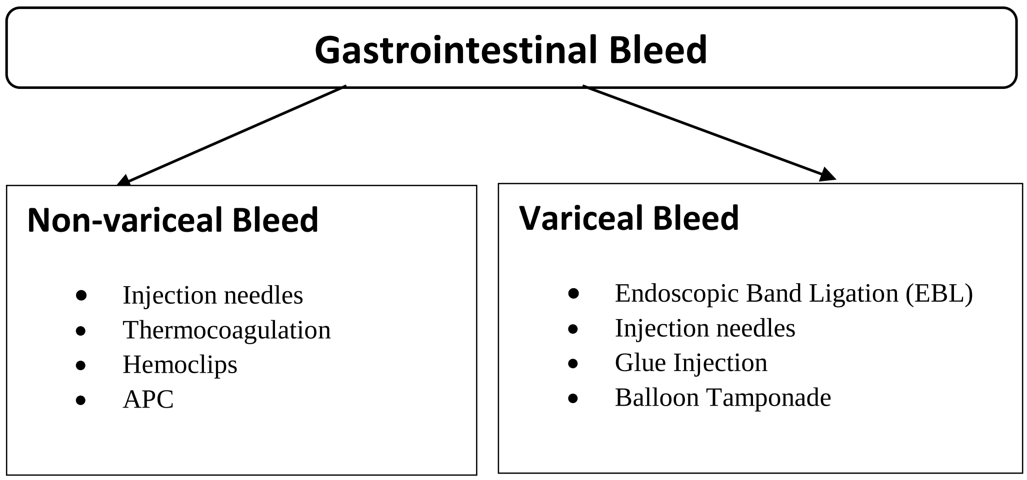

Chart. (1). Classification of GI bleeding.

Injection Needles

Needles for injection consist of three parts: an outer coating of plastic or polytetrafluoroethylene sheath, the inner hollow part of core needle and handle. The needle core is manipulated through a handle. The Luer lock connector on handle allows syringe attachment. (Fig. **1**) The needle part is kept inside of the sheath during progression through the working channel of an endoscope. Hemostasis is achieved by mechanical tamponade and cytochemical reaction with injecting agents. Injection needles are available in various sizes ranging from 21-25 G. The length is between 200-240 cm. Injection needles deliver the hemostatic agent at the bleeding site. For glue injection, a 21G needle is used while for sclerotherapy, a 23 G needle is preferred. Injection needles are also used for the elevation of sessile polyps during polypectomy and tattooing of the polypectomy site for future reorganization. Commonly used agents during injection are as below (Table. **9.1**).

CHAPTER 10

Robotic Surgery

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Abstract: Primarily, it is a computer-assisted surgery. It's a modified future of minimally invasive surgery. With this method, the surgeon makes decisions and gives commands, and a robot carries out the surgery. The main advantage of robotic or minimally invasive surgery is that instead of operating patients through large incisions, patients get operated on through small incisions with less trauma to the tissue. There is less pain and a shorter hospital stay with an early return to work.

Keywords: Console, 3-D view, -Da Vinci system, Robot, Simulation, ZEUS.

INTRODUCTION

primarily, it is a computer-assisted robotic surgery. It's a modified future of minimally invasive surgery. With this method, the surgeon makes decisions and gives commands, and a robot carries out the surgery. The main advantage of robotic or minimally invasive surgery is that instead of operating patients through large incisions, patients get operated on small incisions with less trauma to the tissue. There is less pain and a shorter hospital stay with a sooner return to work.

Most commonly used surgical robot is "Da Vinci system" (Fig. **1**). It consists of a surgical console, a patient-side cart and instruments, and imaging processing equipment [1]. The surgeon controls the instruments and the camera from a console located in the operating room. Placing his fingers into the master controls, he can operate all four arms of the Da Vinci simultaneously while looking through a stereoscopic high-definition monitor that places him inside the patient, giving him a better and a more detailed 3-D view of the operating site more than the human eye. The robot system is very costly, costing around 12-20 crores (in Indian rupees).

ZEUS [2] was the first surgical robot to perform surgery when it was used in 1997 to reconnect fallopian tubes in the state-of-the-art robotic surgery in Cleveland,

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Ohio, USA.The company that developed the ZEUS robot was purchased by Intuitive Surgical, Inc., and after years of attempts to upgrade the system, they brought out the da Vinci surgical robot. In 2005, the US Food and Drug Administration (FDA) approved the use of the da Vinci robotic system in gynecological surgery. A recent report by Intuitive Surgical, Inc. pointed out that during 2007–2013, the number of robotic surgical systems were doubled in the US (from 800 to 2001) and Europe (from 200 to 443). The same report stated that 1.5 million robotic surgeries had been performed until 2013 in the world [3].

Advantages of Robotic Surgery

- Surgeon controls movements of sophisticated instruments using console.
- Complex procedures done with ease, stability, accuracy.
- Better reach to deep areas, less conversion to open.
- Minimal blood loss.
- Quicker recovery, less hospital stay, minimal need for antibiotics.
- For patient –less pain, no scar, normal activity [4].

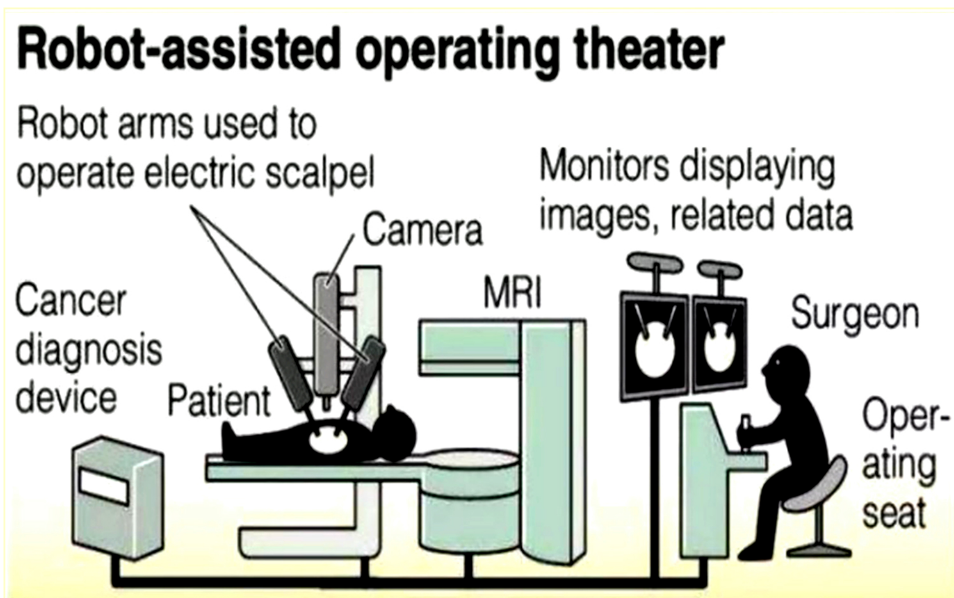

Fig. (1). Diagrammatic presentation of robotic surgery.

CONCLUSION

As compared to open and laparoscopic methods of surgical approach, the learning curve of robotic surgery is in its niche. However, the chances of robotic systems replacing laparoscopic systems are very high in the near future in view of advancing surgical technology and bringing surgery into the digital age. Major concerns in robotic surgery are the cost and long learning curve. Hence further research to evaluate a true benefit over conventional therapy for robotic surgery to take full root.

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