Section

1

Tips and Tricks in Laparoscopic Urology

CHAPTERS

1

Ergonomics in Laparoscopic Surgery

Abhishek Singh, Arvind P Ganpule, Sudharsan Balaji, V Mohan Kumar

INTRODUCTION

Laparoscopic surgery has slowly and steadily evolved over the last century. It all probably started in the year of 1902 when Georg Kelling, a German surgeon, was working on minimally invasive techniques to stop gastrointestinal (GI) bleeding. Kelling proposed that creating a pneumoperitoneum and raising the intra-abdominal pressure could stop GI bleeding, he named this procedure Luft-tamponade (air-tamponade). In an endeavor to observe the effect of air-tamponade on the visceral organs, Kelling introduced the Nitze cystoscope through the abdominal wall of a dog and visualized the visceral organs. This was the genesis of laparoscopic surgery and it was named Coelioscopy.[1]

The first human laparoscopic observations were made by Hans Christian Jacobaeus, who was an internist from Stockholm Sweden. Jacobaeus introduced a trocar with a trap valve, in the abdominal cavity of the patients having ascites and after evacuation of the fluid, he created pneumoperitoneum and laparoscopy was again done using a cystoscope.[2]

In early 1980s Semm's demonstrated laparoscopic appendectomy, influenced by his work Erich Mühe on 12th September 1985 did the first laparoscopic cholecystectomy. He was a surgeon ahead of time, he had the tenacity to fight the German Medical and social system to prove his rationale. Today, it may seem the most predictive evolution but in the 1980s, Mühe's work was not very well received by the surgical community.[3]

Development of Laparoscopy in the Field of Urology

Laparoscopic surgery in the field of urology was relatively late to develop. Cortesi et al demonstrated first diagnostic use of laparoscopy in a case of undescended testis in 1976.[4] But, it was only in the year 1990 that Dr Ralph Clayman demonstrated laparoscopic nephrectomy.[5] Around the same time Schuessler, et al demonstrated first pelvic lymphadenectomy and later on he went onto describe laparoscopic radical prostatectomy.[6] In 1990, 1st laparoscopic varicocele surgery was also demonstrated. Laparoscopic donor nephrectomy was demonstrated by Ratner et al in 1995 and now progressively has become a very commonly done procedure.[7]

The development of laparoscopic urology was very slow, by 1990 it was already about 50 years since laparoscopy had come into existence and still there were not many surgeons around the world who were performing urological procedures laparoscopically.

Urological laparoscopic surgery developed late as it had a steep learning curve, two-dimensional vision was difficult to adapt, there was loss of haptic sensation, surgeons believed that very few urological surgical procedures could be done laparoscopically and lastly it was thought that urological laparoscopic procedures are much more complex as compared to gynecological and general surgical procedures.

Why do Urological Laparoscopic Surgery?

- *Magnificent visualization:* If there is one reason that a surgeon should start doing laparoscopic surgery, it is the magnificent visualization that laparoscopy offers. During the 1980s, major advances took place in the camera systems. By late 1990s and early 2000s, high definition (HD) camera systems became available. HD systems had higher resolution than standard definition systems, in general, they have a video image of greater than 480 vertical scan lines. After HD systems came the full HD systems with progressive scan which had 1080 vertical lines. These vertical lines are a measure of the clarity, the screen or the camera is going to offer. Now we have 4k systems available, these systems have a resolution of 2 times the vertical and 2 times the horizontal resolution of a full HD system (1080p). Further to this, quantum laser emitting diode (Q LED) and 8k technologies have already hit the television market and soon will be incorporated into medical grade monitors and cameras. The vision that laparoscopic surgery offers is only getting better with technology and surgeon has started to see anatomical details better than before.

  Many open surgeons who have started doing laparoscopy confess that they had never seen anatomical details like it is seen in laparoscopic surgery. To site a few examples, the two layers of Gerota's fascia or the course of lumbar vein on left side and the distinction between the retroperitoneal and gerotal fat are much better appreciated in laparoscopic vision.
- *Dramatic postoperative recovery:* The postoperative recovery after surgery is dramatic in patients undergoing laparoscopic surgery. The patients are ambulatory early, most of them ambulate by the evening of the surgery and allowed orally 8 hours after the surgery. Objectively, postoperative recovery has been studied in randomized controlled trails by measuring the levels of acute phase reactants like C-reactive protein (CRP), interleukin-6 (IL-6), HLA-DR expression on monocytes, level of growth hormone and cortisol levels. It is seen that the rise in these acute phase reactants is less in laparoscopic surgery when compared to open surgery, supporting accelerated recovery of patients post-laparoscopic surgery.[8] The above also proves that immune response to laparoscopic surgery is much less when compared to open surgery.[8]
- *Significant reduction in pain and decreased analgesic use:* Laparoscopic surgery induced pain is less in intensity than the pain caused by open surgery. The visual analog scale pain scores for the patients are significantly less. Though the pain is less it is different in character as compared to open surgical pain. It can be classified as visceral pain which is vague abdominal pain occurring predominantly in the first 24 hours of the surgery, second type of pain is parietal pain which arises from the incision site which also subside in the 1st 24 hours and the third type of pain is the shoulder pain which arises due to irritation of the diaphragm by CO_2, this pain is maximum on the 2nd day and decreases in intensity as the days pass by.[9]
- *Lesser wound related and infectious complications:* Laparoscopic surgery is associated with a lower risk of surgical site

infection.[10] As the wounds are smaller the incidence of infection is also less. Not only the superficial and deep wound infection occur with decreased severity and incidence, also the rate of infection in the deep organ spaces decreases with the use of laparoscopic surgery.[10] Incidence of deep organ space infection decreases in laparoscopic surgery as the abdominal contents are not exposed to the external environment.

- *Reduction in postoperative adhesions:* As the surgical incision is small in laparoscopic surgery, smaller raw areas are created, which in turn leads to a lesser adhesion. Although adhesion can occur at the port site.
- *Video imaging allows active participation of the mentors, trainees and theater technicians:* Laparoscopic surgery is team work and the video imaging system helps the whole team to be involved in the procedure. It makes mentoring possible and allows the team to be prepared for the next surgical steps. If the surgeon is going away at any surgical step, he can be guided by other team members.

Starting a Urological Laparoscopic Program

- Strong leadership support is required to set up a laparoscopic program.[11] As the program is equipment driven, procurement of the instruments is a major task, this is done by the people in leadership position. In an individual practice this role is done by the operating surgeon. In a corporate or government organization, it is the administration which does it.
- The chief surgeon is the center piece of the project; he should initially train himself by attending training program and short fellowship courses. Deterrent here is the cost of training and travelling, which has to be borne by individual surgeon in a stand-alone practice. Detailed description of the surgical procedure should be read, anatomy understood and teaching video watched. Simulation based training helps in developing laparoscopic skills, surgeon should start by doing simple exercises in dry lab, if facilities are not available office endotrainers are commercially available, they can be bought and training started. Cost may be deterring factor; this can be overcome by using low cost endotrainer which surgeon can himself developed (described later in text). Dry laboratory training is followed by wet laboratory simulations and finally the surgeon should embark on the real-time situation.
- *Developing a dedicated laparoscopic team* ***(Fig. 1.1)****:* Laparoscopic surgery is team work, surgeon is only as good as his team. The team consist of a chief surgeon, camera driver (ideally should be a surgeon), anesthesiologist, scrub nurse, circulating nurse and theater electronic technician who can manage all the electronic and other equipment (camera, light source, insufflator) which are used in laparoscopic surgery.
- *Inviting a proctor and sequential training:* The program should be started by inviting a proctor to mentor cases. He or she can be

Fig. 1.1: A dedicated laparoscopy team

Table 1.1: List of basic laparoscopic instruments

Basic instrumentation	
• Scissors • Hook • Suction and irrigation • *Grasping forceps:* Maryland, right angled, bowel holding, toothed grasper • *Diathermy:* Monopolar and bipolar • Harmonic scalpel • Port closure device • Specimen retrieval bag	• Laparoscopic cart • Television monitor • Color video chip camera • High intensity light source • High flow CO_2 insufflator • *Laparoscope:* 0 and 30° • Clip applicator: 5 mm/11 mm • *Trocars:* 12 mm and 5 mm

Fig. 1.2: A basic laparoscopic instrument trolley

Table 1.2: Criteria of patient selection for laparoscopic surgery for a novice

Patient selection
• Upper tract—preferable • Should have no history of: – COPD – *Obesity:* BMI >30 – Extensive prior abdominal or pelvic surgery – Pelvic fibrosis – Organomegaly – Ascites: Benign etiology – Hernia – Iliac or aortic aneurysm

an expert urological laparoscopic surgeon, if unavailable one can consider inviting and experienced laparoscopic general surgeon. Sequential training by observing a few cases, then assisting a few and finally doing a few steps of the surgery and then migrating to do the whole procedure. This basic Halstedian model along with simulation based training will go a long way in training surgeons to become experts.

- *Developing familiarity with basic instrumentation* ***(Table 1.1 and Fig. 1.2)****:* Surgeon should be familiar with the instruments and know correction of basic malfunction. This will remove the frustration barrier and help in development of the program.
- *Initial case selection* ***(Table 1.2)****:* Initial cases that an urologist does should be carefully selected, a well-done case will help the surgeon develop confidence and will go a long way in determining his learning curve. Initially one should start with a beginner-friendly case, in urologic laparoscopy, beginner-friendly case will be an upper tract extirpative surgery in a perimenopause female, with a body mass index of about 25–27. The patient should not have any comorbid illness like chronic obstructive airway disease and vascular malformations of great vessels. Patient should not be suffering from pelvic fibrosis, diseases which may ascites, hernias and any organomegaly.

Components of a Laparoscopic Operating Room (OR) Set up (Figs 1.3 to 1.5)

Components of OR set up include imaging systems, insufflators, hemostatic generators

Fig. 1.3: Components of OR set up

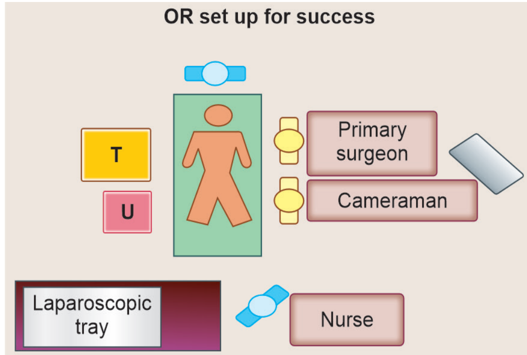


Fig. 1.4: OR set up for right upper tract laparoscopic procedure

Fig. 1.5: OR set up for left upper tract laparoscopic procedure

and instrumentation. For carrying out a surgical procedure there should be a smooth interaction between the various components and the surgical team.

General principles of laparoscopic or room set up:

- The OR room should have a vision cart, which should ideally be hanging from a boom. Vision cart has the monitor and below the monitor are 3–4 shelves which house the insufflator, camera unit, light source, electrosurgical units and other hemostatic generators **(Fig. 1.3)**.
- There should be at least 2 monitors on opposite sides of the OR table. The surgeon should be optically correct and the one monitor should be in front of the surgeon.
- Insufflator should be just below or along the side of the monitor, during initial cases if the surgeon has to turn to look at

Fig. 1.6: Inappropriate positioning of insufflator

the quadromanometric indicator it will be anxiety provoking and also surgeon may not be able to appreciate the uniform distension of abdomen and other signs of appropriate intraperitoneal insufflation **(Fig. 1.6)**.

- The vision cart should be placed in front of the surgeon to make him optically correct.
- All the tubes and cable should be tangle free; this will help in free movement of all the instruments and make the surgery seamless **(Fig. 1.7)**.
- Specially designed drapes and custom made bags can be used to position the instruments, telescope and working elements of the hemostatic generators. The commercially available drapes are disposable, but have multiple pockets where instruments can be placed. If not available bags made of cloth can be designed and used by pinning these bags to the drapes, they can be re-sterilized and used **(Fig. 1.7)**.
- *Positioning of the personnel in the laparoscopic OR **(Fig. 1.5)**:* For an initial upper tact procedure the anesthesiologist is at the head and the camera driver stands cranial to the surgeon and the staff nurse will stand caudal to the surgeon. The 1st assistant should stand opposite to the operating surgeon and will visualize the procedure on the screen which is behind the operating surgeon. The circulating nurse stands behind the operating surgeon and the scrub nurse. For the right-sided upper tract surgeries, the camera driver may move caudal to the surgeon when the surgeon is working in the area of upper pole of the right kidney. The camera driver and surgeon should adjust to each other's body habitus so that minimal restriction of instrument movement occurs **(Fig. 1.8)**. If there is a height discrepancy between the operating surgeon and the camera driver, the camera driver can sit down on an operating chair **(Fig. 1.9)**. Other way around a tall surgeon can sit down and a shorter assistant can drive camera while standing. There may be situations like doing a single port surgery where both may have to sit.

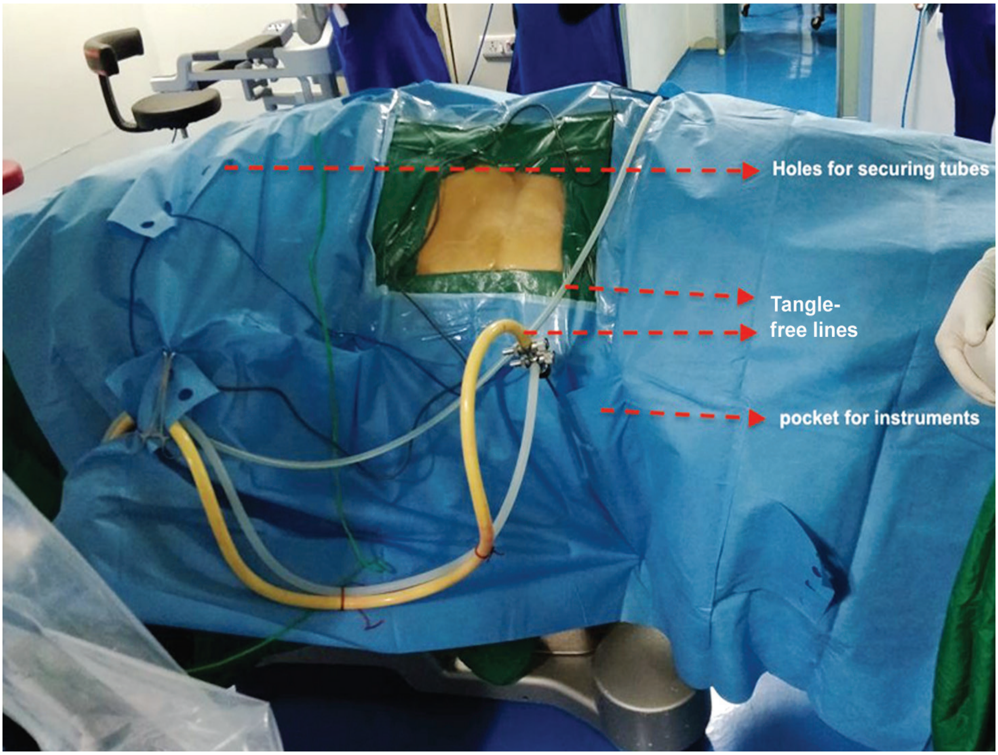


Fig. 1.7: Inappropriate positioning of insufflator

Fig. 1.8: Appropriate positioning of camera driver and surgeon

Fig. 1.9: Appropriate camera driver sitting and driving the camera and surgeon is standing and operating

Urological Surgeries can be Done Laparoscopically

- Surgeries which are accepted as standard of care when done laparoscopically:
  - Adrenalectomy for benign pathology

- Radical nephrectomy for T1–T3a renal cell carcinoma
- Simple nephrectomy for benign disease
- Nephroureterectomy for transitional cell carcinoma
- Dismembered pyeloplasty in adults
- Pelvic lymphadenectomy

Note: Excluding severe inflammatory conditions such as XGP

- Surgeries which are being done routinely at many centers laparoscopically:
  - Partial nephrectomy
  - Radical prostatectomy
  - Living donor nephrectomy
- Surgeries which are only done at centers of excellence:
  - Radical cystectomy and urinary diversion
  - Adrenalectomy for adrenal cortical carcinoma
  - Adrenalectomy for masses greater than 6 cm
  - Retroperitoneal lymph node dissection.

Laparoscopic OR Checklist

The famous book by Dr Atul Gawande "The checklist Menifesto" led to the birth of WHO checklist. In his book, the author talks about the errors in medicine, and they are basically either errors of ignorance which are due to lack of knowledge or there are errors of ineptitude, these errors occur due to lack for appropriate application of the existing knowledge. Modern medicine is all about errors of ineptitude and these sorts of errors can be corrected using checklist.

Laparoscopic surgical checklist that can be used by novice surgeon

- Irrigation aspiration working: Yes/No
- Electrosurgical unit working: Yes/No
- CO_2 tank full and extra CO_2 tank available: Yes/No
- Camera is white balanced and light source is working: Yes/No
- Insufflation is checked for flow and response to kinking of tubing: Yes/No
- Veress needle is checked for flow and proper tip retraction: Yes/No

All the OR (operating room) staff and surgeon should make a checklist which should be pasted on the wall of the laparoscopic or next to the WHO checklist and before incision in all the cases, a ritual of reading though all the checklist items should be done.

Important Pillars of Laparoscopic Surgeries

Laparoscopic surgery stands on the shoulder of excellence in open surgery, because it was the open surgery that gave the surgeons a detailed insight into the human anatomy. But, when this interface of minimally invasive surgery was developed, it required more than only knowledge of surgery. The pillars of laparoscopic surgery are:

- Ergonomics
- Task analysis
- Psycho-engineering

Ergonomics in Laparoscopic Surgery

The word ergonomics come from the Greek words "ergon" meaning work and "nomos" meaning laws of nature. By definition ergonomics is a scientific study of people at work, considering the equipment design, workplace layout, the working environment, safety, productivity and training. In simpler terms, it is designing a working interface between man and the machine to improve task performance. The above can be done by creating working environment that fits the worker's needs. Ergonomics can be universal or specific, and sensorial and physical.

Universal ergonomics include creating a well-ventilated room with appropriate temperature and specific ergonomics include maneuvers like adjusting the height of the operating table to surgeon's height.

Sensorial ergonomics are issues like improving vision, with use of better camera and optical systems precision and dexterity will improve. Physical ergonomics include positioning of surgeon's hands, neck, back in a relaxed position to generate maximum surgical performance.

Factors Unrelated to Human Skill Which Affect the Efficiency in Laparoscopic Surgery

- *Decoupling of the visual and motor axis:* In open surgery vision and the motor movements are in the same axis and they get decoupled in laparoscopic surgery. Humans have to train for this decoupling.
- *Loss of tactile feedback:* There is loss of haptics and the laparoscopic instruments replace the human fingers.
- *Changed visual orientation:* The anatomy that an open surgeon was used to seeing outside-in, will now be oriented inside-out. The surgeon has to compensate for the same.
- *The loss of depth perception* ***(Table 1.3)****:* Initially surgeon will not be able to make out whether the structures are near or far as laparoscopy offers monocular vision which leads to loss of depth perception.
- *Loss of peripheral vision:* Monocular vision is responsible for loss of peripheral vision.
- Relatively static posture during major part of the procedure gives rise to fatigue and ergonomically speaking, contributes to the inefficiency.

Equipment Related Challenges in Laparoscopic Surgery

- 2D vision
- Loss of peripheral vision
- Laparoscopic instruments have only 4 of freedom of movement, which are rotation, up/down angulations, left/right angulations, in/out movement. The robotic endo-wrist technology has 7 of freedom movement as it can flip back on itself.
- Laparoscopic instruments work on reduced efficiency.
- The instrument movements are counter-intuitive, which means that the instrument tip moves to right when the handle is moved to left.

Comparison of open and laparoscopic surgery is given in **Table 1.4**.

Ergonomical considerations for laparoscopic instruments ***(Figs 1.10 to 1.12)****.*

- The instruments should be held at the level of the elbow of the operating surgeon. This will keep the shoulders relaxed.
- *Manipulation angle:* Manipulation angle is the angle formed by the tip of two working instruments. Ideally the manipulation angle should be 60º. If the manipulation angle increases to >75º, there will be abduction of shoulder and fatigue will occur after a period of time.[12]

  Manasnayakorn et al in an experimental set up studied the manipulation angle. Ten different surgeons were asked to do a 5 cm porcine enterotomy closure in a wet lab using different ports which corresponded to different manipulation angle ranging from 45° to 90°. The muscle workload was studied using an electromyography electrode. It was concluded that when

Table 1.3: Comparing open and laparoscopic surgeon

Open vs laparoscopic surgeon	
• Fast • Hand is as good as eye • Dissection precedes • Ergonomics optional	• Slow and steady • Stop when you do not see • Hemostasis precedes • Ergonomics vital

Table 1.4: Comparison of open and laparoscopic surgery

Potential problematic areas	
Open	***Laparoscopy***
• High degree of freedom • Surgeons work in-line with visual axis • Three-dimensional direct vision • Direct tactile feedback	• 2D vision • Loss of depth perception to some extent • Fulcrum effect with tremor enhancement • Only 4° of freedom • View is not under the control of operating surgeon

Fig. 1.10: Manipulation and azimuth angles

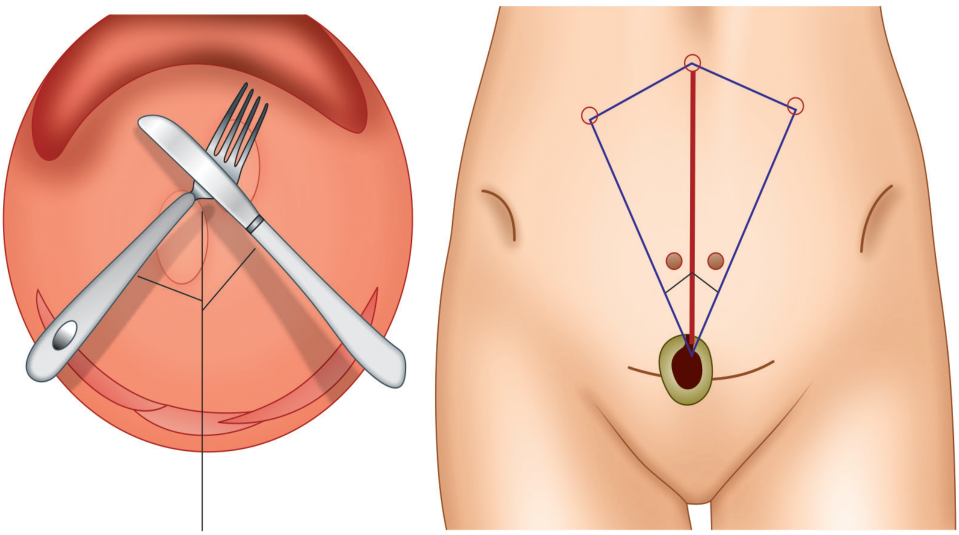
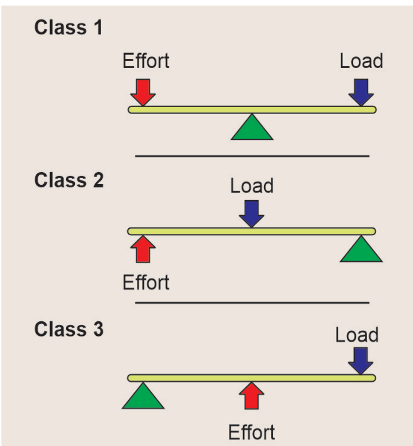


Fig. 1.11: Schematic representation of manipulation and azimuth angles

the manipulation angle is between 45° to 60° the workload on deltoid, trapezius and forearm muscle was least with best outcome which was measured as leak pressures of anastomosis, execution time and error score.[12]

- *Azimuth angle:* Azimuth angle is the angle formed between the single working instrument and the laparoscope. This angle should ideally be 30°, if this angle is less than 15° or greater than 45°, there will instrument fighting and a lot of strain on the upper limbs. Task efficiency is better if both the azimuth angles are equal.[13]
- *Elevation angle:* It is the angle formed between the instrument and the body of the patient. Ideally it should be 30°, whenever it increases to greater than 60°. Shoulder becomes abducted and fatigue occurs. Also, if the elevation angle decreases to 15°, shoulders will have excessive adduction and movement of the instrument will be difficult.

Fig. 1.12: Elevation angle



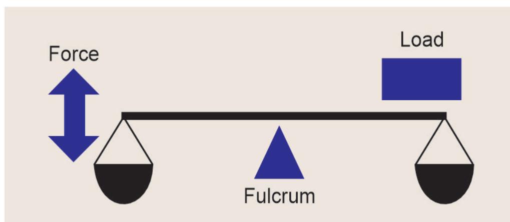


Fig. 1.13: Fulcrum effect

The elevation angle increases when the target organ is too near the port and decreases when the target organ is too far.

Mechanism of working of laparoscopic instruments and its ergonomical implication **(*Fig. 1.13*)**: If the long laparoscopic instrument is used to perform an open surgery, surgeon will surely not be able to operate. This is because the instrument will tend to wobble and there will be minimal control. Laparoscopic instruments behave like levers and abdominal wall is a fulcrum on which this lever moves, therefore, it is possible to do laparoscopic surgery. The portion of the instrument inside the abdominal wall is called the force arm and the portion outside is called the load arm.

Laparoscopic Instruments as Type 1 Lever

Ideally the length of the load arm and the force arm should be the same, this will lead to 1:1 transmission of movement and tip of the instrument will move only as much as the handle moves. Most of the adult instruments are 36 cm in length; so, ideally always 18 cm should be inside. Whenever this happens instruments behave like type 1 lever and there is an exactly equal and opposite transmission of force at the two ends. This may not be always possible; therefore, it is practical to have 18–24 cm of a 36 cm instrument inside the abdominal cavity.

Laparoscopic Instruments as Type 2 Lever

If more than two-thirds of the working length of the instrument are outside, the laparoscopic instrument behaves like type 2 lever. Large movements outside will lead to smaller movement inside. Force is magnified and the movement is rectified (large movement outside leads to smaller movements inside). This what a laborer does when he has to push a large stone, a rod is placed at the edge of the stone with another small stone is placed near the large one, supporting the rod and acting as a fulcrum. Large force can be now applied on the rod to cause small movement of the large stone.

Ergonomically speaking whenever instrument behaves like a type 2 lever, the port is very near the target organ. This leads to another problem, that is, it causes increase in the elevation angle beyond 60°, leading to fatigue. In cases where metal ports are being used and the instrument behaves like type 2 lever, direct coupling of the electric current may occur as the metal tip of the operating instrument is very close to the metal port.

Laparoscopic Instruments as Type 3 Lever

When greater than two-thirds the length of the working instrument are inside the abdomen, the instrument behaves like a type 3 lever. Small movement outside gets transmitted as large movements inside, force gets rectified and movement gets magnified. Type 3 lever behavior of a working instrument is seen when the ports are placed far away from the target organ. When a surgeon is working on the upper pole of the kidney, typically the instrument behaves like a type 3 lever, overshooting of the tip of the instrument may occur, which may lead to the instrument tip to go out of field of vision and injure the spleen or diaphragm on the left side. Diving board used by swimmers is an example of type 3 lever, where the swimmer jumps from the tip of the board and his movement get amplified with minimal force. When working instrument behaves like type 3 lever, the elevation angle decreases leading to fatigue of shoulders. Also, majority of the long length of the instrument is not under vision, this can potentially cause injury.

Ideal Instrument Characteristics

- Length of instrument 36 cm for adults and 28 cm for pediatric patient
- Half inside and half outside
- Type 1 lever
- Telescope should be in the middle to get a better depth perception.

Ergonomic port positioning (baseball diamond concept) ***(Fig. 1.14)****:* Ergonomic port positioning is the port positioning by which a surgeon can achieve ideal working instrument characteristics. If all the ports are ergonomically placed, then the instruments behave like a type 1 lever, the manipulation angle is 60° and telescope is in the middle of the working instruments.

For ergonomic port positioning, baseball diamond concept should be followed. The concept states that 1st determine the target area, for a nephrectomy renal hilum is the target area, for a pyeloplasty pelviureteric

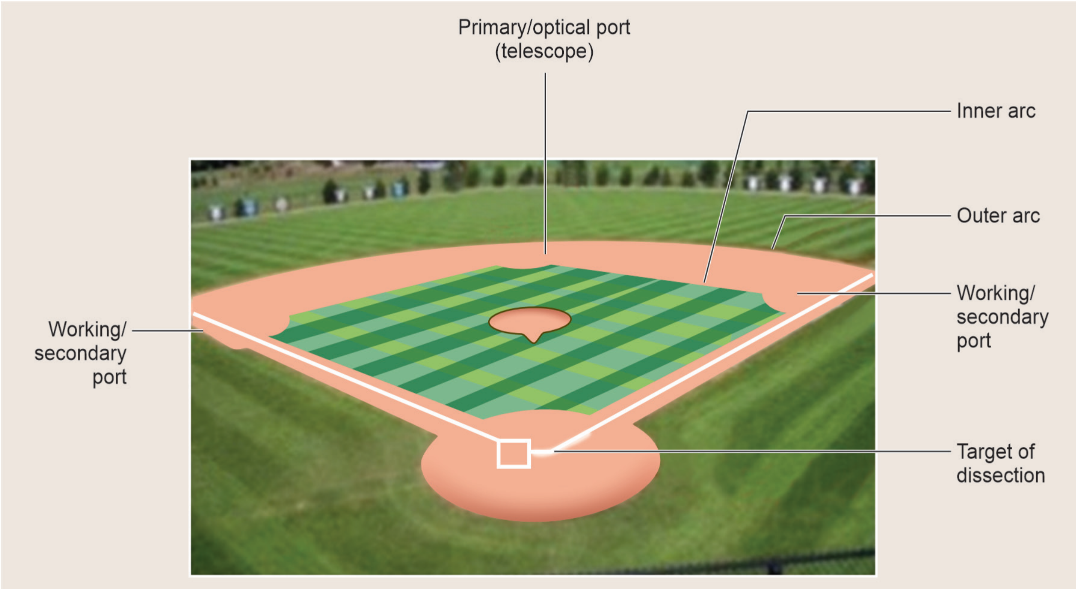


Fig. 1.14: Ergonomic port positioning using baseball diamond concept

junction is the target. After marking the target, two arcs are drawn, 18 cm and 24 cm away from the target area, all the working ports should be between these two arcs for the instrument to behave like type 1 lever.

In real-time situation after marking the target area and drawing two arcs, the camera port is placed in straight line with the target organ, now the right and left ports are placed between the two arcs in such a way that the instruments when placed from these ports form an angle of 60° with each other. 'Triangle law' states that the distance of the working ports from the camera depends on the length of the instrument used. If a pediatric instrument of 28 cm length is used, the distance of the working port from the camera port should be 5 cm to make manipulation angle of 60°, this distance is 7.5 cm when standard 36 cm adult instruments are used and becomes 10 cm when 45 cm bariatric instruments are used.

In real time the above can be achieved in an adult by making a diamond with your both index fingers and thumb. The tip of both the index fingers should be placed at the target organ, the confluence of both the thumbs will give us the camera position and the working ports will be in at the level of anatomical snuffbox. The distance from tip of the thumb to the snuffbox is roughly 7.5 cm.

Depth Cues

As laparoscopes are monocular scope there is a loss of depth perception. Placing camera between both the working instruments gives a better depth perception. Surgeon progressively learns to understand these depth cues and hence is able to say which structure is deep and which one near.

- *Occlusion:* The structure in front will occlude the one behind and cast a shadow, therefore, one may be able to conclude that the structure which is occluding is nearer as compared to the structure which is being occluded.
- *Relative size:* The structures closer to camera appear bigger and the structures which are farther off appear smaller.

- *Ariel gradient:* The structures which are nearer have sharper edges as compared to structures which are farther off.
- *Linear parallax:* Two parallel lines appear to meet each other at a distance and appear parallel to each other at a closer distance.
- *Motion parallax:* Structures near appear to move more as compared to deeper structures.
- *Texture gradient:* Nearer structures appear bright when compared to deeper structures which appear dark.

Fig. 1.15: Mirror imaging for the 1st assistant surgeon

Mirror Imaging (Fig. 1.15)

It is important to understand the concept of mirror imaging in laparoscopy. When an assistant is standing opposite to the operating surgeon and assisting, though he would be seeing the same image as the surgeon all his movements will be opposite to the surgeon's movement as seen on the screen.

Summary of instrument characteristics
- Head should be straight, in axis of trunk, without rotation or extension of the cervical spine.
- Shoulders in relaxed and in neutral position.
- Arms should be along the side of the body
- Elbows should be bent to 70° to 90°
- Forearms in horizontal or in a slightly descending axis
- Hands pronated
- Hands and fingers lightly grip the handles/handpiece
- Gaze should be down
- Neck slightly flexed and in straight line with the monitor.

Fig. 1.16: Ergonomic posture of operating surgeon

Ergonomic posture of operating surgeon is shown in **Fig. 1.16**.

Co-axial Alignment (Fig. 1.17)

It is an important ergonomic consideration in laparoscopic surgery, the surgeon, target organ and the monitor should be in the same line. The monitor should be slightly lower than the eye level of the surgeon, so that the surgeon has a 15°–20° downward gaze.

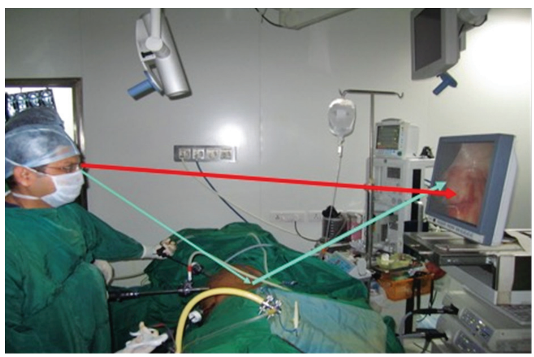


Fig. 1.17: Co-axial alignment

Downward gaze keeps the sternocleido-mastoid muscle relaxed and prevents its fatigue. This will also keep the eye in resting position preventing the oculomotor fatigue.

Position of the Monitor in Relation to the Surgeon

The monitor should be placed at a distance of 5 times the length of the diagonal of the monitor, for a 21-inch monitor the surgeon should be standing 105 inches away from the monitor. At this distance image formation occurs on macula of retina which has maximum acuity of vision and color perception. When the image is placed near it is large for macula and when away it is small for macula.

Operating Room Considerations in Ergonomics

- *Height of OT table:* Height of the operating table should be calculated by the formula 0.49° × height of the surgeon. Laparoscopic OT table must be able to reach up to 24 cm from ground. The patient should be roughly at the level of waist of the surgeon.
- OT lights should have an illumination of 20 lacs, dark light leads to poor visualization and bright light causes optical illusions.

Task Analysis

- Stepwise description of any task
- Components
  - Procedural steps
  - Executional steps
- Scientific sequential arrangement of steps

Task analysis is stepwise description of any task and the task is restructured into its component steps, each of these steps is arranged in a sequence for the task to be finished.

Task analysis is a learning tool and can be used by a novice surgeon for further training.

Psychoengineering

It is one of the pillars on which laparoscopic surgery stands. All the surgeons should be familiar with their machines. They should know the basic management of troubleshooting. For example, if the pneumoperitoneum is not being maintained, the gas tubing may be kinked, inlet valve of the port may be closed or CO_2 cylinder may be empty. Anticipating these troubles may save the day for any surgeon. A laparoscopic surgeon should not be temperamental, should be polite to the entire team, this will help form a better team and the member will work with more commitment.

Training in Laparoscopic Surgery

In this section of the chapter, we will try to understand:

- Ingredients of a surgery
- Learning curve
- How to use dry and wet lab to best of our advantage?
- Do you have a mentor?
- Top professionals have coaches, do we?

Learning a Laparoscopic Motor Skill

Learning a laparoscopic motor skill should start in a dry lab using basic simulation models, after this the trainee can proceed to wet lab on animal models.

Fitts and Posner have described 3 phases of learning a new motor skill:[14,15]

- *Cognitive phase:* In this phase student tries to learn a task and he is tentative, takes small steps at a time and all the steps are intellectualized. This can be seen when a novice starts practicing motor skill in a dry lab on an endo trainer. If the task given to him is transferring bead from one bowl to other, he will slowly hold the instrument, tentatively grasp the bead and slowly move it to the other bowl.
- *Integrative phase:* It is a phase where the information that the trainee has about the task has been converted into purposeful movements. The trainee is still thinking about the task but is able to finish the task with fluidity. If we consider the above

example of bead transfer, the trainee is now able to hold the bead in his instrument and fluidly transfer it from one bowl to other the movement is slow but purposeful and continuously being thought about. Here the trainee is gradually developing hand eye co-ordination, dexterity and depth perception.

- *Stage of automation:* This is a stage of learning where the movements become precise and quick, and are extremely purposeful. Considering the example of bead transfer, the trainee will quickly be able to grasp the bead in non-dominant hand and transfer it to the dominant hand and then into the bowl. As he does the task he is not continuously thinking about the task, it starts to come to him naturally.

Factors Affecting Training in Laparoscopic Surgery

Whenever training programs are started, it is extremely important to understand whether they are effective or not. Also, what are the steps needed to improve training.

1. *Effective feedback:* Feedback is very important to know if one is doing the right thing. Feedback can intrinsic or extrinsic. Intrinsic feedback is what a trainee gives to himself, it is like talking to oneself. After training for a few hours one realizes the depth cues, like what is near is bigger and brighter, remembering this fact in one's mind is intrinsic feedback.[16] Extrinsic feedback is the one which is given by a mentor, it can be a summative feedback given at the end of the training or it can be concurrent feedback which is given as your performing training.[17] It has been found that summative feedback is more effective in training students as they are able to concentrate better once the task is over.
2. *Deliberate practice:* Goal directed learning and practice helps in better training. Deliberate practice is mindful practice of a particular step of surgery. "It is like, when cricketer Virat Kohli gets out to a hook shot, he will keep practicing the hook shot till perfects it".

   If a surgeon has struggled to reflect the colon off the kidney in one case, he should revisit the video of the surgery and practice the component steps like precision, hand-eye co-ordination and dexterity. This mindful training leads to transference of the motor skill to the operating room.[18] Question which remains to be answered is how much should one practice and for how long? Broadly speaking practice should be distributed over period of time, not extending to more than 45 min to 1 hour in a session, but should extend over longer period of months to a year.[19,20] Aim of deliberate practice is to reach the stage of automation.[21]
3. *Concept of a pre-trained novice:* The term pre-trained novice was coined by Gallagher, pre-trained novice is a trainee who has reached a stage of automation in a simulated environment.[22] This trainee when starts operating a case, he does not have to be bothered about concentrating on dexterity, hand-eye co-ordination, etc. he starts to pay attention to anatomical details and avoiding complications. The problem with this learning model is that we do not know how much time does an index individual take to get to the stage of automation. Certain academic institutions have based it on the number of hours, a trainee has spent in lab doing exercises, but rather it should be proficiency bases and assessed by a mentor.[23,24]
4. *Graded sequential practice:* While practising motor skills, a surgeon should start with easier exercises and progressively graduate to more difficult ones. It has been demonstrated in studies that, with increasing level

of difficulties in simulation models the motor skills improve.[25]

5. *Cognitive learning:* Surgery is not only about learning a motor skill, this skill should blend with excellent anatomical, physiological and pathological knowledge. In cognitive training, apart from the motor skills the trainee is also taught anatomical details and pathological basis of the surgery. This knowledge helps him apply his motor skill better and leads to faster and more efficient training.[26]

Simulators in Laparoscopic Surgery

- *Mechanical simulators:* They can be either a commercially available box trainer or a home-made endotrainer. Home-made endotrainer is equally effective in training but are not validated.
- *Animal-based simulation models:* They can be made to train in particular skill or also a particular procedure. They can be cadaveric animate models or living animal models. A few animal models available are:
  - Porcine nephrectomy model
  - Porcine partial nephrectomy model
  - Chicken pyeloplasty model
  - Chicken model for urethrovesical anastomosis.
- *Virtual reality training models:* These models are like video games; these are computer generated programs which create situations on a screen and motor action are carried out to complete the tasks.[27]

Constructing an office endotrainer:[28] (Muljibhai Patel Urological Hospital's Office Endotrainer) **(Figs 1.18 to 1.20)**.

Design Construct

A wooden frame 20 inches in length by 15 inches in breath is made **(Fig. 1.18)**. In the center of the frame, two half-inch wooden bars, 15 inches in length are nailed vertically, 2 inches apart **(Fig. 1.18)**. At the base of the above two vertical bars a third, half an inch wooden bar, 4 inches in length is nailed horizontally. Lateral to the vertical bars on both sides, whole of wooden frame is fitted by a 6 mm thin wooden sheet. Multiple holes of 15 mm are cut out on the wooden sheets and are covered by a rubber cork, which is a bottle cap of 100 ml saline/contrast bottles **(Fig. 1.18)**. These corks act like ports. The whole assembly is mounted on 4 wooden rods, the two rods in front are 9 inches in height and the rear two rods are 5 inches in height **(Fig. 1.19)**. All these four rods are screwed on hinges and are

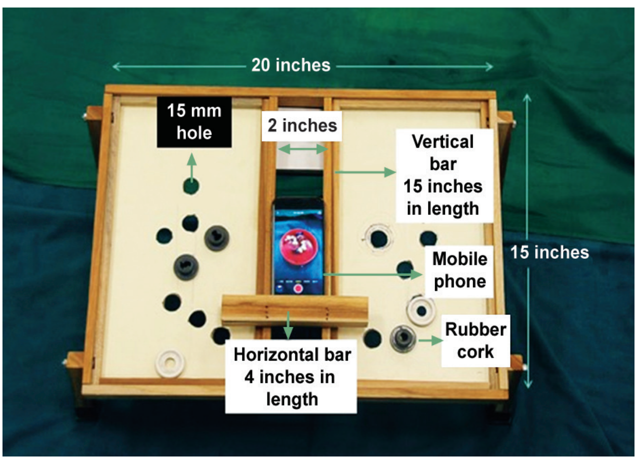


Fig. 1.18: Endotrainer design

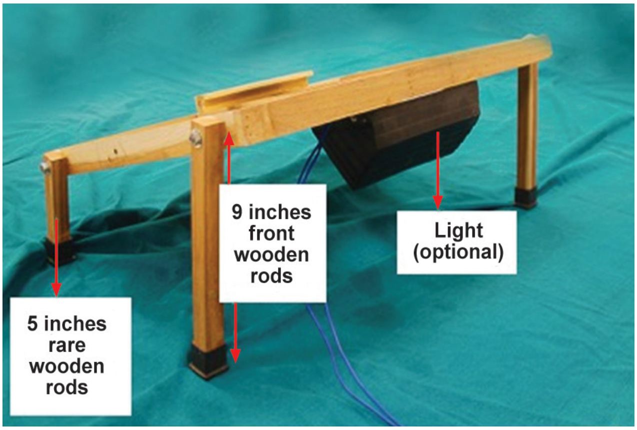


Fig. 1.19: Endotrainer design

foldable. It takes about an hour for a carpenter to make this device and cost of construction of device was 700 rupees. An additional light can be fitted under the frame **(Fig. 1.19)**, but on most occasions a well-lit room provides adequate light as the device is open by the sides.

Using this Device

This device is simple to use, a mobile phone or a tablet is used as a screen with this device. The device is vertically placed on the two vertical bars of the wooden frame and rests on the horizontal bar. The device is put on camera mode and then the desired exercise is carried out. The room light of a well-illuminated room is good enough for vision; the light mode off mobile phone or tablet can also be used.

Conventional laparoscopic or laparoscopic training instruments like Maryland grasper, bowel grasper, laparoscopic scissors and needle holder are used with the device. Endo-training material like suturing mat, beads, glove fingers and needles can be used for carrying out various exercises like bead holding and transfer, circle cutting and suturing **(Fig. 1.20)**.

Advantages

- Device is simple to construct and low cost.
- It is sleek and can be used as an office endotrainer, which will be very helpful for busy surgeons wanting to learn laparoscopy as it can be kept in their office.
- Vision is good as most of the mobile phones and tablets have high quality cameras. One can zoom in and out.
- Multiple holes on both sides act as multiple ports, has an ergonomical advantage.

Disadvantages

- Surgeon looks in same axis as the device though the exercise in question is not visible to him.
- Surgeon may take some time to adapt to the device.

Ingredients of Laparoscopic Surgery

As we try to learn laparoscopic surgery we must know what are the key ingredients of learning laparoscopy.

- *Anatomical knowledge in general:* While starting surgery, it is of utmost importance to know the basic anatomy. For example, in any upper tract urological procedure, surgeon has to know the relation of renal artery to renal vein.
- *Laparoscopic anatomical knowledge:* Laparoscopic anatomy is different from open surgical anatomy. The anatomy does not change but the orientation and the perspective changes. To site an example, in

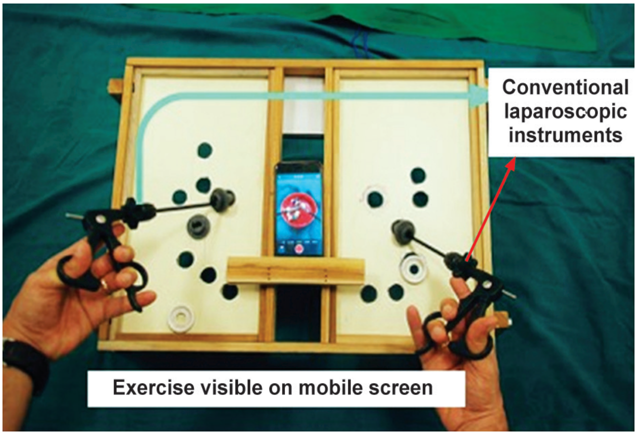


Fig. 1.20: Use of an office endotrainer

laparoscopic surgery it is easier to find the renal artery from the lower margin of the renal vein, even when the artery is at the upper border of the renal vein.

- *Radiological information:* Radiological information acts like global positioning system in laparoscopic surgery. It tells the operating surgeon the details of all the landmarks and where can one find them intraoperatively. Also, the surgeon can be well prepared for the anatomical variations.
- *Procedural steps:* Each procedure is divided into procedural steps. Like for a nephrectomy, procedural step will be port placement, bowel reflection, lifting the ureterogonadal packet, identification of renal vein, dissecting the upper pole, identification of aorta and renal artery, dissection of artery followed by vein, clipping of vessel, ureteral clipping and separating the specimen all around.
- *Executional steps:* Each procedural step is further divided into smaller steps known as executional steps. Let us consider an example of lifting ureterogonadal packet during laparoscopic nephrectomy. This procedural step is divided into the following executional steps:
  - Identifying the ureterogonadal packet
  - Identifying Gerota's fascia
  - Opening the Gerota's fascia
  - Lifting the packet—at a point where gonadal and ureter cross
  - Keeping the psoas sheath with psoas muscle
  - Do not dissect in-between gonadal vein and ureter, keep tissue on ureter.
  - *Extent of dissection:* Carinal—renal vein, caudal—crossing over the iliac artery and lateral—up to lateral abdominal wall
- *Component movements involving the executional steps:* Component movements should be individually practiced to execute a step.

  Skill sets required to complete an executional step.

  For example: Lifting ureterogonadal packet:
  - Why do it? As it helps exposing the renal hilum.
  - Identification of ureter is done by anatomical knowledge, by the acronym, water flows under the bridge and by peristalsis.
  - Opening of the Gerota's fascia requires ambidexterity, traction, countertraction.
  - Lifting of the packet at the point where gonadal and ureter cross is done using

suction and a dissector alternately making a to and fro motion ambidextrously.
- Keeping the psoas muscle sheath with psoas is done using suction as a dissector and depth perception is critical for this step.

Keys to Learning Laparoscopy

- Deconstruct the skill to component parts
  - Know your anatomy very well
  - Learn the steps of a laparoscopic procedure
- Practice component parts
  - Hand-eye co-ordination, ambidexterity
  - Depth perception
  - Cutting and suturing
- Practice to the point of failure
- Immerse yourself in the process

Learning Curve of Laparoscopic Surgery (Fig. 1.21)

Malcom Gladwell in his book the outliers said that it takes 10,000 hours to master a skill.[29] When he said this, he meant that for somebody to become world class athlete or musician it requires 10,000 hours, it is not that we need 10,000 hours to learn a new skill. Skill acquisition will start as early as 20 hours of training. While learning, the trainee should deconstruct the skill into smaller part. Always one should learn enough to self-correct and remove all the distraction barriers. Frustration barriers can be removed by repetitive practice. The learning curve will have a slow beginning followed by a steep acceleration and finally a plateau.

Top Athletes and Singers have Coaches, should we Surgeons also have them?

This is a very intriguing question that Dr Atul Gawande asked in his article published in the NewYorker.[30] When all the top professions have coaches why do not we surgeons have them, in a profession which requires error elimination to the level of sigma six.

He described in this article that when he invited a mentor to observe him for a parathyroid surgery, how a summative feedback given by the mentor improved his performance. Small errors like improperly directed headlight when directed properly could make surgery easier.

I had a similar personal experience in the gym (AS) one day, when I saw two young men train, one of them would train his latissimus dorsi muscle and the other one would train his forearm muscles almost everyday. I happened

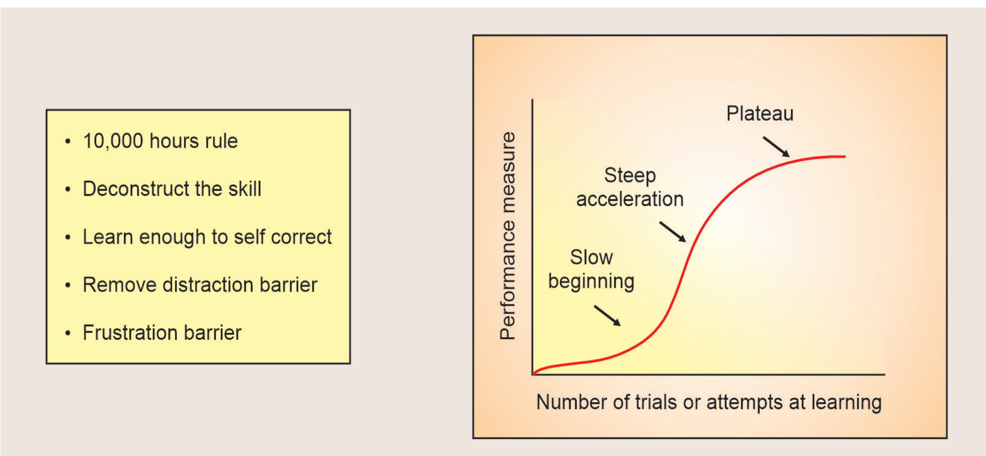


Fig. 1.21: The learning curve

to ask them the reason for this training, the first bloke replied that "I am a bowler and I need strong wings to bowl faster" and the second one said "I am a batsman and play for a local T20 league, I need strong forearms so that I could hit the ball out of the park". After listening to both of them I wondered, "I also use my shoulders everyday for performing laparoscopic surgery, which is technically very demanding, yet I had never thought of training my deltoid muscles".

REFERENCES

1. Litynski GS. Laparoscopy: The Early Attempts: Spotlighting Georg Kelling and Hans Christian Jacobaeus. JSLS: Journal of the Society of Laparoendoscopic Surgeons 1997 Jan;1(1):83.
2. Jacobaeus HC. Ueber die oglichkeit die Zystosk opiebeiUntersuchungseroserHonlungenanzuwenden. unchen Med Wchenschr. 1910;57:2090–2092.
3. Walker Reynolds J. The first laparoscopic cholecystectomy. JSLS: Journal of the Society of Laparoendoscopic Surgeons 2001 Jan;5(1):89.
4. Cortesi N, Ferrari P, Zambarda E, Manenti A, Baldini A, Morano FP. Diagnosis of bilateral abdominal cryptorchidism by laparoscopy. Endoscopy 1976;33:8.
5. Clayman RV, Kavoussi LR, Soper NJ, Dierks SM, Meretyk S, Darcy MD, Roemer FD, Pingleton ED, Thomson PG, Long SR. Laparoscopic nephrectomy: initial case report. The Journal of urology 2017 Feb 28;197(2):S182–86.
6. Schuessler WW, Schulam PG, Clayman RV, Kavoussi LR. Laparoscopic radical prostatectomy: initial short-term experience. Urology 1997 Dec 1;50(6):854–7.
7. Ratner LE, Montgomery RA, Kavoussi LR. Laparoscopic live donor nephrectomy: a review of first 5 years. Urol Clin North Am 2001;28: 709–19.
8. Veenhof AA, Vlug MS, van der Pas MH, Sietses C, van der Peet DL, De Lange-De Klerk ES, Bonjer HJ, Bemelman WA, Cuesta MA. Surgical stress response and postoperative immune function after laparoscopy or open surgery with fast track or standard perioperative care: a randomized trial. Annals of surgery 2012 Feb 1;255(2):216–21.
9. Kum CK, Wong CW, Goh PM, Ti TK. Comparative study of pain level and analgesic requirement after laparoscopic and open cholecystectomy. Surgical Laparoscopy, Endoscopy and Percutaneous Techniques 1994 Apr 1;4(2):139–41.
10. Richards C, Edwards J, Culver D, Emori TG, Tolson J, Gaynes R, National Nosocomial Infections Surveillance (NNIS) System. Does using a laparoscopic approach to cholecystectomy decrease the risk of surgical site infection? Annals of surgery 2003 Mar;237(3):358.
11. Gyedu A, Bingener J, Dally C, Oppong J, Price R, Reid-Lombardo K. Starting a Laparoscopic Surgery Programme in the Second Largest Teaching Hospital in Ghana. East African medical journal 2014;91(4):133–37.
12. Manasnayakorn S, Cuschieri A, Hanna GB. Ideal manipulation angle and instrument length in hand-assisted laparoscopic surgery. Surgical endoscopy 2008 Apr 1;22(4):924–29.
13. Supe AN, Kulkarni GV, Supe PA. Ergonomics in laparoscopic surgery. Journal of minimal access surgery 2010 Apr;6(2):31.
14. Anastakis DJ, Regehr G, Reznick RK, Cusimano M, Murnaghan J, Brown M, Hutchison C. Assessment of technical skills transfer from the bench training model to the human model. The American Journal of Surgery 1999 Feb 28;177(2): 167–70.
15. Rowan AN. Is justification of animal research necessary? JAMA 1993;269:1114.
16. Stefanidis D, Heniford BT. The formula for a successful laparoscopic skills curriculum [discussion in Arch Surg 2009;144(1):82.] Arch Surg 2009; 144(1):77–82.
17. Xeroulis GJ, Park J, Moulton CA, Reznick RK, LeBlanc V, Dubrowski A. Teaching suturing and knot-tying skills to medical students: a randomized controlled study comparing computer-based video instruction and (concurrent and summary) expert feedback. Surgery. 2007 Apr 30;141(4):442–49.
18. Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. Acad Med. 2004;79(10 suppl):S70–81.
19. Moulton CA, Dubrowski A, MacRae H, Graham B, Grober E, Reznick R. Teaching surgical skills: What kind of practice makes perfect? A randomized controlled trial. Annals of surgery. 2006;244(3):400–9.

20. Mackay S, Morgan P, Datta V, Chang A, Darzi A. Practice distribution in procedural skills training. Surgical Endoscopy and Other Interventional Techniques. 2002;16(6):957–61.
21. van Dongen KW, Ahlberg G, Bonavina L, et al. European consensus on a competency-based virtual reality training program for basic endoscopic surgical psychomotor skills. Surg Endosc 2011;25(1):166–71.
22. Gallagher AG, Ritter EM, Champion H, et al. Virtual reality simulation for the operating room: proficiency-based training as a paradigm shift in surgical skills training. Ann Surg 2005; 241(2): 364–72.
23. Korndorffer JR, Dunne JB, Sierra R, Stefanidis D, Touchard CL, Scott DJ. Simulator training for laparoscopic suturing using performance goals translates to the operating room. Journal of the American College of Surgeons. 2005 Jul 31;201(1): 23–29.
24. Ahlberg G, Enochsson L, Gallagher AG, Hedman L, Hogman C, McClusky DA, Ramel S, Smith CD, Arvidsson D. Proficiency-based virtual reality training significantly reduces the error rate for residents during their first 10 laparoscopic cholecystectomies. The American journal of surgery. 2007;193(6):797–804.
25. Ali MR, Mowery Y, Kaplan B, DeMaria EJ. Training the novice in laparoscopy: more challenge is better. Surg Endosc. 2002;16(12):1732–36.
26. Kohls-Gatzoulis JA, Regehr G, Hutchison C. Teaching cognitive skills improve learning in surgical skills courses: a blinded, prospective, randomized study. Can J Surg 2004;47(4): 277–83.
27. Coleman J, Nduka CC, Darzi A. Virtual reality and laparoscopic surgery. British Journal of Surgery. 1994;81(12):1709–11.
28. Tak Gopal R, Singh AG, Ganpule AP, Sabnis RB, Desai MR. Office Laparoscopic Endotrainer or Commercially Available Laparoscopic Endotrainer. Podium presentation, WZUSICON 2016.
29. Gladwell M. Outliers: The story of success. Hachette UK; 2008, Nov 18.
30. Gawande A. Top athletes and singers have coaches. Should you. The New Yorker 2011 Oct 3:44–53.

2

Basics in Laparoscopic Urologic Instrumentation

Arvind P Ganpule, Abhishek Singh, Sudharsan Balaji, V Mohan Kumar

INSTRUMENTS USED FOR GAINING ACCESS

Veress Needle (Fig. 2.1)

This is the key instrument for gaining access using the closed technique for pneumoperitoneum insufflations. Veress needle can be classified as disposable and nondisposable.

The different parts of the Veress needle are: (a) Shaft, (b) tip and (c) hub.

- *Shaft:* The Veress needle is available in a size of length 80 mm, 100 mm and 120 mm. Longer 150 mm needle for obese patients is also available. Disposable needle is 14 gauge in diameter. Reusable needle is larger in diameter (3 mm). The shaft is metallic and radiopaque. It has got a conduit for passage of gas for insufflation.

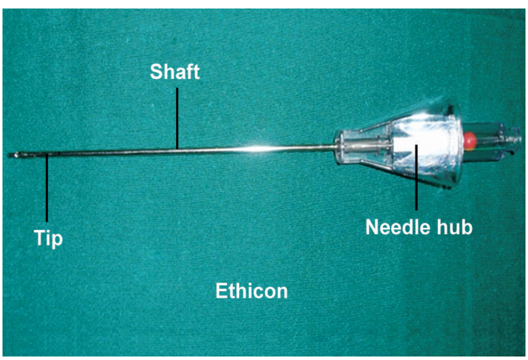


Fig. 2.1: Veress needle and its parts

- *Tip:* The tip of the Veress needle will show a vent for insufflation of the gas. The tip is always beveled. The beveled tip just a few centimeters beyond the blunt needle. The blunt needle springs forward once the tip of the bevel enters the abdomen.
- *Hub:* The hub of the needle shows a floating ball. The floating ball remains suspended when the needle is in a negative milieu. The ball also helps in performing the hanging drop test for ascertaining the accuracy of access. Ball (red or green) at the center of the hub floats when the tip of the needle is in the peritoneum. The hub has a Luer lock arrangement, which helps to attach syringe. The indicator suggests the position on the needle. Green color in the indicator suggests that the needle is in a negative milieu (peritoneum), red color indicates that the needle is in preperitoneal space or is in the mesenteric fat or the needle is blocked. This safety mechanism is seen in Ethicon™ needle.

The four steps which should be meticulously followed to ensure that the position of the Veress needle is proper are as follows:

1. *Aspiration:* The hub of the needle is aspirated to check for red (blood), yellow (bowel contents), green (bile). If in the peritoneal cavity, only air is aspirated.

2. *Hanging drop test:* A drop of saline is placed on the hub of the needle, and we see for a rapid drop of fluid column. Rapid drop of saline indicates a peritoneal placement of the needle tip.
3. *Low initial intra-abdominal pressure:* Initial pressure should be less than 5 mm Hg at a rate of 1 litre/min and should gradually go on increasing. In case the needle is perfectly placed, an initial negative pressure reading may be seen. If an initial pressure of 8 mm of Hg is seen, but it starts to go down immediately, this scenario is also acceptable as needle may be against some tissue initially.
4. *Uniform distension:* After achieving complete insufflation the abdomen should be uniformly distended and tense like a football. At this stage the abdominal pressure should be equal to set pressure.

Hasson's Cannula (Figs 2.2A and B)

The original Hasson cannula was a metal cannula. It consisted of a metal shaft with a rubber hub. This cannula is typically used when an open access is gained, in children and in hostile abdomen (multiple scars). The newer version of these cannulas is disposable. It consists of a cuff that remains outside abdomen and snugly fitting the port site. The part of the trocar which is supposed to remain inside the abdominal wall has an inflatable balloon. These two features help in maintaining the position of the cannula.

Ports

The ports are classified as follows:
- *Depending on the make* **(Fig. 2.3)***:* (a) Disposable, (b) nondisposable
- *Depending on the tip:* (a) Cutting tip, (b) noncutting or dilating **(Figs 2.3, 2.4A and B)**
- *Depending on the size:* 2 mm, 5 mm, 10 mm, 12 mm, 15 mm, 20 mm
- *Depending on the type of valve:* (a) Flap valve, (b) trumpet valve **(Fig. 2.4C)**

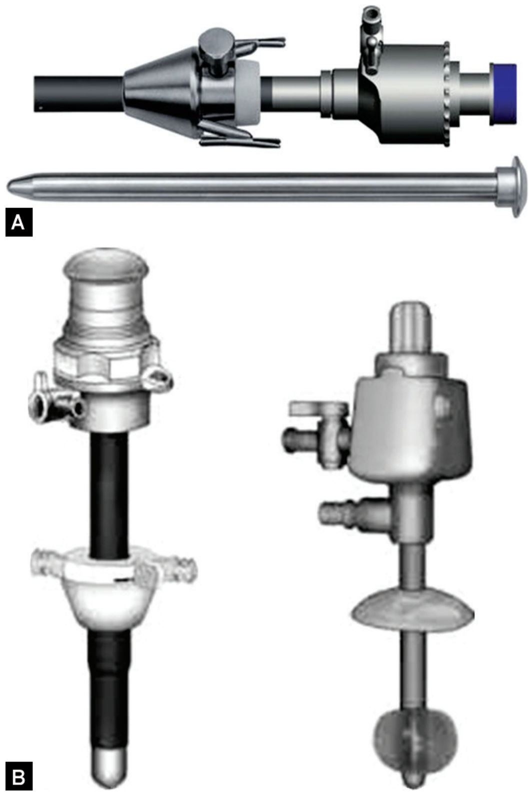


Fig. 2.2A and B: Hasson's cannula

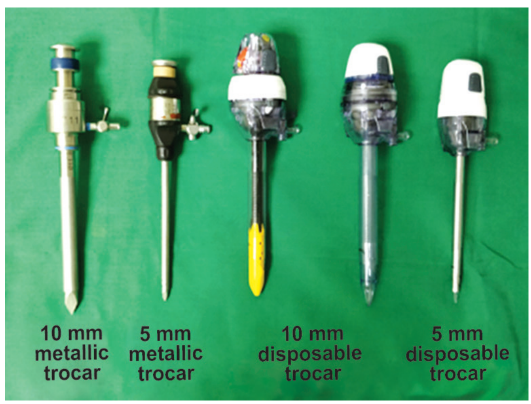


Fig. 2.3: Types of trocars

The different parts of the trocar are
- *Obturator:* The obturator can be blunt with a dilating tip **(Fig. 2.4B)**, cutting tip or blunt tip. The dilating tip trocars like the one by Ethicon™ (EndoPAT Xcel™

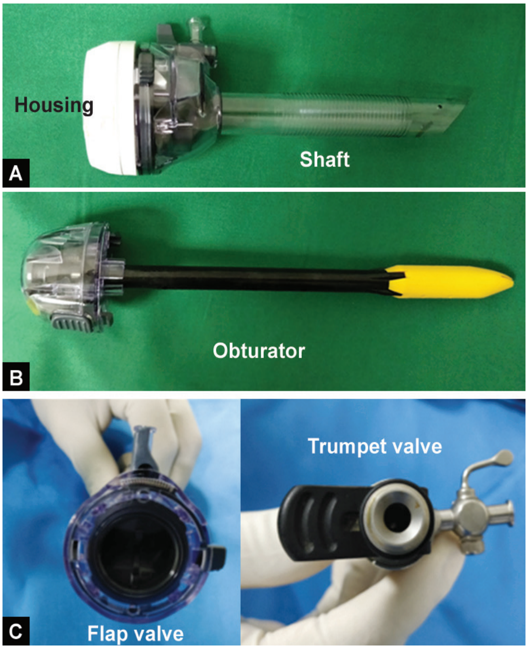


Fig. 2.4A to C: (A and B) Parts of a trocar; (C) Types of valve

B series) have a transparent shaft with a facet for telescope placement at the top and a lock by the side. This trocar can be used to gain entry in the abdomen under vision. The dilating tip dilates through the anterior abdominal wall muscles rather than cutting through it. The cutting tip trocars cut through the anterior abdominal wall to gain entry into the peritoneum, these can be either metallic or made of plastic. The cutting tip trocars have a blade (EndoPAT Xcel™ D series by Ethicon™), the blade is to be loaded with a push button. Once the trocar meets the resistance of the anterior abdominal wall, the blade cuts through the muscle and fascia of the abdominal wall, the moment of the blade crosses the abdominal wall and into the peritoneum, there is a loss of resistance and the blade retracts back making trocar a blunt end trocar. A blunt trocar is the one which is used to gain access in the open method and also used to get a re-entry into the abdomen once the port which was placed slips out during the procedure.

- *Housing and the cannula* ***(Fig. 2.4A)****:* This is the part of the trocar that acts a conduit for the instruments. The housing features the valve (flap valves in disposable trocars and trumpet valves in non-disposable trocars). The trumpet valves will only allow the passage of instrument which is equal to size of the trocar used with the cannula, if a smaller size instrument is used it will cause leakage of gas. A multiseal flap valve is made of multiple rubber leaflets, which coapt around the passing instrument and hence, it allows passage of instrument which are equal to or smaller in size to the trocar, without leakage of gas. The gas vents in all trocars lies distal to the valves. This prevents smudging of the lens during introduction or removal of the telescope.
- *Special variants of trocars:*
  - *Trocars with pistol handles:* They have handle which can be used to place a trocar.
  - *Hybrid trocars:* They are trocars with 5 mm as well as 10 mm channels so that both size instruments can be placed through them.

Instruments used for retraction and dissection: Retracting and dissecting instruments are of the most commonly used instruments in laparoscopy. Some of the commonly used ones are:

- Maryland forceps
- Bowel grasping forceps—double jaw action type and single jaw action type
- Allis laparoscopic forceps
- Right angles laparoscopic forceps

These instruments can be disposable or reusable. The reusable ones are made of three parts, namely (a) handle, (b) outer sheath and (c) insert.

Handle: It is the part used for holding a laparoscopic instrument, it has finger grip. The handle may have a locking mechanism depending on the make of the instrument, the locking mechanism can be of ratchet type (KarlStorz™) or button type (Wolf™). The instruments like Maryland forceps have a pillar for attachment of a monopolar cautery cable. These instruments have circular knob which is used to rotate the shaft.

Outer shaft: It is an insulated hollow housing which holds the insert. The insulation should be checked regularly as breech in insulation can cause thermal injury to bowel.

Insert of the instrument: The purpose for which the instrument will be used depends on the insert. The insert can have a Maryland tip or a bowel grasping tip or an Allis tip. The insert get locked into the outer shaft which get attached to the handle **(Fig. 2.5)**.

Fan retractor: It is a retractor used to retract bowel or solid organs. It has 3–5 blades which open like a fan and aid in retracting the organs laparoscopically. Available as 5 mm or 10 mm instrument.

Needle Holders (Figs 2.6A and B)

Laparoscopic needle drivers are used for intracorporeal suturing. Needle driver has a beak, shaft and a handle. The needle holders are classified depending on the beak of the needle holder as straight beak, parrot beak and self-riding. They have different grips, namely handle grip and a pistol grip.

Laparoscopic Scissors (Fig. 2.6C)

Like the retracting and dissecting instruments the non-disposable scissors also have three parts which are the outer sheath, handle and the insert.

The disposable scissors are one piece instrument. All the scissors can be classified on the basis of the tip as curved tip or straight tip, they can have short or long jaws. A special type of scissor which is articulating and rotating jaws is available, this feature allows the scissor to access relatively difficult angles and locations.

INSTRUMENTS USED FOR HEMOSTASIS

Clips: The variety of clips available:

- *Non-interlocking titanium clips:* They are available in a cartridge of six clips. They are cheap in comparison to other clips available. One clip costs approximately 60 INR (Indian national rupee). They are radiopaque. They require separate applicator for the application of the clips. As they are not absolutely secure in comparison to other clips they should be used for securing bleeders over the Gerota's fascia or small venous tributaries, particularly in donor nephrectomy. The

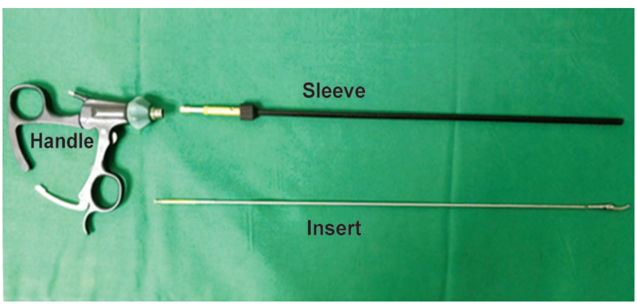
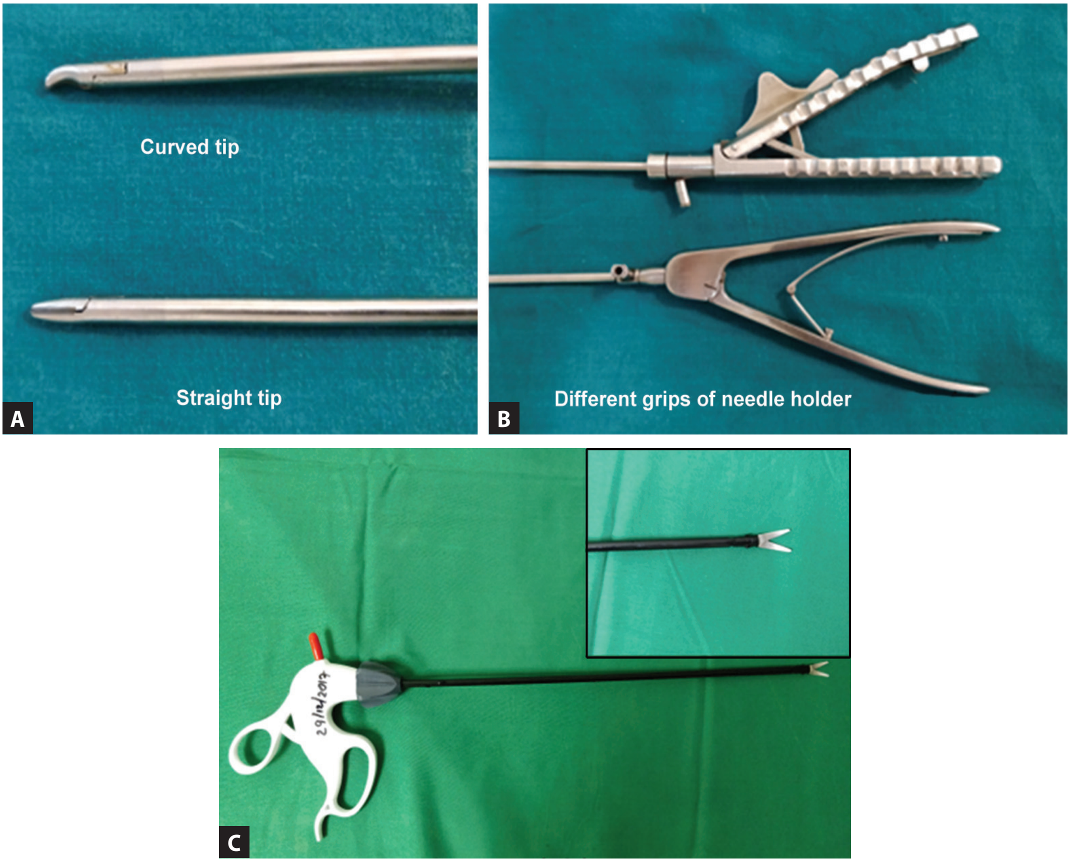


Fig. 2.5: Parts of laparoscopic instrument



Figs 2.6A to C: (A and B) Needle holder tip and handle; (C) Laparoscopic scissors

advantage of these clips is that, they can be removed during bench surgery.

- *Interlocking clips* **(*Fig. 2.7*)***:* A number of variety of clips is available (allport, ligamax). The clips are extremely secure and can be used for securing the renal vein and the renal artery. The length of the clip is approximately 16 mm. They are available with preloaded clip appliers, each clip applier has 20 preloaded clips. Every time the handle is pressed one clip is deployed. These instruments are preloaded; multiple clips can be deployed, without taking the instrument out of abdominal cavity. The clips are radiopaque. The clips have to be twisted open with the help of two hemostats if they have to be unclipped.

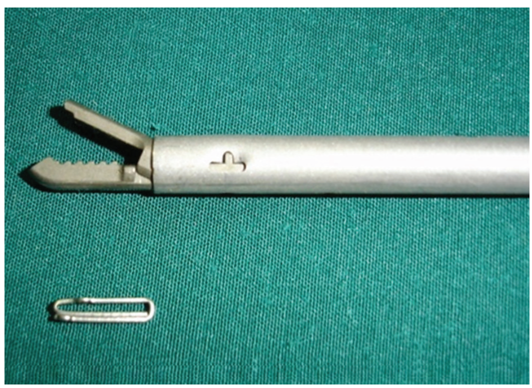


Fig. 2.7: Interlocking clip with applicator

A few of the clip applicators have an indicator, indicating the number of the clips left to be deployed.

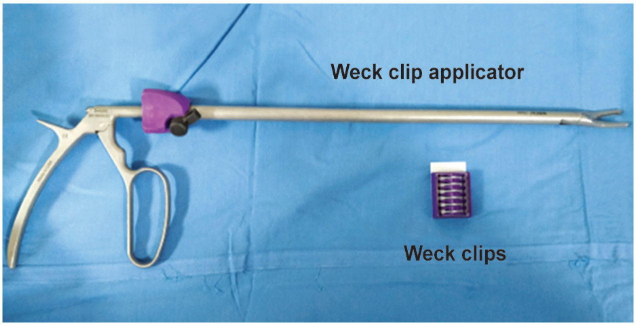


Fig. 2.8: Weck™ clip with applicator

- *Weck clips* ***(Fig. 2.8)****:* The Hem-o-loc clips (Teleflex Medicals), popularly known as Weck™ clips, are available in three variants (Teleflex, NC, USA)—green (5 mm), purple (10 mm) and gold clip (15 mm). The clips are made of nonabsorbable polymer, extremely secure and are radiolucent. The clips are used for securing the renal vein, renal artery. The 5 mm clips can be used for securing the gonadal vessels. Golden clips are used to secure large renal veins, especially right renal vein. Following the US FDA warning (black box) the clips have been contraindicated for use in laparoscopic donor nephrectomy. The warning came following reports of deaths following the use of these clips in donors. A multicenter study by Ponsky et al included over 1000 patients with 486 donor nephrectomies did not find any of the clips that slipped.

The authors suggested the following steps to be followed while applying Weck™ clips:

1. The vessels to be secured should be circumferentially dissected.
2. The knob of the clip should be seen.
3. Two clips should always be applied on the patient side.
4. Always keep a cuff of 2 mm beyond the clip.
5. Once the clip is applied the surgeon should be able to feel the click and all the people in the theater should be able to hear the click.

The Weck clips can be removed by custom made specific unclippers. In addition, an innovative way of unclipping Weck clip is to use ultasonic energy like harmonic and burn the clip at the level of knob or the 'V' of the clip. The clip immediately disengages.

STAPLERS

Staplers are devices used for tissue approximation **(Fig. 2.9)**. Different tissues have different properties and hence different types of cartriges are used for different tissues. In addition, an innovative way of unclipping weck clip is to use ultrasonic energy like harmonic and burn the clip at the level of knob or the 'V' of the clip. The clip immediately disengages.

Classification of Stapler

- Depending on the form: Linear, curved and circular staplers.
- Depending on whether it has a blade or not it can be called cutting or a non-cutting stapler.
- It can be classified as articulating or non-articulating staplers. The tip of the articulating stapler can be moved around to confirm to the shape of the tissue to be stappled.
- Stapler can be disposable or reusable.

The staples of the stapler are made of different materials, titanium is one of the most commonly used materials, which is a stable metal and does not produce any immune reaction. Other materials which are used for

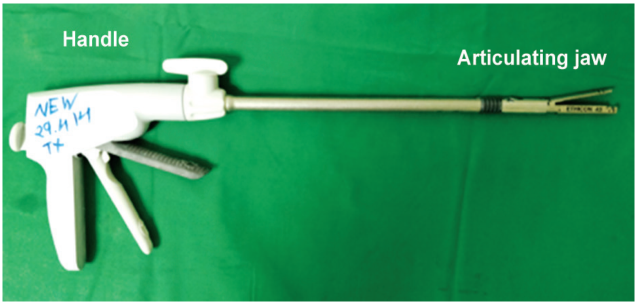


Fig. 2.9: Laparoscopic stapler

Table 2.1: Some frequently used laparoscopic staplers

Sl. No.	*Stapler (manufacturer)*	*Advantage*
1.	Echelon Flex™ GST (Ethicon)	Better grip on movement, least slippage
2.	The Echelon Flex™ Powered Endopath (Ethicon)	Battery power stapler, more stability, less tissue trauma
3.	Endopath® EMS (Ethicon)	Multifeed stapler for single use
4.	EndoGIA™ Tri-Staple™ Technology (Coviden)	Ergonomic design, can be used on wide range of tissue, precise articulation and one hand grasp

making staple include stainless steel and synthetic absorbable materials.

Cartridges are the cassettes containing the staples and are to be loaded onto the stapler gun. They are color-coded and depending upon the tissue to be stapled appropriate cartridge is used. The cartridges differ for different types of stapler. The height of the staples is determined by the tissue to be stapled, mesentery requires lesser height of the staples as compared to bowel. Color coding for various cartridges varies as per the height of the staples. For Ethicon™ staplers blue-colored cartridges are used for bowel and the white-colored ones are used for vascular pedicles.

Factors determining choice of the laparoscopic staplers **(Table 2.1)**:

- Whether it can access the target site
- Ability to articulate and rotate
- Ability to complete the staple line and cut
- Minimal movement of the gun during firing of the stapler
- Size of the gun will determine what size of the trocar should be used.

Currently there are two major players in the laparoscopic stapler market, Ethicon™ and Medtronics™ (Coviden earlier) and these companies occupy 70% of the market share of the sales.

HEMOSTATIC AGENTS

Hemostatic Agents are Either Available as Sheets or Solutions

Agents commonly used and available as sheets

- *Surgicel™ (Ethicon, USA):* It is oxidized cellulose polymer which is a unit of poly-anhydroglucuronic acid. It induces blood clot formation.
- *Surgicel SNoW™, Fibrillar™:* It is same as Surgicel™ but woven or knitted so that it has better tissue adherence.

Agents commonly used and available as solutions

- *Floseal™ matrix (Baxter):* It contains thrombin made from human plasma and gelatin granules. The gelatin granules swell up and give a mechanical tamponade effect. The thrombin in Floseal interacts with normal coagulation mechanism and accelerates conversion of fibrinogen to fibrin, resulting in accelerated clot formation.

- *Surgiflo:* Hemostatic matrix (Ethicon) is absorbable porcine gelatin paste, it is put over the sutured surface of bleeding organ for hemostasis.
- *Evicel™ (Ethicon):* It is a human fibrin-based hemostatic agent, can be stored at room temperature for 24 hours. It is available as airless spray and is not dependent on patient's coagulation profile.

Rescue Stitch and Tray

To salvage bleeding in minimal access surgery a rescue stitch can be used. Bleeding in minimal access environment can be very challenging for the surgeon. Rescue stitch can save the day, when used judiciously.

Rescue stitch is not available commercially but, is made by taking 4 inches of polyglactin 0 or polypropylene 3–0 on a large needle, ideally CT1 needle is suitable as it can be seen in the pool of blood. A thread is knotted at the end of the suture and a Weck™ clip (Teleflex, NC, USA) is applied proximal to it. Once the bleeding vessel is identified, the suture is passed through both the edges of the vessel and then the Weck clip is sinched over the bleeding vessel, this will control more than 50% of the bleeding. Another throw is now passed through the vessel walls making it a figure of 8 stitch and then two ends of the thread are tied to make a secure knot. Rescue stitch is a part of the rescue tray which contains, a Maryland forceps, a needle driver, a Satinsky clamp, Surgicel™ (Ethicon, Somerville, USA) bolster and a cartridge of Weck clip. The Maryland forceps is used to hold the edges of the vessel, needle driver is kept in the tray with a rescue stitch held in the jaws and is used to pass the needle through the bleeding vessels. Satinsky clamp can be used to clamp vessels and Surgicel bolster is used to pack the bleeding area. The rescue stitch should be plasma sterilized and then stuck to the wall of the operating room in accessible position so that it can be readily available for use in emergency.

3

Basics in Port Placement and Abdominal Wall Entry

Sudharsan Balaji, Arvind P Ganpule, V Mohan Kumar

POINT OF ENTRY (Fig. 3.1)

Multiple authors have identified different points of initial entry into the abdomen like umbilicus and Palmer's point. We prefer to insufflate the abdomen at the point of first port placement. The surface marking is arrived with the marking of the anterior superior iliac spine of the ipsilateral side and lower border of umbilicus. The midpoint of the line joining these two points is the reference point. It is wise to measure the distance of this point from the subcostal line in the long axis of the patient. A minimum of 12–14 cm is the usual and adequate distance to provide the necessary space for instrument handling and to avoid clashing between instruments. Account should be made for the increase of this distance in the long axis after pneumoperitoneum by 2–3 cm. For example, if the distance of this reference point from the subcostal line is 15 cm, then the actual distance after insufflation will be around 18 cm and in which case, we prefer to place the first port about an inch (2.5 cm) above the reference point. This correction is mandatory as caudal placement may be detrimental for upper polar dissection. On the contrary, if the distance of the reference point from the

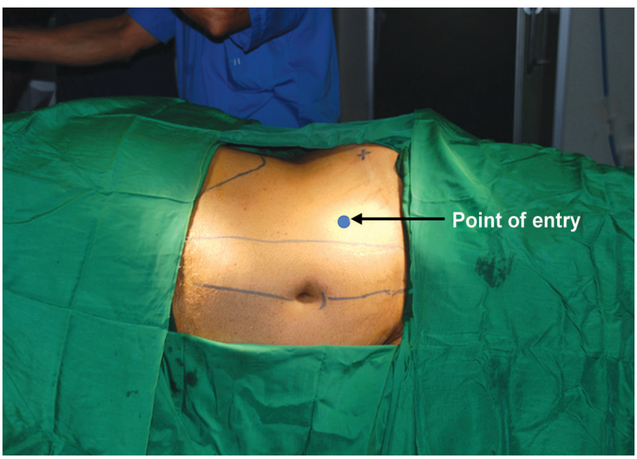


Fig. 3.1: Point of entry

subcostal line is only 12 cm, after insufflation it usually becomes 14 to 14.5 cm. In this case, we have to place the first port on the reference point as further cranial shifting may cause crowding of the ports externally with subsequent instrument clashing.

Another correction that is usually done is the lateral correction that is required in obese patients. Hence, in obese patients or those with falling abdominal pannus in the lateral position, the reference point is shifted up to a maximum of one inch (2.5 cm) laterally.

Entering the Abdomen at the Palmer Point

Dr Raoul Palmer, a gynecologist, described entry into the abdominal cavity through the left upper quadrant. He described the point of entry as Palmer's point. Palmer point is a point 3 cm below subcostal margin on the left side along the midclavicular line.

Though authors do not use this point of entry on a regular basis, it has been used by them in cases where access is failed from the left iliac fossa in left upper tract surgeries.

With these corrections on the longitudinal and mediolateral axes of the patient in specified circumstances, the corrected reference point is marked. We prefer creating pneumoperitoneum using Veress needle in all adult patients. The Veress needle is held like a dart and advanced into the abdomen. A typical three passes are observed—first at the fascia, second through the muscle and the last the most obvious, the peritoneum with a loud click as the inner sharp tip retracts inside. The position is confirmed with the marker on the hub, aspiration to check for blood/bowel contents followed by instillation of 3 cc of saline and confirming free flow under gravity. This is then followed by insufflation up to a preset pressure of 20 mm Hg.

We use a bladed 12 mm trocar for the first port at this reference point. Free flow of gas through the gas vent after removal of obturator confirms the entry into peritoneal cavity. The 30° camera should be kept ready and white balanced, before this port placement and an immediate check laparoscopy is done to see for proper insufflation, to check for underlying bowel, mesenteric, solid organ or vascular injury.

Port Placement for Laparoscopic Urological Surgeries

Laparoscopic Nephrectomy (Fig. 3.2)

The next port is placed in the same line as the first port, one finger breath below the costal margin. Typically this is a 5-mm dilating port for the left side and a 12-mm port on the right side. Right hand port in case of a nephrectomy should be a 12-mm port, as it will allow passage of Weck clip applicator, which would be used to secure the renal hilum. Third port (camera port) is placed at the junction of upper one-third and lower two-thirds along the lateral border of rectus.

The liver retraction port should be at the level lower border of liver, in the midline or on the opposite side, it should pass through the falciform ligament. The position of the port can be pre-confirmed by using a syringe filled with saline and needle. The needle is inserted and saline injected to look for the trajectory of the port. If the above principles are followed, a proper liver retraction can be achieved. Similarly, a fourth port is placed at least four finger breaths lateral from the first port and two finger breaths cranial to the anterior superior iliac spine. This port is used to retract the ureterogonadal packet and place traction on the kidney. A needle-syringe with saline is injected from the outside to note the trajectory of these ports before placement.

Laparoscopic Pyeloplasty ***(Fig. 3.3)***

The port placements are similar for a pyeloplasty barring a few minor changes. For reconstructive surgery, all the ports are placed

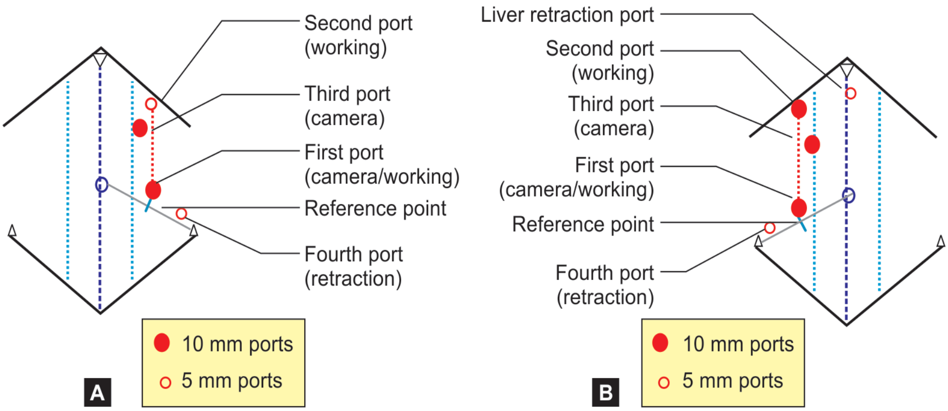


Fig. 3.2: Ports for laparoscopic nephrectomy

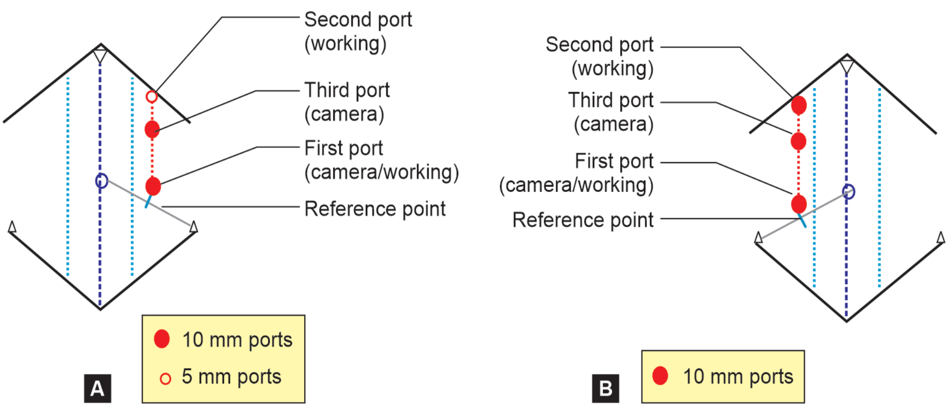


Fig. 3.3: Ports for laparoscopic pyeloplasty

in a straight line and triangulation is avoided. So, the third port is not placed pararectally, but in the same line as the first and second ports. Authors, routinely perform a retrograde ureterography before starting a pyeloplasty and mark the level of PUJ on the skin surface. This helps in placing the camera port (third port) exactly in front of PUJ and the position of the second port is adjusted appropriately. The working port is placed closer to the camera, as compared to nephrectomy, this keeps the operating surgeons arms by the side of the body making the movements stable and ergonomically correct.

Laparoscopic Urologic Pelvic Surgeries ***(Fig. 3.4)***

The basic principles for port placement during urologic pelvic surgeries remain the same. The Veress needle followed by the camera port is placed in the midline about 2 cm above the umbilicus. Care is taken to place the ports even more cranially (roughly 3 cm above the umbilicus) for a radical cystectomy as this helps to take down the urachus along with the bladder. Rest of the ports is placed in an inverted fan-shaped manner. Right hand working port is 10 mm and is placed roughly at the level of inferior border of umbilicus, pararectally. Left

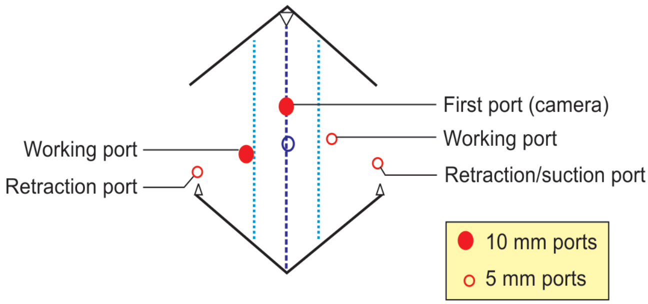


Fig. 3.4: Ports for laparoscopic urologic pelvic surgeries

hand port is a 5 mm port which is placed just above the level of the right hand port, pararectally. Retraction ports are placed on either side at approximately four finger breaths/ 7.5 cm lateral and 2–3 cm caudal to the left and right working port in the mid-axillary line. Care is taken to place the left side retraction port at a higher level than the right as it can be used for retraction as well as suction by the camera driver. The left side retraction port can be either 5 mm or 10 mm depending on the surgeon and assistant experience.

When a unilateral pelvic surgery is being performed like ureteric reimplantation, orchiopexy, marsupialization of lymphocele the port positioning will change. For the left-sided procedures the right hand port will move cranially and the left hand port will move caudally and medially. This will help following the baseball diamond concept of port placement.

4

Energy Sources in Laparoscopic Surgery

Abhishek Singh, Arvind P Ganpule

INTRODUCTION

Energy sources have become an integral part of surgery for cutting, coagulation, hemostasis and sealing during dissection and surgeries.

Electrosurgery: It is the use of radiofrequency alternating current during surgery to increase the cellular temperature to vaporize or coagulate the tissue.

Electrocautery uses direct current in which current is passed through a resistant metal wire electrode which generates heat. [1]

A regular electrosurgical generator uses current of 50/60 Hz and increases the frequency of current to 200,000 Hz. Such frequencies are radio frequencies, when current passes at such high frequency through the human body, no neuromuscular stimulation occurs, and patient does not get an electric shock.

Classification

It can be classified based on the type of electrosurgical unit (ESU) generator used:

- *Simple generator:* Monopolar/bipolar cautery
- *Advanced bipolar systems:*
    - Ligasure
    - Enseal
- Ultrasonic: Harmonic scalpel
- Integrated (ultrasound and advance bipolar) : Thunderbeat

Monopolar Generator[1]

These are the most commonly available electrosurgical units in all operating rooms **(Fig. 4.1)**.

Monopolar circuit traverses from generator—active electrode—patient—patient return electrode.

Various waveforms generated by electrosurgical generators **(Fig. 4.2)** are[1]:

- *Cut:* Waveform is constant, heat is generated rapidly leading to tissue vaporization or cutting.
- *Coagulation:* Waveform is interrupted, less heat is produced, and no tissue vaporization occurs instead coagulation occurs.
- *Blend current:* It is modification of duty cycle. It uses a lower cycle, so less heat is produced and decreased heat produces coagulation.

Electrosurgical Tissue Effects (Fig. 4.3)

Cutting

By using this mode, the probe acts like a hot knife, as the intense heat produced will vaporize the tissue. When the electrode is kept slightly away from the tissue, the maximum

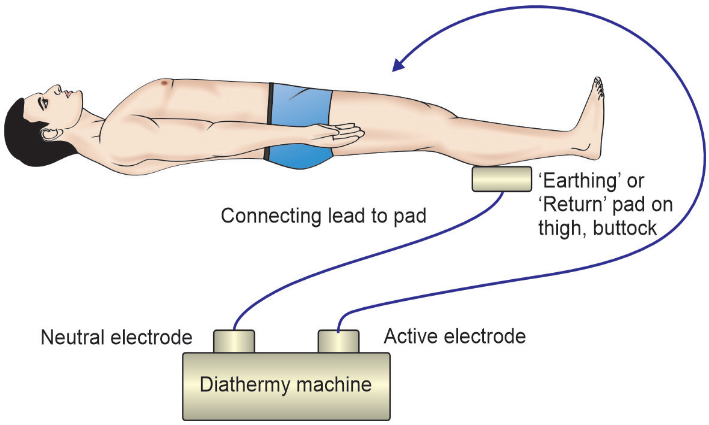


Fig. 4.1: Monopolar circuit

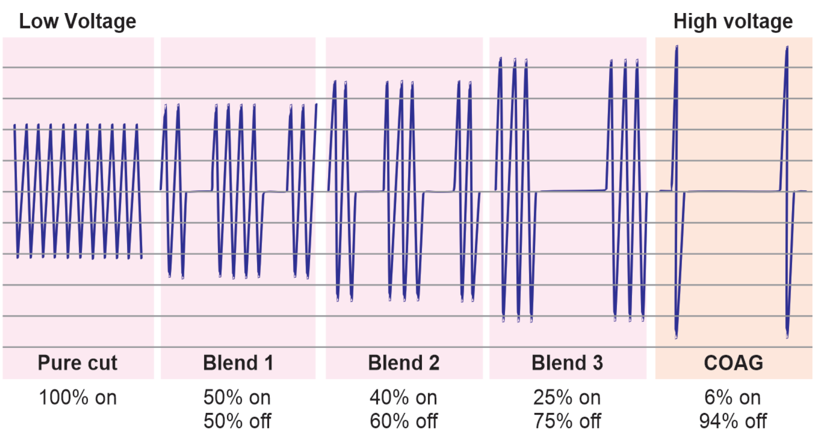


Fig. 4.2: Waveforms of cutting and coagulation

Fig. 4.3: The cutting current makes a deep incision and coagulation current has lateral spread

current concentration and cutting can be done.

Coagulation

In this mode, charring occurs involving a large area. In coagulation mode, the duty cycle (on time) is only 6%, this leads to heating up of tissue and coagulation rather than vaporization.

Patient pad placement: Patient plate should be in contact over a large muscular surface area. Bony areas should be avoided. Soft pads are better than metallic plates as they give uniform area of contact. The pads should be placed near the area of interest of surgery so that the pathway of current in the body is minimum.

Bipolar[1]

In this form of electrosurgery, active and the return electrode are the part of the bipolar

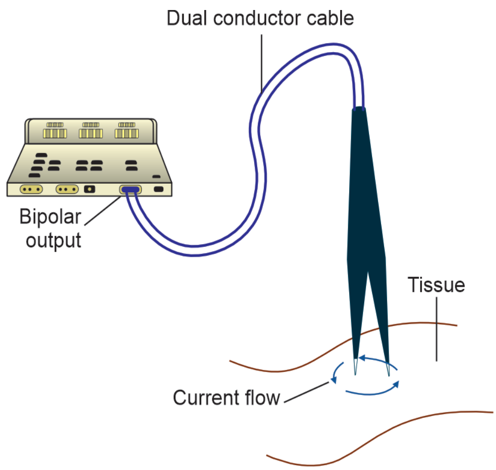


Fig. 4.4: Bipolar circuit

device and no patient plate is required. The current passes from one prong of bipolar device to the other through the tissue in between and circuit is completed **(Fig. 4.4)**.[2,3]

Advanced Bipolar Systems

- *Ligasure (Medtronic):* It is an advanced bipolar energy source which combines pressure and energy to create a seal. It consists of a specialized generator system that has vessel sealer capability also **(Fig. 4.5)**.[6]
  Ligasure is an advanced bipolar system that uses a combination of high current, lower voltage and pressure by the instruments to work as a hemostatic and a vessel sealer. It has a low mist generation, minimal charring, minimal sticking and less thermal spread. It has a feedback mechanism, which gives a beep sound once the tissue is adequately sealed. Even vessels up to seven millimetres can be sealed using this device. The seals are created by melting the collagen and elastin in the vessel walls and forming it into a permanent seal. It does not rely on proximal thrombus for hemostasis. Sealed blood vessel can withstand up to three times higher blood pressure than normal.

Enseal™ (SurgRx, Inc. Palo Alto, CA) (Fig. 4.6)

The Enseal system uses an advanced bipolar technology to seal the tissue within the blades of the instrument. It uses a patented blade technology that has a strong uniform compression along the tissue sealing line. It includes conductive particles embedded in the jaws of the instrument, which is temperature sensitive. These particles control the current that goes into the contact tissues.[4,5] Once the tissue heats above a critical level, these nanoparticles interrupt the flow of current. This cycle is continued till the entire tissue segment is uniformly heated and fused. The vessel walls are fused through coagulation, compression and protein denaturation. It can seal vessels up to 7 mm with a seal strength of 7 times the systolic pressure.

Ultrasonic Generators

High power ultrasound waves can be used to produce surgical cutting, coagulation, and dissection of tissues **(Fig. 4.7)**.[7]

Fig. 4.5: Ligasure

Fig. 4.6: Enseal

Fig. 4.7: Ultrasonic generator

Fig. 4.8: Thunderbeat

These systems operate at high frequency of 55 kHz, which cleave loose tissues by frictional heating providing cut and coagulate at the same time.

The handpiece contains piezoelectric crystals which are present under pressure amid metal cylinders. On activation, piezoelectric ceramic disks in handpiece become excited and this electrical energy is transferred into mechanical energy. Mechanical energy is amplified at nodes and a maximum amplitude of 55,000 Hz is reached at blade tip. It causes compression of tissues, broken hydrogen bonds and cell protein denaturation. Ultrasonic surgery causes slower coagulation as compared to electrosurgery. However, excessive heating of ultrasonic dissectors is an issue which causes lateral thermal spread. So, one must be careful while using this instrument as a dissector.

Integrated Ultrasound and Advanced Bipolar Generators

Thunderbeat

The Thunderbeat™ (Olympus), was the first device to integrate the ultrasonic and advanced bipolar generator **(Fig. 4.8)**.

Ethicon has also come up with an integrated generator: Ethicon Endo-Surgery™. The sealing capabilities of this device are same as ultrasonic or advanced bipolar depending on the generator used.[8]

They have advantages of both the bipolar system and the ultrasonic system. Since both energies are used together, the heat generation of combined bipolar is lesser.

Safety Considerations

- *Direct application*: Direct application of an active electrode to an unintended area can cause direct tissue injury.
- *Direct coupling*: When the activate active electrode touches a nearby metallic instrument, the instrument gets energised and this energy may travel through another path to the patient plate causing injury. For example, a monopolar energy touches a laparoscopic telescope and if the telescope is with bowel, then telescope will cause thermal injury to the bowel **(Fig. 4.9)**.
- *Insulation failure*: If there is a break in the insulation, the energy through the instrument can cause tissue injury. For example, if a portion of monopolar instrument has an insulation break and this area comes in contact with bowel, it can lead to bowel injury **(Fig. 4.10)**.
- *Capacitative coupling*: It happens when the charge generated within an insulator separates two conductors. It completes circuit and cause surrounding organ injury. For example, hybrid cannula with suction and hook has metallic hook covered by an

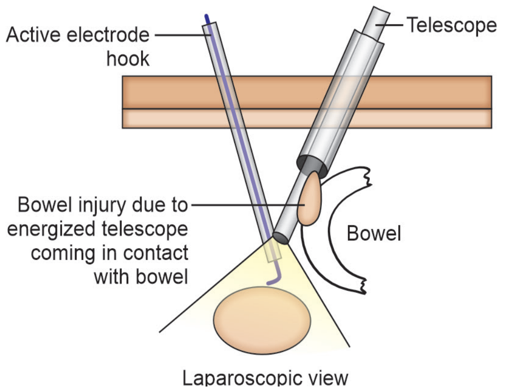


Fig. 4.9: Direct coupling of current

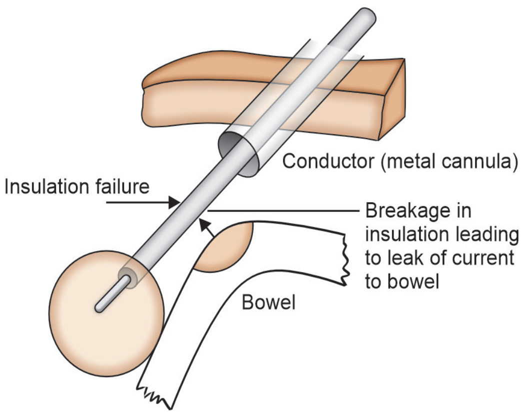


Fig. 4.10: Insulation failure

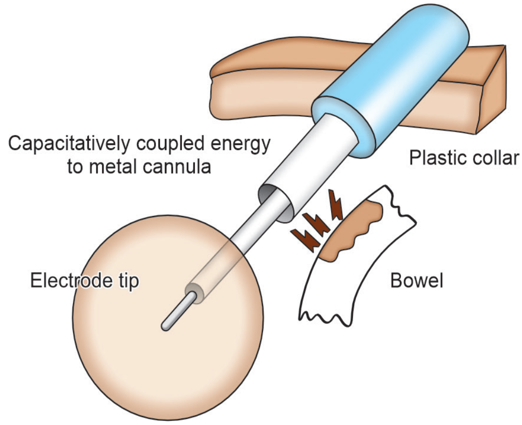


Fig. 4.11: Capacitative coupling

insulator which is fixed within a metallic suction cannula. The insulator can act as a capacitor and when it comes in contact with adjacent bowel, it may cause bowel injury **(Fig. 4.11)**.

REFERENCES

1. www.asit.org/assets/documents/Prinicpals_in_electrosurgery.pdf
2. Chen J, Jensen CR, Manwaring PK, Glasgow RE. Validation of a Laparoscopic Ferromagnetic Technology-based Vessel Sealing Device and Comparative Study to Ultrasonic and Bipolar Laparoscopic Devices. Surg Laparosc Endosc Percutan Tech. 2017;27(2):e12-e17. doi: 10.1097/SLE.0000000000000385. PMID: 28234706; PMCID: PMC5377999.
3. Hubner M, Demartines N, Muller S, Dindo D, Clavien PA, Hahnloser D. Prospective randomized study of monopolar scissors, bipolar vessel sealer and ultrasonic shears. Br J Surg. 2008 Sep;95(9):1098-104. doi: 10.1002/bjs.6321. PMID: 18690630.
4. http://www.ethicon.com/healthcare-professionals/products/advanced-energy/enseal/enseal-g2-tissue-sealers
5. Heniford BT, Matthews BD, Sing RF, Backus C, Pratt B, Greene FL. Initial results with an electrothermal bipolar vessel sealer. Surgical endoscopy. 2001;15:799-801.
6. Ping H, Xing NZ, Zhang JH, Niu YN, Zhang JZ, Wang JW. A single institution experience using the LigaSure vessel sealing system in laparoscopic nephrectomy. Chin Med J (Engl). 2011;124(8):1242-5. PMID: 21543004.
7. Tomita Y, Koike H, Takahashi K, Tamaki M, Morishita H. Use of the harmonic scalpel for nephron sparing surgery in renal cell carcinoma. J Urol. 1998 Jun;159(6):2063-4. doi: 10.1016/S0022-5347(01)63247-6. PMID: 9598518.
8. http://medical.olympusamerica.com/products/thunderbeat-1.

5

Tips and Tricks in Laparoscopic Adrenalectomy

Arvind P Ganpule, Sudharsan Balaji, V Mohan Kumar, Abhishek Singh

LEFT SIDE TRANSPERITONEAL ADRENALECTOMY

Port Positioning

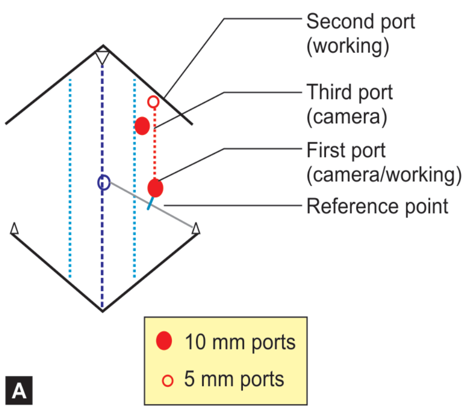
The port position is dictated by the size of the adrenal lesion, the pathology and the laterality of the mass.

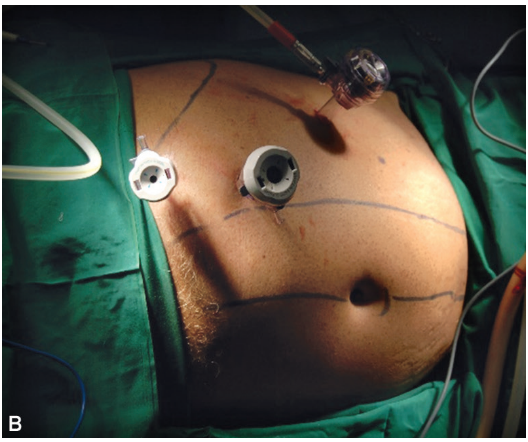
Port Placement

The principles of port placement are that the area of interest should be at the apex of the angle formed by the two working ports with the camera in center **(Figs 5.1A and B)**.

Pneumoperitoneum

The pneumoperitoneum is created either with the open technique or the Veress needle technique. The site of creation of the pneumoperitoneum depends on the approach utilized. If the open technique is employed, the umbilicus is the choice of access. If the Veress needle is used, it is inserted in the ipsilateral iliac fossa. Once the pneumoperitoneum is created, the ports should be inserted in such a way that the camera port lies in front of the adrenal. The ports are inserted as follows:





Figs 5.1A and B: Ports for laparoscopic left adrenalectomy

Three ports are inserted. The 10 mm camera port is at the lateral border of the umbilicus in front of the adrenal gland. The other two ports are placed on either side 5–7.5 cm away from the camera port. The right hand port should always be a 10-mm port and is placed one finger breath below the costal margin in the midclavicular line on the right side. The left hand port is 5–7.5 cm caudal and lateral to camera port on the right side. Principle of placing a liver retractor is same as nephrectomy in right. Proper positioning of liver retracting port is critical to exposure of adrenal gland. The port position for a left-sided adrenalectomy mirror is the right side. An additional 5 mm retraction port can be placed along the anterior axillary line at the level of lower pole of the kidney.

Steps

Bowel Mobilization

The line of Toldt is incised and the colon is mobilized inferiorly **(Fig. 5.2)**. The extent of the caudal mobilization is not as extensive as that in nephrectomy. The aim being to expose the renal vein. In contrast, the mobilization of the splenocolic and lienorenal ligaments should be extensive. On the left side, the spleen is extensively mobilized giving an appearance of a open book **(Fig. 5.3)**. This part of the dissection is vital in adrenalectomy on the left side. Unless the spleen is mobilized extensively the renal vein and the adrenal vein dissection would not be optimal. If this step is not done aggressively, the spleen keeps on obstructing the vision of the surgeon. The splenorenal ligament is preferentially taken down with harmonic scalpel. The advantage of using this modality is that, it helps in securing the small vessels in the ligament. It is essential that, this step is done prior to identifying the renal vein, allowing full medial rotation of the spleen away from the surgical field.

Identification of the Renal Vein

The renal vein is identified as a bluish hue with subtle venous pulsations seen through the Gerota's fascia **(Fig. 5.4)**. If the identification of the renal vein is challenging, one can identify the gonadal vein and trace it till its confluence with the renal vein. The next

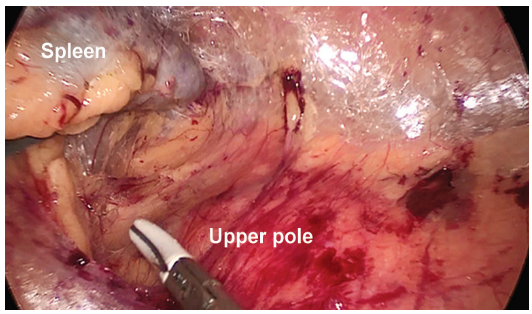


Fig. 5.3: Dissection of upper pole

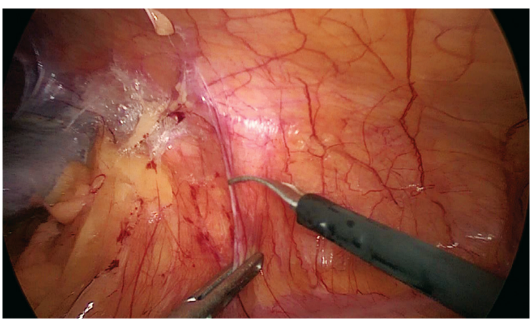


Fig. 5.2: Reflection of colon

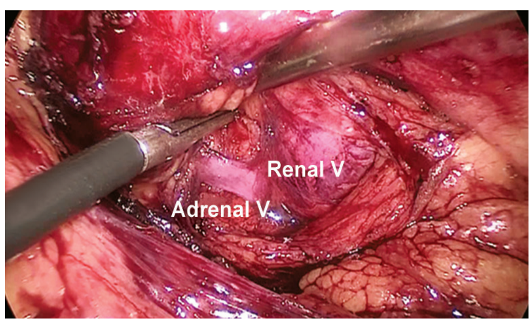


Fig. 5.4: Identification of renal vein and adrenal vein

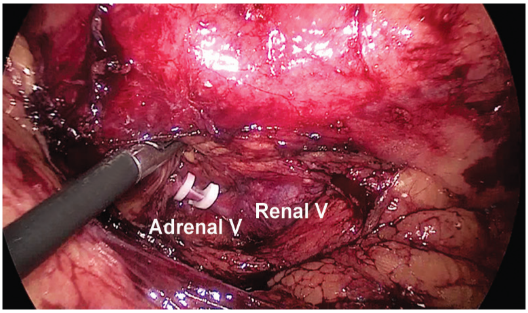


Fig. 5.5: Clipping of adrenal vein

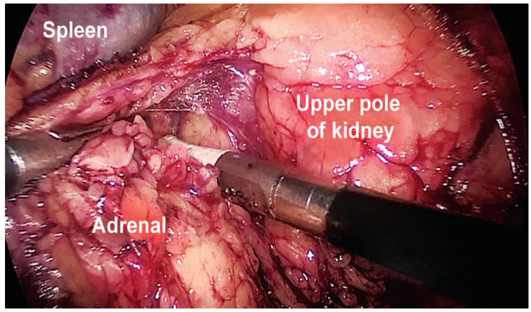


Fig. 5.6: Dissection between kidney and adrenal

step in the procedure is securing the adrenal vein **(Fig. 5.5)**. The dissection of the adrenal vein starts at its confluence with the renal vein. The dissection should be adequate to allow safe clipping and transection of adrenal vein. The dissection is deemed to be adequate if the adrenal vein is seen entering the adrenal gland or the lower border of the adrenal gland is clearly seen. The inferior phrenic vein is considered to be the landmark to assess the adequacy of the dissection. The adrenal vein is secured with the help of either interlocking clips or hemolok clips. It is essential to keep an adequate amount of cuff of adrenal vein at the renal vein end. In addition, a cuff should be left beyond the clips to ensure that the clips do not slip. The controversy exists as regards the need to secure the adrenal vein prior to dissection or it is necessary to dissect and secure it after the dissection of the tumour. The authors prefer to secure the adrenal vein prior to dissection of the SOL in pheochromocytoma and other functional tumors.

Dissection of the Plane between the Adrenal and the Upper Pole of the Kidney

The Gerota's fascia over the upper pole of the kidney is opened to expose the upper pole of the kidney and the adrenal gland. Special precaution to be exercised, include avoiding injury to a upper polar branch of the renal artery or an accessory renal artery. This information can be obtained from the review of preoperative CT images. The dissection should proceed between the adrenal gland and the upper pole of kidney till the posterior and lateral abdominal wall muscles are seen **(Figs 5.6 and 5.7)**. The gland is gradually separated from the upper pole of the kidney, throughout its length and breadth. It is important to avoid grasping the adrenal during the course of the dissection.

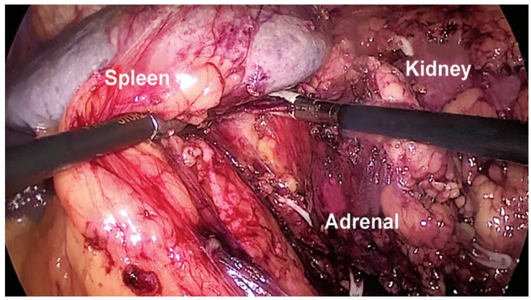


Fig. 5.7: Dissection between adrenal and spleen

At this point adrenal gland is separated all around and advanced energy sources are used to secure hemostasis at the gland is supplied by multiple small arterial branches, and after separation, the adrenal gland is entrapped in the specimen retrieval bag (Nadiad bag).

Right Side Adrenalectomy

The port placement varies on the right side that a 5-mm port is required for retraction of the liver **(Fig. 5.8)**.

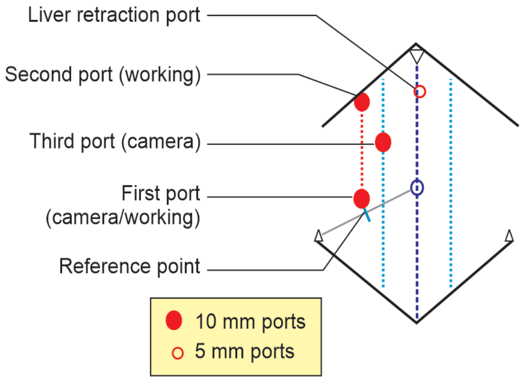


Fig. 5.8: Port placement for laparoscopic right adrenalectomy

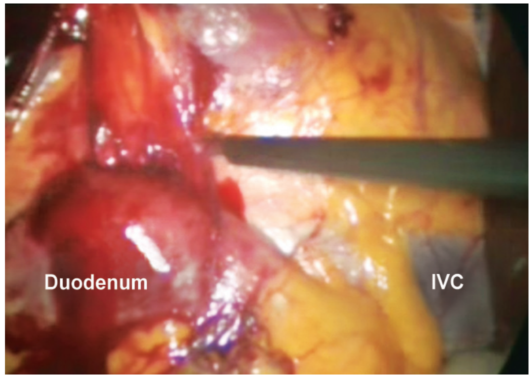


Fig. 5.9: Kocherization of duodenum and identification of IVC

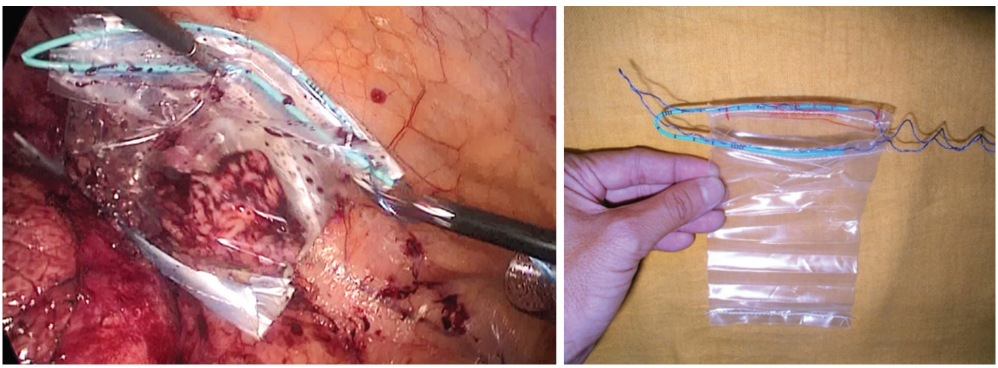


Fig. 5.10: Entrapment of specimen in Nadiad bag

The duodenum is kocherized and the inferior vena cava completely exposed **(Fig. 5.9)**.

On the right side, the renal vein is exposed. This acts as a landmark. Once the renal vein is exposed, it is traced till its junction with the inferior vena cava. The dissection proceeds along the upper border of the inferior vena cava. Once the IVC is identified, the plane in between the psoas muscle and the inferior vena cava (IVC) is found. This is essential as unless the adrenal gland is lifted, the adrenal vein does not tent up. The course of the adrenal vein on the left side is parallel to the IVC, tenting or lifting the adrenal makes the adrenal vein vertical. The adrenal vein as on the left side is secured with the help of hemolok clip.

Dissection in between the Kidney and the Adrenal

As on the left side all care should be taken to safeguard the accessory renal artery and the branches of the renal artery.

Specimen is entraped using Nadiad bag **(Fig. 5.10)**.

Issues with Management of Pheochromocytoma

Management of pheochromocytoma involves preoperative, intraoperative and postoperative periods.

Goals: The goals in management are to control hypertension, pheochromocytoma related symptoms and to avoid complications.

Preoperative Management

The preoperative management of pheochromocytoma patient starts 2 weeks before surgery. A thorough cardiac evaluation is a must in all the cases. The patient should be started on alpha blockers. Phenoxybenzamine is commonly prescribed. Prazocin is more commonly used. Phenoxybenzamine is started 7 to 14 days prior to surgery with a starting dose of 10 mg twice daily which can be titrated up to 1 mg/kg. Prazocin can be started at the dose of 2.5 mg daily. Selective alpha blockers such as terazocin or doxazocin can be used sometimes. The advantages of selective alpha blockers are the dose can be titrated, the tachycardia will be less and it can be taken on the day of surgery.

Beta blocker is started 2 days later as patient may develop reflex tachycardia and arrhythmia due to alpha blockers. Beta blockers should never be started before alpha blockers. Selective β_1 blockers such as atenolol, metoprolol preferred. If BP is not controlled, then metyrosine can be given followed by calcium channel blockers. The measures to be taken one to two days prior to surgery are as follows.

Increase in intravascular volume by adequate fluids (1–2 L of bolus on the night before surgery). Last dose of alpha blockers should be taken on the night before surgery and the morning dose should be omitted. Blood pressure and heart rate should be monitored.

Surgery can be done if the following criteria (Roizen) are met

- In hospital BP hold not be more than 160/90 for at least 24 hours before surgery.
- Orthostatic hypotension should be present but upright BP should not be less than 80/45.
- No more than one extrasystole/5 min
- No ST/T wave changes in ECG for one week.

Intraoperative Period

Adequate precautions should be taken including preparation, minimal tissue handling, deep plane anesthesia, use of shorter acting drugs, and fluids after vein clamping. Adequate vascular access in the form of central line and two large IV lines is a must. Drugs such as sodium nitroprusside, NTG and esmolol should be kept ready. The crisis can occur during induction, tumor manipulation and vein clamping.

Postoperative Period

Hypotension should be avoided with adequate fluids. Pressor agents should be avoided in the postoperative period. We should be aware of the possibility of rebound hypoglycemia due to insulin excess and manage accordingly.

6

Tips and Tricks in Laparoscopic Pyeloplasty

Arvind P Ganpule, V Mohan Kumar, Sudharsan Balaji, Abhishek Singh

INTRODUCTION

Pyeloplasty regardless of the approach, namely open, laparoscopic or robotic offers excellent results. The approach to be chosen depends on the age of the patient, the degree of hydronephrosis, extent of extrarenal pelvis and surgical expertise available. Regardless of the approach the success rates exceed 95% in expert hands.

Stenting

In all pediatric open pyeloplasty cases, our choice of stenting is an antegrade splint. The antegrade splint is placed after completion of the medial wall of the reconstruction. The splint is typically a 3 of 4 Fr ureteric catheter. The ureteric catheter along with a percutaneous nephrostomy in the form of a Foley catheter is placed. The postoperative protocol for removal of these tubes is to remove the ureteric splint after 5 days and clamp the percutaneous nephrostomy. This ensures that the reconstruction is patent. The patient is observed for a day for any increasing hydronephrosis or pain and thereafter the percutaneous nephrostomy is removed. We believe employing this approach for this subset of patients helps to avoid manipulating the urethra for stent insertion as well as extraction of stent and thus preventing the possible complications.

In all the adult pyeloplasties, authors perform a preoperative retrograde pyelogram. The advantage of doing this was fourfold; it helped us to decide in initial part of the learning curve if a laparoscopic approach was feasible, it also helped to place a single J ureteric catheter which in turn helped in keeping the pelvis distended and helped in dissection. A collapsed pelvis makes the dissection extremely difficult. Second, the ureteric catheter offers an opportunity to keep the guidewire and perform a spatulation. If in the step of spatulation, the insertion of blade of scissors is difficult, the ureteric catheter can be removed and the spatulation can be performed over the guidewire. The single J ureteric catheter is replaced with double J stent after completion of the procedure.

In pediatric laparoscopic and robotic pyeloplasty an antegrade stent is placed either with a miniport or with a 18 Fr angiocath. The position of the stent is ascertained with efflux of urine from the side holes of stent.

Preoperative Imaging Assessment

Ultrasonography

The sonography gives the following information, namely degree of hydronephrosis, cortical thickness, amount of extrarenal pelvis and the echogenicity of the kidney. In the laparoscopic approach, giant hydronephrotic kidney's need decompression with a preoperative PCN. This apart from making the procedure less challenging also helps in additional assessment of the renal function.

CT Angiography

CT angiography in pelviureteric junction obstruction (PUJO) helps in assessing the presence or absence of crossing vessels which would further help in dissection of the PUJ. Although clinically useful, the guidelines do not suggest this imaging modality as the standard of care for investigations.

A preoperative imaging helps in understanding the lie of the pelvicalyceal junction. For instance, if a transperitoneal pyeloplasty is to be attempted, then a PUJO which is situated posteriorly would be an extremely challenging situation. The easiest lie for performing a pyeloplasty would be anteriorly located pelvis which is extrarenal.

*Positioning of the Patient **(Fig. 6.1)***

The patient is positioned at the edge of the table with the upper leg extended and the lower leg flexed. The pressure points are secured using pillows and cushioned. The patient is strapped with two straps, one over the thigh and the other over the chest. The patient is placed in a 45 tilt if the transmesocolic approach is employed.

Port Positioning

The preamble for proper port positioning is that the camera port should be in front of the PUJO. The exact location of the port position can be ascertained with either imaging or retrograde pyelogram. A preoperative pyelogram will help us to mark the position of the port on the skin. The rest of the ports should be placed in such a way that the working and the retracting port are equidistant from each other (equal azimuth angle). The choice of size of the ports varies depending on surgeons' experience and personal preference. The instrument retraction port can be 5 mm or 10 mm in size. The port positioning has been discussed in detail earlier.

Steps in Port Positioning

Step 1: Retrograde pyelogram and ascertain the exact position of the ureteropelvic junction.

Step 2: Veress needle insertion at the midpoint of the ASIS and the umbilicus.

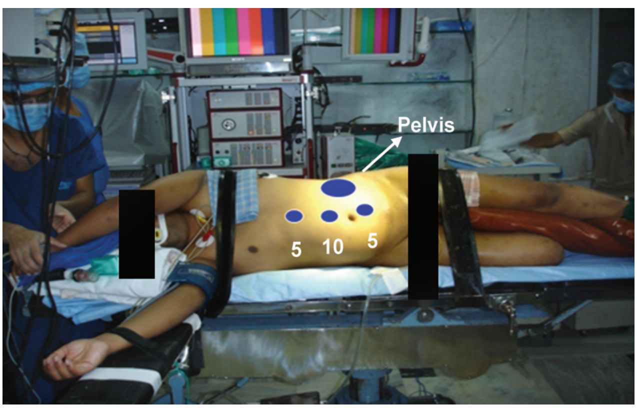


Fig. 6.1: Patient positioning and port placement for laparoscopic pyeloplasty

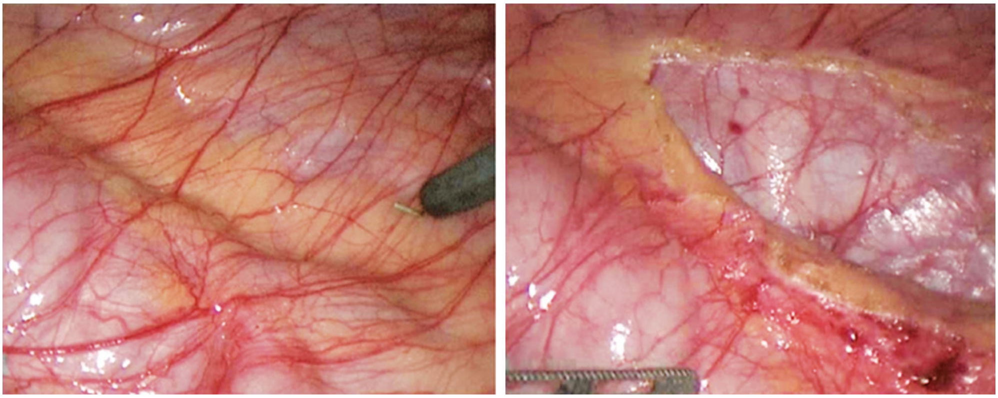


Fig. 6.2: Reflection of bowel

Step 3: Once the pneumoperitoneum is created the camera port is inserted in front of the renal pelvis.

Steps of Dissection

The steps of the dissection are as follows:

1. *Reflection of the bowel:* The reflection of the bowel need not be as extensive as in laparoscopic nephrectomy **(Fig. 6.2)**. The plane of the dissection should be initially outside the Gerota's fascia (extragerotal). The extent of dissection should extend from the iliac crossing up to the splenorenal ligament. It is not necessary to take down the splenorenal ligament. The dissection should delineate the PUJ adequately. The pelviureteric junction should be dissected either by starting the dissection at the ureterogonadal packet or proceeding from the renal pelvis. This helps in identifying the crossing vessels, if any. A preplaced ureteric catheter as described earlier is of benefit for this step as it keeps the pelvis distended and thus facilitating dissection.
2. *Transmesenteric approach:* The transmesocolic approach is employed if the mesenteric arcades are not thick, the arcades are easily visible and the mesenteric fat is not very dense **(Fig. 6.3)**. This approach is of particular benefit in pediatric patients as the mesenteric fat is not thick. This approach saves time of reflection of the bowel.

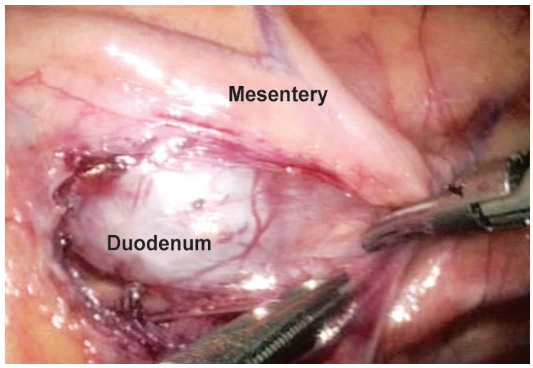


Fig. 6.3: Transmesenteric approach

3. *Dissection of the crossing vessels:* The vessels should be circumferentially dissected. The dissection of the vessel can be aided by use of a vascular sling. The dissection of the vessel is considered to be complete if the PUJ is completely mobile behind the crossing vessel **(Fig. 6.4)**.
4. *The transabdominal hitch stitch:* The challenges in laparoscopic pyeloplasty include the need to avoid as many ports as possible. The more the number of ports and instruments inside the abdomen, the more will be the challenges involved. A transabdominal hitch stitch helps in offsetting this problem. This stitch should be taken on the anterior abdominal wall

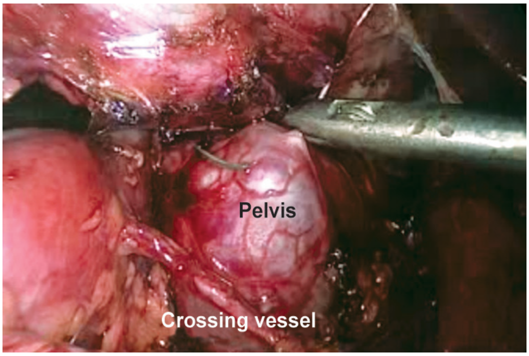


Fig. 6.4: Dissection of crossing vessel

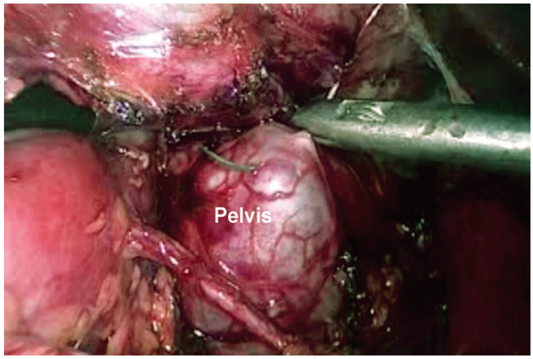


Fig. 6.5: Hitch stitch

opposite the pelviureteric junction. The stitch is taken with a straight needle either a silk or polypropylene. Thereafter, the stitch is passed through the anterior wall of the pelvis **(Fig. 6.5)**. The advantage of passing such a stitch is that the ureteropelvic junction is well aligned. In addition, during the critical step of spatulation the hitched up pelvis helps in aligning the dependent pelvis with the spatulated ureter. The position of the transabdominal stitch is important as the aim of this stitch is to lift the pelvis in the right direction. In addition, the advantage of a transabdominal hitch stitch is that it helps in identifying the most dependent part of the pyelotomy.

5. *Pyelotomy:* We prefer to perform the pyelotomy by starting the incision near the hitch stitch. Typically from an ergonomic perspective it is easier to perform the pyelotomy using the left hand for a left-sided procedure and using the right hand for a right-sided procedure. The caveat for this step is that the incision should not extend to the lower pole calyx. This, if done, runs the risk of developing a lower pole infundibular stenosis. The incision on the pelvis should be done till the dependent part of the incision is reached **(Fig. 6.6)**.
6. *Spatulation:* Optimal spatulation of the ureter is the key to success. The different surrogate markers to define appropriate spatulation are evidence of opening up of the strictured segment. Adequate spatulation is evident if longitudinal ureteral folds are seen. It is easier to spatulate the right ureter with the right hand of the surgeon while the left ureter is preferentially spatulated with the left hand **(Fig. 6.7)**.
7. *Suturing:* The important points to be considered are the length of the suture, the type of suture material and the needle used.

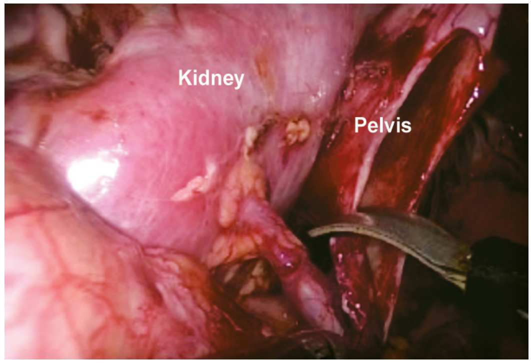


Fig. 6.6: Pyelotomy

Length of suture material: The ideal length of suture would be between 10 and 14 cm. The length of the suture is decided on the length of the pyelotomy incision and the suture line. Too long a suture would make the suturing difficult.

Type of Suture Material

Vicryl: The suture material has a good memory. It has a good knot tying ability.

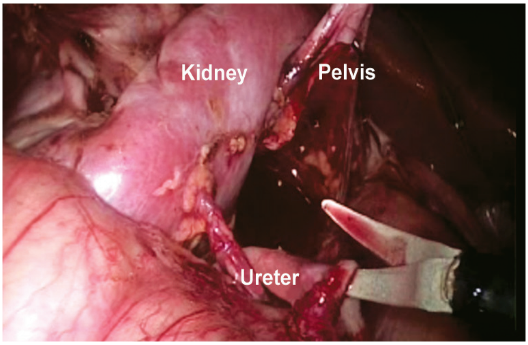


Fig. 6.7: Spatulation

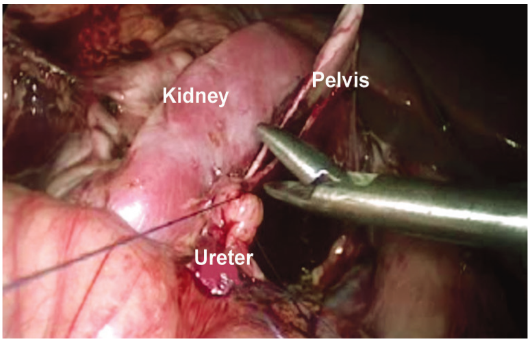


Fig. 6.8: Corner stitch

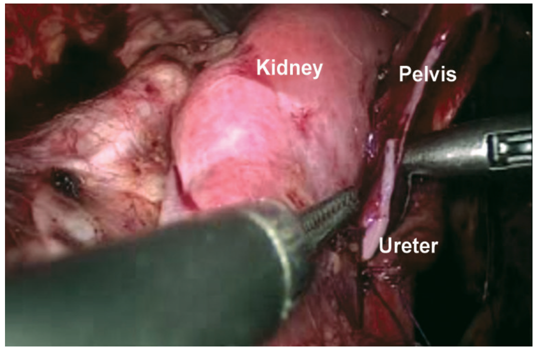


Fig. 6.9: Posterior wall closure

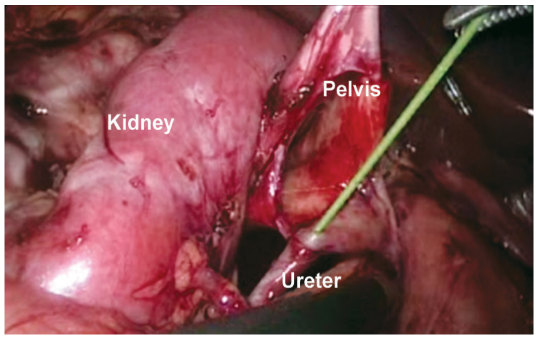


Fig. 6.10: Anterior wall closure with DJ stenting

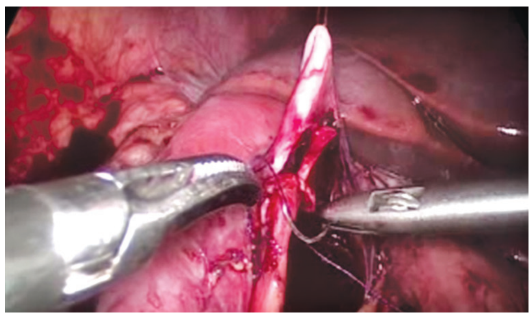


Fig. 6.11: Pyelotomy closure

Monocryl: It has good tissue holding property. However, this suture material does not have memory and hence the knot tends to loosen.

Bidirectional sutures: Typically used if the surgeon is not careful about as in robotic prostatectomy.

The angle stitch is critical and this should pass exactly through the "V" of the spatulation. The redundant pelvis should not be excised **(Fig. 6.8)** till the end as this acts as a handle for manipulating and adhering to the principles of no touch technique in pyeloplasty. Once the spatulated ureter is sutured to the dependent pelvis, the needle is brought below the neo UPJO so that the medial/posterior wall is sutured **(Fig. 6.9)**, and following this the anterior/lateral wall is sutured **(Fig. 6.10)**. A stent when deemed necessary can be passed through a miniport after the completion of the medial/posterior wall. On the contrary, the pigtail/ureteric catheter placed at the beginning can be changed to a DJ stent at the completion of the procedure under fluoroscopy. The pyelotomy is closed as a continuation of either the medial or lateral wall suture **(Fig. 6.11)**.

Postoperative drain is indicated if the pelvis friable, sutures are cutting through or if the surgeon that the anastomosis is not secure.

7

Tips and Tricks in Laparoscopic Radical Nephrectomy

Raghunath S Krishnappa, Nagaraja VH, Srivatsa N, KR Seetharam Bhat, Tejus C, Abhishek Singh, Arvind P Ganpule

There are currently five laparoscopic approaches to renal surgery: Transperitoneal, retroperitoneal, hand assisted, robotic, and laparoendoscopic single-site surgery (LESS) and natural orifice transluminal endoscopic surgery (NOTES). This chapter would focus on the transperitoneal and retroperitoneal approaches.

The choice of surgical technique should be based on patient-specific considerations (e.g. tumor location and size) and the technical expertise available. In most institutions, laparoscopic radical nephrectomy (LRN) has replaced open radical nephrectomy (ORN) in many patients, especially if the tumour size is less than 10 cm. Numerous studies have established the oncologic outcomes of LRN to be equivalent to that of ORN.

TRANSPERITONEAL APPROACH

Preparation, Positioning and Port Insertion

As described in the section of port positioning for renal surgery **(Fig. 7.1)**.

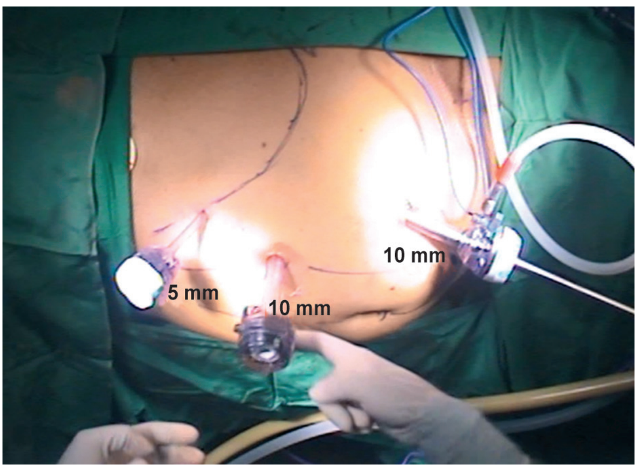


Fig. 7.1: Port placement for laparoscopic radical nephrectomy

Operative Technique

- Reflection of colon and dissection of upper pole of kidney **(Fig. 7.2)**
  Left: The white line of Toldt is incised from the level of iliac vessels inferiorly, through the splenophrenic attachments. Splenocolic ligament should be incised to allow the spleen, colon and tail of pancreas to fall medially. The thin colorenal attachments are incised and the plane between the mesentery of the ascending/ descending colon and anterior surface of Gerota's fascia is identified. Mesenteric fat has a brighter hue of yellow compared with the retroperitoneal or Gerota's fat, which allows for identification of the correct plane of dissection. Identifying these natural tissue planes are easier with proper traction-countertraction maneuvers. The main distinguishing feature between simple and radical nephrectomy is that the Gerota's fascia and fat are removed with the kidney in LRN as against the simple nephrectomy.

  Right: Incise the white line of Toldt from base of cecum, extending cephalad and then through the triangular ligament of the liver. The 5 mm port in the epigastrium is used to pass a self-retaining forceps, which is passed beneath the liver edge and affixed to the upper edge of the incision in the line of Toldt. Medial traction on the colon reveals colorenal attachments that should be divided to complete the colon reflection. Avoid thermal injury to gallbladder and duodenum. A Kocher maneuver may be required to fully expose the medial portion of the kidney and the connective tissue overlying the renal hilum and inferior vena cava.
- Dissection of the lower pole of kidney and ureter **(Fig. 7.3)**
  Left: At the lower pole of the kidney, the ureter and gonadal vein are identified. In the upper 1/3 of its course, the gonadal vein is medial to the ureter. A plane is created medial to the gonadal vein and ureter, and continued until the psoas muscle is encountered. Transection of the gonadal vein in male may result in transient testicular pain in the post-operative period. Left renal vein receives gonadal vein, adrenal vein and lumbar vein. Knowing where to look for the veins is vital for preventing vascular injury and minimizing blood loss. The most insidious of the three tributaries into the left renal vein is the lumbar vein which is posterior to the renal vein and can result in significant bleeding if injured. Ureter is

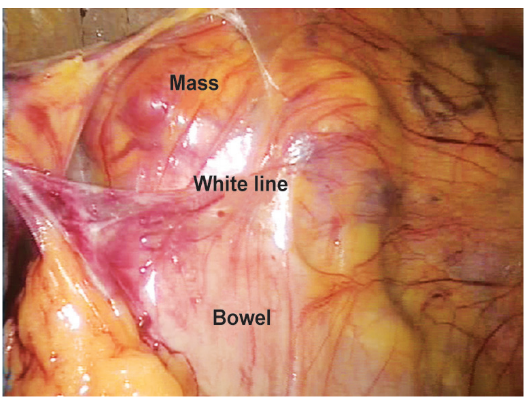


Fig. 7.2: Bowel reflection

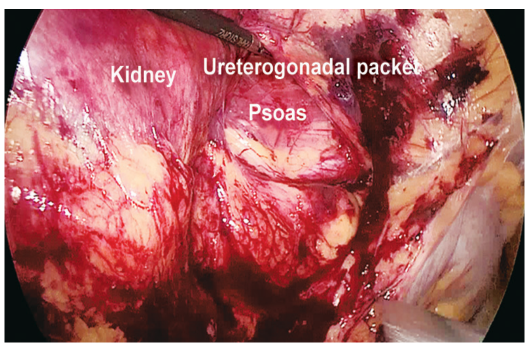


Fig. 7.3: Dissection of lower pole with lifting of ureterogonadal packet

identified just deep to the gonadal vessels ("water under the bridge"). The ureter is not divided at this time, because it can be used to help elevate the kidney. Care should be taken to stay above the psoas fascia to minimize postoperative thigh numbness.
Right: The gonadal vein enters the IVC near the lower pole of the kidney so it is usually preserved.

- *Renal hilar dissection:* There are generally three ways to address the renal hilum: Anterior (most commonly done), posterior, and inferior approach with a "renal lift" maneuver. The renal vein is usually clearly seen and is readily exposed by blunt dissection, but the renal artery is surrounded by a thick layer of lymphatic tissue that requires sharp dissection before it is clearly exposed. Safe dissection of the hilum requires medial retraction of the colon and bowel, and anterolateral retraction of the kidney **(Fig. 7.4)**.

For an anterior approach, on the right side, the vena cava is dissected to expose the origin of the renal vein. The renal artery is usually located directly posterior or slightly inferior to the right renal vein.

On the left side, the renal vein is found by following the left gonadal vein superiorly, to its insertion into the renal vein.

The posterior approach requires the release of the lateral attachments of the kidney for complete medial rotation of the kidney. The renal artery pulsations will be first encountered. One must be aware that the artery crosses posterior to IVC on the right side **(Fig. 7.5)**.

- Ligation of renal blood vessels
Three options: Endovascular gastrointestinal (GI) stapler, Weck Hem-o-lok clips and titanium clips **(Figs 7.6 and 7.7)**.

First the artery is divided and then the vein. In 2006 and 2011, the manufacturer of Weck Hem-o-lok ligating clips (Teleflex Medical) and the Food and Drug Administration respectively issued alerts stating that Weck Hem-o-lok ligating clips are contraindicated for the ligation of the renal artery during laparoscopic donor nephrectomy owing to a few donor deaths

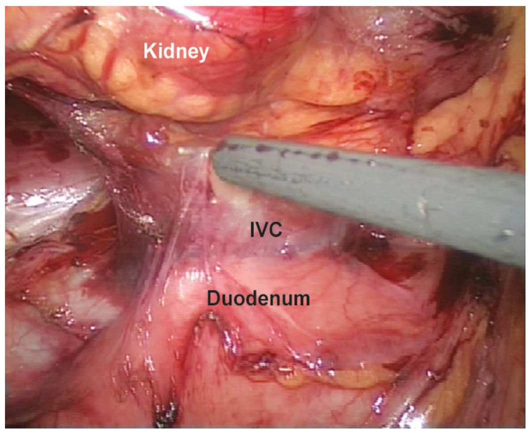


Fig. 7.5: Kocherization on right side

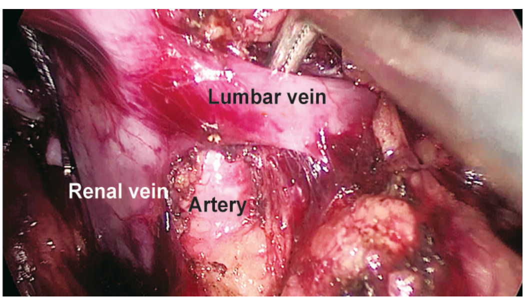


Fig. 7.4: Hilar dissection

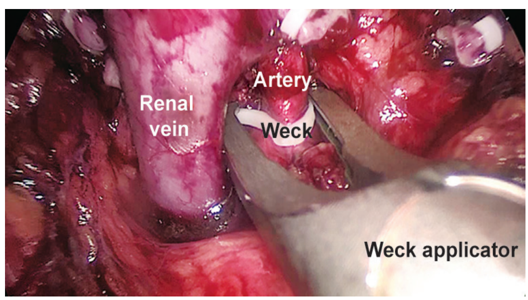


Fig. 7.6: Renal artery clipping

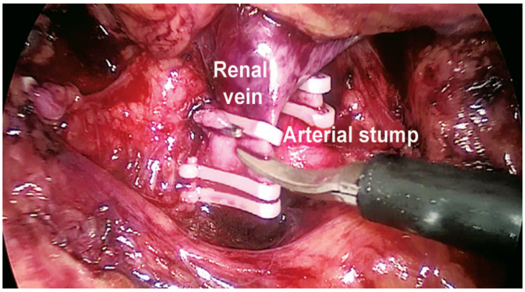


Fig. 7.7: Renal vein clipping

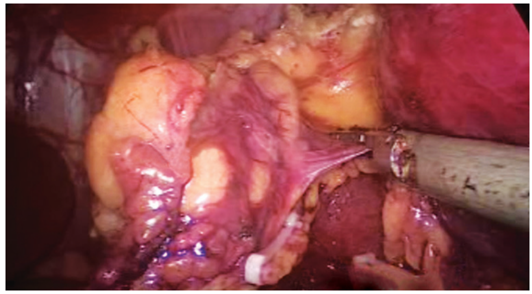


Fig. 7.8: Isolation of upper pole and adrenal gland

linked to failure of the clips in ligating the vessel. But Hem-o-lok clips are still being used safely in majority of the LRN cases in India.

- *Isolation of upper pole and adrenal gland:* The adrenal may be removed en bloc with the kidney when indicated **(Fig. 7.8)**. In adrenal sparing surgery, the Gerota's fascia is opened over the upper medial aspect of the kidney. The perinephric fat is then gently peeled off circumferentially above the upper pole of the kidney. It may be necessary to clip and transect the ureter at this point, to reflect kidney anteriorly for easy upper pole dissection.
- *Regional lymphadenectomy:* Suspected lymph nodes may be removed, and a full hilar or retroperitoneal dissection can be carried out if necessary based on preoperative factors.

For left-sided renal masses, the lymphatic tissue on the anteromedial surface of the aorta from the level of the superior mesenteric artery cranially to the bifurcation of the aorta caudally is removed.

For right-sided renal masses, when lymphadenectomy is considered, the paracaval, precaval, retrocaval, and inter-aortocaval nodes from the right crus of the diaphragm to the bifurcation of the IVC are sampled.

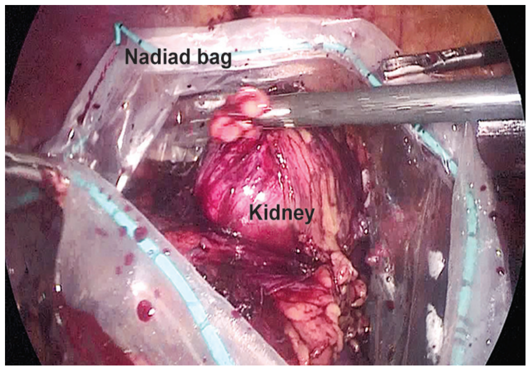


Fig. 7.9: Bagging of specimen

- *Organ retrieval:* The kidney can be removed intact through a separate incision or by morcellation in a sac **(Fig. 7.9)**. Histopathology report may be compromised if morcellated.
- *Port site closure:* As a rule, all midline ports greater than or equal to 10 mm, and all non-midline ports greater than 12 mm are closed. In more obese patients, Carter-Thomason device is used to approximate fascia under direct vision.

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Laparoscopic Radical Nephrectomy

RETROPERITONEAL APPROACH

The patient is placed in the lateral flank position with a kidney bridge or flexing the table. The primary port is placed using a 1.5 cm incision below the 12th rib at mid-axillary line, deepened down to the thoracolumbar fascia. A retroperitoneal space is created using Gaur balloon (tying the finger of a glove over a K-90 catheter) and inflating it with saline up to 500–700 ml. Two secondary ports are inserted under laparoscopic vision. Second port (10 mm) at renal angle, at least 3 finger breadths distant from first port and third port (5 mm), 3 finger breadths anterior to first port, forming a straight line with the other ports.

After port insertion, standard surgical steps in sequence are followed: Ureter identification → hilar vessel dissection and division → kidney mobilization.

Transperitoneal Versus Retroperitoneal Laparoscopic Radical Nephrectomy (LRN)

Several retrospective and a few prospective studies have been performed comparing the transperitoneal and retroperitoneal approaches for LRN. The retroperitoneal approach seems to have the disadvantage of a limited working space and difficulty in orientation due to the absence of clear landmarks. However, it can provide a rapid and direct access to the renal hilum.

The transperitoneal approach, in contrast, has a large working space with easier orientation, but the access to the renal hilum requires mobilization and retraction on the bowel. Despite these technical differences, there appear to be no differences in terms of complications between these two approaches.

In practice, the choice of approach is influenced by tumor location, patient's body habitus, previous intra-abdominal surgery, and surgeon factors such as personal preference, technical skills and learning curve.

Important Surgical Caveats (Bail me out)

- If you are struggling, do not hesitate to place a 5 mm port to provide a better working angle.
- When dissecting the midportion of the kidney medially on right side, the first structure encountered will always be the duodenum, not the IVC. Temporarily lowering the pneumoperitoneum to 5 mm Hg will help it to fill out.
- The hook can be used to dissect on the anterior wall of IVC. When approaching the lower pole, beware of the insertion of the gonadal vein on the anterolateral surface of the IVC.
- *Bowel injuries:* Minimize use of monopolar energy. Use cold scissors/bipolar/ultrasonic energy instead.
- *Splenic injuries:* Minimize traction.
- *Diaphragmatic injuries:* Minimize use of cautery at the upper pole of the kidney.
- *Renal hilum injuries:* Avoid metallic clips. When stapler is used, pay attention not to include metallic clips in the staple line. Always inspect the cartridge of the stapler before use. When Hem-o-lok clips are used, follow the above instructions.
- *Local and port-site metastases:* Use endobag and avoid morcellation.
- *Chylous ascites and lymphoceles:* Clip large lymphatics that crossover the left renal vein.

8

Tips and Tricks in Laparoscopic Ureteric Reimplantation

Rohan Batra, Arvind P Ganpule

INTRODUCTION

Laparoscopic ureteric reimplantation is the procedure used to correct lower ureteric strictures or reflux. The most common causes of lower ureteric pathologies in adults are iatrogenic (endourological procedure or other pelvic surgeries), primary obstructive megaureter, reflux (VUR), inflammatory or malignancy. The treatment of lower ureteric pathology depends on the etiology of the disease. Cases which are not amenable to endoscopic treatment require a ureteric reimplant. Certain cases may require adjunct procedures like a psoas hitch or a boari flap. The laparoscopic technique offers numerous advantages over traditional open surgery, including reduced postoperative pain, shorter hospital stays, faster recovery, and improved outcomes. Here, we will explore the step-by-step approach to performing laparoscopic ureteric reimplantation, highlighting key considerations, potential challenges, and the benefits associated with this technique.

Evaluation and Patient Selection

Before undertaking laparoscopic ureteric reimplantation, a comprehensive preoperative evaluation is crucial. This evaluation includes a thorough medical history review, physical examination, laboratory tests, imaging studies (such as ultrasound, CT scan, DTPA scan) to assess renal function and identify any associated abnormalities. Patient selection is vital, and factors such as anatomical variations, body habitus, previous surgeries, and comorbidities must be considered.

Patient Preparation and Anaesthesia

This involves ensuring the patient is adequately informed about the surgery, risks, benefits, and expected outcomes. Bowel preparation is not necessary before this procedure. General anesthesia is required with a lithotomy position with Trendelenburg position.

A cystoscopy should be done before the procedure to see the ureteric orifice. We prefer to place a 5 Fr ureteric catheter before embarking upon the laparoscopy part of the procedure. After placing the ureteric catheter, a Foley's catheter is placed.

In some cases, the DJ stent is already placed in the ureter. In that case, the DJ stent can be replaced with a 5 Fr ureteric catheter. In case the ureteric catheter does not pass through the stricture part, the guidewire can be passed through while the ureteric catheter is kept up to the lower part of the stricture.

Trocar Placement and Instrumentation

The pneumoperitoneum is established through an umbilical incision. A 10 mm

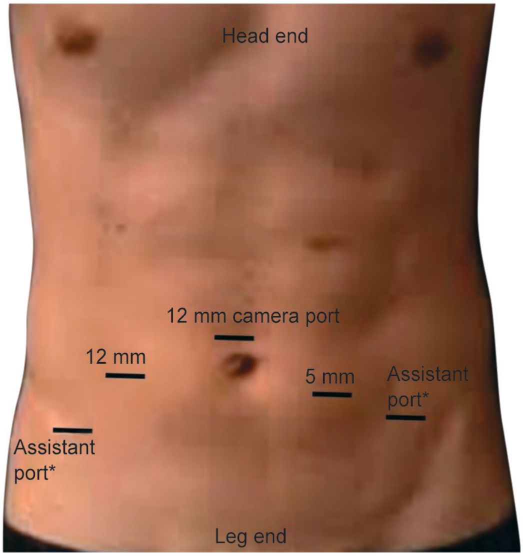

Fig. 8.1: Port position for the surgery

umbilical port is used for the laparoscope. After visualising the peritoneum for any adhesions and ruling out any injury, the patient is placed in a Trendelenburg position. This helps in visualization and bowel displacement. Additional 10 mm and 5-mm ports are placed 7–8 cm away from the midline. It is important to ensure proper trocar placement to optimize exposure and minimal instrument movement **(Fig. 8.1)**.

Exposure and Dissection

Once the trocars are in place, adequate exposure of the surgical field is important. This involves mobilizing and dissecting the lower ureters to the level of the ureterovesical junction. The ureter is identified beneath a layer of peritoneum just at the bifurcation of iliac vessels. Gentle tissue handling and meticulous dissection are crucial to avoid inadvertent injury to adjacent structures and preserve blood supply of the ureters. Careful attention should be made to the vascular supply, particularly in cases where previous surgeries or inflammatory processes may have caused anatomical distortions. Ureterolysis is carried out in caudally to preserve the blood supply of the ureter. Gentle handling of the bladder helps in reducing postoperative bladder spasms.

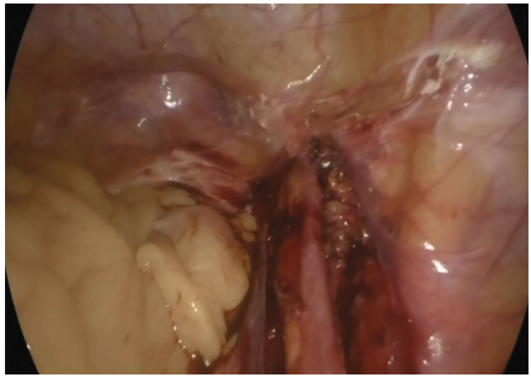

Fig. 8.2: Laparoscopic view of ureter and bladder after ureteric dissection

Ureteral Mobilization and Reimplantation

After adequate exposure is achieved, the next step is ureteral mobilization and reimplantation **(Fig. 8.2)**. The ureter is carefully dissected from the surrounding tissues, maintaining its blood supply. This is followed by transection of the ureter at an appropriate distance from the bladder, creating a healthy segment for reimplantation. The position of the neo-hiatus should be such that it should correspond well with the anatomical course of the ureter. The distal ureter is then spatulated medially to create a wider opening for anastomosis, while ensuring that the ureteral blood supply is preserved. The rugosities of the ureteric mucosa will indicate that the spatulation has been adequate and ureter at spatulation area is healthy **(Fig. 8.3)**.

Then the bladder is filled and the bladder is dissected from the anterior abdominal wall between the obliterated umbilical ligament and umbilicus. The space of Retzius is entered and a proper place is decided for neocystotomy **(Fig. 8.4)**. At this juncture, the bladder is filled with around 150–200 ml

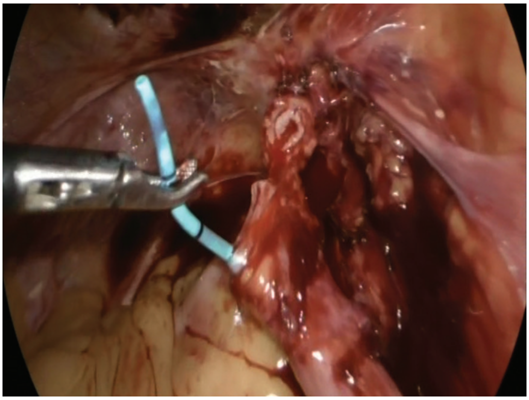

Fig. 8.3: Dissection of ureter, ureteric catheter is seen

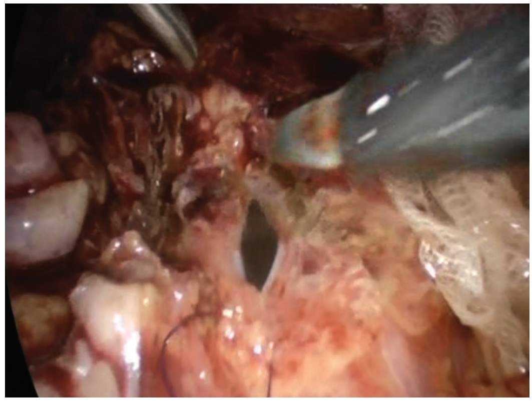

Fig. 8.5: Cystotomy incision

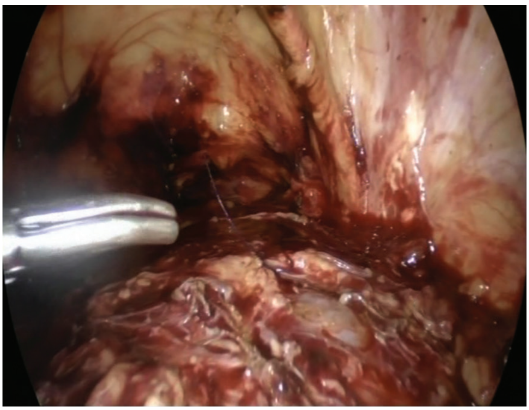

Fig. 8.4: Dissection of urinary bladder and marking of cystotomy site

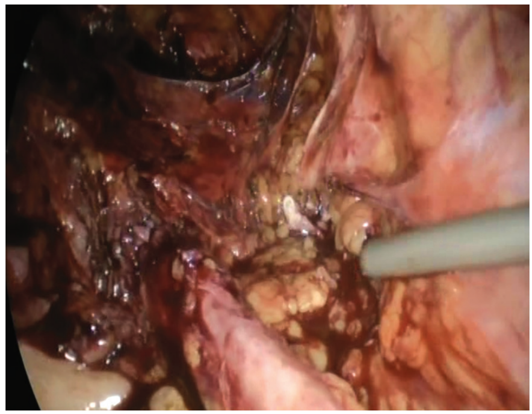

Fig. 8.6: Ureteric reimplant completed

saline. The bladder serosa and muscle fibers are divided with the help of hook cautery and blunt dissection until the bladder mucosa is visualized. If there is a megaureter, then tailoring of the excess ureter can be made and excess ureter can be cut **(Fig. 8.5)**. The corner stitch is taken with the help of 3–0 polyglactin sutures (vicryl or monocryl) with mucosa of bladder and whole thickness of ureter. After that, one wall of the anastomosis is closed with the help of continuous sutures. After that, DJ stent over guidewire is placed with the help of a miniport inserted infraumbilically in midline. After proper placement of the DJ stent, other wall of anastomosis is done in the same manner **(Fig. 8.6)**. The detrusor fibers can be closed with interrupted sutures. In some cases, if the anastomosis is in tension, then psoas hitch is done. The DJ stent is kept for 4–6 weeks and removed thereafter. If the lower end of the ureter does not reach the dome of the bladder, then Boari flap is made of approximately 5 cm base. The principle is that the anastomosis should be tension free. If any suspicion of impaired blood supply is there, the anastomosis site can be covered with an omental wrap.

The integrity of the anastomosis is tested by either performing a cystoscopy, filling of bladder with saline or injecting methylene blue dye into the bladder and assessing for leakage. However, it is not done routinely. An intraperitoneal drain can be kept for 2–3 days. The trocars are then removed, and the incisions are closed.

Postoperatively, patients are closely monitored for any signs of complications such as infection, bleeding, or urinary leakage. Pain management, early ambulation, and appropriate antibiotic prophylaxis are essential. Patients are typically discharged within 2–3 days. The catheter can be removed between 5 and 10 days and a 1-month follow-up appointment is scheduled to assess their progress and remove DJ stent.

CONCLUSION

Laparoscopic ureteric reimplantation is an effective and minimally invasive surgical technique for treating ureteral defects or reflux. With careful patient selection, meticulous surgical technique, and appropriate postoperative care, it offers several advantages over open surgery, including reduced pain, shorter hospital stays, faster recovery, and improved cosmetic outcomes.

9

Tips and Tricks in Laparoscopic Orchiopexy

Rohan Batra, Arvind P Ganpule

INTRODUCTION

Undescended testes, also known as cryptorchidism, is a common congenital condition characterized by the absence of one or both testes in the scrotal sac. If left untreated, it can lead to long-term complications such as infertility and an increased risk of testicular cancer. Laparoscopic orchiopexy is a minimally invasive surgical technique through which we can bring the intra-abdominal testis to the scrotum. Here, we will explore the step-by-step approach to perform laparoscopic orchiopexy, highlighting its benefits, potential challenges, and outcomes associated with this surgical technique.

Preoperative Evaluation and Patient Selection

A comprehensive preoperative evaluation is crucial before undertaking laparoscopic orchiopexy. This includes a detailed medical history review, physical examination, and imaging studies such as ultrasound. In many cases, USG cannot determine the position of testis, so magnetic resonance imaging (MRI) can be done to identify the position and location of the undescended testis. However, a diagnostic laparoscopy has to be explained to the patient and parents. Patient selection is essential, as factors such as age, testicular position, and associated anomalies can influence the surgical approach and success rate. Also, any syndromic associations, endocrine disorders have to be determined before any surgical procedure. The ideal definitive management of an undescended testis should take place between 6 and 12 months of age. However, many a times, patients present very late in their teens. At that point, a detailed discussion should be done regarding the success of procedure with respect to fertility issues.

Patient Preparation and Anaesthesia

The patient and their parents or guardians should be well-informed about the procedure, its risks, benefits, and expected outcomes. Bowel preparation is not required. Patient requires a general anaesthesia with either a modified lithotomy position or a frog-leg position.

Always do a proper examination under anaesthesia again. 18% of the non-palpable testis become palpable under general anaesthesia.

Trocar Placement and Instrumentation

Once the patient is properly anesthetized and positioned, trocars are inserted for laparoscopic access. The pneumo-peritoneum is usually created using an open access in small

Fig. 9.1: Port placement for left laparoscopic orchiopexy

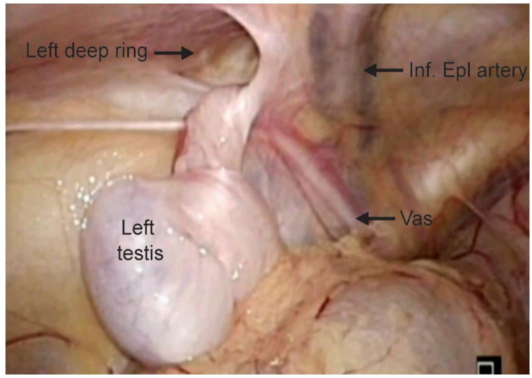

Fig. 9.2: Laparoscopic view of left UDT with deep ring, vas and inferior epigastric artery

children at the umbilicus. A 5-mm umbilical port is usually used for the laparoscope. Additional 5-mm ports are placed strategically for instrumentation considering the rules of triangulation. The working trocars are placed 6–8 cm away from the camera port with triangulation done towards the ipsilateral deep inguinal ring. Proper trocar placement is crucial for optimal visualization and instrument maneuverability **(Fig. 9.1)**.

Exploration and Identification of the Undescended Testis

The laparoscope is introduced, and the abdomen is insufflated to create a pneumoperitoneum. Then, the undescended testis is located and relations with iliac vessels is determined. This can be done by systematically examining the inguinal region, the inguinal canal, iliac vessels and vas. Careful identification of the testicular blood vessels and the vas deferens is necessary to ensure their preservation during the procedure. The anatomy of an undescended testis is of utmost importance. Care should be taken to identify if there is a long looping vas, as it is the most important structure that should not be damaged.

The variations that can be encountered during the laparoscopy are patent processes vaginalis, peeping testis (with external pressure on the inguinal canal, the peeping testicle can be visualized) and vanishing testis (blind ending vessels) **(Fig. 9.2)**.

Mobilization of Testis and Examining Vessel Length

Once the undescended testis is identified, it is mobilized. This is achieved by gently dissecting the testis from its surrounding lateral attachments first while preserving its blood supply. Sometimes, the lateral dissection has to be proceeded higher up. After dissecting the lateral attachments, median attachments up to the medial umbilical ligaments are released. After dissecting lateral and medial attachments, the gubernaculum is dissected. The gubernaculum can be clipped or taken down with advanced energy. It helps in holding the testis. To assess the adequate length of the testis, it should reach up to the opposite deep inguinal ring. If it reaches the opposite deep inguinal ring, then it is ready to be taken down into the scrotum. The testis is then brought into the inguinal canal or scrotum **(Fig. 9.3)**.

There are various ways in which the testis can be brought down through a scrotal incision.

- Open incision and dilatation through an artery forceps

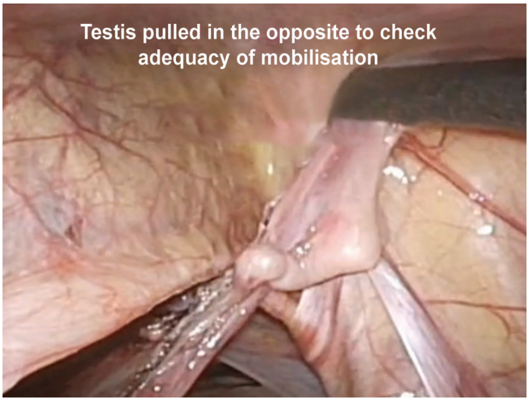

Fig. 9.3: Traction on testis to check the adequacy of mobilisation of testis

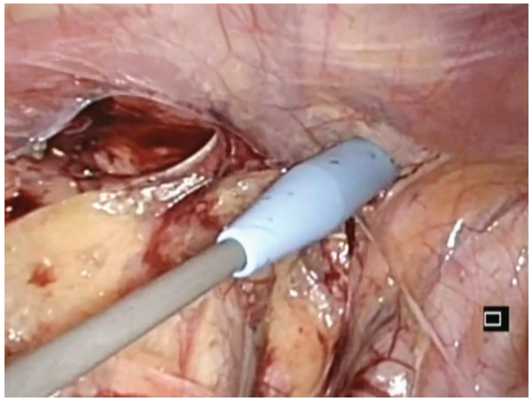

Fig. 9.4: Dilatation of tract with amplatz

- Using a laparoscopic port
- Using Amplatz sheath and dilators **(Fig. 9.4)**

One potential disadvantage of using an open incision and dilatation through an artery forceps is that there is sudden loss of pneumoperitoneum and can lead to difficult manoeuvre during bringing down of testis. A 10 mm laparoscopic port helps in circumventing that disadvantage. Alternatively, we use serial dilatation and Amplatz dilators to create a tunnel. This helps in serial dilatation of tissues which is atraumatic. Also, we can know the exact position of the dilators over guidewire which has to be lateral to the median umbilical ligament. After dilating up to 30 Fr Amplatz, the testis is easily delivered down up to the scrotum.

Closure and Postoperative Care

After successful mobilization, fixation of the testis is done in the subdartos pouch. Care must be taken whether there is any torsion or twist to the cord or not. After placing the testis in the scrotum, a check laparoscopy should also be done to check any tension on the cord, and to ensure full haemostasis. Meticulous closure of the port sites and wound is performed through subcuticular absorbable sutures. Postoperative care includes pain management, observation for any signs of complications, and proper wound care. The patient is usually discharged within two days and scheduled for a monthly follow-up visit to monitor healing and testicular position.

VIDEO

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Laparoscopic Orchiopexy