Diagnostic Laparoscopy

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INTRODUCTION

Diagnostic laparoscopy is a minimally invasive surgical procedure that allows the visual examination of intra-abdominal organs in order to detect any pathology. This procedure allows the direct visual examination of intra-abdominal organs including large surface areas of the liver, gallbladder, spleen, peritoneum, pelvic organs, and retroperitoneum. Biopsies, aspiration, and cultures can be obtained, and laparoscopic ultrasound (US) may be used.

Diagnostic laparoscopy is safe and well tolerated and can be performed in an outpatient or inpatient setting under general anesthesia **(Fig. 1A)**. There may also be unique circumstances where office based diagnostic laparoscopy may be considered under local anesthesia. These circumstances should include only procedures where complications and the need for therapeutic procedures through the same access are extremely unlikely. Manipulation and biopsy of the viscera is possible through additional ports. Diagnostic laparoscopy is the most commonly performed gynecological procedure today. Its greatest advantage is that it has replaced exploratory laparotomy.

Diagnostic laparoscopy was first introduced in 1901, when Kelling, performed a peritoneoscopy in a dog and was called "celioscopy". A Swedish internist named Jacobaeus is credited with performing the first diagnostic laparoscopy on human in 1910. He described its application in patients with ascites and for the early diagnosis of malignant lesions.

In last 10 years, laparoscopy has made a great difference to the diagnosis of abdominal acute and chronic pain. It has evolved as an informative and important method of diagnosing a wide spectrum of both benign and malignant diseases. Exploratory laparoscopy also allows tissue biopsy, culture acquisition, and a variety of therapeutic interventions. Elective diagnostic laparoscopy refers to the use of the procedure in chronic intra-abdominal disorders. Emergency diagnostic laparoscopy is performed in patients presenting with acute abdomen.

INDICATIONS

The indications for diagnostic laparoscopy can be divided into two main groups.

Nontraumatic and Nongynecological Acute Abdomen Like

- Appendicitis
- Diverticulitis
- Duodenal perforation
- Mesenteric adenitis
- Intestinal adhesion
- Omental necrosis
- Intestinal infarction
- Complicated Meckel's diverticulum
- Bedside laparoscopy in the intensive care unit (ICU)
- Torsion of intra-abdominal testis

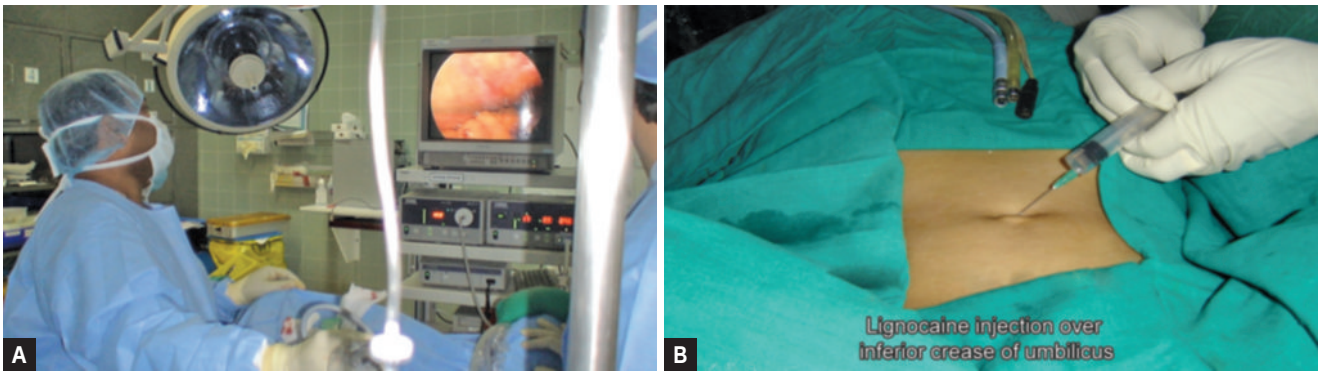
Gynecological Abdominal Emergencies Like

- Ovarian cysts
- Pelvic inflammatory diseases
- Acute salpingitis
- Ectopic pregnancy
- Endometriosis
- Perforated uterus due to criminal abortion
- Salpingitis

One of the important uses for diagnostic laparoscopy is the investigation of female infertility. Tubal causes of infertility are found in almost 15% of couples. In these patients, laparoscopy not only allows tubal patency to be assessed but also enables other features in the pelvis to be examined. Most important findings related to infertility are kinking of the tube, fimbrial damage or ovarian adhesions. The presence of corpus luteum is considered as good evidence of current ovulation.

If tubal recanalization surgery is planned, it is a good idea to perform a preliminary laparoscopy to assess the prospect of successful anastomosis. If the length of remaining tube is less than 2 cm, the recanalization surgery should not be attempted and in vitro fertilization (IVF) should be recommended.

Ovarian biopsy can also be taken at the time of diagnostic laparoscopy to diagnose the cause of amenorrhea and infertility. Although the functional test of ovarian stimulation by gonadotropin-releasing hormone is more in use, but it can be still of help if the presence of primordial follicles is in doubt in primary amenorrhea or premature ovarian failure.



Figs. 1A and B: (A) Diagnostic laparoscopy; (B) Local anesthesia can be used for diagnostic laparoscopy.

RELATIVE CONTRAINDICATIONS

Contraindications may include:

- Hemodynamic instability
- Mechanical or paralytic ileus
- Uncorrected coagulopathy
- Generalized peritonitis
- Severe cardiopulmonary disease
- Abdominal wall infection
- Multiple previous abdominal procedures
- Late pregnancy

However, the final decision is determined not only by the clinical condition of patients, but also by the surgeon's judgment.

Choice of Anesthesia

Diagnostic laparoscopy can be performed under local anesthesia. Sedation with diazepam and pethidine can be used to make patient unaware of procedure because unpleasant sensation of stretching of peritoneum due to pneumoperitoneum cannot be abolished by local anesthesia.

Local anesthetic 4% Xylocaine can be injected subcutaneously over inferior crease of umbilicus **(Fig. 1B)**.

Epidural anesthesia is not preferred by many anesthetists because to anesthetize the entire peritoneum, a high block is necessary which would interfere with intercostal nerves and respiration will be affected. General anesthesia with good muscle relaxation is ideal in laparoscopic surgery.

LAPAROSCOPIC ANATOMY

Diagnostic laparoscopy may be helpful for many undiagnosed surgical problems and therefore knowledge of laparoscopic anatomy of the whole abdomen is necessary. However, most common indications of diagnostic laparoscopy are gynecological and especially related to infertility.

From anterior to posterior, following important tubular structures are found crossing the brim of true pelvis: The round ligament of the uterus, the infundibulopelvic ligament, which contains the gonadal vessels, and the ureter. The ovaries and fallopian tube are found between the round ligament and the infundibulopelvic ligament **(Figs. 2A and B)**.

The fallopian tubes arise from the superior portion of the uterus just above the attachment points of the round ligament. Laparoscopically, the round ligaments overhang the fallopian tube because of uterine manipulation and can be easily mistaken for them. The fallopian tubes towards their lateral end encircle the ovaries partially with their fimbriated ends.

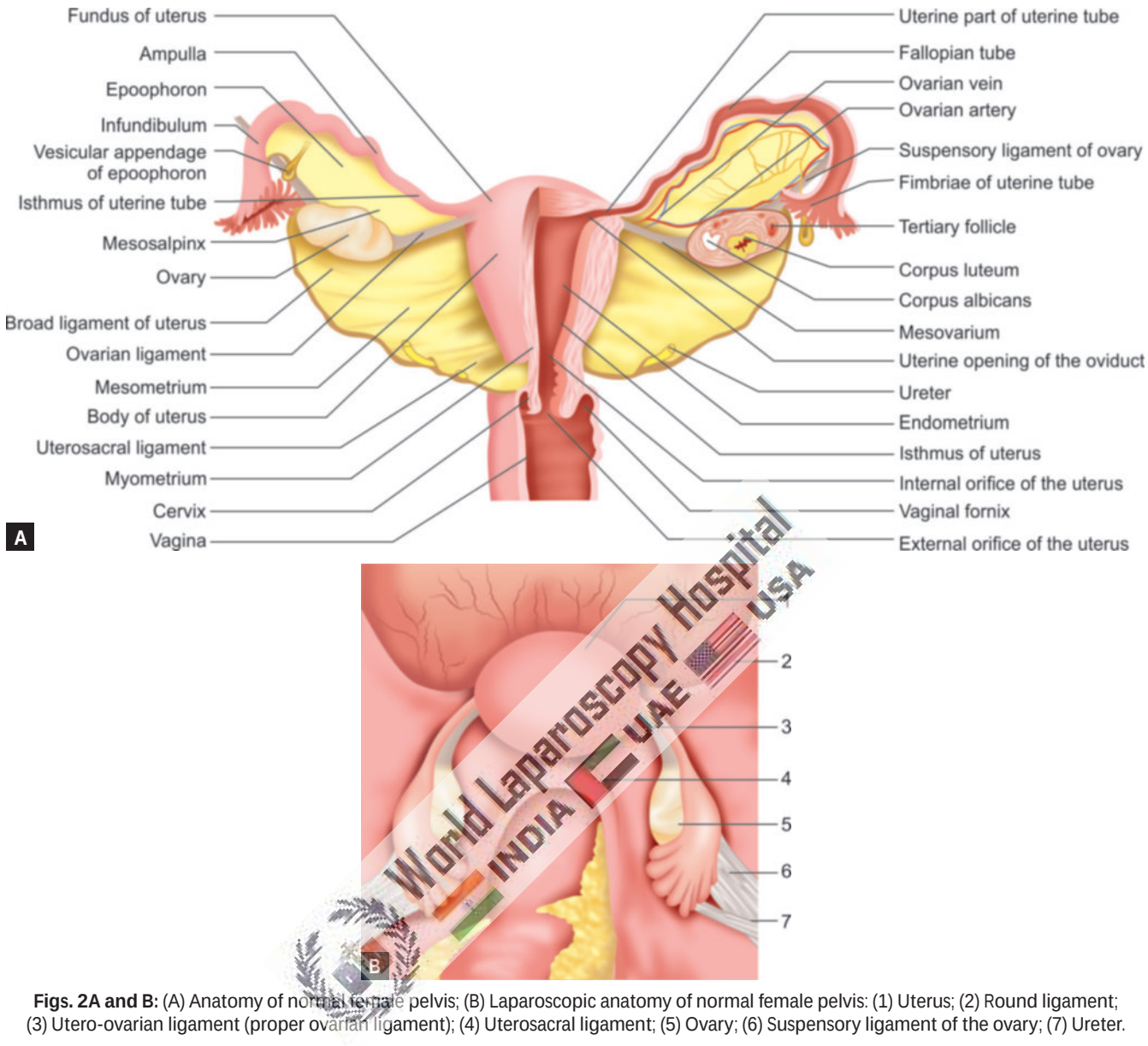
If the uterus is deviated to the contralateral side with the help of uterine manipulator infundibulopelvic ligament is spread out and a pelvic side wall triangle is created. The base of this triangle is the round ligament, the medial side is the infundibulopelvic ligament, and the lateral side is the external iliac artery. The apex of this triangle is the point at which the infundibulopelvic ligament crosses the external iliac artery **(Fig. 3A)**.

Patient Position

The anesthetized patient is placed on the operating table with the legs straight or lithotomy position if patient is female. The lithotomy position will allow the gynecologists and assistant to work simultaneously and uterine manipulation is simultaneously possible. The thighs must not be flexed onto the abdominal wall and should be as they generally are in the full lithotomy position used for other open surgical gynecological procedures. The operating table is tilted head-up or head-down by approximately 15° depending on the main area of examination. Compression bandage may be used on leg during the operation to prevent thromboembolism, especially if patient is in lithotomy position.

Position of the Surgical Team

Before starting diagnostic laparoscopy a best guess is made about the quadrant in which pathology is likely to be found. The surgeon should stand opposite to this quadrant to allow direct view into this quadrant. If the pathology is more likely in pelvic cavity the surgeon stands on left side of the patient **(Fig. 3B)**. The first assistant, whose main task is to position the video camera, is also on the patient's left side.



Figs. 2A and B: (A) Anatomy of normal female pelvis; (B) Laparoscopic anatomy of normal female pelvis: (1) Uterus; (2) Round ligament; (3) Utero-ovarian ligament (proper ovarian ligament); (4) Uterosacral ligament; (5) Ovary; (6) Suspensory ligament of the ovary; (7) Ureter.

The instrument trolley is placed on the patient's left, allowing the scrub nurse to assist with placing the appropriate instruments in the operating ports. Television monitors are positioned on either side of the top end of the operating table at a suitable height for surgeon, anesthetists, as well as assistant to see the procedure.

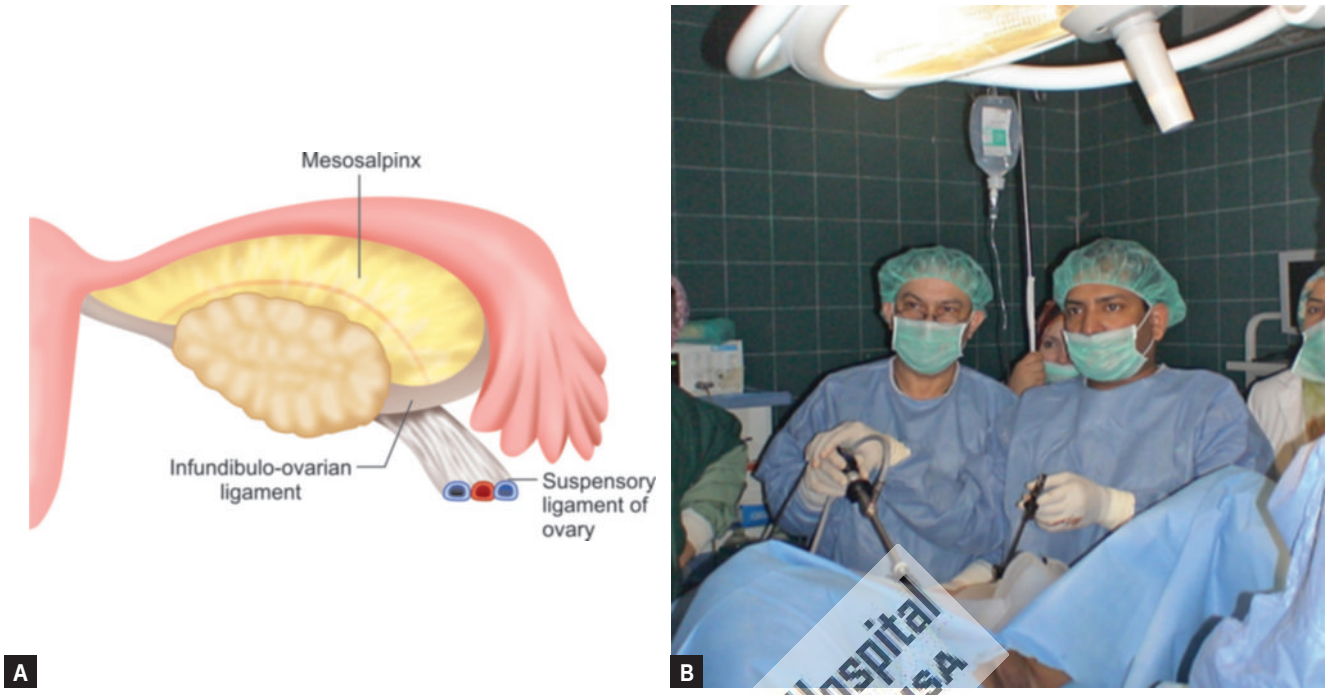
Port Position

Generally one optical port in umbilicus and one 5 mm port in left iliac fossa are required **(Fig. 4A)**. Some gynecologists prefer to put their second port in suprapubic region in midline **(Fig. 4B)**. In our opinion, left iliac fossa port is better because it gives elevation angle of 30° and manipulation angle of 60°, which is ergonomically better. With suprapubic port elevation angle of instrument and tubal structure is 90° and hence lifting up of ovary and tube may be difficult without grasping it.

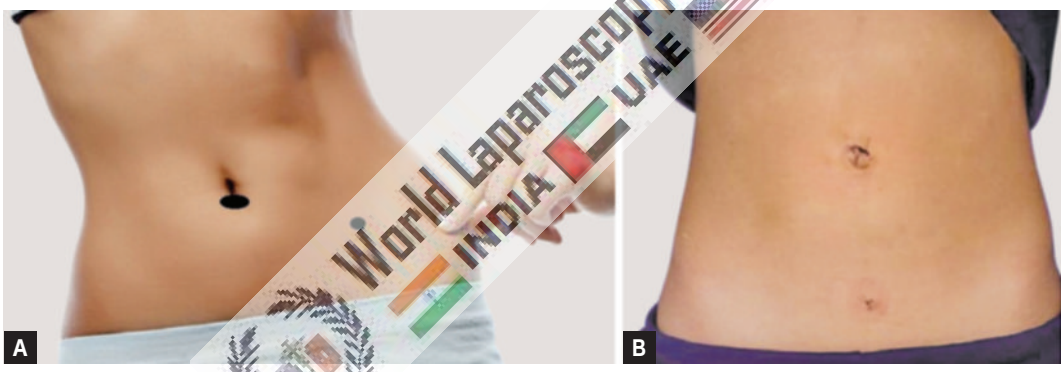
During diagnostic laparoscopy it is advisable that both telescope and probing instrument is held by surgeon himself as he knows better what he wants to see and where he wants to concentrate more and also which structure he wants to see in magnified close-up view. At the time of diagnostic laparoscopy surgeon should try to be very gentle with the tubal structures and bowel so that adhesions will not form and stricture of tube shall not occur.

Viewing of lateral pelvic organs is helped by the manipulation of mobile structure with a second port introduced through the left iliac fossa port. Many gynecologists introduce the second port in suprapubic region but the elevation angle of the instrument is 90° and the mobilization of organs is difficult.

A three-port approach should be used if there is any difficulty in manipulation with two ports, especially in case of extensive adhesions.



Figs. 3A and B: (A) Anatomy of adnexa; (B) Position of surgical team for diagnostic laparoscopy in female.



Figs. 4A and B: Port position for diagnostic laparoscopy.

- 10 mm umbilical (optical)
- 5 mm suprapubic
- 5 mm right hypochondrium

A 30° telescope is employed in most instances, as this facilitates easier inspection of the deeper peritoneal cavity and abdominal organs. The secondary ports are inserted under laparoscopic vision. The selected site on the abdominal wall is identified by finger indentation of the parietal peritoneum.

The optimum incision for optical port is in the subumbilical region. The open technique for trocar insertion is recommended if patient presents with severe abdominal distension. Nitrous oxide is preferably used if diagnostic laparoscopy is performed in local anesthesia because nitrous oxide has its own analgesic effect. Carbon dioxide (CO_2) is the preferred gas if diagnostic laparoscopy is performed under general anesthesia. Insufflation should be very slow and with care taken not to exceed 12.0 mm Hg.

Operative Procedure

The first step in diagnostic laparoscopy is thorough exploration, just as during exploratory laparotomy. A systematic approach to exploration is essential to ensure that nothing is missed.

Systemic Plan of Inspection in Mid Abdomen

Positioning is the primary means of displacing the bowel and exposing peritoneal surfaces. In women with a deep pelvis, the bowel should be displaced gently into the upper abdomen, using a blunt probe or closed blunt grasping instrument to avoid laceration of the bowel or mesentery. An additional port with a blunt tipped instrument may be used, if required. Occasionally, fan retractor can be used to retract full sigmoid colon. This instrument can be inserted through a 5 mm trocar cannula and fanned out in the abdomen to retract the bowel. Some common findings are shown in **Figures 5 to 11**.

Inspection of Pelvis

Patient should be again positioned in steep Trendelenburg's position.

After assessing the genital organs, the gynecologist may wish to view areas outside the pelvis. This should be done by tilting the table head up or laterally to examine the paracolic or subdiaphragmatic spaces. Systematic plan of inspection of pelvis is shown in **(Figs. 9A to C)**.

ROLE OF LAPAROSCOPY IN ASCITES

Although the determination of the etiology of ascites is usually straight forward by history, physical examination, and analysis of ascitic fluid, the diagnosis of tuberculous or carcinomatous ascites may be elusive. In such cases, laparoscopy with biopsy is highly accurate. Peritoneal mesothelioma is frequently missed on ascitic fluid by cytology and by blind biopsy. This entity is readily diagnosed by laparoscopy with peritoneal biopsy. Laparoscopy may be useful in the evaluation of hepatic malignancy (both primary or metastatic). About 80–90% of these lesions are present on the hepatic surface and up to two-thirds of the liver surface may be inspected by laparoscopy. When surgical resection is a therapeutic option, laparoscopy may reveal small (1 cm or less) metastatic lesions, peritoneal metastases, or cirrhosis, which represent contraindications to this plan of resection and are frequently missed on computed tomography (CT), magnetic resonance (MRI), and US. The use of laparoscopic US allows detection of deeper lesions and vascular infiltration.

In a study on the role of laparoscopy in the diagnosis and differential diagnosis of ascites, it was found that out of 2,500 patients who underwent laparoscopy, 30.89% had ascites; of which, liver cirrhosis underlays it in 57.78%, peritoneal carcinosis in 26.29%, primary and metastatic carcinoma in 12.95%, and tuberculous peritonitis in 1.42%, more rarely other diseases. Liver cirrhosis, malignant tumors, and the other hepatic affections with concomitant ascites in their course can certainly be diagnosed laparoscopically. Laparoscopy with oriented biopsy of peritoneum and liver is of decisive importance in differentiating peritoneal carcinosis from tuberculosis. In peritoneal carcinosis the diagnosis (as based in clinical and laboratory findings) coincided perfectly with the laparoscopic and histologic one in 24.5%, and partially in 45.5%. In 30% there was no congruence at all. Laparoscopy and the test methods associated with it contributed to the accurate diagnosis of peritoneal carcinosis in 75.5% of the patients. Ovarian carcinoma (20.9%) and cancer of the stomach (16.3%) underlay peritoneal carcinosis most frequently, other diseases were by far more seldom.

Diagnostic peritoneoscopies were performed in 226 patients with ascites. Satisfactory examination was possible in 220 patients. Clinical diagnosis was confirmed at peritoneoscopy in 82.7% of patients. Peritoneoscopic examination corrected the clinical diagnosis in 13.7%, was inconclusive in 2.6% and was incorrect in 0.8% of cases.

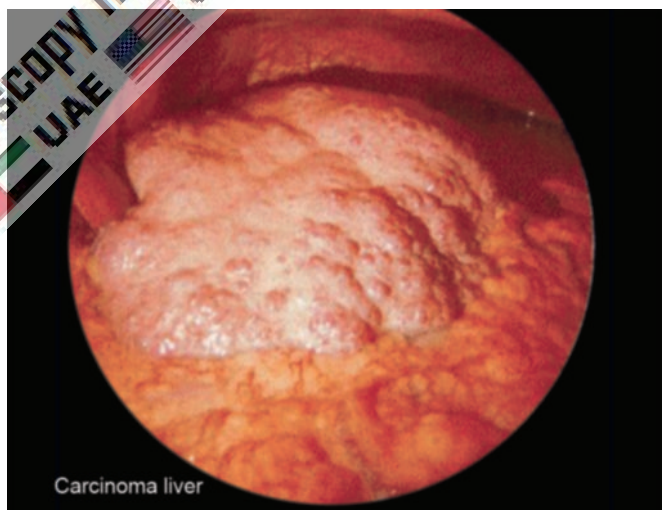
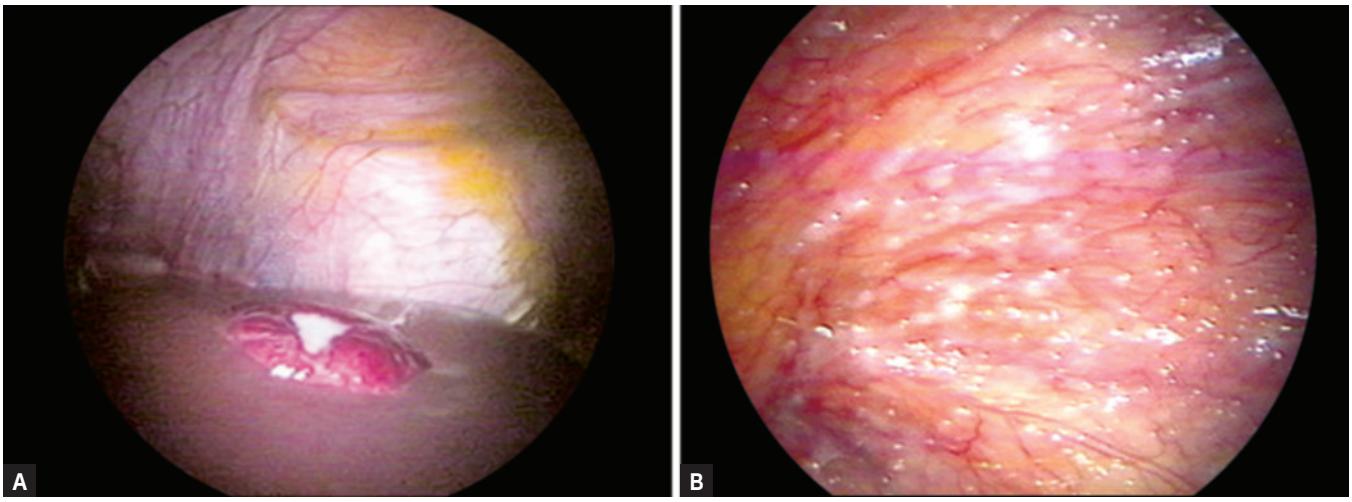
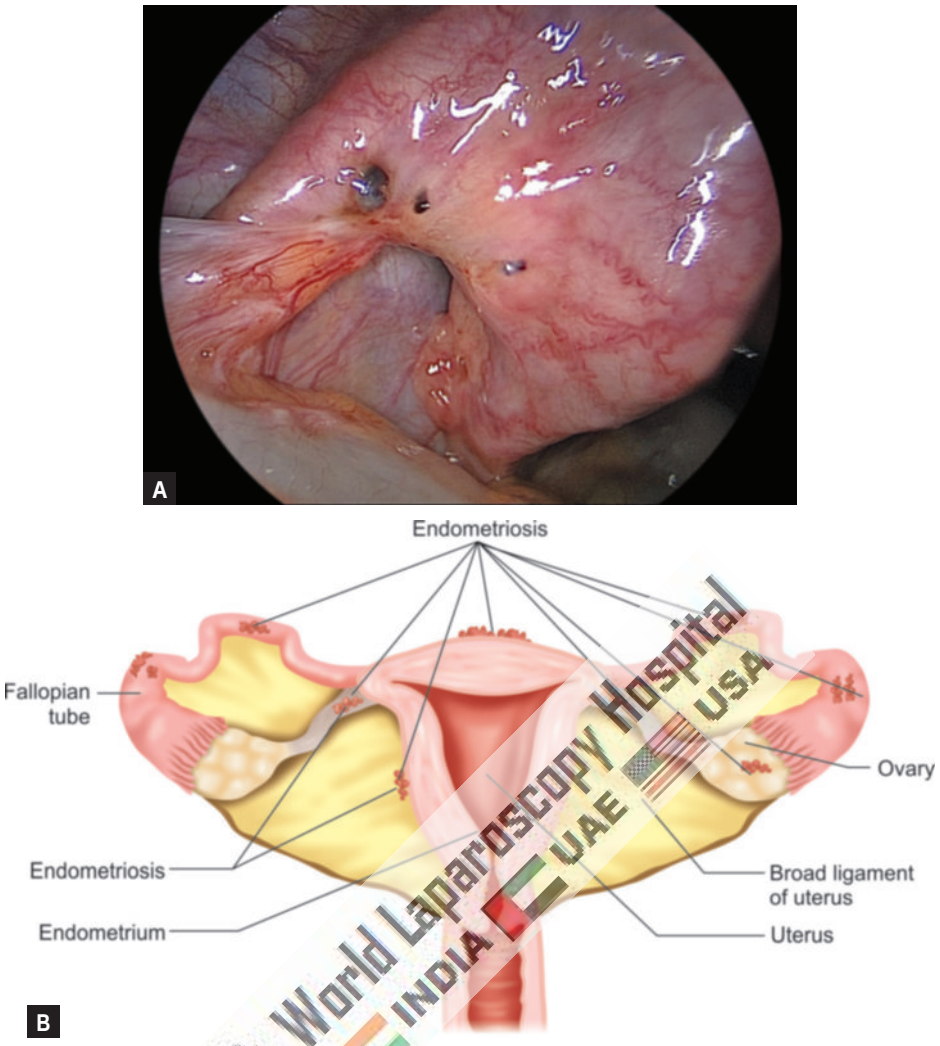


Fig. 5: Hepatic carcinoma.



Figs. 6A and B: (A) Hemangioma; (B) Carcinomatosis.



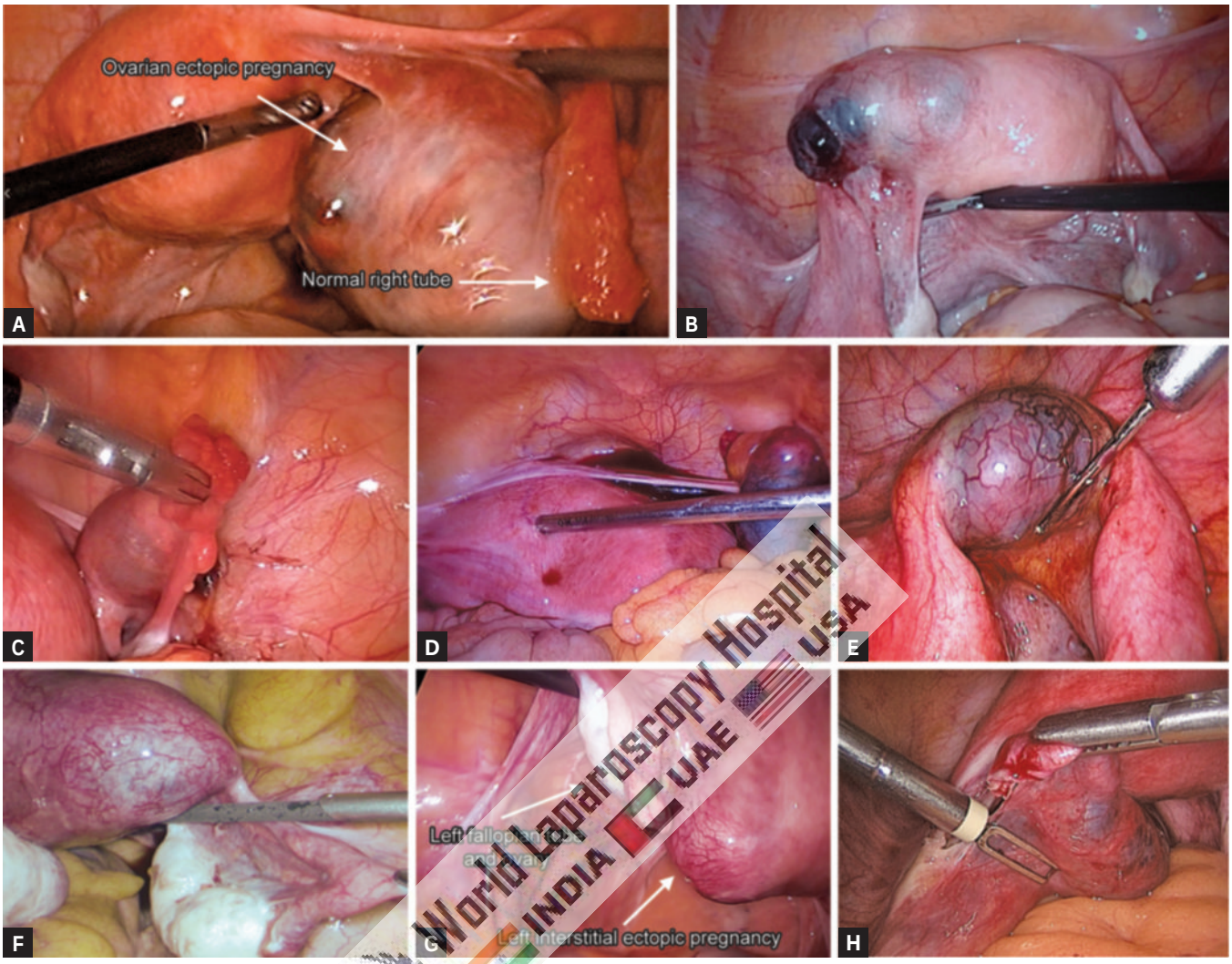
Figs. 7A and B: Endometriosis.

It was 100% diagnostic in malignant peritonitis and 89.5% in patients with tuberculous peritonitis. Pseudomyxoma peritonei and mesothelioma were suspected in one patient each at peritoneoscopy and was confirmed histologically. The utility of routine ascitic fluid examination was reviewed in all patients. The ascitic fluid was transudative in 81.9%, exudative in 8.6% and indeterminate in 9.5% of patients with cirrhosis of liver. Patients with tuberculous peritonitis had exudative, transudative and indeterminate ascites in 71.8%, 3.2%, and 25%, respectively. The ascites in patients with malignant peritonitis was either exudative (80%) or indeterminate (20%). There was considerable overlap in the nature of ascites present in the three groups of patients. We therefore conclude that peritoneoscopy is the most valuable investigation in the diagnosis of ascites, particularly in exudative and indeterminate types.

The Value of Laparoscopic Diagnosis of Tuberculosis

The laparoscopic and pathological diagnosis of 43 patients who underwent abdominal laparoscopy for various indications are presented here. Major indications for the laparoscopy included hepatomegaly in 32 patients, ascites in 28, and pyrexia of unknown origin (PUO) in 18 patients. A combination of two or more of these indications was a more common feature. The most frequently encountered laparoscopic diagnoses were tuberculosis and chronic liver disease (16 patients each), followed by cancer (9 patients). However, on pathological examination of peritoneal or liver biopsy tissue and on follow-up, tuberculosis was confirmed in 12 patients, chronic liver disease in 14 patients, and hepatocellular carcinoma in 11 patients. No complications were encountered during the laparoscopy. Our findings indicate that abdominal laparoscopy is a safe, quick, and inexpensive diagnostic tool, particularly when appropriate and adequate tissue is taken for pathological examination. In such instances, laparoscopy would save an unnecessary laparotomy, especially where tuberculosis and cancer are considered in the differential diagnosis.

Due to its high accuracy, some suggest polymerase chain reaction (PCR) before laparoscopy. In the light of our accumulated experience, we would suggest that PCR of



Figs. 3A to H: Ectopic pregnancy.

ascetic fluid obtained by US-guided fine-needle aspiration is now the investigation of choice for patients with the described clinical and radiological presentations and should at least be attempted before surgical intervention. If the result is negative, diagnostic laparoscopy or, if this is not feasible, laparotomy needs to be performed.

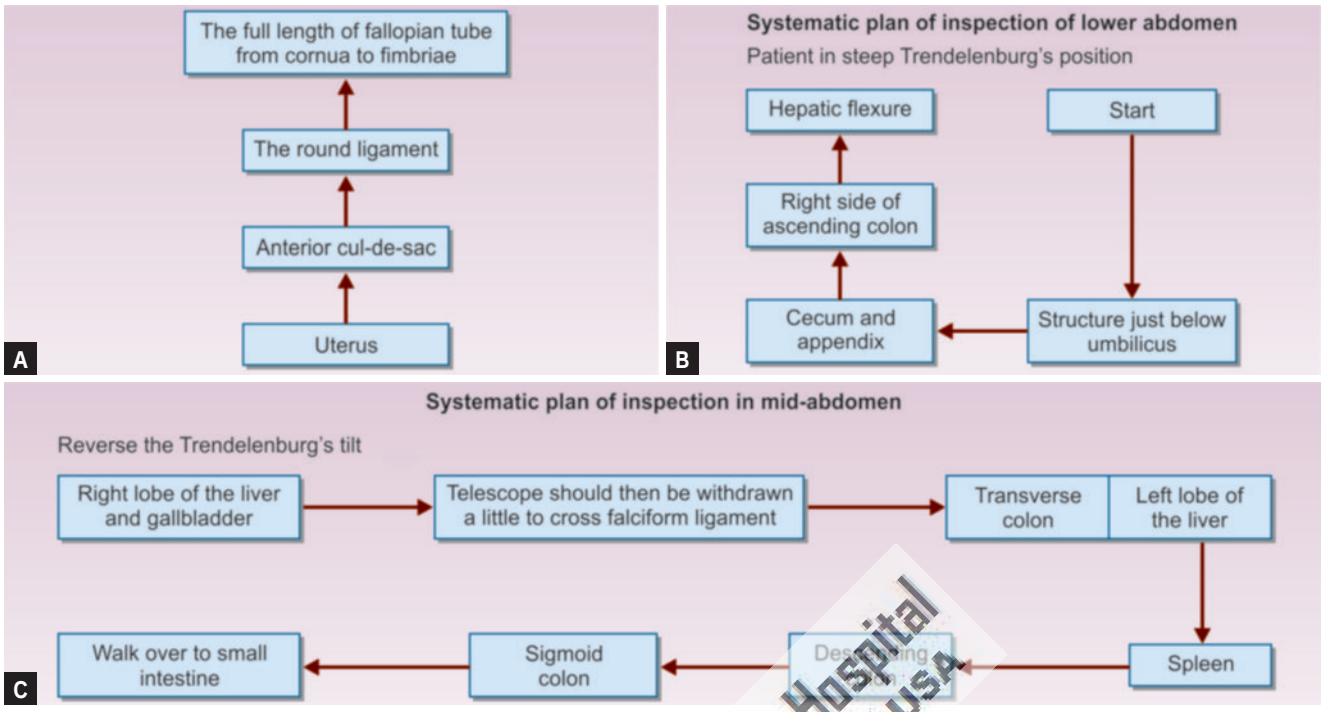
Role of Laparoscopy in Carcinoma Assessment

A pretherapeutic staging system to design operative or neoadjuvant treatments in gastric cancer is needed. Laparoscopy can be done even under local anesthesia as it is a sensitive predictor of peritoneal recurrence.

Staging laparoscopy with peritoneal lavage cytology is a safe, effective tool in patients with locally advanced gastric cancer, especially in patients receiving neoadjuvant chemotherapy. The ability of minimally invasive surgeons and endoscopists to diagnose and palliate unresectable pancreatic cancer is likely to continue to improve and these techniques will play an increasingly important role in the care of patients with pancreatic cancer. Likewise, the accuracy of radiological imaging techniques to detect unresectable disease will also continue to advance and further decrease the incidence of nontherapeutic laparotomies. It is valuable and has many therapeutic uses as in staging of tumor, catheter placement in nephrogenic ascites.

Dialysis Catheter and Laparoscopy

Regarding complications of dialysis catheter insertion, Tiong reported many surgical, early and late complications of dialysis catheter of open Tenckhoff catheter insertion under local anesthesia in a single institution. A review was carried out on 164 insertions in 139 patients over a 3-year period. Tenckhoff catheter insertion for continuous ambulatory peritoneal dialysis (CAPD) is a procedure associated with significant surgical morbidity. Patients with diabetes mellitus, glomerulonephritis, and ongoing sepsis are at greater risk of early complications, and hence, must have their conditions stabilized or treated before surgery. In addition, prolonged surgical time and patients with previous abdominal surgery are at increased risk. The rate of complications may be improved by early consideration of patients with poor tolerance of local anesthetic for surgery or



Figs. 9A to C: Systematic plan of inspection of pelvis.

Fig. 10: Bicornuate uterus.

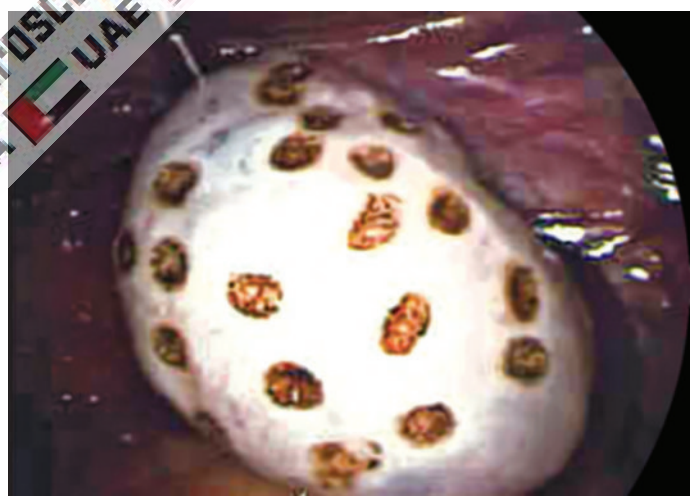


Fig. 11: Polycystic ovary.

with previous abdominal surgery for laparoscopic insertion under general anesthesia. To prevent late complications dominated by CAPD peritonitis, patient's nutritional status and care of the catheter should both be optimized.

Open insertion of peritoneal dialysis (PD) catheters is the standard surgical technique, but it is associated with a relatively high incidence of catheter outflow obstruction and dialysis leak. Omental wrapping is the most common cause of mechanical problem; laparoscopic omental fixation technique is of higher value, in addition laparoscopic surgery also enabled diagnosis of intra-abdominal pathologies and treatment of the accompanying surgical problems during the same operation.

Port-site Metastasis

The risk of port-site metastases in those undergoing laparoscopy for gynecologic malignancy was highest in those with ascites in a study of 82 patients. The study participants underwent 87 procedures that involved 330 trocar sites. The overall risk of port-site metastases per procedure was 2.3%, and per port site was 2.4%, Dr Nimesh Nagarsheth, at an international congress sponsored by the Society of Laparoendoscopic Surgeons reported 39 patients with endometrial cancer, 29 with ovarian cancer, and 14 with cervical cancer. About 20 of those were treated for recurrent cancer, and 10 of them had ascites. They were followed for an average of 361 days. Port-site metastases occurred in two

patients. The first developed metastases at five sites, and was diagnosed 13 days after second-look laparoscopy for stage IIIB ovarian cancer. The second had metastases at three sites, and was diagnosed 46 days after second-look laparoscopy for stage IIIC primary peritoneal cancer. Both patients had ascites.

Laparoscopy and Ascites

Laparoscopy in ascites is a safe and cost-effective diagnostic modality and its rules extended the diagnostic procedure often providing definitive diagnosis in unexplained cause of ascites.

In such instances, laparoscopy would save an unnecessary laparotomy; especially where tuberculosis and cancer are considered in the differential diagnosis.

DISCUSSION

The usual site of insertion of the trocar/cannula for diagnostic laparoscopy is below or to the side of the umbilicus. This position may require to be altered in the presence of abdominal scars. The use of a 30° forward oblique telescope is preferable for viewing the surface architecture of organs. By rotation of the telescope, different angles of inspection can be achieved.

The first important step after access to the abdomen has been gained, is to check for damage caused by trocar insertion. A second 5 mm port is then inserted under vision in an appropriate quadrant to take in a palpating rod.

A systematic examination of the abdomen must be performed just as in laparotomy. We begin at the left lobe of the liver but any scheme can be used as long as it is consistent. Next, check around the falciform ligament to the right lobe of liver, gallbladder, and hiatus. After checking the stomach, move onto the cecum and appendix and check the terminal ileum. Follow the colon round to the sigmoid colon, and then check the pelvis. Surgeon should be conversant with sampling and biopsy techniques, and the use of position and manipulation to aid vision.

At the time of diagnostic laparoscopy all the abdominal organs are inspected for any gross anatomical abnormalities. Abdominal cavity is inspected for excess of fluids. Samples are taken if free fluid is present for laboratory tests (chemistry, cytology or bacteriology). Peritoneal lavage and adhesiolysis may need to be performed to improve visualization of organs. At the time of peritoneal lavage, when fluid is sucked from the cul-de-sac, it is important to keep all the holes of the suction-irrigator beneath the level of the fluid to avoid removing pneumoperitoneum. If the suction-irrigator is positioned improperly, the CO_2 gas will be removed undesirably. However, with high-flow insufflators, pneumoperitoneum is rarely lost and quickly restored.

When performing a diagnostic laparoscopy to confirm appendicitis, a-5 mm port is placed in the left iliac fossa to facilitate manipulation. The patient is placed head down and rotated to the left to displace the small bowel from the pelvis and allow the uterus and ovaries to be checked. This, however, should be limited to avoid contamination of subphrenic spaces, if this is not already present.

Ending of the Operation

During diagnostic laparoscopy, surgeon can perform therapeutic laparoscopy if indicated when having a prior consent or can be obtained from patient's relative.

At the end of surgery, abdomen should be re-examined for any possible bowel injury or hemorrhage. The entire accessory instrument and then port is removed. The telescope should be removed leaving gas valve of umbilical port open to let out all the gas. Once the complete gas is out, for removing primary cannula, telescope or any blunt instrument should be introduced again and cannula should be pulled over that instrument to prevent pulling of omentum or bowel. Wound should be closed with suture. Vicryl should be used for rectus and unabsorbable intradermal or stapler for skin. Only 10 mm port wound is necessary to repair. Adhesive sterile dressing over the wound should be applied. Patient may be discharged on the same day after operation if everything goes well. The patient may have slight pain initially but usually resolves. Diagnostic laparoscopy is a useful method for reducing hospital stay, complications, and return to normal activity if carried on in proper manner.

Laparoscopy for Abdominal Trauma

Trauma is the leading cause of death between 1 and 44 years. In all age groups, it is surpassed only by cancer and atherosclerosis in mortality. The evaluation and treatment of abdominal injuries are critical components in the management of severely injured trauma patients. Because missed intra-abdominal injuries are a frequent cause of preventable trauma deaths, a high index of suspicion is warranted. Multiple factors, including the mechanism of injury, the body region injured, the patient's hemodynamic and neurological status, associated injuries, and institutional resources influence the diagnostic approach and the outcome of abdominal injuries.

Laparoscopy was first used for a trauma patient in 1956 by Lamy, who observed two cases of splenic injury. Since then, Gazzaniga noted that laparoscopy is useful for determining the need for laparotomy. In 1991, Berci reported that he had reduced the number of nontherapeutic laparotomies performed for hemoperitoneum by 25% through the use of laparoscopy in 150 patients with blunt abdominal trauma.

Data show that laparoscopy is a useful modality for evaluating and managing hemodynamically stable trauma patients with penetrating injuries. Increased use of laparoscopy in select patients with penetrating abdominal trauma will decrease the rate of negative and nontherapeutic

laparotomies, thus lowering morbidity, decreasing length of hospitalization, and provide for more efficient utilization of available resources. As technology and expertise among surgeons continues to improve, more standard therapeutic interventions may be done laparoscopically in the future. Mandatory surgical exploration for gunshot wounds to the abdomen has been a surgical dictum for the greater part of this century. Although nonoperative management of blunt solid organ injuries and low-energy penetrating injuries such as stab wounds is well established, the same is not true for gunshot wounds. The vast majority of patients who sustain a gunshot injury to the abdomen require immediate laparotomy to control bleeding and contain contamination. Nonoperative treatment of patients with a gunshot injury is gaining acceptance in only a highly selected subset of hemodynamically stable adult patients without peritonitis. Although the physical examination remains the cornerstone in the evaluation of patients with gunshot injury, other techniques such as CT, diagnostic peritoneal lavage (DPL), and diagnostic laparoscopy allows accurate diagnosis of an intra-abdominal injury. The ability to exclude internal organ injury nonoperatively avoids the potential complications of unnecessary laparotomy. Clinical data to support selective nonoperative management of certain gunshot injuries to the abdomen are accumulating, but the approach has risks and requires careful collaborative management by emergency physicians and surgeons experienced in the care of penetrating injury. Sosa reported 121 consecutive abdominal gunshot wounds managed with laparoscopy. About 79 (65%) had negative laparoscopy, and these patients were managed without laparotomy. Another 7.2% avoided nontherapeutic laparotomy.

It is very important to determine the presence, location, and severity of intra-abdominal injury to decide the surgical intervention; and to thoroughly evaluate intra-abdominal organs for associated injuries in the trauma patient. For stab wounds, serial physical examination is supplemented by local wound exploration, DPL, abdominal US, abdominal CT, MRI, and in some cases, angiography to maximize the value of surgical intervention and to reduce negative and nontherapeutic laparotomy. Despite having many positive qualities, these diagnostic methods have some drawbacks. DPL is an invasive but sensitive procedure; it may result in nontherapeutic laparotomy with its attendant morbidity. The use of CT is limited to the hemodynamically stable patient. There has been increasing interest in the use of abdominal US because it is portable, noninvasive, rapid, and easily repeatable. However, it is less accurate for diagnosis of diaphragmatic and hollow viscera injury. With experience in laparoscopic cholecystectomy and the advent of improved and readily accessible laparoscopic equipment and devices, laparoscopic surgery became widespread for intra-abdominal operations, setting the stage for renewed interest in its applications for the diagnosis of traumatic abdominal injuries and examination of their therapeutic potential.

In the evaluation and management of the abdominal injury, current diagnostic methods have a defined sensitivity, specificity, and accuracy, but none of these represents a gold standard. Thus, abdominal exploration by laparotomy should not be discarded as a worthy diagnostic and therapeutic procedure for patients with equivocal and unreliable findings. It is associated with complication rates as high as 40% including a 10–40% negative laparotomy rate, a 20% morbidity rate, a 0–5% mortality rate, and a 3% long-term risk of bowel obstruction secondary to adhesions.

Laparoscopy has been reported infrequently as a therapeutic tool in selected trauma patients. Examples of therapeutic laparoscopy include repair of diaphragmatic lacerations with sutures, staples, or prosthetic mesh; suturing of gastrointestinal perforations; hemostasis of low-grade liver and splenic lacerations; resection of small bowel and colon; cholecystectomy; splenectomy; and distal pancreatectomy. Autotransfusion of collected blood from the hemoperitoneum is another potential application. Fabian in a large study of 182 trauma patients reported one suture repair of diaphragmatic injury. Successful laparoscopic repair of small bowel, colon, and rectal injuries, and laparoscopic repair of a small gastric stab wound using hernia stapler have been reported recently. For the repair of solid visceral injuries, there are three methods that merit investigation: (1) The totally laparoscopic procedure, (2) the laparoscopically assisted procedure, and (3) hand-assisted laparoscopic surgery (HALS). The argon beam coagulator, fibrin glue, topical hemostatic agent, and absorbable mesh may be beneficial for hepatic and splenic lacerations. Laparoscopic repair of bowel injuries can be performed using suture or staples. Primary suture repair of a small bowel injury would be amenable by a totally laparoscopic procedure. Using a porcine model, Pietrafitta and Soperet described a technique for an intraperitoneal functional end-to-end anastomosis of the small intestine. Milsom and Bohm modified these techniques and reported that their technique for intracorporeal intestinal anastomosis has been proven safe in dozens of animal and human procedures, but that it had some drawbacks. It requires a long operating time and needs two or three 30 mm endogastrointestinal anastomosis (GIAs) and a skin incision for specimen retrieval. Recently, animal research has assessed the potential for hand-assisted laparoscopic exploration to detect traumatic injuries. Asbun reported that hand-assisted laparoscopic exploration is more accurate than laparoscopic exploration alone in detecting injuries (63% vs. 38%), but that it still resulted in an unacceptable rate of missed injuries.

Hand-assisted laparoscopic surgery allows for the application of minimally invasive surgical techniques to complex intra-abdominal operations, particularly when

specimen removal is required. The rationale for this approach is that the hand offers the surgeon some advantage in terms of tactile feedback, exposure, retraction, and orientation, enabling the surgeon to perform with greater safety and efficiency. Most trauma surgeons consider omental herniation through an anterior abdominal stab wound an indication for laparotomy because frequently there are significant intra-abdominal injuries. As an alternative to laparotomy, the herniated omentum was evaluated and managed, with laparoscopy performed through the abdominal stab wound or using it for accessory trocar. If there are no significant injuries, the wound can be managed without further treatment. Depending on the surgeon's preference, therapeutic laparoscopy can be continued.

The complications of laparoscopy for trauma include not only the usual complications of anesthesia and laparoscopy, but also some that are unique to the trauma patient. Fabian independently reported the development of tension pneumothorax in patients with diaphragmatic injury from positive-pressure pneumoperitoneum. If suspected, induction of pneumoperitoneum is stopped and an immediate needle thoracocentesis is performed, followed by a tube thoracostomy, if needed. However, routine prophylactic tube thoracostomy is not indicated. The risks of gas embolism in patients with intra-abdominal venous injuries, especially liver lacerations, are another problem. Among 133 laparoscopic examinations of trauma, Smith did encounter this complication in two patients with injuries of the inferior vena cava tamponaded by clot.

This potential problem of laparoscopy has stimulated interest in "gasless" laparoscopy based on expansion of the peritoneal cavity by mechanical retractors. In addition to averting the risks of tension pneumothorax and gas embolism, it facilitates the use of conventional instruments such as hemostats, needles, sutures, and electrocautery, resulting in significant cost savings. The major disadvantage of gasless laparoscopy, however, is the excessive cost of the powered mechanical arm and the poor exposure in the lateral gutters. Less expensive apparatus to lift the abdominal wall is expected in times to come. The transperitoneal absorption of CO_2 may cause metabolic and hemodynamic changes such as acidosis, cardiac suppression, atelectasis, subcutaneous emphysema, and increased intracranial pressure, resulting in more profound consequences for the trauma patient. Joseph demonstrated that CO_2 pneumoperitoneum causes significantly increased intracranial pressure in a porcine model of head injury.

The results of this study led them to recommend the avoidance of CO_2 pneumoperitoneum for the evaluation of patients with head injuries. Undoubtedly, gasless laparoscopy could replace CO_2 pneumoperitoneum in these cases. Missed intra-abdominal injuries are among the most frequent causes of potentially preventable trauma deaths. The evaluation and management of abdominal trauma is dependent on multiple factors, including mechanism of injury, location of injury, hemodynamic status of the patient, neurological status of the patient, associated injuries, and institutional resources. Therefore careful selection, high index of suspicion, and a low threshold for laparotomy will provide the patient the benefits of minimal invasive surgery and reducing the rates and morbidity of unnecessary laparotomy.

The diagnostic laparoscopy of various organs is shown in **Figures 12 to 17**.

Complications

Complications may occur during access, trocar insertion, or the diagnostic manipulation of viscera. These complications include, cardiac arrhythmias, hemodynamic instability due to decreased venous return, bleeding, bile leak, perforation of a hollow viscus, laceration of a solid organ, vascular injury, gas embolism, and subcutaneous or extraperitoneal dissection due to the insufflation gas. If proper sterilization

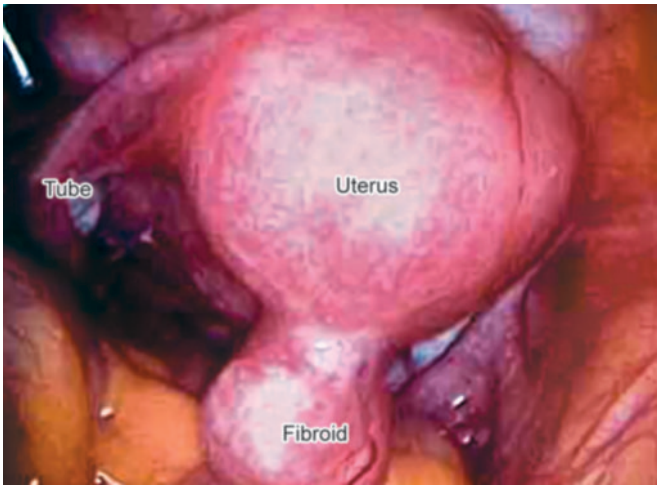


Fig. 12: Fibroid.

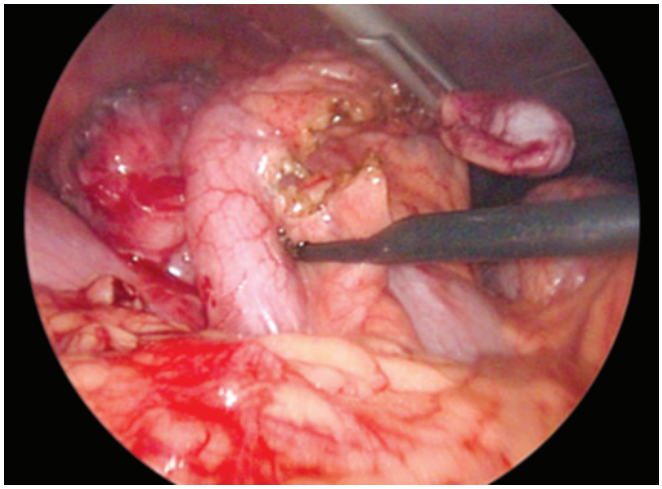


Fig. 13: Adhesion of appendix.

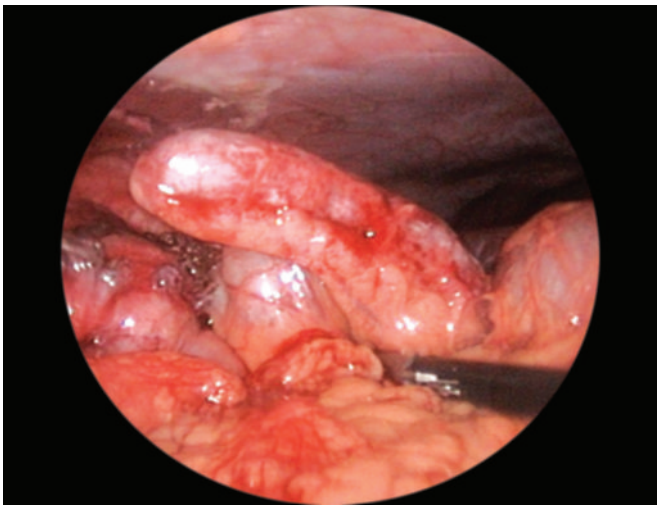


Fig. 14: Acute appendicitis.

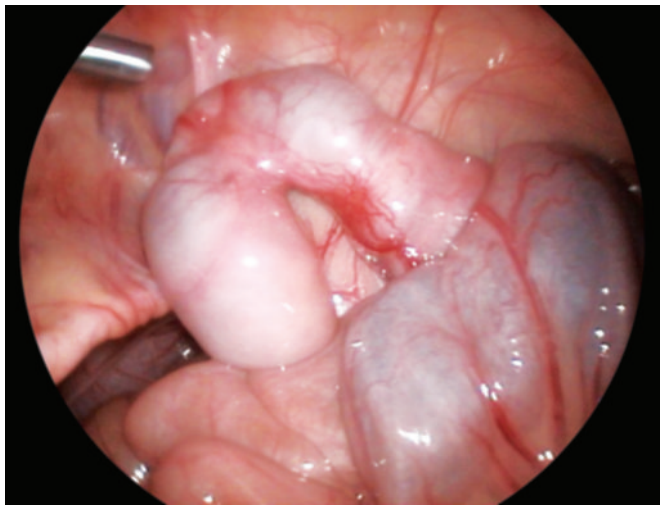


Fig. 15: Diverticulum.

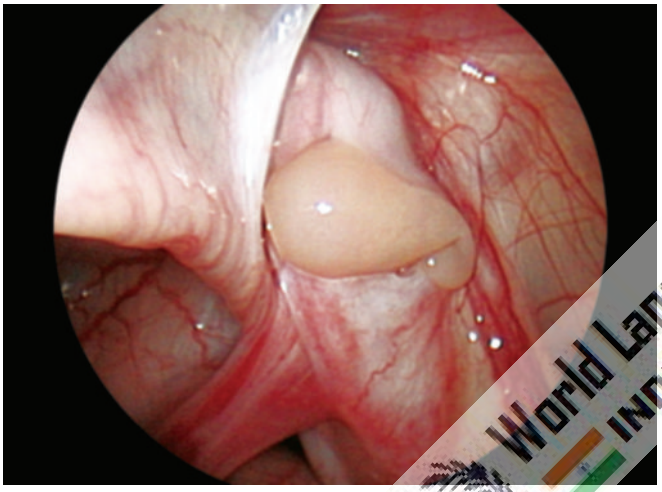


Fig. 16: Impalpable testes.

Fig. 17: Perforation of small bowel.

of instrument is not done then wound infection or leakage of ascites may occur postoperatively. Failure to accurately diagnose the extent of intra-abdominal pathology is another potential complication for which patient may have to go for resurgery.

CONCLUSION

Diagnostic laparoscopy is one of the very important methods of investigation for patients in whom the diagnosis or extent of the disease is unclear or the abdominal findings are equivocal. It can be performed safely in an inpatient or outpatient setting, potentially expediting diagnosis, and treatment. This laparoscopic procedure helps to achieve the final diagnosis without any significant complication and less operative time, it can be safely concluded that diagnostic laparoscopy is a safe, quick, and effective adjunct to nonsurgical diagnostic modalities, for establishing a conclusive diagnosis, but whether it will replace imaging studies as a primary modality for diagnosis needs more evidence.