Laparoscopic appendectomy with Endo Loop ligaation versus clipping of the stump: review article

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Abstract:

Introduction:

Treatment of appendicitis is essential to prevent further morbidity and mortality, and the margin of error in overdiagnosis is acceptable. Currently, the rate of negative appendectomy is approximately 20 percent **[1].**

Appendectomy is the standard management of acute non-perforated appendicitis, while appendicular abscess is treated by percutaneous aspiration guided by ultrasound and in appendicular mass; the treatment of choice is non- operative management with antibiotics followed by delayed appendectomy. Ochsner and Sherren first described conservative treatment **[2].**

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Appendicectomy:

Appendicectomy is performed under general or spinal anesthesia, with the patient in a supine position on the operating table. When the laparoscopic technique is used, the bladder must be empty. Before preparing the entire abdomen with an appropriate antiseptic solution, the right iliac fossa was palpated for the mass. Draping of the abdomen follows the planned operative technique, considering any requirement to extend the incision or convert the laparoscopic technique to an open operation **[3].**

Preoperative Preparation

When deciding to perform an appendectomy for acute appendicitis, the patient should proceed to the operating room with minimal delay to minimize the chance of progression to perforation. Patients with appendicitis may be dehydrated by fever and poor oral intake; therefore, intravenous

fluids should be initiated, and pulse, blood pressure, and urine output should be closely monitored **[4].** Before incision, a single dose of antibiotics should be administered, typically second-generation cephalosporin **[4].**

Markedly dehydrated patients may require a Foley catheter to ensure an adequate urine output. Severe electrolyte abnormalities are uncommon with non-perforated appendicitis, as vomiting and fever have typically been present for 24 hours or less but may be significant in cases of perforation. Any electrolyte deficiencies should be corrected prior to the induction of general anesthesia **[7].**

Open appendicectomy:

Open appendectomy: The surgeon makes a cut of approximately 2–3 inches over the abdomen (laparotomy) to remove the appendix.

Laparoscopic appendectomy:

The appendix was visualized through a long, tube-like camera (laparoscope) after making multiple small cuts in the abdomen. The appendix was then removed using surgical tools **[5].**

Standard procedure:

*** Position of the patient:**

The patient was placed in a 15° Trendelenburg position with both arms and at least the left arm tucked alongside the body to give the surgeon and the assistant comfortable space. A rotation to the left can be useful. In this position, the ascending colon was slightly suspended from the lateral wall, and the small intestine fell away from the operative field. The surgeon stood on the patient's left side. The assistant stood on the surgeon's right side. The monitor is usually placed on the patient's right side **[6].**

A pneumoperitoneum is created in a standard fashion using either the Veress needle technique, the open Hasson technique, or by inserting a non-traumatic bladeless Opti-View port **[7].**

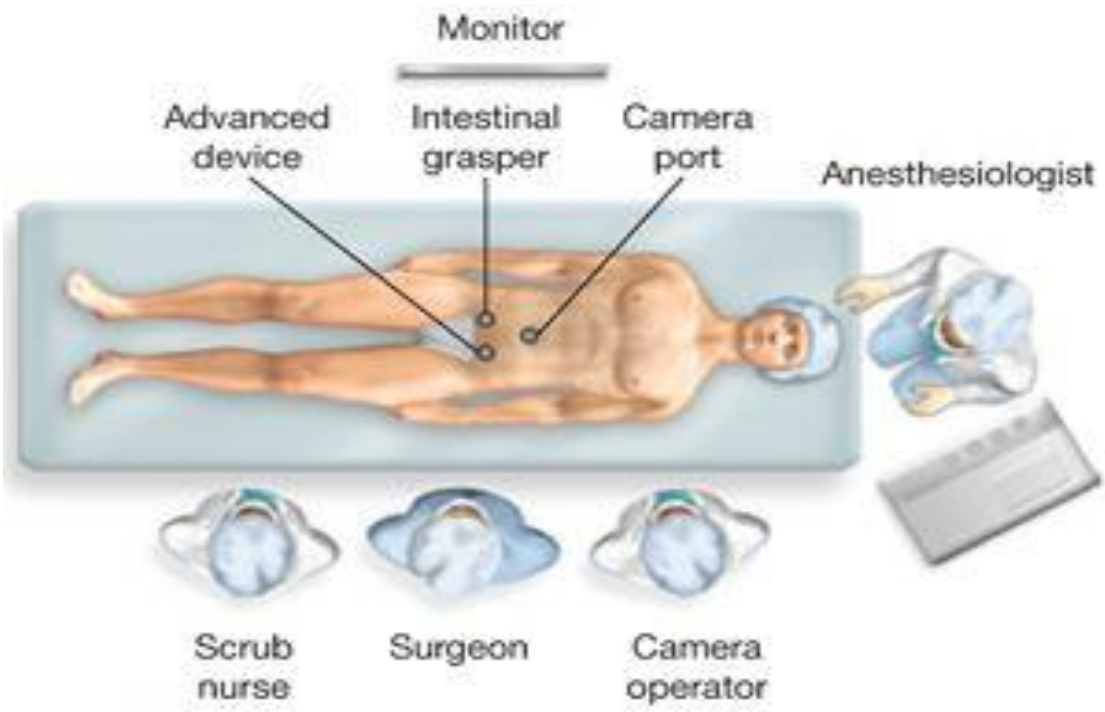

Figure (1): Position of the patient in laparoscopic appendectomy **[4]**

B. Trocar placement

The first trocar is usually 10 mm long and is introduced at the lower margin of the umbilicus. Insertion should be performed in a slightly oblique manner to prevent incisional hernias. The intraperitoneal pressure was set to a maximum of 14 mmHg in adults. The abdomen was then visually assessed. A second 5 mm suprapubic trocar was inserted into the working instrument. A third operating trocar is essential and can be introduced into either the right or left iliac fossa **[7].**

The third was better in the left iliac fossa, lateral to the inferior epigastric vessels. This site was chosen to allow an adequate distance from the first two ports and triangulation toward the appendix. This means that the two operating instruments approach each other at a 90-degree angle, allowing for much better tissue manipulation and dissection **[7].**

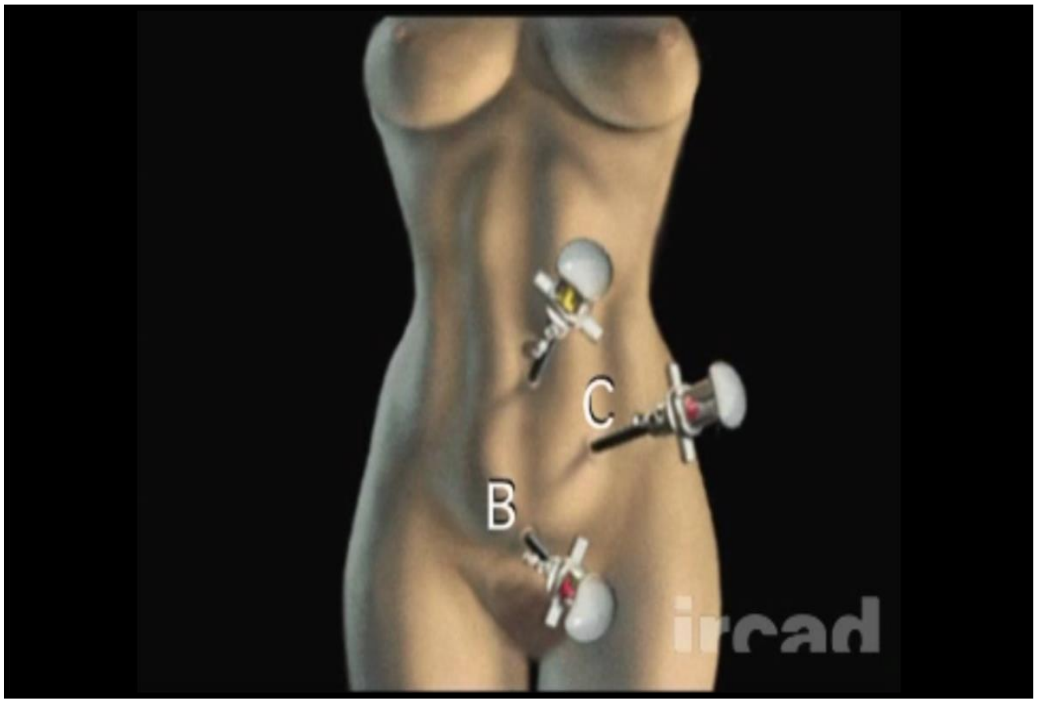

Figure (2): Trocar placement: The 3-port approach is shown in the photograph, with (10-mm) port in the umbilicus and (10-mm) port in the left lower quadrant and 5-mm suprapubic **[8].**

Some surgeons place a second port in the lower left quadrant. Placement was based on the location of the appendix and the surgeon's preference **[9].**

An additional 5-mm port may be placed in the upper midline or right upper quadrant. This may occasionally be necessary to mobilize the retrocecal appendix. It is generally not advisable to place a port directly over the area of dissection. The camera port can be placed in the umbilicus port **[7].**

C. Identification and mobilization of the appendix

After port insertion, a quick diagnostic laparoscopy was performed to confirm the diagnosis and assess other pathologies **[7].**

The surgeon's left hand operated on a Babcock grasper to retract the cecum and expose the appendix. If the appendix is significantly inflamed and friable, it is advisable not to grasp the appendix itself but rather to place the Babcock around it or at the level of the mesoappendix. Occasionally, an endoloop can be placed around the appendix and mesoappendix to create a handle for holding a particularly inflamed appendix. Cautery scissors can be used to incise the retroperitoneal attachments of the cecum to allow it to be pulled anteriorly, thus optimizing access to the appendix and its mesentery. The surgeon's right hand operates a dissecting instrument or cautery scissors, which creates a window in the mesoappendix at the base of the appendix **[7].**

Dissection at the base of the appendix enables the surgeon to create a window between the mesentery and base of the appendix. The mesentery and the base of the appendix were secured and divided separately. The mesoappendix can be divided using a 5-mm harmonic scalpel or Liga-Sure or between clips, depending on the thickness of the tissue **[7].**

D. Transection techniques

Either suture ligation or staplers can be used to divide the appendix and mesoappendix. Suture ligation, either with free ties or pre-tied endoloops, is inexpensive or only requires a 5-mm port, but it demands more skill and may initially take more time. The stapling technique requires less skill and is initially time-saving, but it is more expensive and requires a 12-mm port **[10].**

1) Endoloop technique

In this technique, the mesoappendix is first divided using cautery, and the appendix is subsequently divided between the two endoloops. The appendix was visible from the tip to the base. Ultrasonic coagulating shears can be used; however, this is an additional expense. Care must be taken to avoid touching and burning adjacent loops of the bowels with cautery devices. Portions of the mesoappendix were cauterized and cut with scissors until the base of the appendix was identified and completely freed. Two endoloops or free ties were inserted and tied at the base, leaving sufficient space to transect the appendix. Transection should be performed without cautery to prevent late stump necrosis at the ligated base. After transection, the appendiceal stump mucosa was carefully cauterized **[10].**

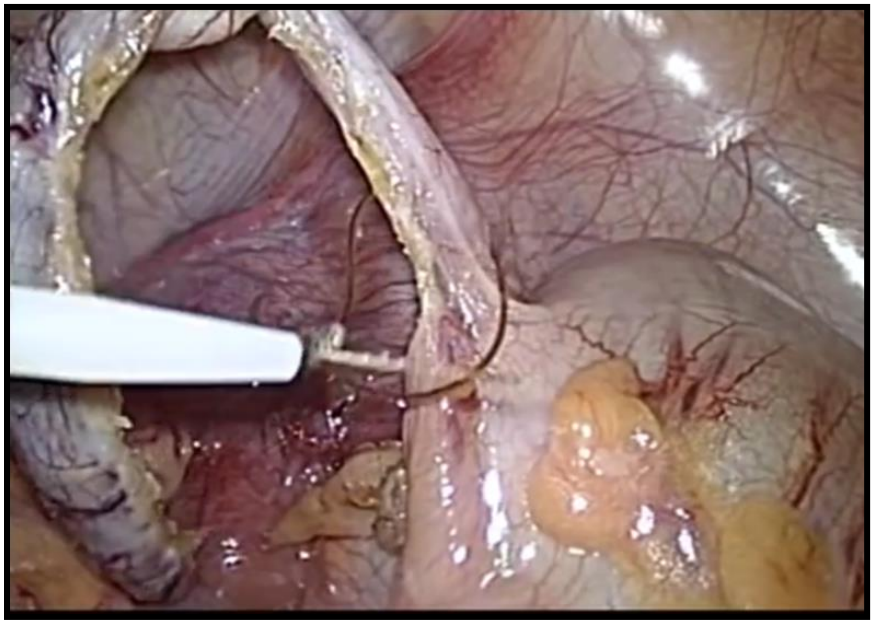

Figure (3): Endloop technique: ligation of the base of the appendix **[8].**

E. Specimen retrieval

As care is needed to avoid contamination of the abdomen and port-site wounds, the appendix is placed in an impermeable retrieval bag before removing it from the abdomen. Alternatively, if the appendix is not too large, it can be pulled into one of the larger ports and withdrawn with the entire port **[7].**

F. Irrigation and drainage

The purpose of irrigation is to remove all debris, purulent fluid collection, and blood from the surgical area. There is no advantage of irrigation in early appendicitis, without any pus, and there may be a risk of spreading contaminated fluid throughout the abdomen **[11].**

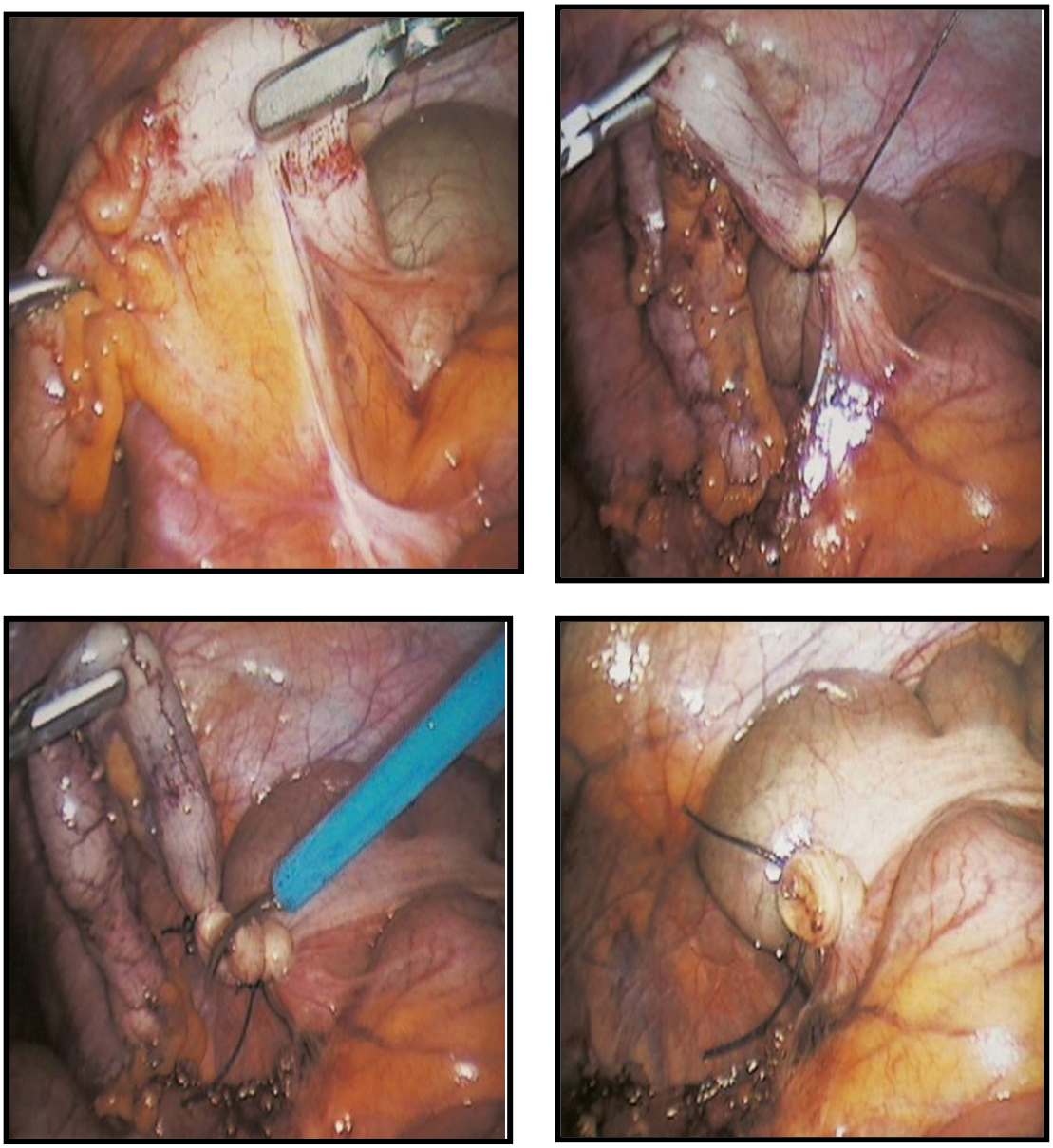

Figure (4): Laparoscopic appendectomy. Securing mesoappendix with bipolar diatermy, unipolar hook, clip or high energy ultrasound Securing appendix by pretied loops. Appendix removed through a cannula - usually 10mm or more **[8].**

In most cases, a drain is not necessary. However, if residual contaminated fluid is left in the peritoneal cavity, a mature abscess is drained, or if the appendiceal/cecal stump is of suboptimal quality, the placement of a small closed-suction drain may be prudent. It was brought in through a separate 4 to 5 mm incision in the right lower quadrant, not through one of the trocar sites, and laid along the cecum into the pelvis to drain the dependent areas. After a few days, the drain was removed once the fluid quality was serosanguinous**.** trocars were then removed under direct vision. The fascia at the 10-mm trocar site was closed, and all wounds were closed primarily **[8].**

II. Contraindication of laparoscopic appendectomy

A. Absolute contraindication:

1. **Abdominal wall sepsis**: Risk of infection in the peritoneal cavity **[7].**
2. **Severe cardiac diseases:** decompensated cardiac disease, conduction defects, recent myocardial infarction (within three months), and severe obstructive respiratory diseases are contraindications to laparoscopy, because mechanical distension of the abdominal cavity by gas impairs lung expansion and proper oxygenation. Moreover, cardiac patients cannot tolerate prolonged supine or Trendlenburg positioning **[7].**
3. **Appendicular mucocele:** When an appendicular mucinous tumor is encountered during laparoscopy, a situation requiring atraumatic appendectomy is indicated. This clinical situation should be considered as an indication for conversion to open appendectomy **[7].**

B. Relative contraindications

1) **Multiple previous abdominal operations:** Most experienced laparoscopists agree that an occasional patient with multiple previous abdominal surgeries is unsuitable for laparoscopy. Although multiple previous operations may be contraindicated, one or two previous elective procedures may pose no problem. Good preoperative planning by the surgeon makes the initial entry. Treatment site at a distance from the previous scars and the use of the open technique for access and careful adhesiolysis **[7].**

2) Generalized peritonitis: It has previously been considered to be a contraindication for the laparoscopic approach because of the theoretical risk of malignant hypercapnia (as under high abdominal pressure created by the pneumoperitoneum can lead to increased trans-peritoneal absorption of insufflated Co_2 into systemic circulation in addition to reduced diaphragmatic movement, with subsequent decreased pulmonary Co_2 excretion, which can be prevented by slowing the insufflation rate of Co_2 into the peritoneum) and toxic shock syndrome (which occurs due to bacterial translocatin with increased absorption of toxins under high abdominal pressure, which can be avoided by extensive irrigation of the abdominal cavity to reduce the contents of bacteria, toxins, and fibrin with a good course of antibiotic therapy perioperatively; however, laparoscopy is feasible and safe in cases of peritonitis, and laparoscopic treatment is particularly effective in the case of appendicular and gastroduodenal perforation. In addition, the diagnostic use of laparoscopy can be beneficial with an unclear cause for peritonitis **[11].**

3) Pregnancy: In the past, laparoscopic procedures were contraindicated; however, studies have shown that laparoscopic appendectomy can be safely performed during pregnancy. One limitation may be the size of the gravid uterus, which interferes with adequate visualization and instrumentation in the third trimester of pregnancy **[12].**

4) **Portal hypertension** may increase the risk of abdominal wall bleeding and complications during surgical dissection **[12].**

5) **Abdominal aortic or iliac aneurysm:** These patients are at increased risk of vascular injury during veress needle placement and trocars introduction **[12].**

6) **Abdominal hernias:** Abdominal hernias are not as strong a contraindication as was once thought. If careful attention is paid to maintaining appropriate intra-abdominal pressure, inguinal or umbilical hernia will not be disrupted **[12].**

III. Complications of laparoscopic appendectomy

Although laparoscopic appendectomy is considered feasible and safe, severe complications can occur. It must be emphasized that more than half of the laparoscopic complications are related to the entry technique, and one-fourth to one-fifth of the complications are not recognized intra-operatively **[13].**

A. Complications related to anesthesia:

For laparoscopy, major anesthesia-related complications did not differ from those in open cases. Cardiac arrhythmias and cardiac arrest have been reported in some instances, usually because of a profound vasovagal response to rapid peritoneal distension, patient's position, increased abdominal pressure, or air embolism **[13].**

B. Complications related to entry:

Complications related to entry with closed laparoscopy include those that occur with the use of a needle (Veress or any other type) for pneumoperitoneum creation and those related to the insertion of the primary trocar. No major injury was related to the insertion of secondary trocars. Injuries associated with blind entry affect the major vessels, small and large bowel, stomach, liver, spleen, bladder, uterus, and abdominal wall vessels **[14].**

Therefore, a carefully well-executed open technique decreases the rate of entry complications and increases the rate of intraoperative detection of complications **[14].**

1) **Abdominal wall vascular injury:** Nearly all instances of abdominal wall bleeding are related to entry injury and the insertion of lateral trocars. The most frequent injuries are to the inferior epigastric and muscular vessels **[14].**

2) **Hernia at the site of abdominal wall trocar: A major advantage of laparoscopic surgery is that** ventral hernia formation is lower than that with laparotomy incision. Hernias that develop at the trocar site usually result from a lack of closure or improper closure of trocar wounds and, in most instances, preventable complications. It is generally agreed that 5-mm trocar wounds do not require closure, while larger trocar wounds require

closure because hernia formation occurs more frequently and the risk of bowel incarceration (Richter hernia) is high **[14].**

C. Complications related to pneumoperitoneum:

1. **Subcutaneous emphysema**: Mild to severe localized or generalized subcutaneous emphysema manifests as the presence of (CO2) in the subcutaneous tissue and generally does not have clinical consequences **[15].**

2. **Pneumo-mediastinum and pneumothorax:** intra-peritoneal gas may ascend and cause a pneumomediastinum. Pneumothorax or pneumomediastinum may also occur when gas passes through congenital defects of the diaphragm, usually in the right hemidiaphragm, and may result from perforation of the diaphragm during an upper abdominal procedure [15].

3. **Gas embolism:** Gas embolism is a complication of the direct entry of gas into the arterial or venous system. This usually occurs during or shortly after insufflation, but may result from direct intravascular insufflation of CO2 or other gases during the operation. Gas embolism is an uncommon complication that is associated with a high mortality rate. The magnitude of a clinical event is directly related to the type of insufflated gas. Small amounts of soluble gas (CO2) probably occur frequently and have no clinical consequences, whereas large amounts of soluble gas or smaller amounts of insoluble gas (air and nitrous oxide) may cause death **[15].**

4. **Post-operative shoulder pain:** A combination of factors are thought to be responsible for the development of postoperative shoulder pain in some patients. Irritation of the diaphragm by the formation of carbonic acid on its peritoneal undersurface as a result of the use of (CO2) or stretching of the phrenic nerves by pneumoperitoneum or by pressure from the abdominal organs, mainly the liver, because the Trendelenburg position may cause shoulder pain **[15].**

D. Complications related to the patient's position:

1) **Brachial plexus neuropathy:** Brachial plexus neuropathy was observed in patients who underwent laparoscopy. This was attributed to the combination of shoulder braces with 90-degree right arm abduction and Trendelenburg position. The mechanism of brachial plexus injury appears to be related to torsion, stretching, pinching, or ischemia of the cervical branches at the level where they pass beneath the coracoid process and between the clavicle and the first rib. Brachial plexopathy can be prevented by avoiding shoulder braces, with both arms tucked to the side **[16].**

2) **Hypercapnia:** Severe hypercapnia due to difficult ventilation has been reported to be due to the combination of large diaphragmatic hernia, pneumoperitoneum, and the Trendelenburg position and requires conversion of operation to laparotomy **[16].**

E. Complications related to the operative procedure:

1. **Intestinal injuries:** Approximately one-third to one-half of bowel injuries are related to entry, and the rest are caused during the operative procedure. Thermal injuries occurred the most frequently. In a few instances, bowel injury results from using grasping forceps or scissors **[17].**

2. **Urinary bladder injuries:** The most common type of urinary injury observed in slightly more than half of patients is bladder perforation, followed by fistula, ureter ligation, and ureter transection. A mechanical device is responsible for the accident, including unipolar and bipolar cautery, loop suturing, trocars, laser devices, staples, and sharp dissection **[17].**

3. **Major vascular injuries:** Major vascular injuries that occur after entry are much less frequent than those that occur during the blind entry phase of surgery. Lymphadenectomies or other procedures performed near the large vessels carry a greater risk. Major vascular injuries usually require laparotomy, but laparoscopic repair is possible in some instances, depending on the size and type of the vessel, localization of the injury, and visualization of the injury. Laparoscopic repair of vena cava injuries is feasible **[18].**

F. Septic complications:

Wound infection: Before the introduction of the endo-catch instrument, many trocar site infections were reported in some instances. With the use of this instrument to remove infected specimens from the intra-abdominal cavity, the incidence of wound infections is significantly reduced. Generally, the incidence of wound infections during laparoscopic appendectomy is very low **[18].**

Intra-abdominal collection: The incidence of intra-abdominal abscess, especially perforated or gangrenous appendicitis, is high. It can be diagnosed by ultrasonography or computed tomography as a fluid collection that contains pus on ultrasonographically guided aspiration or drainage, and some abscesses can be resolved with antibiotic therapy alone **[19].**

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