Laparoscopic surgery: A cut above
Since the 1990s, laparoscopic surgery has been the surgical technique of choice. There are many benefits for patients who undergo laparoscopic surgery compared with open surgical procedures, but it’s important to understand the complications that may occur, as with any surgical procedure. The OR nurse must be knowledgeable regarding the advantages and disadvantages of laparoscopic surgery to properly anticipate unintended complications and ensure patient safety and quality of outcomes.

**Definition of laparoscopy**

Laparoscopy is a surgical procedure that allows for visualization of the abdominal cavity through a small incision, typically through a trocar using a laparoscope that has a camera and a light source. The camera transmits the images via a computer system. The picture is then displayed on one or more monitors for the surgeon, first assistant or resident, and OR staff to visualize. A trocar consists of a sheath or cannula and an obturator that has a three-sided pointed shaft that is twisted to separate muscle to gain access to the surgical site. In laparoscopy, the trocar separates the muscle and fascia until it’s in the peritoneum. There’s an access port that allows the carbon dioxide to flow into the abdominal cavity, as well as the cannula portion that

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While laparoscopy continues to be the surgical technique of choice, there are complications, some fatal, you should know more about.

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allows access for the instrument and disposable materials (one-time use supplies) to enter the abdominal cavity. To allow for optimal conditions for the surgeon to adequately visualize and expose the abdominal organs, a combination of approaches are used. The gastrointestinal (GI) tract is decompressed once a patient is under general anesthesia. The patient is then placed in the Trendelenburg position. Neuromuscular blocking drugs (NMBDs) are given, and a pneumoperitoneum is created in the abdominal cavity. The GI tract is decompressed once a patient is under general anesthesia. The patient is then placed in the Trendelenburg position. Neuromuscular blocking drugs (NMBDs) are given, and a pneumoperitoneum is created in the abdominal cavity. The GI tract can be decompressed prior to surgery if the surgeon has the patient perform a bowel preparation. GI tract decompression may continue during surgery if a nasogastric or orogastric tube is inserted into the patient’s stomach immediately after the induction of anesthesia. Lastly, NMBDs are given to the patient during the induction of anesthesia to help relax the abdominal wall muscles and facilitate the placement of the trocars and insufflation of the pneumoperitoneum.

The pneumoperitoneum is achieved by insufflating the abdomen with carbon dioxide to a pressure of 12 to 15 mm Hg. The normal abdominal pressure is 0 to 5 mm Hg. Clinically significant increases in abdominal pressure are considered to be above 10 mm Hg; abdominal pressure above 15 mm Hg can result in abdominal compartment syndrome, which can affect multiple organ systems. Carbon dioxide is the most suitable gas to create the pneumoperitoneum and is clearly the gas of choice in laparoscopy. The ideal gas should be nontoxic, readily soluble in the blood, colorless, nonflammable, cost-effective, and expelled from the body easily. Oxygen and air can result in an embolism, since they aren’t readily absorbable in the blood, and nitrous oxide doesn’t have a predictable absorption. Other gases such as helium are practically insoluble compared to carbon dioxide, and argon gas causes a more significant depressant effect on hemodynamics than carbon dioxide. It’s critical for the surgical team to understand all of the physiologic effects that occur with a pneumoperitoneum during a laparoscopic procedure for optimal patient outcomes.

**Surgical techniques for abdominal access**

There are a few surgical techniques that may be used to gain access to the abdominal cavity to establish pneumoperitoneum. The first method is considered a closed technique and uses a Veress needle. This needle is typically inserted in the abdominal cavity via the umbilicus. This is a blind technique. The surgeon feels and/or listens for two punctures. The first is when the needle goes through the skin/fascia and the second is when the needle penetrates the peritoneum. Once this is performed, the surgeon may confirm that he or she is in the abdominal cavity by aspiration through a syringe filled with sterile water. A drop test is done where the fluid (via gravity) goes into the abdominal cavity. If it fails to do so, then the surgeon knows the needle isn’t in the proper place or may have come across adhesions preventing access to the peritoneum. Once the surgeon has confirmation that the needle is in the abdominal cavity, pneumoperitoneum is initiated followed by the insertion of trocars.

Another method used to access the peritoneum is considered an open technique and involves the surgeon making an incision typically near or in the umbilicus. The tissue is dissected to the anterior abdominal fascia. The surgeon may or may not place sutures in the peritoneum. Next, the surgeon incises the peritoneum under direct vision. Once the surgeon confirms a safe access to the peritoneum, a wedge-shaped Hasson-type trocar is inserted to form a seal. Pneumoperitoneum is initiated and maintained. At the end of the procedure, this method requires the surgeon to repair the fascia via a suture.

**Complications of laparoscopy**

The incidence of complications occurring during a laparoscopic procedure is 1% to 5%, with a mortality of approximately 0.05%. Complications can be grouped into three categories depending on the phase of the procedure: complications of access, physiologic complications related to the pneumoperitoneum, and complications that occur during the operative procedure.

**Complications of access**

Complications associated with the closed technique of using the Veress needle and trocar insertion for access include injuries to the bowel and major retroperitoneal vessels, which can result in significant morbidity and mortality. Less serious complications of closed technique may include fascial dehiscence and herniation, abdominal wall hematoma, and wound infection. Complications for the open technique are often less severe.
Studies have shown major vascular and bowel injuries to be quite rare, with less frequent wound complications associated with the open technique compared to the closed technique.

**Bowel injuries.** Bowel injuries along with major vessel injuries represent the most serious complications that occur with laparoscopic surgery. When considering laparoscopic surgery, it’s important to remember that the intestines are located in all quadrants of the abdominal cavity; some portions are extra peritoneal, and some are intraperitoneal (see Division of the abdomen into four quadrants or nine regions). Injuries to the intestines may occur via a perforation, since long pointed instruments are used in laparoscopic procedures, or they may occur from the initial trocar or Veress needle insertion. Injuries may also occur via sharp dissection, thermal injury, or traction from tissues or serrated graspers. The patient may need to undergo additional surgical procedures to correct the problem.

Small bowel injuries not identified intraoperatively become apparent 2 to 4 days post-op. Symptoms present as nausea, fever, pain, and lower abdominal pain. If still not recognized by 5 to 6 days post-op, the patient presents with an elevated white blood cell (WBC) count and worsening symptoms. An exploratory laparotomy, performed by a general or colorectal surgeon, is required to correct the injury.

Large bowel injuries can cause an abscess or infection due to the nature of higher bacterial counts present in the large bowel. The most frequent injury to the rectosigmoid colon occurs when there is pelvic adhesiolysis during the cul-de-sac dissection, resection of pelvic masses, or treatment of pelvic adhesions. In this situation, the patient typically presents 3 to 4 days post-op with fever, lower abdominal pain, epigastric pain, nausea, and anorexia. The symptoms worsen along with an elevated WBC count 5 to 6 days post-op. Treatment to correct this injury is the same as for a small bowel injury.

**Vascular injuries.** The most fatal complication associated with laparoscopic surgery is a vascular injury. Identification of vascular structures within the surgical area and avoidance of these vessels are the best methods to prevent vascular injuries. Recognizing a vascular injury, keeping calm, and promptly controlling the hemorrhage either laparoscopically or through open conversion are keys to a successful repair of a vascular complication.

One concern is if the injury is retroperitoneal. When this occurs, it may be difficult for the surgeon to detect a vascular injury. These injuries, as with bowel injuries, are caused by either the trocar insertion from the laparoscopic instrument or tearing adherent tissue. The reasons for this type of injury are the close proximity of the retroperitoneal vascular structures,
such as the distal aorta and right common iliac artery to the abdominal wall.

Other vessels that may be injured are the inferior vena cava, iliac vessels, and epigastric vessels, especially the inferior epigastric vessel. The repair of this type of injury can be accomplished in a variety of methods depending on the size and location of the injury. Small injuries may be controlled using a vessel sealing device and/or electrosurgery. Larger injuries may require assistance from a vascular surgeon in addition to surgical clips or sutures.11

**Hernia and weeping peritoneum.** Herniation can occur at the trocar site especially if either a Hasson technique is used to access the peritoneum or a 10 mm or larger diameter trocar is inserted and used. This type of injury may occur at either the umbilicus or at an extra umbilical site if it’s not closed properly. The surgeon must be cognizant to close the fascia to prevent herniation from occurring.7,8

**Complications from pneumoperitoneum**

The carbon dioxide used to create the pneumoperitoneum can cause irritation to the peritoneum and, although rare, a weeping peritoneum or pyrexia. Patients who experience this type of injury report symptoms of vomiting, abdominal cramps, and elevated heart rate. If left untreated, severe peritonitis may occur.2,5

**Pneumoperitoneum.** The next category of complications involves physiologic complications related to pneumoperitoneum (see *Pneumoperitoneum established for a female patient undergoing a laparoscopy*). Carbon dioxide is pumped into the abdominal cavity via a trocar to create the pneumoperitoneum needed for visualization of structures. It also allows the surgeon to use instruments within the abdominal cavity and avoid internal structures.

There are several local and systematic effects associated with pneumoperitoneum, including increased heart rate, intra-abdominal pressure (IAP), mean arterial pressure, systemic pulmonary vasculature and systemic vascular resistance, and a decrease in cardiac output and venous return.4 This, in turn, causes a reduction in tissue perfusion, reduced exchanges of gases, respiratory acidosis from the absorption of carbon dioxide, and a decrease in cardiac output up to 30% related to a decrease in stroke volume.7

Systemically, a pneumoperitoneum causes respiratory acidosis and transient hypercapnia.4

The longer the patient has a pneumoperitoneum, the more likely the patient will experience hypercapnia and acidosis. Oliguria may occur, as there is reduced renal perfusion. It activates the renin-angiotensin-aldosterone system resulting in renal cortical vasoconstriction, which when decreased, causes medullar renal flow and glomerular filtration to decrease as well.

Lastly, adhesion formation may occur from the pneumoperitoneum. This occurs from mesothelium desiccation damage and underlying connective tissue drying in as little as 30 seconds. Preventive techniques such as low carbon dioxide flow rates, low IAP, short duration of pneumoperitoneum, minimal damage to abdominal structures, minimal blood loss, and preventing hypothermia should be encouraged.4

**Complications from the surgery**

**Infection.** The most frequent complication in laparoscopic surgery is infection. It’s not associated with the laparoscopic technique itself but is mainly associated with proper maintenance of aseptic technique and sterilization of the OR equipment and instruments. In addition, adequately disinfecting the OR environment, including floors and walls, and minimizing traffic and dust can lower the risk of infection.5 Superficial incisional surgical site infections (SSIs) tend to occur within the first 30 days after the procedure and involve only the skin and subcutaneous tissue. Deep incisional SSIs involve the deeper fascia or muscle layers and also occur within the first 30 days after the procedures. If an implant was inserted in the patient or if the infection involved an organ that was manipulated or opened during the procedure, the infection could appear up to the first year after the procedure.12 If the SSI involved an organ, the criteria to classify it as an SSI would be purulent drainage, an
abscess, or other evidence on direct exam that showed an infection involving the organ. Although laparoscopic surgery has a lower SSI rate than open surgery, it’s still a concern in laparoscopy.

In 2005, The Surgical Care Improvement Project protocol was initiated in an attempt to reduce surgical mortality and morbidity. Parts of this initiative included prophylactic antibiotics given within 1 hour of the surgical incision, proper antibiotic selection, prophylactic antibiotics discontinued within 24 hours after the completion of the surgical procedure, proper hair removal with clippers, normothermia, and proper glucose management. All of these therapies were collaboratively initiated to improve surgical outcomes and reduce SSIs.

Electrosurgery injuries. Electrosurgery during laparoscopic surgery is often used in minimally invasive abdominal procedures. The use of electrosurgery in open surgery has been shown to be safe in the past 50 years. In laparoscopic surgery, the energy used must be passed through cannulas and have insulated active electrodes. The first type of electrosurgical energy injury is related to insulation failure. This occurs from damage to the insulation surrounding the portion of the instrument meant to protect opposing structures from the current. This damage is typically a break or hole in the insulation. This break allows a pathway for the electrical current to leave the device as it travels through the circuit to the patient return electrode. An arc may occur, and tissue not meant to be cauterized may be cauterized.
Another complication of electrosurgery is direct coupling, which occurs when the energized electrode, while activated, comes unintentionally in contact with another metal instrument or object in the abdominal cavity. If this occurs, unintended tissues may suffer damage due to the electrical current completing its circuit through the metal instrument.\(^\text{14}\)

**Vessel sealing device injuries.** Over the past few years, bipolar energy devices have been used successfully in laparoscopy.\(^\text{15}\) These devices use vibrations or bipolar energy to seal or cauterize tissues. A grounding pad used in monopolar electrosurgery to complete the circuit isn’t needed when these devices are used. The alternating current is distributed through the target tissue. One of the benefits of this technology is the ability to use lower voltages to achieve the same tissue effect with decreased thermal spread, reducing damage to surrounding tissues.\(^\text{15}\)

Complications may occur if the intended cauterized tissue isn’t properly sealed and bleeding occurs. Damage can also occur when the instrument heats up and inadvertently touches unintended tissues and organs. The surgeon and the OR staff should take care when using these technologies to prevent an unanticipated adverse event.\(^\text{15}\)

**Laser injuries.** During laparoscopic laser surgery, the primary complication that can occur is due to reflection to the patient’s abdominal structures while using the laser through a trocar. Other injuries include accidental activation of the laser prior to use or material within the surgical field that may ignite. Overall, laparoscopic laser surgery is safe and effective, but having an individual designated to run the laser is a precaution that should always be taken to prevent risk or injury.\(^\text{16}\)

**Sickle cell disease.** It’s important for patients with sickle cell disease, a disorder of the blood caused by inherited abnormal or distorted (sickled) hemoglobin, to have a thorough workup prior to any laparoscopic surgery. In sickle cell disease, the abnormal cells are fragile and prone to hemolysis, which can cause anemia.\(^\text{17}\) In patients with sickle cell disease, who have pulmonary hypertension, pneumoperitoneum can be fatal, as the high pressure in the arteries of the lung narrow and their walls thicken, causing systemic vascular resistance and pulmonary vasculature.\(^\text{18}\) The surgeon, anesthesiologist, and OR staff must collaborate to assess the benefits of laparoscopy in this patient population and determine if the benefit outweighs the risks associated with the procedure.\(^\text{18}\)

**Urologic injuries.** During a laparoscopic procedure, the surgeon takes precautions to protect the ureters, especially when there’s a concern of distorted anatomy. Some techniques to prevent this complication are the insertion of ureteral catheters placed prior to the laparoscopic portion of the procedure to allow the surgeon to more readily visualize the ureters. If a ureteral injury occurs, it may be challenging to diagnose, as up to 50% of a unilateral injury is asymptomatic.\(^\text{19}\) A cystoscopy with indigo carmine administration can be performed after the procedure to see if the ureters are functioning properly via visualizing ureteral flow. For minor injuries, a stent may be inserted, but surgical repair may be needed for more severe injuries.\(^\text{10}\)

Another urologic injury that may occur is a bladder injury, particularly in women with severe endometriosis or with a previous cesarean section. In these patients, the bladder may become adherent to the abdominal wall during laparoscopic hysterectiony or laparoscopically assisted vaginal hysterectomy, causing an unintended injury to occur. This type of injury can be identified intraoperatively via air in the urinary catheter, hematuria, or drainage of urine into the abdominal cavity. Most of these types of injuries require prompt surgical intervention by a urologist.\(^\text{19}\)

**Complications associated with anesthesia.** For optimal patient outcomes, OR staff should monitor pathophysiologic changes associated with general anesthesia in laparoscopic surgery patients. Hemodynamic effects such as increased heart rate,
increased intra-abdominal pressure, and decreased cardiac output during a laparoscopy are primarily due to the pneumoperitoneum. Healthy patients tolerate this procedure better than those with comorbidities. Patients with cardiac disease are at increased risk for further complications, as the carbon dioxide gas used to create the pneumoperitoneum depresses the patient hemodynamically.

The Trendelenburg position can also cause hemodynamic effects, such as decreased venous return and cardiac output, increased intracranial and intraocular pressure, and venous stagnation, which may cause cyanosis and edema in the face and neck, especially during a prolonged period of time. Dysrhythmias may occur in these patients during the insertion of the ports or during the pneumoperitoneum from the insufflation of carbon dioxide, causing a profound increase in vagal tone; therefore, slow insufflation is recommended during this procedure. Pulmonary effects due to an increase in pressure on the diaphragm and reduced expansion or compression of the lungs may also occur. Atelectasis can result from a decreased end-expiratory lung volume that’s insufficient to maintain alveoli patency. Morbidly obese patients have greater peak airway pressures and may not be able to tolerate a prolonged Trendelenburg position.

Other pulmonary effects include subcutaneous emphysema, endobronchial intubation within a bronchus, pneumothorax, and gas embolism. The most common respiratory complication is subcutaneous emphysema. It’s caused by extra peritoneal insufflation of carbon dioxide. An endobronchial intubation is caused by the elevation of the diaphragm by the pneumoperitoneum, resulting in only one lung being ventilated. The anesthesia team should watch for decreased oxygen saturation and pulmonary compliance to recognize this.

Serious complications include pneumothorax and gas embolism. When a pneumothorax occurs, the surgical procedure should be terminated, release of the pneumoperitoneum initiated, and a chest tube inserted. A gas embolism, which can occur during pneumoperitoneum and has a mortality of 30%, is rare and can be fatal if not treated immediately. Signs of a carbon dioxide embolism include cyanosis, profound hypotension, hypercapnia and hypocapnia, dysrhythmias, and asystole. This occurs due to a “gas lock” in either the vena cave or right ventricle and an interruption in circulation results. This occurs mostly during the initial insertion of the Veress needle but may occur at any point during the surgical procedure. Treatment consists of placing the patient in a left lateral head down position and hyperventilation. A central line is inserted to aspirate the gas. CPR and hyperbaric oxygen may also be required.

Rare complications. One rare complication is necrotizing fasciitis and carries a high associated mortality. In this situation, an aggressive bacterial infection invades the soft tissue with rapid necrosis of the fascia and subcutaneous fat. Only a few reported cases of necrotizing fasciitis have been reported after laparoscopic surgery. Early diagnosis and aggressive surgical intervention are critical to survival.

Other common complications. Pneumonia, bronchitis, thromboembolism, adhesion formation, and abdominal wall ecchymosis may commonly occur from either the effects of carbon dioxide administration for the pneumoperitoneum, entrance of the abdominal cavity with a foreign body, or local vascular hemorrhage from a port entry required to perform a laparoscopy. Surgeons and perioperative staff should be aware of these common complications and implement best practices to prevent injuries from occurring.

Contraindication for laparoscopy
Laparoscopic surgery is contraindicated for patients with severe heart failure, respiratory insufficiency, uncorrectable coagulation defect, diffuse peritonitis, and distended bowel. In addition, a patient who has had previous abdominal surgery may not be the best candidate for this surgical technique, as there may be extensive adhesions. Older adults are at greater risk for laparoscopic complications along with the morbidly obese. These patients have a decreased reserve, often have poorer health, and decreased pulmonary and cardiovascular function.

Nursing considerations
Preoperative preparation for patients undergoing laparoscopy should include a medical history and physical exam, complete blood count with differential, serum electrolytes, urinalysis, prothrombin time, partial thromboplastin time, bleeding time, and imaging as indicated. In addition, depending on the surgeon’s preference and the surgical procedure, a bowel preparation may be completed prior to surgery. If this is required, patients should be encouraged to have a clear liquid diet the day prior to surgery.
Patients may also be required to take a shower the evening prior to surgery with an antiseptic soap. Nurses should instruct their patient to clean their umbilicus using a cotton swab, as the abdominal access is often through the umbilicus. The patient should also be instructed to not eat or drink anything either after midnight prior to surgery, or 6 to 8 hours before the procedure. Nurses should review medications (prescription, over-the-counter, supplements, vitamins, and herbal medicines) the patient should take on the day of surgery and which ones may need to be stopped a few days prior to the day of surgery.5

The patient’s position during the surgical procedure must be considered. Patients should have proper body alignment maintained. If in a lithotomy position, the patient’s legs should be placed in padded stirrups, avoiding hyperflexion of the legs. Hyperflexion can cause compression of the femoral nerve of the peroneal nerve. The patient’s buttocks should only extend beyond the end of the OR table by a few centimeters to allow for either uterine manipulation or insertion of a stapling device.22

Body habitus must be considered for all patients regardless of weight. Trocars are inserted almost vertically. The distance between the trocar tip and the sacral promontory is relatively small.22 Care should be taken, as major vessels can be injured during the insertion of the trocar. In thin patients, the force required to insert the trocar may be less than anticipated because of a thin fascia. During all trocar insertions, the practitioner must be cognizant of the force required to insert the trocar without injuring abdominal structures.16 Once the trocar is inserted, carbon dioxide should be infused slowly and set at a pressure of 15 mm or less.2

Nursing considerations for the immediate post-op phase are to assess the patient for pain and provide the appropriate amount of pain medication prescribed by the surgeon following the patient’s pain rating results. The pain seen in laparoscopy is less severe when compared to open surgical procedures, but it can still be considerable. Monitoring of vital organ function is accomplished via continuous monitoring of peripheral oxygen saturation, BP measurement, respiratory rate, and electrocardiography monitoring.23 Lastly, antiemetics should be administered if the patient experiences nausea and vomiting after surgery.23

Postoperatively, patients should be monitored for pain, fever, chills, elevated WBC count, herniation, and infection. (See Signs and symptoms of laparoscopy complications.) If the patient is discharged from the hospital shortly after the surgical procedure, the nurse should educate the patient to recognize the signs and symptoms of complications and quickly contact their physician if they have any concerns. Patients should also be encouraged to move and walk as much as tolerated to minimize the risk of postoperative complications.

Summary
Laparoscopic surgery has many benefits to patients when compared to open surgery. Even so, it’s important for nurses to properly communicate to patients that all surgery has the potential for complications. Knowing the signs of laparoscopic complications, accurately diagnosing, and expeditiously correcting unintended injuries before they’re fatal are crucial to optimal patient outcomes following laparoscopic surgery. OR

Signs and symptoms of laparoscopy complications5

Notify the surgeon if the patient develops any of the following signs and symptoms that may indicate an injury related to the laparoscopic procedure.

- Fever
- Chills
- Nausea
- Vomiting
- Lower abdominal pain
- Abdominal tenderness
- Abdominal distension
- Epigastric pain
- Bleeding or increased redness at the surgical site
- Abscess
- Decreased urine output
- Tachycardia
- Hypotension
- Cardiac dysrhythmias
- Tachypnea

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DOI:10.1097/01.ORN.0000433525.56540.65