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Laparoscopic Electrosurgical Complications: Stay Informed

Objectives

1. Describe the frequency of laparoscopic electrosurgical complications.
2. Discuss the causes of these complications.
3. Describe preventive measures for avoiding complications.

The number of laparoscopic procedures being performed today continues to increase with more and more accidents being reported. For example, statistics reveal that 1.3 to 5 per 1,000 laparoscopic patients have experienced bowel complications while over 67 percent of laparoscopic injuries will go unnoticed at the time of surgery. Of the total general surgery malpractice claims in 2000, only 9 percent of the claims were from laparoscopic accidents but represented 39 percent of the monies paid out. Laparoscopic accidents continue to occur with medical malpractice claims awarding large sums of money for these incidents. The most common laparoscopic accidents are caused from instrument perforation, insufflation hazards, positioning problems, electrosurgery thermal burns, and inappropriate reprocessing. These accidents are all preventable with the appropriate knowledge, skill, and devices. In this article, laparoscopic accidents will be reviewed in detail while highlighting the required control measures to eliminate and minimize them.

The expected outcome of any surgical procedure is that the patient will be free from injury. Maximizing patient outcomes with minimal or no complications can be obtained through education, early recognition, and early intervention. Over the past 20 years, there has been a dramatic change in the technology to incorporate safety parameters. The advent of minimally invasive surgery has grown tremendously with the introduction and development of new technology. In the United States, nearly 4.9 million general and pelvic endoscopic surgery procedures were performed in 2003. The advantages of laparoscopic surgery over open surgery include lower overall treatment costs, reduced patient trauma, shorter hospital stays, and faster recovery times. These benefits have resulted in the conversion of many types of open surgery procedures to laparoscopic procedures, a continuing trend that is being driven by advancements in the array of products that includes access devices, access site closure devices, computer-aided instrument guidance systems, computer-aided training systems, endoscopes, hand instruments, and insufflation devices, among others. However, the overall majority of operative team and delivery care team have limited education necessary to ensure safe practices in performing minimal access surgery.

Electrosurgery

Electrosurgery in laparoscopic procedures is the preferred surgical device for controlling bleeding. It is an excellent tool for cutting, coagulating, and ablating tissue during all surgeries, and has been the standard surgical tool since the 1930s. Today, over 90 percent of all surgeries utilize electrosurgery. There are three specific considerations when thinking about minimally invasive surgery,

QUESTIONS (true or false):		
More than 80 percent of laparoscopic injuries are unnoticed during surgery.	T	F
Approximately 2 percent of laparoscopic procedures result in bowel complications.	T	F
Electrosurgery is the preferred method of controlling bleeding in laparoscopy.	T	F
Electrosurgery is used in approximately 60 percent of surgeries.	T	F
Bipolar electrosurgery is the method of choice for cutting/coagulating tissue.	T	F
Stray electrosurgical burns can be fatal.	T	F
Most surgeons are aware of insulation degradation on monopolar electrosurgical probes.	T	F
The life expectancy of a reusable instrument is approximately two years.	T	F
Seventy-five percent of surgeons are aware of the concept of capacitive coupling.	T	F
Patients with thermal burns may not present with symptoms until a week after surgery.	T	F

the first of which is a moist atmosphere. The second is limited access to the tissue because the eyes of the scope are at the end and scopes can not look back on themselves. Lastly, the surgeon has limited visibility due to rigid scope delivery, leaving a field of view of 3-5 cm.

Monopolar electrosurgery is the method of choice for cutting and coagulating tissue in laparoscopic procedures. Although it serves an important clinical function, it also poses a risk of unintended and unrecognized internal burns as a result of stray energy induced by instrument insulation failure and capacitive coupling.

Note: Based on a 1993 survey by the American College of Surgeons, more than 85 percent of surgeons use monopolar electrosurgery for laparoscopic procedures.

Stray electrosurgical burns can be fatal. Burns are caused by stray energy resulting from insulation failure (a break in the insulation surrounding the active electrode) and capacitive coupling (an electrical phenomenon whereby current passes through intact insulation). Insulation failure and capacitive coupling cause electrical current to come in contact with non-target tissue, causing unintended injury. Unlike external skin burns, which are usually recognized immediately following a case, stray electrosurgical burns occur outside the view of the laparoscope, and unbeknownst to the surgeon. Because the surgeon is unaware of the stray electrical currents during surgery, he/she is unable to intervene and prevent injury to the patient.

Significant morbidity is associated with stray electrosurgical burns, including physical pain and suffering, a prolonged recovery, extensive follow-up medical treatment, and corrective surgeries that radically affect a patient's physical abilities and quality of life. The complications of these stray internal burns can put the patient in a life-threatening condition. The most feared complication is bowel perforation, resulting in intestinal content leakage into the peritoneal cavity (i.e., fecal peritonitis). Bowel injury and resulting complications account for most of the fatalities associated with laparoscopic procedures.

Note: Over 500 surgeons surveyed at the American College of Surgeons were asked if they have ever heard of insulation degradation on monopolar electrosurgical probes during laparoscopy. The results: 29 percent said no and 71 percent said yes.

With a conventional, non-shielded instrument, the primary insulation is the only line of defense from stray electrical burns.

The life expectancy of a reusable instrument is calculated for about one year. With emphasis on cost containment in surgery, facilities are using instrumentation beyond its expected life. Most hospitals have no formal protocol for testing to ensure that the surgeon is handed an instrument free of insulation failure. Inspection of conventional, non-monitored, non-shielded instruments before and after use may help reduce the risk, but is not fail-safe and is user-dependent. Breakage of insulation can be a result of the constant entry and removal of the instrument during surgery and the handling and sterile processing of the instrument. A slight tear in the instrument will create an increase in the power concentration (current density), and a high voltage waveform (coagulation) will create a larger hole in the insulation or create a hole in weak insulation. The temperature of the electric current delivered is 700 degrees centigrade. Resting temperature of tissue is 37 degrees centigrade. Tissue death occurs at 45 degrees centigrade, but patients will not present with symptoms initially due to a delay in perforation. If there is a break in the insulation on the instrument, the surgeon will not notice a change in the current delivered at the tip.

Note: The American College of Surgeons was surveyed asking what mode of current delivery they used most often, and 74 percent stated they used the coag waveform.

Another electrosurgical safety concern of laparoscopic surgery is the occurrence of capacitive coupling. As the use of laparoscopic surgery has increased, the need to lessen the responsibility of processing instruments has trended facilities to use disposable instruments and trocars more often than the reusable instruments. Reusable instruments have multiple working parts making them difficult to process, and the disposable-shielded trocar lessens the potential for internal injury on entry. In the majority of laparoscopic surgeries, the mixing of reusable and disposable instruments sets up capacitive coupling. Capacitive coupling occurs when current flows between two conductors that are separated by an insulator and the stray current produces tissue burns. Capacitance allows current to pass to non-targeted tissue through intact insulation. The movement of the electrically charged ions forms a capacitive couple that can cause currents to heat and sufficiently burn tissue.

Note: The American College of Surgeons was surveyed asking surgeons if they had heard the term capacitive coupling and 49 percent of the surgeons responded "no."

When leakage current occurs and becomes excessive, bowel perforation may result, causing exposure of the intestinal contents into the peritoneal cavity. The injuries attributable to stray energy burns are less understood than other surgical injuries, partially due to the difficulty in detecting and diagnosing thermal injuries.

Although rare in occurrence, a generally accepted incidence of unexpected burns to the bowel during laparoscopic electrosurgery is 1 percent to 2 percent and is responsible for most of the fatalities associated with laparoscopic procedures. Patients with clinically significant symptoms of the complications from thermal burns often present three to seven days after surgery, placing the patient at risk for delayed diagnosis and treatment. Complications resulting from a delay in the diagnosis and treatment of laparoscopic electrosurgical injuries can include organ damage, vessel hemorrhage, perforation, and peritonitis. The patient may present with symptoms such as non-specific abdominal pain or slight rise in temperature, which are all specific to normal post-op laparoscopy. Injured

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areas may be compromised by a secondary infection, making the identification of the primary cause difficult to diagnose. These complications may be erroneously attributable to some other injury, such as instrument laceration.

When an internal burn occurs, the infections are from the interaction of three elements: organisms, tissues, and host defense. Surgery reduces the resistance of the host. Coupled with this, the burned, necrotic, devitalized avascular tissue enhances infection by providing excellent media for microbial growth. The post-op systemic infection of bacteremia/septicemia is from the dissemination of microorganisms into the bloodstream from a distributing focus, the thermal burn.

The intestinal tract harbors many microorganisms. Leakage into the peritoneal cavity can be a source of generalized peritoneal sepsis. Anaerobic organisms thrive in an unoxygenated environment. The most common organisms from spillage of contaminants from the enteric flora are *Escherichia coli* and *Bacteroides fragilos.* Another contributing factor to high mortality, if left untreated, is *Clostridium perfringens* (a highly resistant, gas-producing spore-causing gas gangrene). Gram-negative bacilli are often resistant to long-established antibiotics (normally prescribed post-operatively). Because these infections carry a high risk of bacteremia, they require prompt interventions.

Tissue with a thermal injury usually presents 48-72 hours post-op. Because these patients are home within 24 hours, electrosurgical injuries occurring during laparoscopy often go unrecognized only to present three to seven days afterward with fever and abdominal pain. Only 20 percent of these injuries are recognized at the time of surgery, whereas 80 percent go unrecognized, with the average delay being 10 days. Fecal peritonitis resulting from the contamination of the abdominal cavity by bacteria from a bowel perforation is the most feared complication of thermal injury even with antibiotic therapy, with a mortality rate estimated at 25 percent.

These are unique electrosurgical issues specific to laparoscopic surgery. When comparing open surgery versus closed surgery, the atmosphere is moist, promoting conductivity of electrical current. There is limited access to the surgical tissue, and laparoscopy is still primarily rigid scope delivery. With normal laparoscopy, there is a technique referred to as the "last look" technique. The surgeon releases the gas from the abdomen slowly, while visually looking for injury or bleeding before removing the trocar. Unfortunately this is not a routine practice, even though it should be done. Commonly, the trocar sheath is removed after the gas is manually depressed from the abdomen. If an injury has occurred, the likelihood of it being noticed is minimized.

According to AORN's *Recommended Practices for Endoscopic Minimally Invasive Surgery*, "Perioperative team members should monitor continually the functioning of equipment and the integrity of endoscopic instruments to ensure that hazards are minimized. Rationale: Use of active electrode monitoring (AEM) devices eliminates chance insulation failure, and capacitive coupling."

The implementation of active electrode monitoring eliminates the chance of insulation failure and capacitive coupling and has brought us to the point of necessitating AEM as the emerging standard of care. AEM addresses patient complications due to unintended electrosurgical burns out of the surgeon's field of view. AEM provides us with an efficacious, reusable, cost-effective system that brings about no change in surgical technique for the surgeon and essentially eliminates the chance of catastrophic patient injury from thermal damage to tissue. This technology has been recommended by organizations and in publications representing all the communities involved in laparoscopic surgery including nursing, surgical, risk management, ERCI, manufacturing and the biomedical field.

Under normal operating conditions, AEM delivers 100 percent of the power to the surgeon's intended site. Capacitively coupled energy is continually drained safely back to the generator by the protective shield. Stray energy sensed through a primary insulation defect in the protective shield is the key to fail-safe operation. When primary insulation fails or capacitive coupling occurs, the AEM shuts off the generator, protecting the patient from a life-threatening burn. AEM alerts the perioperative staff and interrupts power to the active electrode upon evidence of stray energy. Unintended laparoscopic burns now are preventable with the introduction of AEM.

The Association of Trial Lawyers founded a laparoscopic surgery subgroup in 1994, making it clear that laparoscopy was a ripe area for liability claims. In 1995, a founding member of the group indicated that members had "identified stray electrical current during laparoscopy as a promising basis" for malpractice cases.

It is quite obvious that something must be done, not only for the safety of patients, but also for the safety of the surgical team. Data from the Physician Insurers Association of America (PIAA) showed an increase of burns in the year 2000, showing the rate of burns to be at 5.38 percent of 1,426 claims.

Change in technology does not necessarily require a change in technique or practice. To promote safety practices, perioperative personnel must make the change as transparent as possible. The perioperative professional has an opportunity to protect the patient from the dangers of stray electrosurgical burns incurred during laparoscopic surgery. Safe and effective practice requires a skilled and knowledgeable work force and appropriate equipment that operates reliably to reduce errors in our practice. The greatest factor in the safe and effective use of electrosurgery is adequately trained personnel.

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