

Practice Point

Electrosurgical injuries and their prevention in Laparoscopic Surgery

Javid Ahmad Bhat, Bashir Ahmad Gors, Irfan Nazir Mir

Department of General Surgery, SKIMS

Electro surgery is one of the most commonly used energy systems in laparoscopic surgery. The surgical team should have a good understanding of the principles of electro surgery and tissue effects to avoid complications. The risk of complications is linked to the surgeon's fundamental knowledge of instruments, surgical technique, biophysics, relevant anatomy, and safe technical equipment.

Background: Though the exact incidence of laparoscopic electrosurgical complications is very hard to ascertain, the incidence of complications related to laparoscopic electro surgery has been reported to be 2 to 5 per 1000 in 1990s. Electro thermal injury may result from the following situations:

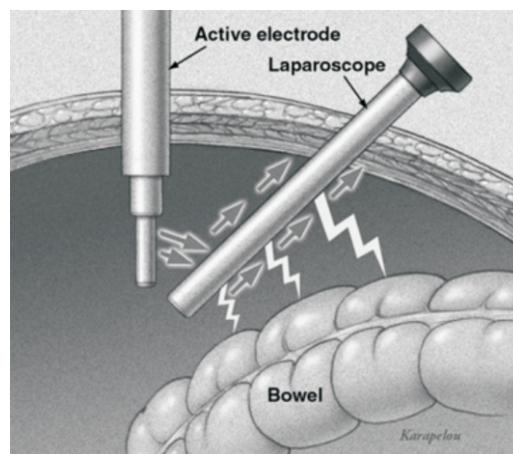
1. Direct application
2. Insulation failure
3. Direct coupling
4. Capacitive coupling
5. Alternative site burn
6. Thermal Injury Secondary to Fiber optic Cables
7. Surgical smoke.
8. Electro thermal burn to surgeon.

Direct application: Proximity between the electrode and the tissue can determine contact (desiccation) or noncontact tissue effect (fulguration). The dwell time determines the amount of tissue effect. Prolonged activation will produce wider and deeper tissue damage more than the anticipated desired tissue effect.

Insulation failure: The risk of a break may be increased when using a 5-mm insulated instrument through a 10-mm sleeve, or by repeated use of disposable equipment.

Insulation failure can also be caused by excessive use of reusable instruments, particularly with repetitive passage through trocars and frequent mechanized sterilization. 18% of insulation defects are located in the distal third part of the instrument which are most likely to create a catastrophic electrosurgical injury. Originally described as "Zone 2" by Voyles and Tucker, the location along the instrument, which is outside the view of the monitor but distal to the protective cannula, carries the highest risk for creating an injury that even the most attentive surgeon is unable to detect. Disposable instruments have a lower incidence of insulation failure compared with reusable instruments.

Direct coupling: Direct coupling comes from unintended contact of a noninsulated instrument (e.g., laparoscope, metal grasper forceps) within the abdomen. Electric current will flow from the active electrode into the secondary conductor and energize it.



Correspondence:

Dr. Javid Ahmad Bhat, Fellow
Department of General Surgery, SKIMS
Email: drjavidbhat@gmail.com

How to cite this article: Bhat JA, Gors BA, Mir IN. Electrosurgical injuries and their prevention in laparoscopic surgery. JMS 2021; 24 (4):50-52

Received: 2021-11-27 Accepted: 2021-12-07

Access this article online



Website:
www.jmsskims.org

DOI:
<https://doi.org/10.33883/jms.v24i4.1117>



Capacitive coupling: Capacitive coupling is electrical current that is established in tissue or in metal instruments running parallel to but not directly in contact with the active electrode. Capacitive coupling occurs when electric current is transferred from one conductor (the active electrode) through intact insulation and into adjacent conductive materials (e.g., bowel, etc.) without direct contact. Longer length of instruments, thinner insulation, higher voltages, and narrow trocars increases the risk of this type of injury. Capacitor coupling can be minimized by activating the active electrode only when it is in contact with target tissues and limiting the time length of high-voltage peaks. For example, in a hybrid trocar sleeve a nonconductive (plastic) locking anchor is placed over a conductive (metal) sleeve. The plastic anchor will stop the transmission into the abdominal wall over a large surface and allow capacitive coupling to adjacent bowel resulting in bowel burns.

Alternative site burn: Alternative site burn can occur if the dispersive pad does not make sufficient contact with the patient's skin. The primary purpose of the dispersive pad is to provide a grounding path from the patient back to the generator and ensure an area of low current density. Should this ground path be compromised in quantity or quality of the pad/ patient interface, the electrical circuit can be completed via other grounded contact points thus producing high current densities and causing a burn. Examples of such contact points include electrocardiogram (EKG) leads, towel clips, intravenous stands or stirrups, and neurosurgical head frames. The electrosurgical dispersive pad should be placed on an area of clean, dry skin over a large muscle mass, avoiding bony protuberance, scar tissue.

Thermal Injury Secondary to Fiber optic Cables: Laparoscopy requires a reliable light source to provide adequate visualization. Thermal damage may however occur secondary to the fiber optic light source. In a study conducted by Hindle et al, it was found that the maximum temperature at the optical cable was between 119.5° C and 268.6° C. They also found that when surgical drapes were exposed to the tip of the light source, the time to char was 3 seconds to 6 seconds, and significant injury was recorded with the optical cable 3mm from the skin. Hindle et al concluded that the temperature at the tip of the optical light cord can induce extreme damage and can produce immediate superficial tissue necrosis that can extend into

the subcutaneous fat even when the optical tip is not in direct contact with the skin. **Surgical Smoke:** Research studies have confirmed that this smoke plume can contain toxic gases and vapors, such as benzene, hydrogen cyanide, formaldehyde, bioaerosols, dead and live cellular material and viruses.” Smoke evacuation systems be used to reduce potential acute and chronic health risks to patients and personnel.

Electro thermal burn to surgeon: The surgeon is also susceptible to electro thermal burns during electrosurgical procedures, even while wearing surgical gloves. Surgical gloves can pass radio frequency current by three mechanisms: hydration (low resistance conduction), capacitive coupling (induced charge from the hemostat to the sweating conductive skin of the surgeon), and high-voltage dielectric breakdown (e.g., holes in glove). Consequently, during the course of long procedures that expose gloves to large amounts of blood or fluid, surgeons should consider replacing gloves before reactivating electro surgery.

Prevention of electrosurgical injuries

1. Thorough preparation and training of the operating room staff.
2. Regular equipment maintenance.
3. A thorough knowledge of biophysical principles of electrosurgical devices.
4. Avoid hybrid trocar sleeves.
5. Do not activate the electrode in air.
6. Inspect insulation carefully
7. Use the lowest possible power setting
8. Use a low-voltage waveform (cut)
9. Use brief intermittent activation.
10. Do not activate in close proximity or direct contact with another instrument
11. Use bipolar electro surgery when appropriate
12. Capacitive coupling is increased by open circuits, use of 5-mm cannulas (versus 10 mm), and higher generator voltages. This situation can be avoided by using multiple, short activation times that allow normal tissue to remain cool.
13. Utilize the modern available technology to eliminate

concerns about insulation failure and capacitive coupling.

- a. Active Electrode Monitoring Systems: When in place, this system continuously monitors and actively shields against stray current. It can be effectively minimize the potential hazards for the patient.
- b. Tissue Response Generator: Tissue response generators are the next step in the evolution of electrosurgical generators. By using a computer-controlled tissue feedback system that senses tissue impedance or resistance, a consistent electrosurgical clinical effect is obtained through all tissue types
- c. Vessel Sealing Technology: Core to this technology is the use of bipolar electro surgery that relies on tissue response generators. This advanced electrical current is combined with optimal mechanical pressure delivery by the instruments to fuse vessel walls and create a seal. Specifically, high current and low voltages are delivered to the targeted tissue and denature the collagen and elastin in the vessel wall while the mechanical pressure from the instrument allows the denatured protein to form a coagulum. Thermal spread is reduced compared to traditional bipolar electrosurgical systems.d. Ultrasonic Technology: The Harmonic scalpel is an ultrasonic surgical instrument for cutting and coagulating tissue, operating at a frequency of 55.5 kHz/second or 55,500 cycles per second. There is no electrosurgical current

generated. The combination of mechanical energy and the heat that is generated causes protein denaturation and formation of a coagulum that seals small blood vessels.

REFERENCES

1. Massarweh NN, Cosgriff N, Slakey DP. Electrosurgery: history, principles, and current and future uses. J Am Coll Surg 2006; 202:520.
2. Feldman LS, Brunt LM, Fuchshuber P, et al. Rationale for the fundamental use of surgical Energy™ (FUSE) curriculum assessment: focus on safety. Surg Endosc 2013; 27:4054.
3. Wu MP, Ou CS, Chen SL, et al. Complications and recommended practices for electrosurgery in laparoscopy. Am J Surg 2000; 179:67.
4. Alkatout I, Schollmeyer T, Hawaldar NA, et al. Principles and safety measures of electrosurgery in laparoscopy. JSLS 2012; 16:130.
5. Hefermehl LJ, Largo RA, Hermanns T, et al. Lateral temperature spread of monopolar, bipolar and ultrasonic instruments for robot-assisted laparoscopic surgery. BJU Int 2014; 114:245.
6. Fuchshuber P, Schwaitzberg S, Jones D, et al. The SAGES Fundamental Use of Surgical Energy program (FUSE): history, development, and purpose. Surg Endosc 2018; 32:2583.