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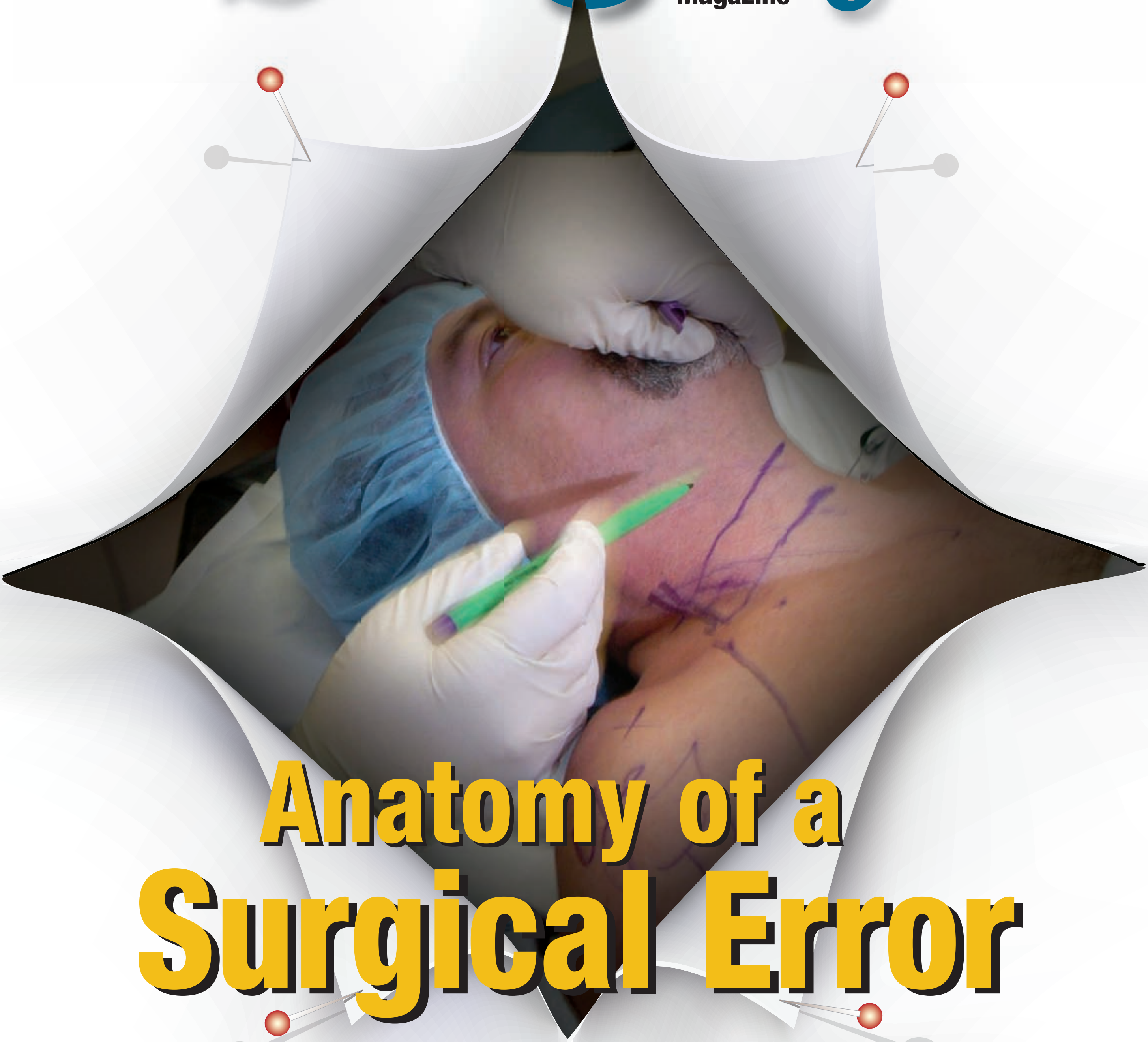


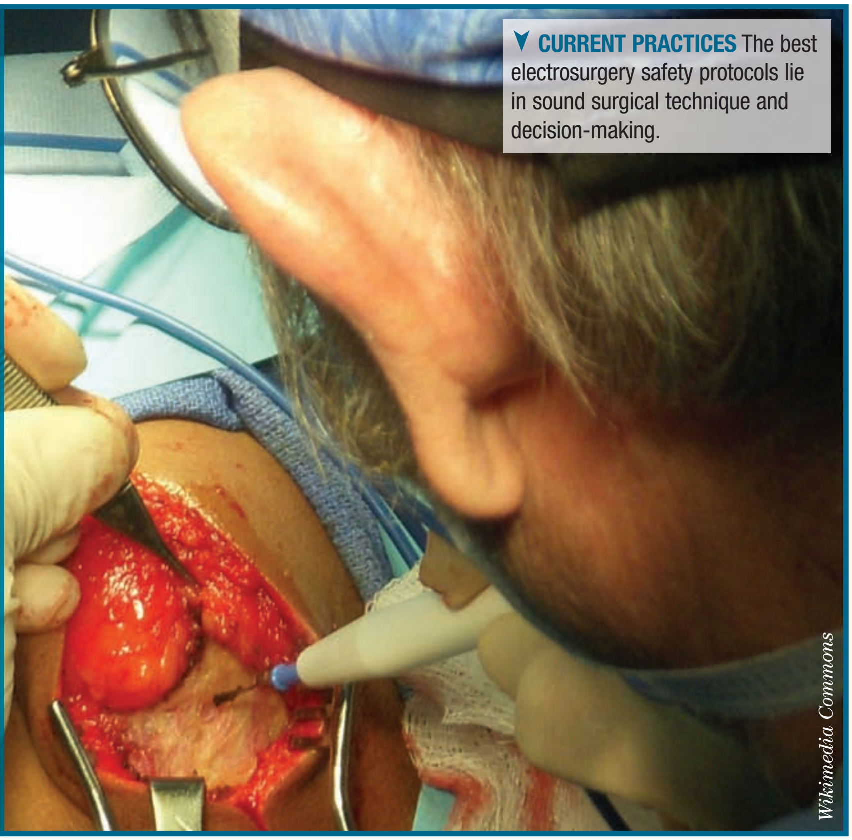
Anatomy of a Surgical Error

In this era of checklists and quality reporting and malpractice litigation, why do these mistakes keep happening? A surgeon tells all. P. 20

Playing It Safe With Electrosurgery

A clear understanding of the fundamentals and the latest devices designed with safety in mind will help you avoid trouble in the OR.

Daniel Cook | Managing Editor



CURRENT PRACTICES The best electrosurgery safety protocols lie in sound surgical technique and decision-making.

Considering electrosurgery's widespread use, you'd think most surgeons would know how the devices work and how to prevent stray currents from causing electrothermal injuries. But Arnold Advincula, MD, FACOG, FACS, bets you'd find that most physicians couldn't answer even the most basic questions about electrosurgery's fundamental principles. The medical director of the gynecologic robotic surgery program at Florida Hospital in Celebration addressed how best to protect patients in the September 2010 issue of *Clinical Obstetrics and Gynecology* and discussed the concepts with us. Here's what he had to say.

A quick review

During monopolar electrosurgery, current passes from the active electrode on the surgical instrument to a grounding electrode pad placed on the patient's skin and back to the electrosurgery generator. Bipolar energy passes between active and return electrodes on the surgical instrument as it cuts tissue inside the patient. The patient is part of the electrical circuit during both forms of electrosurgery.

Surgeons choose between "cut" (constant high current, low voltage) and "coag" (non-continuous low current, high voltage) waveforms. The coag setting increases lateral tissue damage and charring potential due to its quick burst of energy upon activation, so surgeons should set generators to the lowest possible voltage. The cut setting, available on most bipolar generators, limits those risks.

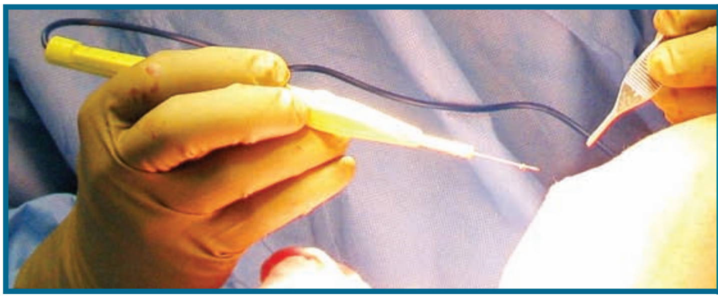
Tissue responds in different ways to the heat generated by electrical currents:

• **Vaporization.** Tissue is vaporized when heated rapidly to 100ºC or more in the cut mode. Steam generated during this process explodes tissue cells to create the cutting effect. Thermal spread is minimal as long as the active electrode is held just above the target tissue and kept in a constant, controlled motion.

• **Fulguration.** Occurs when tissue is heated above 200ºC, which carbonizes cells and creates coagulation that starts hemostasis. When done correctly using the coag setting, fulguration results in wide, shallow cuts.

• **Desiccation.** Holding the active electrode in cut mode against tissue dries and collapses cells when the tissue is heated to 90°C. Using the coag setting for this purpose results in more thermal spread.

Greater amounts of electrical current increase heat production and potential for collateral damage to surrounding tissue. Tissue type also impacts heat production: Muscle and skin have low heat resistance, making them better electrical *conductors*; fat and bone, on the other hand, are better electrical *insulators* due to their high heat resistance.



Device manufacturers have incorporated safety mechanisms into the newest instrument and generator designs.

How injuries occur

Here are 5 common causes of electrothermal injuries:

- **Insulation failure.** Occurs if current leaks from breaks in an instrument's protective outer coating. High-voltage coag settings heighten this risk.
- **Direct application.** Thermal injuries caused when active electrodes come in contact with unintended tissue because of surgeon error or accidental activation of the electrosurgery handpiece.
- **Direct coupling.** Occurs when monopolar energy jumps from the intended electrode-generator circuit to another conductive metal, which causes thermal injury to any tissue the instrument is touching at the time. This risk is heightened when instruments are blocked from the surgeon's field of view, meaning injuries could initially go undetected.
- **Capacitive coupling.** Capacitors are insulators that come between 2 conductors. Metal trocars and cord clips, for example, could draw electricity from its intended circuit, causing thermal injury to non-targeted tissue or skin burns.
- **Alternative site burns.** Occur during monopolar electrosurgery when the dispersive pad is not in complete contact with the patient, which could force current to concentrate at the exit site or find an alternate route to the ground. Make sure dispersive pads are larger than the active electrode and placed on highly vascular muscle masses, away from electrocardiogram leads and metal towel clips.

Avoiding user error

Device manufacturers are doing their part, incorporating safety mechanisms into the newest instrument and generator designs.

Disposable electrosurgery pencils limit insulation failure risks caused by wear and tear and repeated sterilization, but insulation breaks are still possible. Always inspect an instrument's shaft before use. Also run your fingers along the instrument to feel for irregularities too small for the naked eye to detect. Devices that test the integrity of an instrument's insulation provide extra peace of mind.

Instruments and generators that actively monitor the amount of energy delivered by active electrodes and automatically shut down whenever stray energy is sensed protect against insulation failure and capacitive coupling injuries. Some generators also sense tissue impedance and adjust energy levels accordingly to deliver safe amounts of current to the instrument.

High levels of unregulated energy applied to a vascular pedicle decrease tissue moisture, which increases resistance to energy. So while the outside of the pedicle is sufficiently energized, electrical energy moves along the path of least resistance before the pedicle's inside is properly heated, leading to increased bleeding during dissection. Generators with tissue impedance monitoring technology deliver consistent levels of energy, resulting in cleaner cuts with less bleeding. **OSM**

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