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Irrigation Solution: Will Your Choice Affect the Electrosurgical Outcome or Patient Safety?

Irrigation is fundamental to most surgical procedures. Fluids help clear the surgical field of active bleeding, improving visualization in both open and closed procedures. In addition, endoscopic procedures utilize irrigation fluid as a distention medium in hollow organs and joint spaces and to flush out resected tissue debris. The question is, does the choice of irrigation solution impact patient safety or the effectiveness of **monopolar** electrosurgery at the surgical site? Simply stated, the answer is **yes**.

The irrigant of choice for open surgical procedures is usually "saline". A 0.9% saline solution is considered isotonic to the body, meaning that its composition is comparable to that of other bodily fluids. Saline is a **conductive**, electrolyte-containing, low-viscosity fluid comprised of sodium chloride (NaCl) and distilled water. Irrigation fluid selection for an open electrosurgical procedure is not as critical, because the pooled fluid is typically suctioned away prior to the application of monopolar current. Open procedures also afford the surgeon a full view of the surgical field as electrosurgery is applied.

Conversely, endoscopic procedures require greater consideration when choosing the appropriate irrigant, because electrosurgery will be applied "underwater," in a confined space with a significantly reduced visual field. Most underwater procedures are particularly demanding, because of the impedance offered by the fluid and the resulting need for high-powered electrosurgical generators. Some important factors to consider when choosing a distention medium are the conductive properties of the fluid, the type of surgical procedure (diagnostic or operative), the active electrode configuration, and the duration of activation.

Distention media

From an electrosurgical perspective, irrigation solution should be selected based on its conductive properties or lack thereof. "To initiate and sustain a desired electrosurgical effect, a concentration of current density must be maintained between the active electrode and the target tissue. Because electrolyte-containing distention media such as saline and [lactated Ringer's] are both effective conductors, monopolar electrosurgery is ineffectual when the active electrode is used in these fluids. The readily conductive nature of the surrounding media acts to enlarge the surface area of the electrode, which causes a dramatic reduction of current density."[1] The resulting loss of surgical effect due to the dispersion of current usually prompts a request for routine power settings to be significantly increased. However, this will only have a minimal effect, because the conductive solution transfers the electrical current away from the target tissue to adjacent tissues outside of the surgeon's field of vision, increasing the potential for injury.

To minimize such risks, nonelectrolytic solutions are recommended because they are **non-conductive** and do not contribute to dispersal of the electrosurgical current. Numerous non-conductive fluids are available; some of the most common are 1.5% glycine, 3% sorbitol, 5% mannitol, and sterile water. Urological and gynecological procedures frequently require the use of such fluids, but they have disadvantages and not all are appropriate for every procedure. For example, sterile water is the irrigant commonly used for transurethral resection of bladder tumors (TURBT), because it is not absorbed through the bladder. On the other hand, sterile water would not be used for transurethral resection of the prostate (TURP), because it is not

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isotonic and may result in hemolysis of erythrocytes and possible renal failure when absorbed in large amounts through vascular openings. The most widely used urologic irrigants for TURP procedures are 1.5% glycine and 3% sorbitol, whereas "5% mannitol rather than glycine or sorbitol should be considered for hysteroscopic procedures when using monopolar energy."[2]

Surgical Procedure

A diagnostic endoscopic procedure will utilize irrigation mainly for distention and improved visibility during examination. For simple observation, the choice of irrigant is not critical because high frequency energy is not used and the tissue remains intact. On the other hand, operative endoscopic procedures utilizing a therapeutic treatment modality may open venous sinuses, allowing for intravascular absorption of the irrigation fluid. When large amounts of non-conductive fluid are absorbed during lengthy procedures, serious complications such as congestive heart failure, pulmonary edema, cerebral edema, and hypotension, can result. Although beneficial from an electrosurgical standpoint, "nonelectrolytic solutions should be monitored closely in long cases requiring large volumes of media."[3]

Active Electrodes

There are numerous active electrodes available for endoscopic procedures, depending upon the surgical application. The tip configuration is important, because the amount of exposed surface area can affect the current density and resulting tissue effect, as well as the irrigation solution chosen. Arthroscopic procedures are performed in small joint spaces and typically use hook or blade electrodes that are insulated to the tip. The uninsulated tip portion of the electrode has a small surface area to concentrate the electrosurgical current; therefore, lower power settings can be used as compared to urological or gynecological procedures. Because the conductive portion of the electrode and the joint space are small, conductive irrigants are usually acceptable if approved by the electrode manufacturer.

Active electrodes used for urological and/or gynecological procedures can have a comparatively small surface area (e.g., wire loop) or a large surface area (e.g., rollerball, roller barrel), and can affect tissue heating differently, predicated on their individual design. High power settings will be needed for both types of electrodes, because of the fluid environment and tissue impedance, but the larger surface area electrodes will require the highest power setting. A rollerablation electrode **should not** be used with a conductive fluid, unless otherwise indicated by the electrode manufacturer, because a significant portion of its surface area is in contact with the dispersive medium, resulting in the loss of surgical effect. Increasing the settings will only increase the total amount of current conducted through the patient return electrode (PRE). "If high power settings are used for an extended period of time in a conductive solution, the surface area of the PRE may be too small to disperse the current safely. Concentration of any current creates heat. Should the heat exceed 45°C (112° F), varying degrees of tissue injury will occur."[4]

Duration of Activation

How long the active electrode is activated depends upon the task at hand. Large amounts of tissue require longer activation times (duty cycle) to achieve tissue removal or ablation. At the same time, deactivation times are just as important. The longer the activation time, the more current travels through the patient's body. For some demanding clinical procedures, a duty cycle of 20 seconds on and 10 seconds off is acceptable, but in general, short activation times are recommended. Again, the use of conductive fluids with large surface area electrodes, high-powered generators, and long activation times during lengthy procedures can increase the risk of patient injury.

Closed procedures, although beneficial, do have certain risks associated with them. For those endoscopic procedures requiring the use of monopolar electrosurgery in a distention medium, several factors should be considered to minimize these risks.

Recommendations:

- **Use non-conductive solutions** unless specific medical reasons indicate otherwise.
- Confirm the use of an appropriate medium with the surgeon before any electrosurgical procedure.
- Follow the active electrode manufacturer's instructions for use (IFU) with regard to settings and irrigation fluid.
- Use the lowest power setting possible to achieve the desired electrosurgical effect.
- Use short activations. If long activation times are necessary, allow for "off" time to permit the tissue to cool.
- Consider the use of two PRE's (requires a special adapter), instead of just one, when using rollerablation electrodes to help disperse large amounts of current. Follow the manufacturer's IFU for application of the PRE's.
- "Suspend the use of any electrosurgical unit (ESU) when a surgical effect is not evident or is less than expected for the surgical circumstance. Verify correct distention/irrigation medium selection and good PRE contact before proceeding with electrosurgery or increasing the ESU's power setting."[5]

1) Brill A.I. "Energy Systems for Operative Hysteroscopy." Obstetrics and Gynecology Clinics of North America 27(2): 317-326, June 2000.

2) Loffer F.D., Bradley L.D., Brill A.I., Brooks P.G., Cooper J.M., Hysteroscopic fluid monitoring guidelines from the Ad Hoc Committee on Hysteroscopic Fluid Guidelines of the American Association of Gynecologic Laparoscopists. J Am Assoc Gynecol Laparosc. 2000; 7: 167-168.

3) Petrozza J. and Sikking E. "Hysteroscopy." eMedicine Journal 2(9): September 2001.

4) HOTLINE Newsletter. "Patient Return Electrode Lesions." 5(3): September 2000.

5) ECRI Health Devices. "Case Study: Skin Burns Resulting from the Use of Electrolytic Distention/Irrigation Media during Electrosurgery with a Rollerablation Electrode." 27(6): 233-5, June 1998.