Surgical energy in the contaminated wound: too much of a good thing?

Surgical energy has been widely used since its invention in the early 1900. Today, electrosurgery accounts for 80% of all dissections and hemostasis. For surgical energy we commonly refer to the capability of an electrosurgical unit (ESU) to convert energy to destroy cells by desiccation/vaporization. Thereafter, the majority of the surgical procedures have relied on the use of controlled surgical energy because of its effective hemostasis, clear dissection, and reduced post-operative pain. Through advancements in technology there has been a dramatic rise in the introduction of modern surgical energy devices (SED) into practice. While we continue to use more advanced SEDs, their technology, proper use and safety continues to be poorly understood. To address this, the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) has introduced the Fundamentals of Surgical Energy curriculum (FUSE). Previous research has highlighted the relationship between surgical energy and increased risk of microbial colonization after open ventral hernia repair (oVHR) with composite multifilament polyester mesh (Parietex™ PCO). Diathermy has also been associated with lower wound strength compared to scalpel alone.

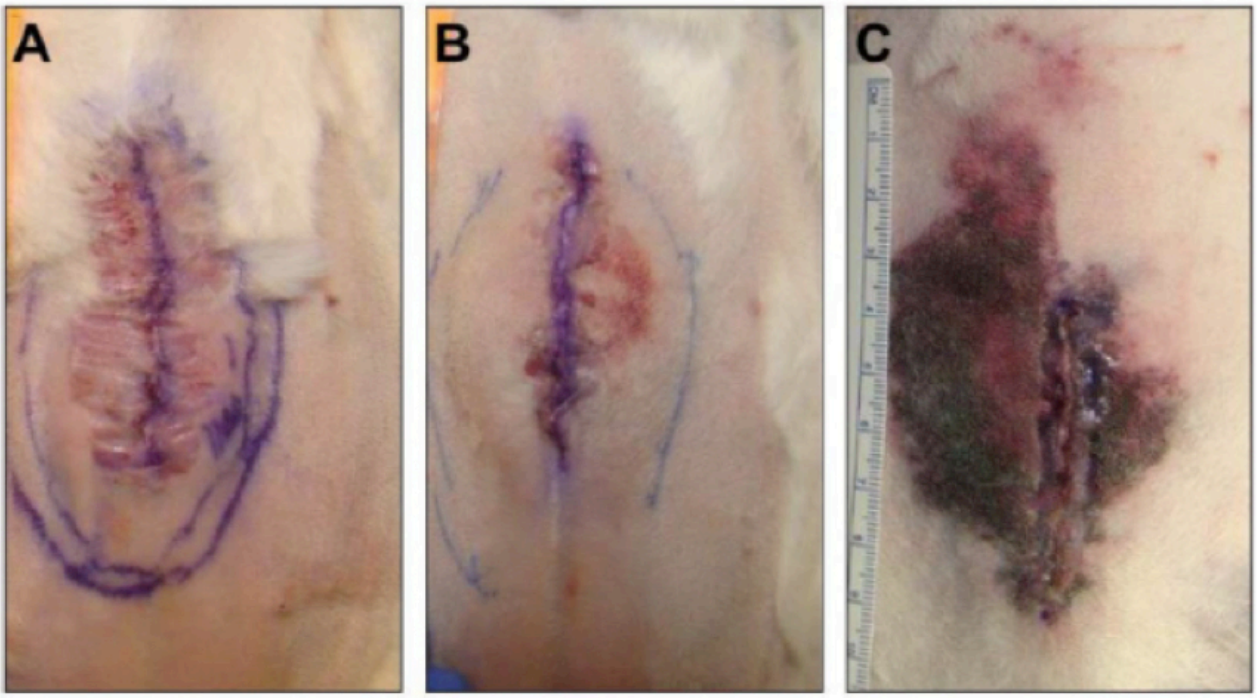

Fig. 1. Postoperative wound appearance. Group 1 showed minimal dermal erythema. Group 2 showed wounds with minimal erythema, and trace of ecchymosis. Lastly, Group demonstrates frankly necrotic tissue at the wound.

In this study we hypothesized that increasing surgical energy in performing the mesh-oVHR would results in higher infectious burden and septic complications. To test this hypothesis we studied nine female New Zealand rabbit undergoing oVHR under different conditions. The animals were randomly and blindly divided into three groups: scalpel alone (Group 1), low energy (diathermy use limited to less than 5 s or 120 Group 2), and high energy surgery (use of diathermy for up to 20s or 600 J - Group 3).

All rabbits underwent incisional hernia repair with Parietex™ Composite PCO (Covidien, Mansfield, MA) and which followed the injection of 1 X 10^5 CFU of *S. aureus* (Fig. 1). Group 1 underwent the surgical procedure with scalpel alone, and hemostasis was obtained with direct pressure. In Group 2, diathermy was only used to maintain hemostasis and in the dissection of subcutaneous tissues. The total energy delivered in this group was 100-120 J. Lastly, in Group 3, the entire procedure was conducted by using surgical energy in cutting mode to the incision of the skin. For the dissection of the subcutaneous tissue, incision of linea alba, and maintenance of hemostasis, the animal received coagulation mode diathermy. In this occasion, the animal received a total of 510-600 J of energy.

Within 24 hours of inoculation, the rabbits in Group 3 started showing signs of sepsis: high fever, increased heart rate, and respiratory frequency. In contrast, rabbits from Group 1 and 2 didn't show any alteration in vitals.

At 48 h, a qualitative evaluation of the wound appearance showed significantly increased erythema, swelling, warmth, and hyperpigmentation in group 2 and 3 compared to Group 1. Animals' wounds in Group 3 showed clear signs of necrosis. Adhesion scores were different as well, with rabbits in Group 1 having an average adhesion severity score of 0.33 compared to Group 2 and 3 (1.66 and 2.33 respectively).

A

	Day 0	Day 4	Day 7
Group 1	No Growth (3/3)	Few WBC (3/3)	Few WBC (2/3)S. Aureus (1/3)
Group2	No Growth (3/3)	No Growth (3/3)	S. Aureus (3/3)
Group3	No Growth (3/3)	NA	NA

B

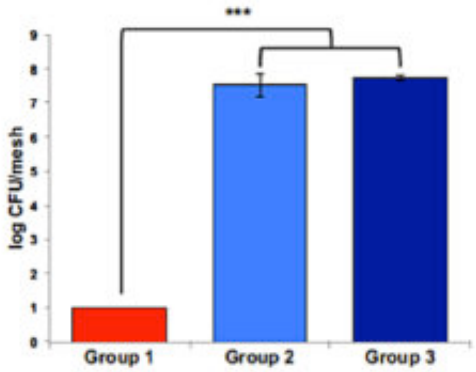

Fig. 2. Bacterial culture. Blood culture data (A). Group 1 and 2 showed 33 and 100% positive blood cultures by POD 7, respectively. Colony-forming units as necropsy (B).

This study highlights the significant association between increasing energy and impaired bacterial wound clearance. High-energy diathermy may increase the amount of devitalized tissue in the wound and therefore cause disruption of normal wound healing, ultimately increasing the chance of bacterial colonization and proliferation (Fig. 2). These factors taken together can promote infectious complications. On the other hand, our study demonstrates that minimizing the amount of surgical energy may reduce the risk of bacterial colonization and sepsis in the setting of mesh prosthesis.

Although with their intrinsic limitations - animal setting, direct mesh contamination - which call for more studies - the present results are extremely encouraging. Moreover, we underline here the need for surgeons to better understand the technologies they're adopting, and to be specifically trained on how to use them, in order to minimize morbidity and improve patient's outcomes. As more and more surgical tools become available the proper use of energy can become confusing. Knowledge and, more importantly, a thorough understanding of all the relevant settings on current surgical energy generators is lacking. As the variety of instruments increase, educational courses such as FUSE will become more important and potentially required to maintain certification. FUSE is a pioneer program aimed at retooling and re-educating surgeons to the advances in surgical energy. We hope this will promote the use of programs such as FUSE and prompt surgeons in any field to be aware of their energy use.

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