Reprinted from the Archives of Otolaryngology
March 1987, Volume 113

Wound Healing and the Shaw Scalpel

Donna J. Millay, MD; Ted A. Cook, MD; Robert E. Brummett, PhD; Edward L. Nelson; Patricia L. O'Neill, PhD

• The Shaw heated scalpel is now widely used in head and neck surgery because it provides better hemostasis intraoperatively. Concerns persist over the immediate and long-term effects of this instrument on wound healing. This study compares heated and unheated Shaw scalpel incisions in the skin of 7-week-old piglets. Tensile strength measurements and histologic evaluations were made at frequent intervals up to nine weeks after incision. Histologic studies showed no differences in the two groups at any time in the study. Tensile strength of wounds was significantly less two weeks after incision in the Shaw scalpel group, but following that time, the wounds increased in strength, and by seven weeks, the two groups were equal in this respect. Thus, we conclude that the Shaw scalpel wounds in pigs are, ultimately, similar to standard scalpel wounds, although there is a period of diminished tensile strength.

(*Arch Otolaryngol Head Neck Surg* 1987;113:282-285)

Accepted for publication Sept 27, 1986.

From the Department of Otolaryngology-Head and Neck Surgery, Oregon Health Sciences University (Drs Millay, Cook, and Brummett and Mr Nelson), and the Department of Biology, Portland State University (Dr O'Neill), Portland, Ore.

Read before the Spring Meeting of the American Academy of Facial Plastic and Reconstructive Surgery, Palm Beach, Fla, May 10, 1986.

Reprint requests to Department of Otolaryngology-Head and Neck Surgery, Oregon Health Sciences University, 3181 SW Sam Jackson Park Rd, Portland, OR 97201 (Dr Cook).

The standard scalpel has long been the instrument of choice for creating surgical incisions because of its accuracy and lack of tissue damage. The major drawback has been the attendant blood loss produced by this instrument. Attempts have been made to develop instruments that coagulate as they cut, but these instruments have proved to make unsatisfactory incisions with excessive tissue damage and delayed wound healing. The Shaw hemostatic scalpel is a new instrument that utilizes a sharp blade for cutting, which is heated to provide simultaneous hemostasis. Clinical studies by Fee[1] and Levenson et al[2] have demonstrated that the hemostatic scalpel does in fact make satisfactory incisions, while providing hemostasis. Studies thus far concerning the effect of the instrument on wound healing have been contradictory.[1-3]

As head and neck surgeons, we operate in the most vascular area of the body, and any instrument providing improved hemostasis could be very helpful. Because of the potential usefulness of this instrument, we thought it was important to establish whether the heated blade did cause sufficient tissue damage to delay wound healing. To this end, we have performed a study comparing the strengths of the heated and the unheated blades in wound healing in the domestic pig, whose skin structure is considered to be most similar to that of man.[4] To evaluate wound healing, we performed histologic sections and tensile strength measurements. Both of these parameters have been widely used in the literature to document wound healing.[5,6] Tensile strength measurements can be used to determine the relative increase in strength of healing wounds as a function of new collagen formation and maturation, while histologic sectioning can document tissue damage to wound edges.

MATERIALS AND METHODS

The hemostatic scalpel used in this study, the Shaw scalpel, consists of three separate pieces: the controller unit, the blade, and the handle. The controller unit uses an electric current to heat the scalpel to a predetermined temperature, from 110°C to 280°C, and then maintains that particular temperature over an extremely narrow range. The blade, the second component of the instrument, contains microcircuitry that utilizes the current provided by the controller unit to produce heat for hemostasis. Several different blades are available to be used with the Shaw scalpel. In this study a No. 15 blade was used, which is similar to a conventional Bard-Parker No. 15 blade in size and sharpness. The scalpel handle, the last component of the instrument, connects to the controller unit with a light cord, and provides for control of blade temperature by the surgeon. No electric current is transmitted to the patient, so no ground is required.

In this study we used a total of five juvenile domestic pigs that were between 6 and 8 weeks of age and weighed between 8 and 12 kg. One pig was used in a pilot experiment to establish the optimal num-

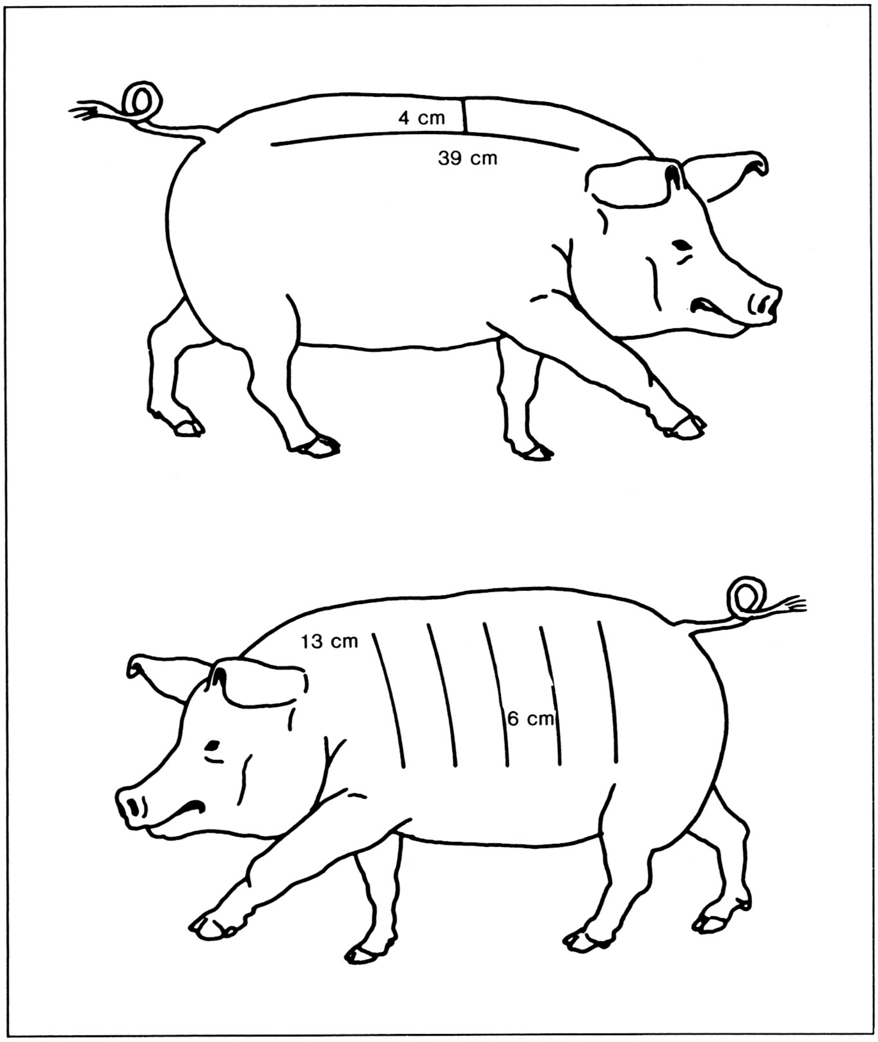

Fig 1.—Placement of skin incisions.

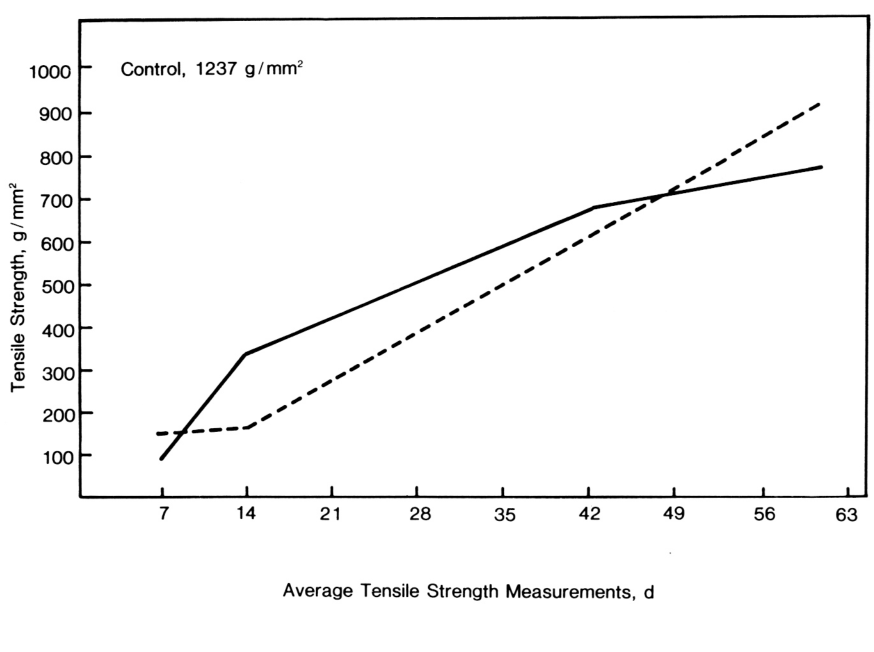

Fig 2.—Average tensile strength measurements of wounds made with heated and unheated hemostatic scalpels. Measurements were taken 7, 14, 42, and 62 days after wounding. Tensile strength measurements of unwounded skin serve as control. Solid line indicates unheated scapel; dotted line, heated scapel.

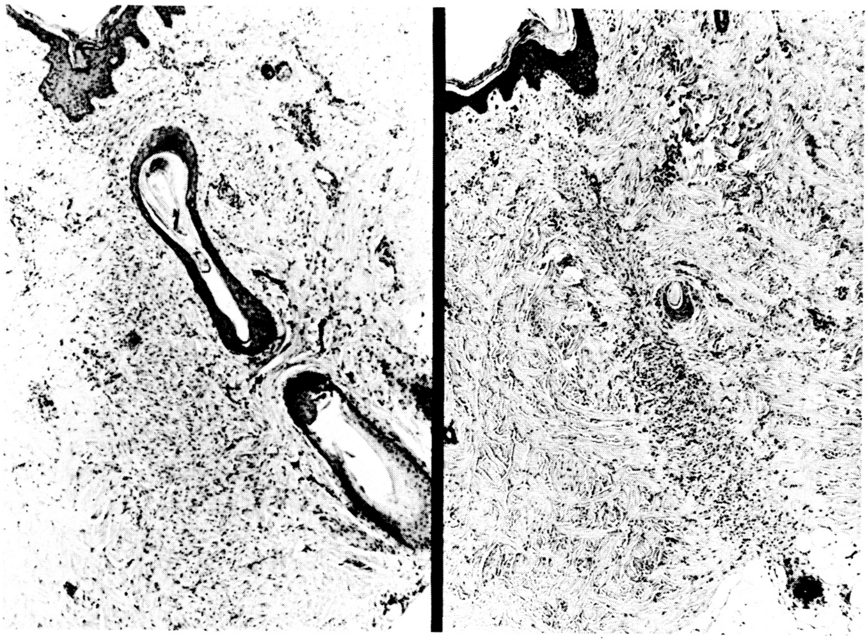

Fig 3.—Histologic sections of incisions 14 days after wounding with heated (left) and unheated (right) blades. Epithelialization is complete, and early collagen formation is seen with no significant difference (hematoxylin-eosin, ×4.0).

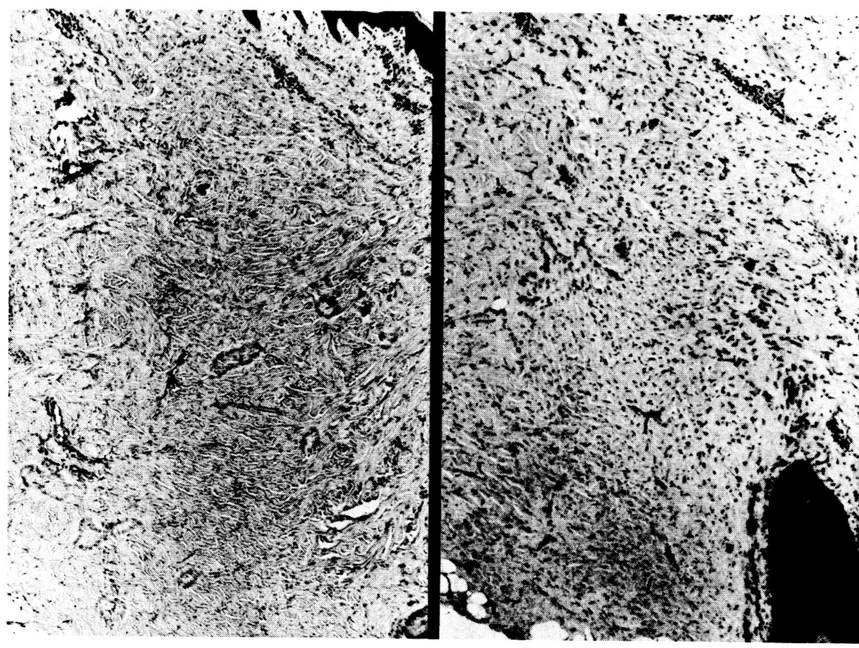

Fig 4.—Histologic sections of incisions 42 days after wounding with heated (left) and unheated (right) blades. Collagen maturation is occurring again with no significant difference (hematoxylin-eosin, ×4.0).

ber of incisions possible per pig while maintaining homogeneous pieces of skin. This animal was sedated with a combination of xylazine hydrochloride, ketamine hydrochloride, and atropine sulfate, and general anesthesia was provided by methoxyflurane (Metaphane). The skin of the back and sides was shaved and scrubbed with povidone-iodine. On the right side, a 39-cm incision was made 4 cm from, and parallel to, the midline using a No. 15 blade scalpel. On the left side, five transverse incisions, 13 cm in length and 6 cm apart, were made, beginning 3 cm from the midline (Fig 1). The incisions were then closed with skin staples spaced 1 cm apart. The wounds were allowed to heal for two weeks. The pig was again anesthetized, and all incisions were removed in a 3-cm strip of skin. One-cm pieces from these strips were evaluated histologically and with tensile strength measurements. In both cases, there was found to be no significant difference related to the area where the skin was removed. Therefore, the transverse incisions were chosen for the study itself, as this format offered more wound length for testing.

The remaining four pigs were then anesthetized as described above. In pig 1, the incisions on the left side were made with the Shaw scalpel using a No. 15 blade heated to 160°C. This temperature was chosen as it was the hottest temperature that was commonly used clinically on skin at our institution and was most likely to produce maximal tissue damage. Incisions on the right side were made in a similar manner with the unheated Shaw scalpel to serve as a control. This procedure was repeated with the three remaining pigs, alternating sides using the heated and the unheated blades. The incisions were again closed with skin staples approximately 1 cm apart. The pigs were reanesthetized on days 7, 14, 42, and 62, and 1 × 3-cm strips of skin were removed from the incisions and again closed with skin staples. One strip was removed from each incision on the above days for tensile strength measurements, and one piece per side of pig was removed for histologic studies.

For tensile strength measurements, the pieces were immediately placed in cold Normosol until testing was performed. Each piece was trimmed to achieve a dumbbell shape, and wound dimensions were measured with a micrometer. A tensiometer was used with a constant rate of 2 mm/s, and force measurements were recorded every 0.2 s. The results were expressed in grams per square millimeter.

Histologic sections were stored in formalin until sectioning and were evaluated blindly. Sections were stained with hematoxylin-eosin and Verhoeff-van Gieson elastic stains. One examiner (E.L.N.) performed light microscopy on all the specimens. Samples were then evaluated using five criteria: epithelialization, inflammation, granulation tissue, fibrosis, and necrosis. A ranking scale was employed, with 0 being minimum and 4 maximum, to assess the above criteria.

RESULTS

There were no gross differences in the wounds throughout the study, and there were no wound infections. Tensile strength measurements were consistent from pig to pig. At day 7, there was no consistent trend. By day 14, the tensile strength measurements of the cold scalpel were consistently higher with a statistically significant difference using Student's t test ($P < .02$). At days 42 and 62, there was no significant difference in values (Fig 2). Histologic sections, which were evaluated using the five criteria listed previously, showed no significant differences or trends throughout the study (Figs 3 and 4).

COMMENT

Few articles have been published concerning the effects of the Shaw scalpel on wound healing, despite the fact that it is now being widely utilized. In 1981, Fee[1] published the first report to our knowledge on the use of the Shaw scalpel and in it discussed his personal clinical use of the instrument in 58 head and neck procedures. In his study, it was found that there was no increased complication rate or grossly observed delay in wound healing. Also, Fee noted by gross observation that there did appear to be improved hemostasis with the Shaw scalpel. Fee also presented a follow-up study in which he again reported further clinical observations discussing the specific use of the Shaw scalpel in parotid gland surgery.[7] Operating time and estimated blood loss were recorded in procedures using the Shaw scalpel vs the conventional blade. Hemostasis was improved with the Shaw scalpel, and operating time was slightly decreased, with no increased complication rate and no obvious delay in wound healing.

Levenson et al[2] published an article in 1982 in which they discussed both clinical experience and animal studies concerning use of the hemostatic scalpel. Clinically, the knife was used in massive débridement of burned areas, with a marked improvement in hemostasis and no increased rate of infection or delayed wound healing. Furthermore, breaking strengths of the incisions were recorded in two different situations. They were measured seven days after wound incisions made with the blade heated at 114°C, 120°C, 140°C, 160°C, and 180°C and were found to be similar. Breaking strengths were also tested in wounds at 7, 14, 21, 28, 35, and 42 days postoperatively. There was a significant difference in favor of the cold scalpel found at 21 days.

Contrary to these favorable reports, recent investigations by Keenan et al[3] studied risk of infection and tensile strength measurements, with less positive results. In this experiment using guinea pigs, wounds were innoculated with bacteria, and those made with the Shaw scalpel showed less resistence to infection. Other wounds were tested for tensile strength at day 15, and the Shaw scalpel incisions were significantly weaker.

Because of this conflicting data, we attempted to perform a well-designed study to establish the wound healing in incisions made with the Shaw scalpel as compared with the cold knife. To do this, we chose to study wound healing by performing serial histologic sections and tensile strength measurements. Tensile strength is a measure that has been found to correlate well with the stage of wound healing.[5,6] It is defined as the amount of load required per cross-sectional area to break a wound or tissue. Clinically and histologically, this correlates with the amount of new collagen production and cross-linking of the collagen found in human wounds and, therefore, with the wound strength and stage of wound healing.

Histologic sectioning was performed to compare wound damage and wound healing with the Shaw scalpel as compared with the conventional scalpel. After ranking the slides using several criteria, no significant difference was found. When tensile strength measurements were evaluated, the only significant difference was found at day 14, where there was a slight advantage of the cold scalpel.

Using two reliable parameters, it appears as though there is no highly significant impairment of wound healing when using the Shaw hemostatic scalpel. This confirms clinical observations that the Shaw scalpel does not impair wound healing.

CONCLUSIONS

The Shaw scalpel has been demonstrated to be a useful instrument in improving hemostasis in soft-tissue surgery. When histologic sections and tensile strength measurements were evaluated, no significant delay was seen in wound healing with incisions made with the hemostatic scalpel. We feel that the heated Shaw scalpel can be safely used in head and neck surgery, with improved hemostasis and no increase in wound complications.

References

1. Fee WE: Use of the Shaw scalpel in head and neck surgery. *Otolaryngol Head Neck Surg* 1981;89:515-519.
2. Levenson SM, Gruber DK, Gruber C, et al: A hemostatic scalpel for burn débridement. *Arch Surg* 1982;117:213-220.
3. Keenan KM, Rodeheaven GT, Kenney JG, et al: Surgical cautery revisited. *Am J Surg* 1984;147:818-821.
4. Donovan WE: Experimental models in skin flap research, in Grabb WC, Myers BM (eds): *Skin Flaps.* Boston, Little Brown & Co Inc, 1975, pp 16-17.
5. Levenson SM: The healing of rat skin wounds. *Ann Surg* 1965;161:293-308.
6. Milch RA: Tensile strength of surgical wounds. *J Surg Res* 1965;5:377-385.
7. Fee WE: Parotid gland surgery using the Shaw hemostatic scalpel. *Arch Otolaryngol Head Neck Surg* 1984;110:739-741.

Printed and Published in the United States of America