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Comparison of Effects of Suture and Cyanoacrylate Tissue Adhesive on Bacterial Counts in Contaminated Lacerations

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We studied the effects of closing lacerations with suture or cyanoacrylate tissue adhesive on staphylococcal counts in inoculated guinea pig lacerations. Wounds closed with adhesive alone had lower counts than wounds containing suture material ($P < 0.05$). The results of a time-kill study were consistent with a bacteriostatic adhesive effect of the adhesive against *Staphylococcus aureus*.

Cyanoacrylate tissue adhesive is an organic polymer that effectively closes simple lacerations in humans and animals (1, 7, 9). However, the risk of wound sepsis for cyanoacrylate adhesive compared with that for suture material has not been quantified. One study used a well diffusion method to conclude that cyanoacrylate adhesive is bacteriostatic for gram-positive organisms (4). It is also known that suture material increases the risk of wound sepsis by serving as an adherent foreign body (4, 10). In contrast, *Staphylococcus epidermidis* adheres to cyanoacrylate adhesive, which may thus promote wound infection (8). To clarify this issue, we studied the difference in wound bacterial counts among the following wound closure methods (our terms are given in parentheses): use of a cyanoacrylate adhesive alone (glue), adhesive and subcutaneous suture (glue/SQ), skin suture alone (suture), and skin suture with subcutaneous suture (suture/SQ). Our null hypothesis was that no differences existed among these closure methods.

We studied 11 male albino guinea pigs weighing between 650 and 800 g each. The technique was modified from an established animal model (2, 3, 5), and the experimental protocol was approved by the University Animal Care and Use Committee.

Four dorsal lacerations 3 cm long were made parallel to the spine to deep fascia. After hemostasis with sterile gauze and pressure, 0.1 ml of a bacterial inoculum was placed in each laceration with a Selectapette (Becton Dickinson and Co., Parsippany, N.J.) sterile pipette system. The lacerations were inoculated with *Staphylococcus aureus* (ATCC 11632) adjusted to a spectrophotometric absorbance of 0.138 to 0.139. Inocula were quantified at approximately 10^8 CFU/ml by standard microbiological methods.

Immediately after inoculation, the four wounds on each animal were approximated in one of four ways: (i) with Nexaband Liquid (*n*-butyl-2-cyanoacrylate and D and C violet number six dye; Veterinary Products Laboratories, Phoenix, Ariz.) (glue), (ii) with subcutaneous suture (i.e., intradermal stitches buried beneath the skin) followed by application of Nexaband Liquid (glue/SQ), (iii) with simple skin suture (suture), or (iv) with intradermal subcutaneous suture followed by simple skin suture (suture/SQ). In selected lacerations, wound edges were approximated manually and a thin line of adhesive was applied along the wound margin with a plastic applicator. Also in selected wounds, one intradermal stitch of 4-0 braided polyglactin 910 suture (Vicryl; Ethicon Inc., Somerville, N.J.) was placed. Similarly, two simple skin stitches were placed with 5-0 monofilament nylon (Dermalon; Ethicon Inc.). The order of closure was advanced by one laceration for each animal. Each wound was dressed with Bioclusive Transparent Dressing (Johnson and Johnson, Arlington, Tex.), a vapor-permeable dressing.

Ninety-six hours after inoculation, all wounds were excised sharply with number 15 scalpels and weighed on sterile gauze with a scale accurate to 0.01 g. Tissue weights varied between 0.07 and 0.18 g. Immediately after excision, the specimens were ground with sterilized mortars and pestles and then were serially diluted in 0.9% saline solution, plated on 5% sheep's blood agar (Remel Inc., Richmond, Va.), and incubated at 37°C overnight. Colony counts were read 24 h after plating. Corrections for variations in tissue weight were made, and bacterial counts were projected for 1 g of tissue.

Quantitative bacterial data were converted to $\log_{10}$ values and were analyzed by a one-way analysis of variance and Tukey B and Dunnett's comparisons of means. The value of alpha was set at 0.05.

Additionally, a time-kill study of Nexaband with *S. aureus* was performed according to National Committee for Clinical Laboratory Standards guidelines (6). Four drops of Nexaband, the approximate amount used to close each laceration, was suspended in Trypticase soy broth before vortexing.

Wound data are summarized in Table 1. Two lacerations were excluded because of a technical abrogation of the protocol. One laceration was excluded from each of the glue and glue/SQ groups. Wound bacterial counts for glue were significantly lower than those for glue/SQ, suture, and suture/SQ. No other comparisons were significantly different. The results of the kill study are summarized in Fig. 1. Broth containing cyanoacrylate exhibited bacterial growth levels significantly lower than those of the control.

The tissue adhesive *n*-butyl-cyanocrylate has been studied as a rapid method of closing human skin lacerations that is less painful than suture (1, 7, 9). Contaminated lacerations closed with suture material are at increased risk of wound sepsis due to local tissue damage (10) and the adsorption of pyogenic bacteria by suture material (8, 11). Further, one study suggests that the combination of *n*-butyl-2-cyanoacrylate and a blue dye may be bacteriostatic for pyogenic gram-positive cocci (4). In contrast, Olson et al. (8) found that *S. epidermidis* rapidly

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TABLE 1. Bacterial counts for contaminated lacerations treated with tissue adhesive and suture[a]

Treatment method	Mean bacterial count ± SD[b]	95% Confidence interval
Glue	1.78 ± 1.9	0.5–3.06
Glue/SQ	4.42 ± 1.92	3.1–5.7
Suture	3.72 ± 1.4	2.83–4.62
Suture/SQ	4.58 ± 1.43	3.67–5.49

[a] The adhesive used was *n*-butyl-2-cyanoacrylate tissue adhesive; skin sutures were done with monofilament nylon, and subcutaneous sutures were done with braided absorbable suture.

[b] Values are $\log_{10}$ conversions of CFU per gram of tissue.

colonizes *n*-butyl-2-cyanoacrylate, producing a biofilm of embedded bacteria.

Eiferman and Snyder used a well diffusion method to posit a bacteriostatic effect of cyanoacrylate on pyogenic gram-positive cocci (4). Theoretical limitations of their study included a possible agar interaction with adhesive. Our kill curve was determined in broth and supports a highly inhibitory effect of Nexaband on *S. aureus*. However, it us unclear whether this antibacterial effect is due to *n*-butyl-cyanoacrylate, the blue dye, or both.

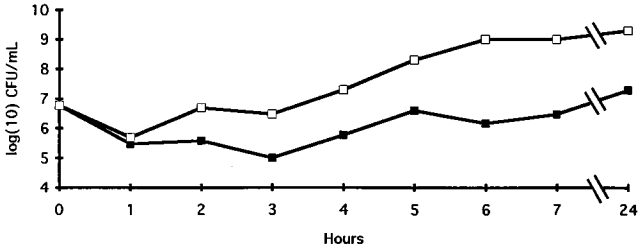

FIG. 1. *S. aureus* kill curve. Closed boxes, cyanoacrylate adhesive; open boxes, control.

Our data show that contaminated wounds closed with cyanoacrylate alone have significantly lower staphylococcal counts than lacerations containing suture material. One reason for this finding is the presence of suture material in some wounds. A bacteriostatic effect of the product containing cyanoacrylate may also be operative, but no study has identified the presence of adhesive in lacerations following surface closures.

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