**Negative pressure dressings on primarily closed wounds improve wound healing parameters at three days in a porcine model**

Meeker, J E; Dahners, L E

University of North Carolina, Chapel Hill, NC

Senior author LED@med.unc.edu

**Introduction:**
Orthopaedic wounds are frequently complicated by local swelling, soft tissue injury, and in some cases loss of dermis. In these situations, wound closure strategy ought to adapt to circumstance, and here modifications of surgical dressings may assist in achieving closure goals.

Negative pressure dressings (NPDs) on closed wounds have been used in various settings. Our clinical experience with this treatment has been encouraging, and while we have been pleased with our results, we wished to obtain objective data to reinforce our practice.

Therefore, we have explored a model to evaluate the effects of NPDs on wound healing. We hypothesized that NPD treatment would have beneficial effects on wound tensile strength, underlying hematoma size, and the clinical appearance of the healing wound.

**Methods:**

Six female Yorkshire pigs (130–165 pounds) were obtained with approval from the institutional care and use committee. Surgical technique involved ten identical, elliptically shaped paraspinous incisions to create wounds closed under tension (FIG). The incisions were carried down through the dermis and subcutaneous fat and into the paraspinous musculature. The dermis was closed with a 2-0 nylon running suture (FIG). Each suture loop was tensioned sequentially to 400–500 grams of tension using a force gauge (GP-72, Jonard, Tuckahoe, NY). The suture ends of wounds on opposite sides of the midline were tied together to allow equal distribution of suture tension between the paired wounds. A sealed envelope was selected at random to determine the dressing intervention pattern.

All wounds were dressed with gauze held in place with Ioban (3M St. Paul, MN). Tubing conveying 125 mmHg of suction was applied to the experimental wound dressings (FIG).

The pigs were fitted with custom jackets to hold the dressings in place, and to allow the animal to ambulate freely in its pen with suction tubing exiting from above. The treatment course lasted 72 hrs, at which point the animal was sacrificed, the wounds were excised in toto, and taken for immediate photography and testing. Each individual wound was sectioned to obtain four uniform strips measured to be 15 mm wide. Calipers were used to measure each wound strip’s precise width to correct for small variations in sectioning.

A servo hydraulic testing apparatus (MTS model 812, Eden Prairie, MN) was used to measure tensile strength, and data was collected using an analog to digital conversion setup (Instron 8500Plus, Norwood, MA). Data was collected for maximum load at failure (N) and energy to failure (MJ).

Cross-sectional photographs of each wound strip were used to measure wound hematoma area. ImageJ (NIH, Bethesda, MD) digital imaging software was used to manually circumscribe and measure hematoma area by a blinded assessor.

At sacrifice, each wound surface was photographed. Three blinded assessors viewed each wound in random sequence. Skin appearance and closure was assessed using a modified visual analog scale.

Statistical comparisons were made between intervention and control wound pairs. Comparisons were reported as “percentages of control.” Data for all outcome measures were compared using a two tailed, paired t-test.

**Results:**
Seven female pigs weighing between 135 and 165 pounds were used in the study. One pig died in the immediate perioperative period due to anesthetic complications, and was excluded from analysis. The remaining six pigs had 56 wounds (28 pairs, four strips for each). The smallest pig only had 8 incisions; one wound pair’s suture broke resulting in wound dehiscence; this pair was excluded from analysis.

Excellent uniform suction was maintained in four of the six pigs. Suction inconsistency/loss was noted in pigs #1 and #4, but both animals were still included in data analysis.

NPD intervention resulted in a 176 +/-227% (1.128 vs. 0.850 mM/m, p=0.035) improvement in energy to failure and a 142+/-65 % (0.470 vs 0.348 N/mm, p=0.001) increase in maximum load at failure.

Data for wound hematoma area was available for the last four pigs (cross sectional photographs were not taken in the first pig, and those taken of the second pig were of inadequate quality for analysis). Blinded measurements of wound hematoma cross sectional areas were 15+/-46% smaller (1.81 vs 2.08 cm², p=0.02) in the suction group than in the controls.

Blinded assessors rated the NPD intervention wounds 44+/-45 % better for closure (6.25 vs 4.61, p<0.001) and 50+/-51% better for skin appearance (6.18 vs. 4.39, p<0.001).

**Discussion:**

This study provides objective data supporting our clinical impression that negative pressure dressings confer clinical benefit to closed surgical wounds. Our model was designed to reflect specific challenges in wound management. The elliptical excisions of tissue from each wound creates a situation where loss of dermis results in consequent wound closure under tension.

Limitations to our findings include the acknowledgement that NPDs may provide little benefit to standard surgical wounds in absence of skin tension or tissue trauma. Nor did our model include a fracture.

Furthermore, a porcine model’s validity may be questioned despite being one of the best surrogates for human dermal morphology and physiology.

A particular strength of our study is the significant positive effect from our intervention. Notably, our mechanical data would have been even stronger had we excluded the 4th pig whose suction failed. The idea of applying suction to closed wounds is not new, but this study provides objective data supporting the concept and using a simple NPD constructed from inexpensive materials.

In summary, our findings provide objective data that NPD wound therapy improves clinical appearance, decreases hematoma size, and increases the mechanical strength of dermal wound closure at three days in a swine model. The clinical relevance of this study lies it its objective support for the human clinical studies that have suggested that closed wounds treated with suction therapy show benefit.