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Wound management with vacuum-assisted closure: experience in 51 pediatric patients

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Abstract

Background / Purpose: Soft tissue loss from infectious, vascular, and traumatic disorders often results in poor healing, painful wound care, and the need for repeated operations. This retrospective study evaluates a single-institutional experience with negative pressure therapy (NPT), using the vacuum-assisted closure (VAC) device in a group of children with diverse soft tissue problems.

Methods: The medical records of 51 patients treated with NPT from January 2000 to July 2003 were reviewed for demographics, diagnosis, duration of VAC therapy, wound closure, recurrent disease, and complications.

Results: Patients were classified by diagnosis: group 1: pilonidal disease (n = 21, primary = 6 and recurrent = 15); group 2: sacral and extremity ulcers (n = 9); group 3: traumatic soft tissue wounds (n = 9); and group 4: extensive tissue loss (n = 12) from the abdominal wall (n = 7), perineum (n = 2), thigh (n = 2), and axilla (n = 1). Group 1 had an average age of 16 years (range, 10-20 years), 67% were obese, and had an average length of follow-up of 13 months (range, 8-36 months). VAC was placed in the operating room in 95% with subsequent outpatient care that included dressing change 3 times weekly. Healing occurred in all patients with primary disease at an average of 37 days. For patients with recurrent disease, 12 healed at an average of 48 days and 3 developed recurrent sinuses. Group 2 was treated with VAC as a bridge to skin grafting or flap closure. All children in group 3 achieved healing without skin grafting at an average of 10 days and with acceptable cosmesis. Negative pressure therapy in group 4 was the only wound treatment in 10 patients and adjunctive to operative closure in 2. Complications from VAC occurred in 5 patients: retained sponge in 2 and device malfunction in 3.

Conclusions: Negative pressure therapy offers a safe, cost-effective alternative to traditional complex wound care in children. Its advantages are less frequent dressing changes, outpatient management, resumption of daily activities including return to school, and a high degree of patient tolerance.

Major soft tissue wounds in children are attended by significant morbidity including frequent dressing changes, patient and parental anxiety about procedural pain, lengthy hospital stays, and the potential for repeated operations. Since 2000, we have used negative pressure therapy (NPT) with the vacuum-assisted closure (VAC) device for the treatment of soft tissue loss from infections, vascular insufficiency, and trauma. VAC is a system that applies controlled negative, subatmospheric pressure to the wound

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bed, a technique that Argenta and Morykwas [1] have shown enhances healing and promotes closure of open wounds. An open-cell foam dressing is placed into the wound cavity and covered with a clear, adherent drape. Negative pressure, usually at 125mm Hg below ambient pressure, is applied to the wound. This technique has been found to remove tissue edema, increase localized blood flow, and enhance formation of granulation tissue [2]. This report summarizes our clinical experience in 51 infants, children, and adolescents who had placement of the VAC system for the management of their soft tissue wounds.

1. Materials and methods

Between January 2000 and July 2003, 51 patients were managed for soft tissue wounds with the VAC device. Their medical records were evaluated retrospectively for demographics, diagnosis, duration of NPT treatment, wound closure, complications, and recurrent disease. The VAC device is manufactured by KCI, San Antonio, Tex. This study was approved by the Institutional Review Board of the Children's Hospital, Columbus, Ohio (0306HSEO68). Patients were classified according to their diagnosis: group 1 (pilonidal disease), group 2 (extremity and sacral ulcers), group 3 (traumatic soft tissue wounds), and group 4 (soft tissue loss from the abdominal wall, perineum, thigh, and axilla).

2. Results

2.1. Pilonidal disease (group 1)

Twenty-one patients presented with acute or chronic pilonidal disease; 6 children had primary cysts/sinuses and 15 had recurrent sinuses. The average age was 16 years (range, 10-20 years), 67% were obese, and all were treated as outpatients. Initially, NPT was used for patients with recurrent pilonidal disease, and offered subsequently to adolescents with primary disease after favorable outcomes in the recurrent group. In 13 of the 15 patients with recurrent pilonidal disease, VAC was placed in the operating room after resection of involved tissues. For 2 of the 15 patients, the wound was packed with saline-soaked gauze and VAC was applied within 24 hours. Obese patients had an average wound closure of 62 days, and lean adolescents healed at an average of 38 days. Of the 6 patients with primary disease, all were treated with VAC in the operating room; healing averaged 30 days in lean adolescents and 45 days in obese patients.

By the third postoperative day, 87% of the children had returned to school with the VAC in place and with scheduled change of the sponge dressing 3 times weekly at home. Fig. 1 illustrates operative placement of NPT and the postoperative result. All of the complications related to VAC occurred in group 1 patients: retained sponge (n = 2) and device malfunction (n = 3). In 1 patient with retained sponge material, operative removal was required and in the other patient removal was performed in the surgical clinic. Malfunction of the device occurred in 3 adolescents, necessitating temporary conversion to saline-soaked gauze and reapplication of the VAC in the surgical clinic. All of these complications occurred early in the clinical series and in the first year of NPT use.

2.2. Sacral and extremity ulcers (group 2)

Nine patients with myelomeningocele-related sacral and extremity ulcers were treated with NPT before definitive skin grafting and/or flap closure. Operative debridement of devitalized tissue was followed by placement of the VAC for an average of 8 days. Successful skin grafting and flap

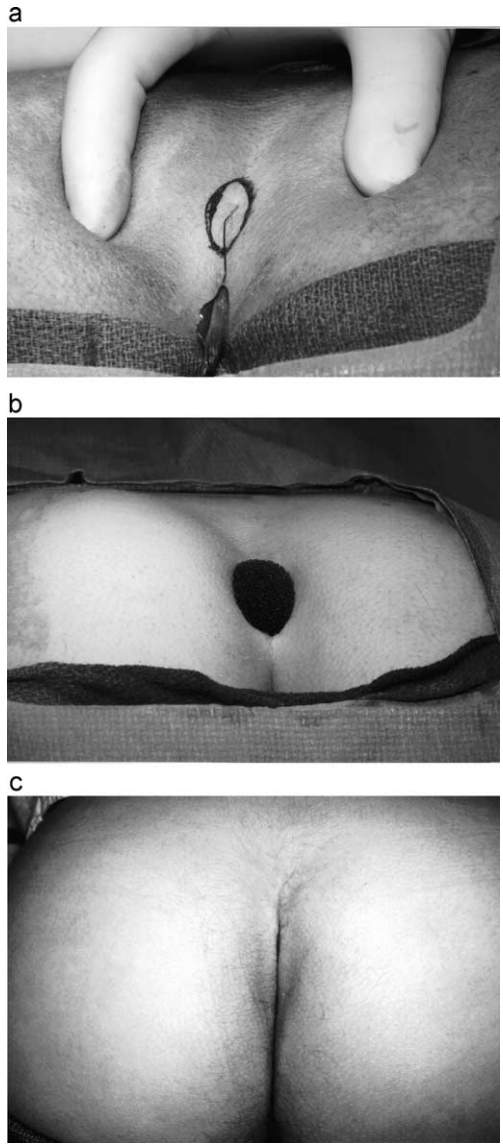

Fig. 1 a, Probe in pilonidal sinus tract with tissue to be excised outlined by marker. b, VAC in tissue defect. c, Postoperative result at 3 weeks.

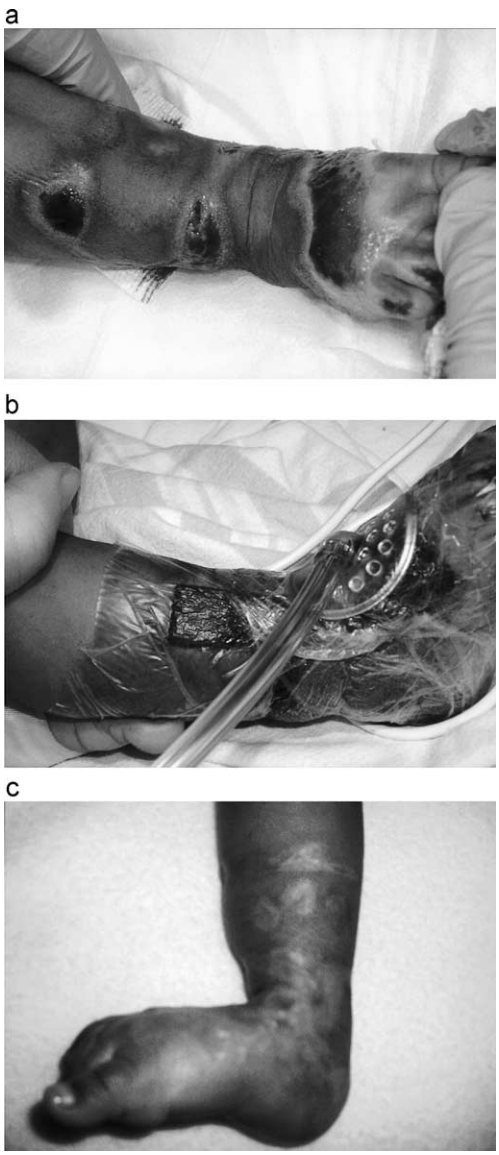

Fig. 2 a, Extremity with soft tissue loss from an intravenous extravasation. b, VAC in tissue defect. c, Healing at 2 weeks.

closure was accomplished in 8 of the 9 children; skin graft failure in 1 child was managed with flap closure and an additional application of NPT.

2.3. Traumatic soft tissue wounds (group 3)

Nine children sustained significant skin and soft tissue loss of the upper (n = 1) and lower (n = 8) extremities from blunt trauma (n = 5), gunshot injuries (n = 2), and intravenous extravasation (n = 2). The patients with blunt and penetrating trauma underwent operative debridement and VAC placement within 24 hours of hospitalization. The 2 infants with tissue loss from intravenous extravasation had NPT instituted after surgical consultation. In all cases, wound healing occurred without the need for skin grafting at an average of 10 days and with acceptable limb function. Fig. 2 illustrates VAC in an infant with extremity tissue loss from an intravenous extravasation to the lower extremity.

2.4. Extensive compartmental tissue loss (group 4)

Twelve infants and children sustained extensive soft tissue loss secondary to infectious complications: abdominal wall (n = 7), perineum (n = 2), thigh (n = 2), and axilla (n = 1). Five of the 7 patients with abdominal wall tissue loss were treated with NPT and had complete healing without further operative intervention. As shown in Fig. 3, a neonate with abdominal fascial dehiscence after restoration of intestinal continuity following necrotizing enterocolitis had VAC placed at the bedside. Progressive wound contraction and healing occurred over a 3-week period. Another neonate with

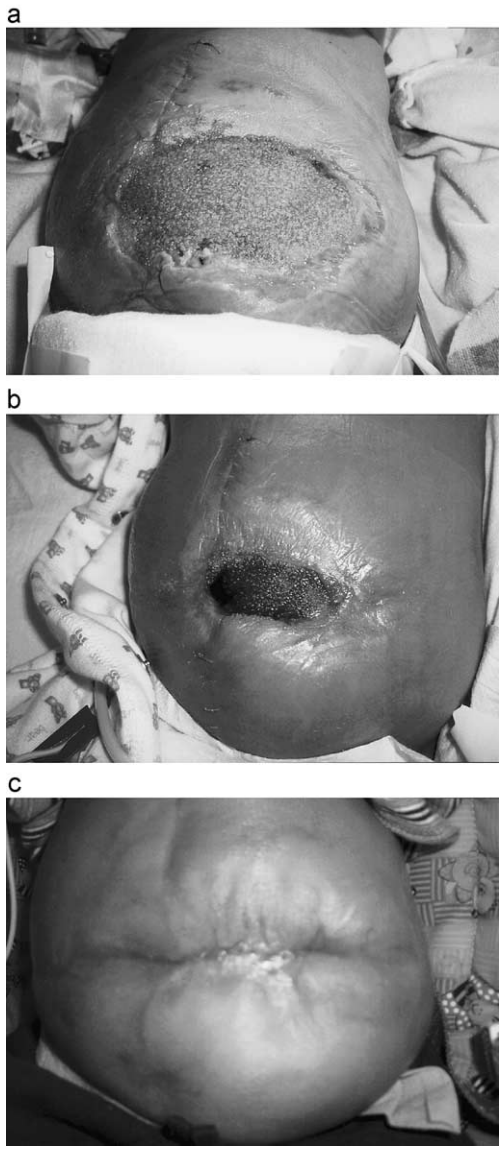

Fig. 3 a, Abdominal wound in a neonate. b, Appearance of wound at 10 days after placement of VAC. c, Healed abdominal wound at 3 weeks postdehiscence.

omphalitis required debridement and resection of a significant portion of the periumbilical skin, soft tissue, and fascia. The VAC was placed on the third postoperative day; wound contraction and complete healing occurred over a 1 month period; at 1 year there was no clinical evidence of ventral herniation. A child with a small bowel fistula after ruptured appendicitis was treated with total parenteral nutrition and VAC; resolution of the fistula and wound healing occurred within 18 days.

Two patients with abdominal compartment syndrome after septic shock and perforated intestine were managed with application of the VAC intraoperatively; fascial closure of the abdomen was performed on the 12th and 16th postoperative days. The other patients with perineal, thigh, and axillary soft tissue loss achieved complete wound healing without skin grafting.

3. Discussion

This clinical series represents the first large group of pediatric patients with diverse causes of soft tissue loss who were managed successfully with NPT using VAC. Numerous case reports in the plastic and general surgical, thoracic, and orthopedic literature detail the advantages of VAC for adult patients [3-12]. Mooney et al [13] treated 27 children with traumatic and infectious lower extremity tissue loss using NPT. They advocated early application of VAC in the setting of both acute and chronic wounds; one third of their patients had either delayed primary wound closure or complete healing without the need for flap closure.

Based on our initial success with NPT in adolescents with pilonidal disease and ulcers of the sacrum and extremities, we expanded the clinical indications for VAC to include infants and children with extensive tissue loss of the abdominal wall, perineum, and extremities. VAC offers several advantages over traditional methods of wound care for patients with large, open wounds: a clean, closed system that permits measurement of fluid losses; a clear dressing for easy visual inspection of the sponge dressing; device change on a periodic basis (typically every other day or every third day) rather than daily or more frequently; and enhancement of wound contracture. In our patients with extensive skin and soft tissue loss from the abdominal wall, NPT allowed progressive wound contracture and obviated the need for secondary operative procedures. These patients achieved abdominal wall healing in a timely fashion and did not have evidence of ventral herniation at long-term follow-up.

At our institution NPT has become the preferred modality for wound management in the majority of children with major soil tissue wounds. When possible, the VAC is placed intraoperatively and subsequent device change is determined by the hospitalization status of the patient. For children with pilonidal disease the VAC is managed on an outpatient basis and changed 3 times weekly by a visiting nurse. These patients are able to return to normal activities using a portable VAC device. Inpatients have their VAC changed by the hospital's enterostomal therapist, typically at the bedside at 3-day intervals. Most children with moderate wounds tolerate device changes with conventional pain medications; patients with extensive tissue loss, such as those with abdominal and perineal wounds, receive conscious intravenous sedation [14].

Although cost-effectiveness was not the focus of this report, NPT was shown to be an economical treatment for adult patients with pressure ulcers [15]. In this study, the authors calculated the estimated time for expected healing of pressure wounds of various sizes and determined that VAC promoted healing 61% faster than similar wounds treated with saline-soaked gauze dressings and reduced cost by 38%, including material costs and nursing visits. There are no prospective studies that address the cost-effectiveness of NPT in pediatric patients. It is our clinical judgment that wound healing is enhanced in children treated with VAC, a situation that is most notable in obese adolescents with large pilonidal wounds.

To date, we have experienced no treatment failures with NPT in which the VAC was removed prematurely and wound care converted to traditional saline-soaked gauzes. The problems of retained sponge material and device malfunction were early in our series; increased skill and familiarity with the device by the home health care nurses in our referral region have eliminated these issues.

The limitations of this report include its retrospective, single-institutional basis and lack of prospective comparison of NPT to traditional wound management with periodic dressing changes. Conclusions about the superiority of the wound VAC over other methodologies must be weighed accordingly, since it is unlikely that a prospective clinical trial would successfully recruit patients into the traditional treatment group. Since the inception of negative pressure treatment for complex wounds, the nursing staff, physicians (surgical and nonsurgical), parents, and patients at our hospital have uniformly favored its application over traditional wound packing and twice-daily dressing changes.

VAC offers a safe and reliable alternative to traditional methods of managing large, open, soft tissue wounds in infants, children, and adolescents. Patients and their families accept this treatment because it affords fewer dressing changes, allows mobility without bulky bandages, and permits return to school and other activities.

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Discussion

D. Ostlie (Kansas City, Mo): Dr Teich, I enjoyed your paper and applaud your group for employing a technique that has really gained enormous popularity in the adult world and introducing it here today to our pediatric colleagues. I have 2 questions for you. The first centers on the management of the dirty wound with the VAC device. Do wounds in your experience need to be clean before the application of the device itself? Second, in Kansas City we have begun to use this device in application of skin grafts, specifically not only in the donor bed but also in the recipient area with great success. Does your group have experience in this regard, and, if so, how have you found your results to be? Thanks.

S. Teich (response): Thank you. Taking your second question first, some of the surgeons have used it over skin grafts. The plastic surgeons have used it for that, especially when they have a skin graft over bony sites or sites that are hard to keep the grafts in contact with the bed. Some people actually advocate using it for donor sites also to improve healing rates. We have not done that. As for your first question, when do you put in on? We put it on a clean wound. If you had a traumatic injury, we may take the patient back and clean the wound, debride it, until we are satisfied that it is clean, and then put the device on. Those kinds of patients are in the hospital and we can look at the wound, when the dressing is changed, with the enterostomal therapist who is in charge of all these patients. We can look at it and decide if we need to debride it further.

A. O'Connor (Tucson, AZ): Dr Teich, I wondered if you could comment on the use of the VAC in neonates with specific regard to what types of pressures should we be putting on the sponges for closure of skin wounds in kids who may have more delicate tissue.

S. Teich (response): I'm not sure if anybody really knows what pressure to use. I don't think we actually decreased the amount of pressure very much. We have used it on patients who have had fistulas without any problems, without continuing the fistula. The fistula has gone on to heal.