MANAGEMENT OF COMPLICATED HEAD AND NECK WOUNDS WITH VACUUM-ASSISTED CLOSURE SYSTEM

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Abstract: Background. The vacuum-assisted closure system (V.A.C.), or negative pressure dressings, has been successfully used to manage complex wounds of the torso and extremities, but its role in the head and neck region has not been frequently described.

Methods. A retrospective study was performed. The V.A.C. system (Kinetic Concepts Inc., San Antonio, TX) was used at the University of Iowa Hospitals and Clinics for management of complicated head and neck wounds.

Results. The V.A.C. system was utilized at 13 sites for 12 patients. Nine subjects had exposed calvarium (4 had failed pedicled reconstructive flaps, 3 had ablative or Moh’s defects, and 2 had traumatic scalp injuries) necessitating bony coverage. Three subjects had the V.A.C. system used as a bolster dressing placed over split-thickness skin grafts (STSGs) used to reconstruct large defects of the face and skull, and 1 patient had a large soft tissue neck defect after radical surgical resection for necrotizing fasciitis. One subject used the V.A.C. system for the management of 2 distinct wounds. All patients had successful healing of their wounds with the V.A.C. system without complication. All STSGs had 100% viability after 5 to 7 days of the V.A.C. system use as a bolster dressing.

Conclusion. This study demonstrates the V.A.C. system is a valuable tool in the management of complicated head and neck wounds.

Keywords: vacuum-assisted closures; V.A.C.; negative pressure dressing; head and neck wounds; scalp injuries; split-thickness skin grafts

Wounds of the head and neck are difficult to manage for a multitude of reasons. The surgeon is often confronted with a delicate balance of achieving an acceptable aesthetic result while allowing optimal functionality of surrounding head and neck tissues. Wounds containing exposed bone are particularly difficult to manage because of the poor vascularity of the exposed tissue. These wounds commonly present after large surgical resections, failed reconstructive procedures, and trauma. Frequently, patients have received previous radiotherapy, chemotherapy, or both. Management of these wounds is often complex and may involve microvascular reconstruction because of limited adjacent tissues available for reconstructive purposes.

Argenta and Morykwas1,2 introduced sub-atmospheric, or negative pressure dressings, in 1997, as a means of managing complicated wounds. This method is often referred to as the vacuum-assisted closure system (V.A.C.) (Kinetic Concepts Inc., San Antonio, TX). Since its intro-
duction in 1997, the V.A.C. system has been widely used in the fields of general plastic surgery, general surgery, orthopedic surgery, and obstetrics and gynecology to manage complicated wounds of the torso and extremities. Its use in head and neck surgery has yet to be defined.

The V.A.C. system facilitates wound healing by several means. The negative pressure applied by the dressing increases dermal and subdermal perfusion, as well as decreases wound edema by actively removing interstitial fluid. Furthermore, the V.A.C. system stimulates granulation tissue growth, limits wound exudate formation, debrides wounds when removed, and may decrease the bacterial load on a wound, although this point is debatable.3

We hypothesized that the V.A.C. system is applicable to a number of wound types in the head and neck region and may expedite wound healing in certain clinical situations. The goal of this study was to evaluate the V.A.C. system in the management of complicated wounds encountered by head and neck surgeons.

MATERIALS AND METHODS

A retrospective study was performed from January 1, 2004 to September 1, 2004 on patients who presented to the University of Iowa Otolaryngology-Head and Neck Surgery service with complicated wounds for which the V.A.C. system was used. IRB approval was obtained.

The V.A.C. system consisted of the ATS model while the patient was hospitalized and the Freedom model for outpatient treatment. Negative pressures ranging from 100 to 125 mm Hg were applied to black polyurethane foam sponge (KinetiCera Inc., San Antonio, TX) trimmed to the appropriate wound size. An occlusive seal over the V.A.C. sponge was maintained by a combination of the occlusive dressing, Tegaderm, Skin Prep, and Benzoine (KinetiCera Inc.). The V.A.C. dressings were changed 3 times a week until adequate wound healing was obtained. Alternatively, the V.A.C. system was left in place for 5 days when used as a bolster to cover split-thickness skin grafts (STSGs). Burn interface dressings were placed between all STSGs and the sponge to prevent inadvertent graft removal when the V.A.C. system was discontinued.

RESULTS

Twelve patients with complex wounds presenting to the University of Iowa, Department of Otolaryngology-Head and Neck Surgery service, from January 1, 2004 to December 1, 2004 were included in the study. The V.A.C. system was utilized for 13 wounds, with 1 patient having 2 different uses (Table 1). Eight patients were men and 4 were women. The average patient age was 61.8 years (range, 43–86 years). The time of the V.A.C. system application varied depending on the indication for its use, with the longest being 6 weeks.

<table>
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<tr>
<th>Patient no.</th>
<th>Wound size, cm</th>
<th>Bone exposure without peristeum</th>
<th>Etiology</th>
<th>V.A.C. goal</th>
<th>Further procedures</th>
<th>Previous radiation</th>
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<td>1</td>
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Abbreviations: V.A.C., vacuum-assisted closure; STSG, split-thickness skin graft; MVA, motor vehicle accident.
weeks to facilitate soft tissue coverage of exposed bone in the orbit and the shortest being 5 days when used as a bolster over STSGs.

Exposed bones of the skull without periosteal coverage were present in 9 patients (69.2%) for a multitude of reasons (4 failed pedicled reconstructive flaps, 3 ablative or Moh's defects, and 2 traumatic scalping injuries). The V.A.C. system was successful in creating a granulation tissue bed in all 8 patients who necessitated bony coverage. One patient did not necessitate soft tissue coverage of his exposed calvarium, because an

FIGURE 1. Necrotizing fascitis of orbit and periorbit. (A) Postdebridement defect. (B) Wound vacuum-assisted closure (V.A.C.) in place. (C) Results after 2 weeks of V.A.C. therapy. (D) Results after 4 weeks of VAC therapy. (E) Results after 6 weeks of V.A.C. therapy reveals complete granulation tissue coverage of the orbit and periorbit and significant wound contracture. (F) Orbital prosthesis in place. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
intact pedicled skin flap was present from a traumatic scalping injury, but the wound did require the V.A.C. system for an initial 5-day period of wound healing and debridement prior to delayed-primary closure of the wound.

The time required for adequate granulation tissue coverage of exposed bone varied depending on the amount of exposed bone initially present. The most prolonged case involved orbital bone exposed following necrotizing fascitis debridement (Figure 1). This wound was successfully covered with granulation tissue and significantly contracted by 6 weeks following the initiation of the V.A.C. system. An STSG was placed over the granulation tissue bed and the final rehabilitation involved construction of an orbital prosthesis.

The V.A.C. system was used as a bolster dressing to cover STSGs on the face or skull in 3 cases (Figure 2). The bolster dressing was left in place for 5 to 7 days in all cases. All skin grafts had 100% take when the V.A.C. system was removed. One of these patients had the V.A.C. system successfully applied to the exposed underlying calvarium to create a granulation tissue bed prior to STSG placement. There was no crusting present on the skin grafts after removal, and all subjects demonstrated a viable graft on follow-up.

The V.A.C. system was useful in the management of traumatic scalping injuries (Figure 3). One patient had an attempt at primary closure that became infected and had a large amount of scalp tissue loss exposing calvarium. The V.A.C.

**FIGURE 2.** Vacuum-assisted closure (V.A.C.) therapy used as bolster over split-thickness skin graft (STSG). (A) Initial defect. (B) STSG covering initial wound. (C) V.A.C. therapy applied over STSG as bolster. (D) STSG results post V.A.C. therapy. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
system was placed and successfully created a granulation tissue bed over the exposed calvarium, and a small local flap was used to close the remaining defect with hair-bearing skin. The second patient had a contaminated scalping injury after a motor vehicle accident. A large posterior pedicle was left intact with a plane of dissection deep to the periosteum exposing his calvarium. The V.A.C. system was placed between the exposed calvarium and the pedicled skin flap for 7 days with 1 dressing change to allow for debridement. Delayed primary closure was then performed without complication 1 week after the initial injury.

Patient comorbidities were common in our study population. Ten of the 12 patients (83.3%) had at least 1 underlying illness that made them high-risk surgical candidates. The most common illnesses were cardiac disease (66.6%) and cancer (66.6%). Other comorbidities consisted of pulmonary disease (58.3%), hypertension (58.3%), diabetes (16.6%), and liver and kidney disease (8.3%). The V.A.C. system was successfully used without complication in all these subjects. One patient died of cardiac disease shortly after completing V.A.C. therapy.

There were no complications in this study. One patient was unable to tolerate the initial 125 mm Hg of negative pressure because of pain when placed over his orbit, so the pressure was reduced to 100 mm Hg for the initial 3 days. It was subsequently increased to 125 mm Hg without difficulty. Two wounds (15.4%) required additional sharp debridement between V.A.C. dressing changes.

**DISCUSSION**

Morykwas and Argenta1,2 first described the use of topical negative pressure dressings in 1997. Their animal model reported a fourfold increase in blood flow to the wound and adjacent tissues, significant increases in granulation tissue forma-
tion when compared with controls, and decreased bacterial counts after 4 days of application. The clinical data matched their animal model data and included 296 patients with a variety of acute, subacute, and chronic wounds of the torso and extremities.

Several studies have been published documenting the benefits of the V.A.C. system in other specialties. It has been shown to increase granulation tissue growth when compared with controls. It has been shown clinically to promote angiogenesis and to actively debride wounds. When studied along with hyperbaric oxygen (HBO) therapy in an animal model, the V.A.C. system significantly increased the rate of healing independent of HBO therapy.

Bony exposure of the calvarium in which the periosteum is absent represented the majority of cases (9 of 13) in which the V.A.C. system was used in this study. Traditionally, these wounds have been difficult to manage because of the poor vascularity of cortical bone. Depending on the wound size, it may require weeks to months of dressing changes to facilitate granulation tissue coverage, as wound healing occurs from the periphery inward when the periosteum is absent. Wound healing time required for granulation coverage of exposed calvarium was significantly improved when compared with similar wounds managed by traditional dressing changing methods in the authors' experience (Figure 4).

Schneider et al described the use of the V.A.C. system as a means of securing split-thickness skin grafts in association with improved wound outcomes when compared with traditional bolster dressings. Scherer et al found fewer graft failures and need for repeated skin grafts in patients wherein the V.A.C. system was used as a bolster. In our experience, the V.A.C. system was an excellent choice for bolster application on the head and neck. It is often difficult to secure a traditional bolster on the head and neck with adequate pressure over the entire graft. The V.A.C. system is an excellent bolster choice for this reason, as the negative pressure allows for good graft contact along all parts of the wound. Also, negative pressure prevents crusting from collecting at graft “pie hole” sites unlike traditional bolster methods.

Scalping injuries are a difficult problem for head and neck surgeons. Because of the traumatic nature of these wounds, infection and tissue loss are common. Molnar et al has previously described a single-stage approach to skin grafting exposed calvarium using the V.A.C. system. In our study, both patients presenting with scalping injuries had an intact skin pedicle. The first wound was repaired primarily and became infected and resulted in a large amount of non-viable scalp tissue. The second wound was grossly infected at presentation, so a delayed primary closure was performed 5 days after the V.A.C. system application, allowing for adequate drainage and debridement. Loss of hair-bearing skin has always been problematic for reconstructive surgeons. The easiest solution is to maintain the viability of the original scalp tissue. This was done successfully in our second patient. When this is not possible, the V.A.C. system is an excellent choice to promote wound healing and contraction to minimize the necessity of additional procedures.

There are many limitations of the V.A.C. system that make it difficult to use for head and neck wounds. The multiple contours of the head and neck as well as the presence of hair-bearing skin make obtaining an airtight seal around the wound difficult. This similar problem has been encountered in other specialties. Particularly difficult areas to obtain an airtight seal in this study included a naso-orbital fistula secondary to necrotizing fascitis with bone loss at the site of the nasolacrimal duct and the neck around the site of a recently decanulated tracheostomy. The naso-orbital fistula was closed with a combination of fascia and fibrin glue, and the tracheotomy site was covered with an occlusive dressing.

Similar wounds for comparison were encountered during this study period, which were not amenable to the V.A.C. system. One patient (Figure 4A) underwent an orbital exenteration for mucormycosis creating a large bony defect. Because of intracranial involvement, dural resection was necessary, which was reconstructed with pericranium precluding the use of the V.A.C. system. HBO therapy (20 dives) and wet to dry dressings were used, and minimal granulation tissue was present after 4 weeks. This patient required a free flap reconstruction. One study patient (Figure 4B) avoided a similar procedure when the V.A.C. system created a healthy granulation tissue bed over the bone exposed orbit allowing a skin graft to be placed. A second patient has had multiple STSG reconstructions after Moh's procedures. Previously, he had partial STSG loss (~25%) when a traditional bolster
dressing was used (Figure 4C) and had 100% viability of the STSG when the V.A.C. system was used as a bolster on the opposite side (Figure 4D). The V.A.C. greatly simplified wound care, facilitated superior wound healing, and prevented further surgical intervention in both of these cases.

Costs of the V.A.C. system differ depending on the institution at which care is initiated and their prearranged third payer contracts. Rental of the inpatient or outpatient V.A.C. system and dressing supplies can range from $100 to $200 a day. Most third party payers cover the V.A.C. system. In our experience, the V.A.C. system has reduced wound healing time, time of hospitalization, and amount of time health care personnel spend tending to a wound. All these factors would need to be analyzed to do a true cost comparison analysis and would be difficult to control.

The V.A.C. system can also be painful and difficult to tolerate. All patients in this study tolerated the V.A.C. system, although intravenous or oral narcotics were required in all cases initially. Although not encountered in this study, concerns exist regarding the placement of the V.A.C. system over large blood vessels and over exposed dura, and is not recommended at this time. Electrolyte abnormalities secondary to fluid losses

**FIGURE 4.** Wound comparison. (A) Minimal granulation tissue covering orbital defect after 4 weeks of hyperbaric oxygen (HBO) therapy and wet to dry dressing changes. (B) Near complete coverage of the bony orbit after 4 weeks of vacuum-assisted closure (V.A.C.) therapy. (C) Partial loss of split-thickness skin graft (STSG) inferiorly and superiorly requiring healing by secondary intention after traditional bolster dressing. (D) Complete viability of STSG after V.A.C. bolster dressing. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]
from wounds are also possible but did not occur in this study.

CONCLUSION

The V.A.C. system has been shown to promote wound healing and facilitate STSG viability in a multitude of studies. In our experience, the V.A.C. system was an excellent modality for managing complex wounds encountered by a head and neck surgery service. The V.A.C. system is also a useful modality when used as a bolster to enhance head and neck STSG take. There were no complications related to the V.A.C. system, and several patients with multiple comorbidities were managed conservatively without the need for large operations.

REFERENCES