Vacuum-Assisted Wound Closure: Clinical Applications

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Abstract: Vacuum-assisted closure (VAC) is a wound management system that exposes a wound bed to local negative pressure to promote healing. Benefits of VAC therapy include removal of fluid from the extravascular space, improved circulation, enhanced granulation tissue formation, and increased bacterial clearance. VAC therapy has been used extensively in human patients to treat a variety of acute and chronic wound conditions. This article reviews the use of VAC therapy in a variety of wound conditions and describes our experiences with using VAC therapy in dogs and cats at the University of Florida.

Vacuum-assisted closure (VAC) is a noninvasive, active wound management system that exposes a wound bed to local subatmospheric pressure, removes fluid from the extravascular space, improves circulation, and enhances the proliferation of granulation tissue. VAC therapy was introduced in human medicine as a treatment modality for managing open fractures and chronic diabetic ulcers and has substantially improved the treatment of many acute and chronic wound conditions in human patients. Much of the original research validating the efficacy of VAC therapy was based on experimental studies performed on animals; however, there are few published reports regarding the clinical use of VAC therapy in veterinary patients.

VAC therapy was first used at the University of Florida Veterinary Medical Center in 2001 for the management of severe, traumatic degloving wounds in a tiger cub. Since that time, we have used VAC therapy extensively in the treatment of acute and chronic wounds in dogs and cats (FIGURES 1 AND 2). This article presents our experience with VAC therapy in dogs and cats and briefly describes VAC therapy use in human patients. The technique for VAC bandage application as well as the mechanisms of action of, complications of, and contraindications to VAC therapy were reviewed in the December 2009 issue of *Compendium*.

Skin Avulsions

We have used VAC therapy to treat a variety of skin avulsions and physiologic degloving (in which the skin remains attached but is separated from the underlying fascia and blood supply) injuries, many associated with severe musculoskeletal trauma. In cases of skin avulsion associated with an open wound, the foam portion of the VAC bandage was placed between the skin and subcutaneous tissue for approximately 3 days until healthy granulation tissue began to form. The foam was then withdrawn from beneath the wound margin and placed over the remaining open wound surface to aid in adherence of the avulsed skin to the underlying granulation bed. When physiologic degloving occurred without an associated open wound, the skin in the avulsed area was fenestrated and a VAC bandage applied over the fenestrated area. Skin adherence to the underlying tissues typically occurred 3 to 4 days after initiation of VAC therapy.

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VAC has been a useful form of wound therapy for appendicular degloving injuries in human and veterinary patients. Treatment of appendicular degloving injuries with surgical reattachment of the skin and an overlying VAC bandage has resulted in reported skin survival rates of between 60% and 100% in human patients. A recent study reported the successful management of 15 dogs with distal extremity wounds using VAC therapy before definitive treatment.

**Abdominal and Thoracic Applications**

We have used VAC therapy for the treatment of septic peritonitis in one dog. After exploratory laparotomy and thorough lavage, a sterile, nonadherent, fenestrated sheet of plastic (Adaptec, Johnson & Johnson, Piscataway, NJ) was sutured to each edge of the incised linea alba. Foam was then placed within the abdominal incision and covered with the adhesive dressing. The airtight VAC bandage allowed the abdomen to remain open, aiding drainage, while minimizing the risk of potential secondary ascending nosocomial infection.

We have also used VAC therapy over an open thoracic cavity in a dog presenting with penetrating bite wounds to the lateral thorax and abdomen (FIGURE 3). Surgical exploration revealed pyothorax, a large thoracic wall defect, and multiple rib fractures with substantial necrosis and contamination of the intercostal musculature. The thoracic and abdominal cavities were thoroughly lavaged, and necrotic tissue was debrided. The ribs were apposed, intentionally leaving an incomplete seal of the thoracic cavity. Foam was placed over the ribs and beneath the surrounding skin, and the remaining VAC components were applied routinely. The vacuum was set at −125 mm Hg and functioned to not only provide continuous suction to the wound but also drain the

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**FIGURE 1**

VAC therapy can be applied to wounds in locations that are difficult to manage with traditional therapy.

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**FIGURE 1**

- Sternal wound (cranial is to the bottom of the image).
- Large bite wound on the dorsum (cranial is to the right).
- Degloving wound of the abdomen and inguinal region (cranial is to the right).

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**Upcoming topics in this series include conventional foreign object removal and suspensory ligament rupture. All Surgical Views articles are peer-reviewed by ACVS diplomates.**

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When the VAC bandage was removed 3 days after surgery, a substantial amount of granulation tissue was present. The wound was closed at this point, and the dog made a complete recovery.

In human patients, VAC bandages are commonly placed on open abdominal incisions after exploratory laparotomy when additional laparotomies are planned. Separation of the open-celled foam from the abdominal and thoracic viscera by a sheet of Vaseline or silicone mesh is recommended to prevent enterocutaneous fistula formation.

Surgical Dehiscence

We have used VAC therapy to treat a number of surgical dehiscences, most of which were associated with wound infection after orthopedic procedures and resulted in exposed orthopedic implants. VAC therapy has been instrumental in accelerating the development of healthy granulation tissue and the rate of contraction, resulting in a decreased time to wound closure.

VAC has been used extensively in human patients for the closure of incisional dehiscences. The use of VAC therapy has been shown to decrease the wound management time required before a delayed secondary closure could be performed as well as to accelerate closure by second-intention healing alone. The human literature also supports the use of VAC therapy in cases of surgical dehiscence with exposed orthopedic implants, bone, or tendons. The VAC system maintains these wounds in a closed environment, preventing further contamination, and enhances the rate of granulation tissue formation over the exposed bone, tendon, or implant.

Chronic Nonhealing Wounds

We have used VAC therapy to manage cats suffering from indolent pocket wounds secondary to atypical Mycobacterium spp infection (FIGURE 2) and traumatic injury. The wounds had been previously managed with wet-to-dry bandages and attempted surgical closure. With VAC therapy, each

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**FIGURE 2**

An indolent inguinal pocket wound in a cat after multiple failed attempts at surgical closure, including omentalization.

A. Before application of the VAC system, the wound has an unhealthy granulation bed.

B. The VAC dressing in place.

C. Granulation bed after 3 days of VAC therapy.

D. At 3-month follow-up, the wound has decreased in size by 90%.
wound dramatically decreased in size over the treatment period. The VAC system was beneficial in removing copious amounts of exudate, thereby keeping the wounds clean and facilitating closure. Each wound decreased in size by approximately 90%, allowing it to be more easily managed by the cat’s owner and seemingly reducing the associated morbidity.

One of the first documented uses of VAC therapy in human patients was for the nonsurgical treatment of chronic nonhealing wounds. Argenta and Morykwas reported on 175 human patients with chronic nonhealing wounds attributed to pressure ulcers, dehisced wounds, venous stasis ulcers, radiation ulcers, and diabetic ulcers. Of the 175 patients treated with VAC therapy, 171 responded favorably, resulting in complete closure or closure after a less invasive skin graft or skin flap.

Postoperative Seroma and Edema Prevention
We have used VAC therapy to prevent postoperative edema and seroma formation after tarsal and carpal arthrodesis, including limb salvage procedures for distal radial osteosarcoma. In these cases, the surgical incision is closed routinely and a strip of foam is placed directly over the incision. The remainder of the VAC bandage is applied, and the pressure is set at –50 mm Hg. The VAC bandage is left in place for 2 to 3 days, after which VAC therapy is typically discontinued.

VAC therapy has been used in human patients to prophylactically manage surgical wounds with a high potential for...
seroma formation or postoperative discharge. VAC dressings are placed over the surgical incision at a low negative pressure (–50 mm Hg) for 24 hours, preventing seroma formation and resulting in wounds that heal uneventfully.

**Bolster Dressing for Skin Flaps and Grafts**

Our experience with VAC therapy used as a bolster dressing for skin grafts has been in cases with degloving injuries to the distal limb. Each wound was treated with VAC therapy for 3 to 6 days until a healthy granulation bed was present. A full-thickness meshed skin graft was then placed over the wound and a nonadherent layer (Adaptec) placed over the graft. A VAC bandage was applied over the grafted area and left in place for 4 to 5 days. Graft survival has been complete in all but one dog, in which the graft bed had an exposed tendon and a defect in granulation tissue. Failure of the graft in this dog was likely associated with premature grafting, and longer treatment with VAC therapy before grafting might have improved the recipient bed and graft acceptance.

A recent study examined the use of the VAC system to prepare wound beds for skin grafting or flaps in 15 dogs with distal extremity wounds. Once a suitable wound bed had developed (range: 2 to 7 days; mean: 4.6 days), wounds were treated with either a skin flap or graft, and VAC was reapplied to secure the graft to the wound bed. The VAC bandage was removed after 72 hours, and 100% of grafts survived.

VAC bandages have been used as a bolster dressing over skin grafts in human patients, and split-thickness skin graft survival is reportedly as high as 97% using this technique. The reported benefits of VAC bandages used in this manner include evacuation of excessive fluid and removal of degradation products, immobilization of the skin graft on the recipient bed, bandage conformation to irregular surfaces, and enhanced neovascularization.

**Compartment Syndrome**

We have used VAC therapy for the treatment of myofascial compartment syndrome in several cases, including two dogs with migrating plant awns in the metatarsus. Secondary infection resulted in severe swelling of the distal paw in both dogs, creating a tourniquet effect around the metatarsus. After a fasciotomy over the mid-metatarsus and lavage of purulent material, VAC therapy was applied to the distal limb. The swelling resolved within 12 hours, and the paw and distal limb survived in total in both dogs. VAC therapy was used for 3 days in both cases. The wounds created by fasciotomy were closed by a combination of primary closure and second-intention healing.

We also used VAC therapy in the management of severe necrotizing sialoadenitis secondary to lymphoma in a 7-year-old Doberman pinscher. Secondary facial edema resulted in severe swelling of the eyelids, dysphagia, and respiratory stridor and distress. A fasciotomy incision was made in the ventral neck, and VAC therapy was applied. In the first 18 hours, 1.8 L of edematous fluid was removed, resulting in resolution of all clinical signs. VAC therapy was discontinued after 2 days, and the incision was closed primarily without recurrence of swelling.

The VAC system has been used in human patients as a dressing for fasciotomy wounds after compartment syndrome. In a retrospective study comparing VAC dressings to simple saline-soaked dressings for fasciotomies, patients treated with VAC dressings had more rapid resolution of edema fluid from the tissue, allowing earlier definitive closure. In addition, a greater proportion of VAC-treated wounds underwent primary closure rather than skin grafting for wound coverage.

**Conclusion**

This article describes the variety of wound conditions that can be treated using VAC therapy. We have found the use of VAC therapy to be invaluable for the treatment of problematic wounds, many of which were unresponsive to other forms of wound management. As knowledge and interest in VAC grow, further study and novel uses of VAC therapy in veterinary practice will likely develop.

**Key Points**

- VAC therapy can be used to manage degloving wounds before closure or skin grafting.
- VAC therapy can be used over exposed bone or orthopedic implants to manage surgical dehiscence.
- VAC therapy bandages can be placed over an open abdomen to manage septic peritonitis.

**References**

1. Which statement regarding the authors’ use of VAC therapy to treat skin avulsion is correct?
   a. In cases of physiologic degloving, the skin should be elevated and foam placed between the skin and subcutaneous tissue.
   b. No attempt to salvage the avulsed skin should be made.
   c. In cases of avulsion associated with an open wound, foam can initially be placed beneath the avulsed skin to aid in granulation tissue formation.
   d. VAC therapy should not be used when concurrent skeletal injury is present.

2. Which is not a function of VAC therapy?
   a. remove extravascular fluid
   b. mechanically debride necrotic tissue
   c. increase the formation of granulation tissue
   d. increase circulation

3. What is a potential complication of using a VAC bandage directly over an open abdominal incision?
   a. enterocutaneous fistula formation
   b. abdominal compartment syndrome
   c. delayed wound healing
   d. VAC bandages should never be used over an open abdominal incision.

4. Which statement regarding use of VAC therapy for management of surgical dehiscence is true?
   a. VAC therapy should not be used over exposed bone or tendons.
   b. VAC therapy enhances the rate of granulation tissue formation over orthopedic implants.
   c. Human studies have not supported the use of VAC therapy for surgical dehiscence.
   d. VAC therapy should not be used if infection is present within the exposed surgical site.

5. Which statement regarding the use of VAC therapy to treat compartment syndrome is false?
   a. Skin grafting is usually required to close fasciotomy incisions after the use of VAC therapy.
   b. VAC therapy enables the removal of large amounts of edematous fluid.
   c. VAC therapy can be used in cases involving infection.
   d. In a human study, use of VAC dressings allowed earlier definitive closure of fasciotomy incisions compared with traditional saline-soaked dressings.

6. Which statement regarding the use of VAC therapy to prevent postoperative seroma formation is false?
   a. The bandage should be placed directly over the incision.
   b. VAC therapy can be used following arthrodesis and limb-sparing procedures.
   c. The bandage should be left in place for 1 week following surgery.
   d. The VAC system will prevent interstitial edema.

7. When the VAC system is used as a bolster dressing for skin grafts or flaps, a nonadherent layer should be placed between the graft and the foam.

8. Which statement regarding abdominal or thoracic application of VAC therapy is correct?
   a. The thorax must be completely closed to prevent the VAC system from applying negative pressure to the chest cavity.
   b. The thorax can be partially closed and the VAC system used to assist drainage of air or fluid from the chest cavity.
   c. VAC should not be used to treat septic peritonitis or pyothorax.
   d. Foam should be placed in direct contact with the peritoneum to promote fluid resorption and tissue healing.

9. Which statement regarding the clinical application of VAC therapy is true?
   a. VAC therapy is ineffective for treating myofascial compartment syndrome.
   b. VAC therapy should not be used to treat chronic wounds.
   c. VAC therapy has been used to effectively treat indolent pocket wounds in cats.
   d. The use of VAC therapy is limited to wounds of the extremities.

10. When VAC therapy is used to decrease the development of postoperative edema associated with arthrodesis, a pressure of _____ mm Hg should be used.
    a. –400
    b. –50
    c. 75
    d. 125