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Case Report

Vacuum-Assisted Closure Combined with a Myocutaneous Flap in the Management of Osteomyelitis in a Dog

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Case Description. A 2.5-year-old female spayed mixed breed dog presented to the Teaching Hospital for draining tracts on the left medial aspect of the tibia. Two years prior to presentation, the patient sustained a left tibial fracture, which was repaired with an intramedullary (IM) pin and two cerclage wires. Multiple antimicrobials were utilized during this time. *Clinical Findings*. Radiographs were consistent with left tibial osteomyelitis. The implant was removed and the wound was debrided. *Treatment and Outcome*. A bone window on the medial aspect of the tibia was created in order to facilitate implant removal. The wound and associated bone window were treated with vacuum assisted closure (VAC) in preparation for reconstructive surgery. Adjunctive VAC therapy was utilized following the caudal sartorius myocutaneous flap. Complications following this surgery included distal flap necrosis and donor site dehiscence. *Clinical Relevance*. This presents a difficult case of canine osteomyelitis with subsequent wound care in which VAC and a myocutaneous flap were useful adjunctive treatments for osteomyelitis. This is the first report of VAC in the management of canine osteomyelitis and management with a myocutaneous flap.

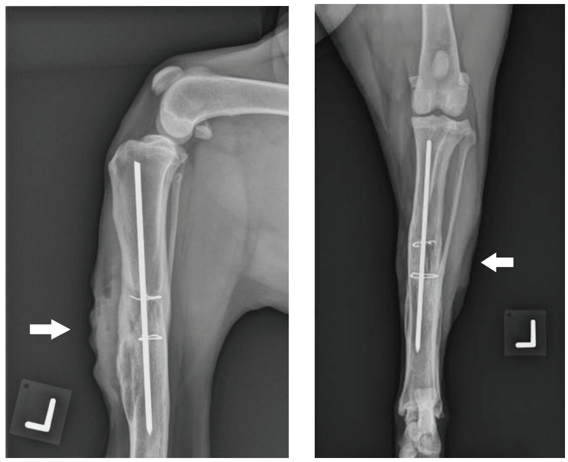
1. Introduction

Muscle is the most versatile tissue for reconstructive surgery and is used in a variety of reconstructive surgical procedures ranging from soft tissue to orthopedics. Muscle flaps, for the most part, are easily dissected and are harvested with little donor site morbidity [1]. Donor muscle selection is based on the dimensions of the defect and function or purpose of the reconstructive procedure and can be harvested alone or as a composite flap (skin and muscle) [2–4]. Muscle flaps augment vascular supply of compromised wounds by inducing angiogenesis, which is used for the management of chronic osteomyelitis, shearing wounds to the distal extremities, decubital ulcers, and ablative oncological procedures [3–5]. The increased blood supply through transferred muscle enhances the host defense mechanism to a compromised wound by increasing local concentrations of immunoglobulins, complement, neutrophils, and oxygen tension [2, 6]. The use of vacuum assisted closure (VAC) therapy is well described as an alternative strategy in the management of a variety of wounds encountered in human medicine and surgery [7–11]. The uses of VAC therapy in human surgery include decubital ulcers, degloving injuries, distal extremity wounds, as a means to secure split thickness skin grafts in anatomically challenging areas, poststernotomy dehiscence following cardiac surgery, open peritonitis, abdominal wound dehiscence and perineal wounds [7–11]. VAC therapy is the controlled application of subatmospheric pressure to a wound using a therapy unit to intermittently or continuously convey negative pressure to a specialized wound dressing to help promote wound healing. The case described below illustrates the simultaneous use of a muscle flap and VAC therapy for the treatment of osteomyelitis in a dog.

2. Case Report

A 2.5-year-old female spayed mixed breed dog presented to the Veterinary Teaching Hospital for chronic draining

Figure 1: Medial aspect of the left hind limb on presentation. The nonhealing draining tracts revealed deep subcutaneous pocketing with purulent discharge.



(a) (b)

Figure 2: Lateral (a) and craniocaudal (b) radiographs of the left tibia. Note that the cerclage wires within the bone are broken with appreciable lucency surrounding the proximal wire. There does not seem to be lucency associated with the intramedullary pin. A large area of remodeled bone is also present on the cranial cortex of the tibia. On the craniocaudal image, between the two cerclage wires, there is an area of lucent bone surrounding a more radiopaque bone suggestive of a sequestrum. The arrows indicate soft tissue swelling and subcutaneous edema surrounding the mid-diaphyseal area. The radiographic interpretation was consistent with osteomyelitis and associated cellulitis.

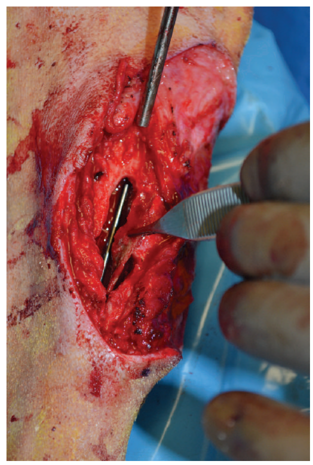


Figure 3: Intraoperative image of the medial wound after debridement of the necrotic tissues and creation of a bone window. The suction tip is placed over the proximal aspect of the tibia. Within the bone window, the intramedullary pin is still present and the thumb forceps are removing a necrotic bone segment suspected to be a sequestrum.

tracts located on the left medial aspect of the tibia. Pertinent medical history included a tibial fracture that was repaired with an intramedullary (IM) pin and cerclage wires two years prior to presentation, which was just prior to the time of adoption at an unknown veterinary clinic. Multiple antimicrobials were utilized over the course of 2 years with only temporary resolution of clinical signs with recurrence after cessation of antimicrobials. Upon presentation, the medial aspect of the left hind limb was warm, swollen, and painful upon palpation, and a serosanguinous discharge was noted focally at the area of the midtibial diaphysis. The affected area was clearly demarcated with a dark purple discoloration noted around the periphery (Figure 1). No other abnormalities were noted on physical examination. Initial diagnostics included a complete blood count (CBC), serum biochemistry profile, and radiographs of the left tibia. Both the CBC and biochemistry profile were within normal limits. Radiographs revealed an intramedullary Steinman pin with 2 broken cerclage wires circling the mid-diaphysis of the tibia. Exuberant periosteal reaction was noted with much of the cerclage wires being overgrown with bone. A zone of lucency was noted around the proximal wire as were soft tissue swelling, gas, and bony lysis (Figures 2(a) and 2(b)). The radiographic interpretation was consistent with osteomyelitis and surrounding cellulitis.

The patient was taken to surgery for implant removal. A medial approach to the left tibia was utilized and the draining tracts were excised and underlying necrotic tissue was debrided. An approximately 10 cm × 5 cm section of devitalized tissue was removed. A round burr and Surgairtome (Surgairtome Two, Hall Power Instruments, ConMed Linvatec, Largo, FL) were used to make a 1.5 cm × 4 cm bone window in order to remove excess periosteum, the broken cerclage wires, and the Steinman pin. It was noted that the Steinman pin was freely moveable both proximally and distally within the medullary canal. Cultures were obtained from the Steinman pin surface prior to removal as well as the deep tissue. Culture samples were submitted for aerobic, anaerobic, and fungal cultures. A sample of exuberant periosteum was also submitted for histopathologic analysis. During surgery a suspected sequestrum was identified and removed (Figure 3). The wound was lavaged and debrided following implant removal, leaving an open bone window. Hemostasis was assessed as adequate. A vacuum assisted closure (VAC) system (V.A.C. Freedom Wound System, Kinetic Concepts Inc., San Antonio, TX) was placed over the tibial window and associated wound. The polyurethane foam dressing (V.A.C., GranuFoam, Kinetic Concepts Inc., San Antonio, TX) was cut to the size of the wound and placed over the bone

Figure 4: The VAC system was applied to wound and set at a negative pressure of 125 mmHg.

Figure 5: The wound and exposed bone after five days of negative pressure wound therapy.

window and wound directly. The self-adhesive drape was then placed and the evacuation tubing (V.A.C., T.R.A.C. Pad, Kinetic Concepts Inc., San Antonio, TX) was placed over the foam-dressing interface (Figure 4). A modified Robert Jones bandage with a lateral splint was placed over the VAC system, which was set to maintain negative pressure of 125 mmHg.

Culture results of the IM pin revealed *Corynebacterium* spp. as well as an unidentified gram + organism. Treatment was initiated with sulfamethoxazole/trimethoprim (15 mg/kg (6.8 mg/lb), PO, q 12 h for 4 weeks) based upon susceptibility results. Histopathology of the submitted periosteal tissue revealed necrotic tissue infiltrated with lymphocytes, plasma cells, and neutrophils, consistent with chronic connective tissue inflammation. Postoperative medication included tramadol (3 mg/kg (1.3 mg/lb), PO, q 8 h) and carprofen (2.2 mg/kg (1 mg/lb), PO, q 12 h). Bandage changes were performed at 2-3-day intervals to assess granulation tissue formation (Figure 5). All bandage changes were performed under sedation with dexmedetomidine (5 mcg/kg (2.3 mcg/lb), IV) and butorphanol (0.2 mg/kg (0.9 mg/lb), IV). Sedation was reversed with atipamezole (0.05 mg/kg (0.02 mg/lb), IM). At the time of bandage changes, the wound was lavaged with sterile saline and the VAC was replaced at 125 mmHg. During the recovery period, packed cell volume and total solids were measured and were within normal limits. Postoperative radiographs were not performed due to monetary constraints.

Figure 6: The medial aspect of the left hind limb taken intraoperatively after the completion of the caudal sartorius myocutaneous flap.

Two weeks following implant removal adequate granulation tissue was noted covering the bone window and a caudal sartorius myocutaneous flap was performed (Figure 6). Packed cell volume (PCV) and total solids (TS) remained within normal limits and were 46% and 7 g/dL prior to reconstructive surgery. Following reconstructive surgery the VAC system was replaced but the negative pressure setting of 50 mmHg was applied over the recipient flap. Additionally, the foam dressing was placed over a petrolatum impregnated gauze (Adaptic, Johnson & Johnson, New Brunswick, NJ) used as an interface dressing. The proximal donor site was closed using subcutaneous and intradermal sutures. The VAC system was supported by a lateral splint and a modified Robert Jones bandage. Bandage changes under sedation were performed every 2 days. Serosanguinous discharge was noted beginning from the day after surgery from the donor site incision. Dehiscence occurred at the proximal donor site four days after surgery at which time, approximately 30% of the skin over the distal aspect of the myocutaneous flap was also noted to be necrotic (Figure 7). This wound, as well as the donor site wound, was then debrided and dressed with the negative pressure treatment. The VAC system was applied over the open wound, the surviving portion of the myocutaneous flap, and the donor site at a negative pressure setting of 50 mmHg. Bandage change was performed 3 days later. After healthy granulation tissue was noted 5 days after debridement, a full thickness mesh skin graft was placed over the distal aspect of the myocutaneous flap. The VAC system was replaced over the graft and myocutaneous flap donor site at 50 mmHg with a lateral splint and modified Robert Jones bandage. Bandage changes were performed every 3 days. After 9 days, the negative pressure therapy was discontinued. Outpatient bandage changes and wound care were continued until the skin graft had healed. The skin graft and donor site healed without further complication and the myocutaneous flap donor site healed by second intention. At 6-month and 1-year follow up conversation by phone, the patient was reported to be using the limb without appreciable

Figure 7: The medial aspect of the left hind limb at bandage change 4 days after reconstructive surgery. The portion of the necrotic skin over the flap was later debrided and treated with a mesh skin graft. The proximal donor wound was treated and healed by second intention.

lameness. The wounds had healed and fur coat had returned over the surgery sites.

3. Discussion

This case describes the use of VAC in the management of chronic osteomyelitis and subsequent myocutaneous flap wound reconstruction. Over ten years ago, Fleischmann and Morykwas introduced the concept of applying negative pressure to wounds in order to promote rapid wound healing [7, 8]. The VAC was quickly accepted as an efficacious treatment modality for wound management in human medicine and is recently being used with more frequency in veterinary medicine [12–14]. Indications for VAC therapy include acute, subacute, and chronic wounds, degloving injuries, reconstructive procedures, decubital ulcers, and burn wounds [7–9, 12, 15]. Clinical reports revealed that VAC was beneficial for treating osteomyelitis, promoting granulation tissue, and reducing the need for reconstructive tissue transfer [11, 16, 17]. VAC was initially utilized in the dog reported here to facilitate granulation tissue formation in an open wound with established osteomyelitis in preparation for reconstructive surgery. It was determined that all nonviable bone was debrided prior to the dressing placement. VAC was subsequently utilized to support additional reconstructive procedures. To our knowledge, this is the first case of VAC in the management of tibial osteomyelitis and subsequent myocutaneous flap in a dog.

The effect of VAC therapy on bacterial clearance and subsequent infection is debatable [13, 18]. In regards to using VAC for osteomyelitis treatment, studies have compared VAC use to conventional wound dressing in open tibial fractures [19]. Results showed that VAC reduced the risk of deep infection by almost 80% when compared to conventional dressing [19]. In agreement with this study, studies and case reports of osteomyelitis treated with negative pressure increased granulation tissue formation, decreased number of reconstructive procedures and have variably affected bacterial burden [5, 11, 20]. With this in mind, the VAC system was chosen to treat the patient in this report. In the case presented here, bacterial culture confirmed preexisting bacterial osteomyelitis with multiple Gram positive organisms. Implant removal, surgical debridement, and VAC therapy in conjunction with appropriate antimicrobial selection and a myocutaneous flap were successful in managing this case, allowing decreased frequency of bandage changes, rapid creation of granulation tissue within the wound, and resolution of clinical signs.

In veterinary medicine, continuous negative pressure of 125 mmHg is commonly used as it provides marked benefit to wound healing while minimizing patient discomfort [12, 13]. In this patient, these standard settings were used initially to facilitate granulation tissue formation. Following reconstructive surgery with a caudal sartorius myocutaneous flap, VAC therapy was applied at 50 mmHg. Although some authors make recommendations that subatmospheric pressure settings of only 50 mmHg are needed to reduce edema over closed incisions or skin grafts, clinical cases report a 95% success rate with split thickness skin grafting and adjunctive negative pressures between 75 and 125 mmHg [7, 21–23]. The negative pressure setting of 50 mmHg was chosen based on clinical experience with skin grafts treated adjunctively with VAC therapy at our institute.

Although granulation tissue was witnessed within the wound and bone window, a caudal sartorius myocutaneous flap was chosen in the place of a skin graft for the additional protection the muscle flap would offer over the tibial bone window. The authors also chose to use a myocutaneous flap in this case because of its superior vascularity and beneficial properties pertaining to refractory osteomyelitis. Mycocutaneous flaps are well defined in the literature for adjunctive treatment of osteomyelitis [2, 6]. The caudal sartorius myocutaneous flap, despite being a type IV muscle, was reported to be an extremely reliable flap due to its blood supply from the saphenous artery and vein and reverse saphenous blood flow as described for the reverse saphenous conduit flap [3, 4]. Possible explanations for the distal myocutaneous flap necrosis seen in this case include lack of proximal muscle excision as was recommended during the original study by Weinstein et al., excessive flap shear in lieu of lateral splint stabilization, or hindered blood flow due to the nature of segmental blood supply to the muscle [3]. The authors initially had concern that the VAC system may have impaired the local blood supply to the flap with excessive negative pressure and subsequent areas of hypoxia, but this is considered unlikely as a decrease in local ischemia and reperfusion injury to free muscle flaps in humans treated with adjunctive negative pressure treatment of 125 mmHg was reported [24]. Although this beneficial effect was not elicited in dogs, we believe that the pressure applied to the wound was potentially subtherapeutic because of the lower negative pressure setting in addition to an interface dressing, which also decreased the pressure delivered over the wound. That being said, the distal aspect of the flap healed without complication following appropriate wound care and surgical placement of a full thickness mesh skin graft. Dehiscence of the donor site was likely due to excessive tension, and therefore the wound was treated and allowed to heal by second intention without further complication. Interestingly, VAC has recently been reported to successfully maintain viability of a tissue flap following partial dehiscence [25]. Moreover, VAC has been associated with increased skin graft acceptance rates and less graft necrosis [26].

Complications considered during the management of this case included ongoing blood loss and hypoproteinemia resulting from application of negative pressure over the medullary cavity. Repeated laboratory values were used to monitor these parameters which remained stable throughout the case. Hemorrhage as a result of VAC is reported sparsely in the literature [27–29]. Furthermore, tibial artery erosion secondary to treatment with VAC was described recently in a traumatic open fibular wound report [27]. In that report, the arterial erosion and subsequent hemorrhage were multifactorial due to concurrent anticoagulant therapy, fungal infection with *Aspergillus*, and the concurrent placement of the VAC system over the exposed artery [27]. In the case reported here, at the time of surgery, there was adequate hemostasis with no appreciable vessels that would be exposed to the VAC foam dressing. Additionally, no adverse effects were noted as a result of transient loss of negative pressure in this case.

In conclusion, the indications for VAC in both human and veterinary medicine are expanding. Originally VAC was examined for use in chronic nonhealing wounds, and the therapeutic benefits in veterinary medicine seen with VAC are starting to be appreciated in its diverse applications which are largely derived from human medicine. Regardless of the type of wound, it is imperative to thoroughly debride the wound before applying the VAC device [10]. Chronic osteomyelitis was once considered a contraindication of VAC therapy [10, 30]. In more recent years VAC has been proven effective in cases of osteomyelitis and traumatic wounds with exposed bone [10, 31, 32]. This case report illustrates VAC as an effective wound healing technique in a canine patient with an open tibial medullary cavity with chronic multiorganism osteomyelitis. This case also lends support to the use of VAC in patients with myocutaneous flap reconstructive surgeries as well as skin grafts.

Conflict of Interests

The authors of this paper have no financial or personal relationship with other people or organizations that could inappropriately influence or bias the content of this paper.

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