CLINICAL TECHNIQUE: NEGATIVE PRESSURE WOUND THERAPY-GENERAL PRINCIPLES AND USE IN AVIAN SPECIES

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Abstract

Negative pressure wound therapy (NPWT) is an adjunctive wound management modality that has been shown to augment the treatment of acute and chronic dermal and subdermal wounds in human and veterinary medicine. The proposed effects of NPWT are multifactorial and include improvement of wound perfusion, reduction of interstitial edema and substances inhibitory to wound healing, enhancement of granulation tissue formation, and reduction in bacterial contamination from a wound bed. Together, the proposed benefits of NWPT can lead to enhanced efficiency of wound healing when this treatment modality is applied to a wound. In this article, the authors provide an overview of the mechanism of action of NPWT. Case selection, system application and management, as well as contraindications to NPWT therapy are presented. Potential uses, practical application, and limitations of use of NPWT in avian species are discussed. Copyright 2014 Elsevier Inc. All rights reserved.

Key words: avian; negative pressure wound therapy; vacuum-assisted closure; wound management

Pet and wild avian species are commonly presented for evaluation and treatment of skin wounds, mostly secondary to trauma. Several anatomical features make wound management difficult in avian species, including a relatively delicate and thin skin, a lack of significant subcutaneous tissue to support formation of robust granulation tissue, a lack of redundant skin available for mobilization and closure, and an overall poor vascular supply to the skin in the distal limbs.[1,2]

Wound healing is an intricate process designed to restore integrity and function to an area of the body that has sustained an injury. Four distinct yet interdependent phases of wound healing have been recognized. They are defined as (1) hemostasis, (2) inflammation, (3) proliferation, and (4) remodeling. Each phase promotes the orchestration of a cascade of biological and cellular events including regulation of cellular components, cellular mediators, growth factors, cytokines, and biochemical signaling pathways, which ultimately are responsible for the successful completion of the wound-healing process. Although each phase of wound healing is referred to independently, without all parts, restoration of integrity to a wound would not be possible.[3-5] Research in chickens has shown that, in general, avian wound healing follows the same stages as described for mammals.[6]

The primary objective in open wound management is to efficiently aid in the body's own ability to restore functional integrity to the compromised tissue. It can be a challenge to identify and facilitate medical or surgical interventions that enhance this process given the variety of etiologies, as well as environmental and species-specific factors that accompany wounds encountered in veterinary medicine. Regardless of

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the wound management technique chosen, basic patient and wound evaluation, as well as wound management principles, must be followed to improve chances for successful healing. Traditional wound management options encompass 3 well-defined types of wound healing: first intention healing, second intention healing, and third intention healing.

Primary or delayed primary closure of a cutaneous wound results in first intention healing. This is defined as appositional healing of 2 skin edges before the formation of granulation tissue. It is most commonly used to treat acute, clean, and minimally contaminated or traumatized wounds. Healing via second intention occurs when a cutaneous wound heals by contraction and epithelialization. This type of healing is often employed to treat large wounds that cannot be closed through first intention owing to size, location, trauma, or contamination. Third intention healing is appositional healing accomplished by secondary closure of wound edges after the formation of granulation tissue within the wound bed.[5] Third intention healing is the most employed and successful way of treating chronic, contaminated, and infected wounds in veterinary patients, and unfortunately often requires intensive open wound management before definitive wound repair. Owing to a lack of controlled studies evaluating the efficacy of specific wound management techniques in birds, wound management protocols are often extrapolated from mammalian species.

Open wound management is ever changing, and many novel techniques and advancements have come to light in recent years. One modality in open wound management that has recently gained popularity in both human and veterinary medicine is that of negative pressure wound therapy (NPWT) or vacuum-assisted closure (VAC). Over the last 25 years, the use of NPWT has gained popularity for the treatment of a variety of wounds including postoperative surgical site infections, dehiscence and peritoneal drainage after abdominal surgery, abdominal and thoracic wounds, traumatic and infected wounds, chronic nonhealing wounds, burn wounds, and as an adjunctive treatment to the application of skin grafts.[3,6-17] Although the human literature on NPWT is quite robust, the veterinary literature contains only a few articles pertaining to the use of NPWT in a variety of species, including horses,[18] dogs,[10,11,13] cats,[12,14,17] a tiger,[15] several chelonian species,[16,19,20] and 2 raptors.[21] The use of NPWT in pigs,[22] rabbits,[23] and rats[24] has been described in experimental studies using animal models for the wound-healing investigations. This review provides an overview of the history and mechanism of action of NPWT, as well as discusses case selection, application, management, and contraindications to NPWT therapy with special attention focused on its practical use in treating open wounds in avian patients.

OVERVIEW OF NPWT

NPWT is defined as controlled application of subatmospheric pressure across a wound bed within a closed environment. To achieve a negative pressure wound environment, an open cell foam dressing with a pore size ranging from 400 to 600 μm is placed over a cutaneous defect or wound. A semiocclusive plastic adhesive film is placed over the foam dressing and adhered to the skin. This dressing creates a complete seal over the wound, resulting in a closed moist wound-healing environment. Once a seal is created, suction tubing is attached to the dressing and connected to a collection reservoir and suction pump. When turned on, the pump applies negative pressure across the wound bed in either a continuous or an intermittent manner (Fig. 1).

MECHANISMS OF ACTION

The proposed effects of NPWT are multifactorial and include improvement of wound perfusion, reduction of interstitial edema and inflammatory or inhibitory cytokines, stimulation of the production of biochemical mediators or changes in cellular function that may result in the enhancement of granulation tissue formation, reduction in bacterial contamination, and enhanced removal of exudative material from a wound.[7,8,10,22,25,26]

Reduction in wound edema results from the application of a uniform negative pressure across the porous sponge in contact with the wound bed. This stimulates removal of excessive extracellular fluid along with other substances, such as exudative material or cytokines that may inhibit wound healing. Removal of excessive extracellular fluid results in a decreased interstitial hydrostatic pressure that allows for improvement of vascular density and restoration of blood flow to previously collapsed blood vessels. The resulting increase in microvascular blood flow to the capillary beds improves oxygenation and nutrient delivery to the wound.[3,8,26] It has been shown that standard pressures of −125 mm Hg enhances microvascular blood flow up to 4 times above baseline controls