Uses of Negative Pressure Wound Therapy in Orthopedic Trauma

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KEYWORDS

• Negative pressure wound therapy • VAC • Infection • Trauma • Open wound • Wound dehiscence • Limb salvage • Open fracture

KEY POINTS

- Negative pressure wound therapy (NPWT) is ideal for soft tissue defects that can heal through secondary intention or require skin grafting.
- NPWT prevents desiccation, reduces edema, limits hematoma, and facilitates wound drainage.
- NPWT is an effective way to downscale the complexity of soft tissue reconstruction.
- NPWT can decreases the risk of wound complication when applied to high-risk incisions after fracture surgery.

INTRODUCTION

Since its inception more than 20 years ago, negative pressure wound therapy (NPWT) has had a major impact in the management of orthopedic injuries. NPWT has been widely adopted for use in a variety of clinical scenarios, and has had reported success in the setting of high-energy trauma, open fractures, infections, and excessive soft tissue damage. However, although its success has led to widespread use in orthopedic trauma, a deeper understanding of its mechanism of action, along with the ideal clinical scenarios for use, is required. This article reviews the nuances of NPWT application, including its mechanism of action, clinical indications, and specific strategies used in order to achieve desired clinical outcomes.

WHAT IS IT?

To administer NPWT, there are 3 main components that create a subatmospheric pressure environment: a porous dressing sealed via an occlusive adhesive, a vacuum device, and a connector that allows communication (**Fig. 1**). In orthopedic trauma, the dressing of choice is a dry, black, hydrophobic, reticulated polyurethane-ether foam with a pore size of 400 to 600 μm (KCI, San Antonio, TX). A polyvinyl alcohol (PVA) foam is also available (KCI, San Antonio, TX). It differs from the large-pore foam because it has a smaller pore size (60–270 μm) and comes premoistened with sterile water. The hydrophilic nature and smaller pore size of the PVA foam offers a less-adherent application and has significantly less granulation and perfusion than the large-pore dressing.[1] Thus, for

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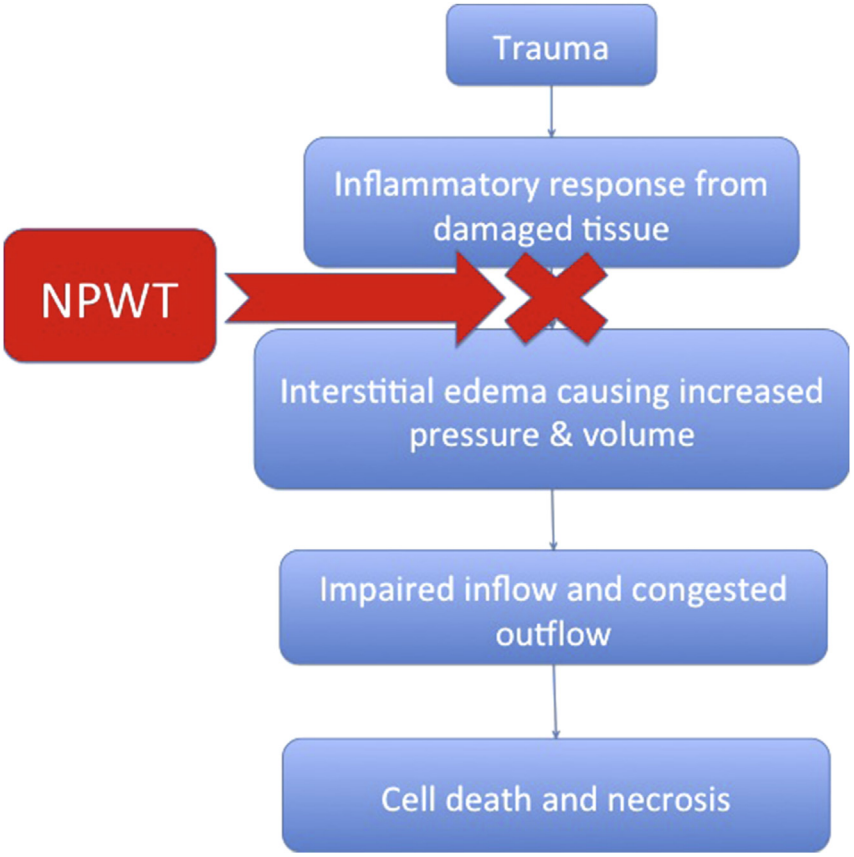

Fig. 1. NPWT disrupts the inflammatory cascade by reducing edema, limiting hematoma, and facilitating wound drainage to augment wound healing.

most of the clinical scenarios in orthopedic trauma, the large-pore foam is preferred. Placed on the area of interest, the wound and sponge dressing are sealed off with a plastic adhesive and occlusive dressing, and communicate with the vacuum device via a connector creating a localized negative pressure environment.

HOW DOES IT WORK?

NPWT allows improved wound management and healing via 2 main mechanisms. Following initial injury, a substantial inflammatory response is generated from damaged tissue, initiating a vicious cycle of increasing interstitial edema and pressure, leading to cell death and necrosis secondary to lack of nutrient inflow combined with a congested outflow of cellular waste (see **Fig. 1**). With the use of NPWT, a subatmospheric environment is created, acting at the level of the interstitium to eliminate unwanted edema, inflammatory mediators, and bacteria (see **Fig. 1**). This environment creates more favorable healing conditions by removing the volume that obstructs inflow and outflow, allowing greater nutrient and oxygen inflow as well as venous drainage.[2]

In addition, NPWT promotes mitogenesis and granulation tissue formation via increased cellular substrate recruitment. Dynamic tissue formation is facilitated by the mechanical strain placed on the tissue by the negative pressure environment. The strain created by the vacuum allows microdeformation and stretch at the cellular level, allowing cellular chemotaxis, angiogenesis, and new tissue formation via the recruitment of growth factors (ie, vascular endothelial growth factor [VEGF], Fibroblastic Growth Factor [FGF]-2).[3,4] Labler and colleagues[3] analyzed wound fluid from NPWT dressings and noted significantly higher levels of interleukin-8 and VEGF compared with fluid analyzed from a standard dressing. Furthermore, histologic analysis noted significantly higher levels of angiogenesis and granulation tissue formation.

The effect of the subatmospheric environment is also evident at the genetic transcriptional level. Chen and colleagues[5] measured the presence of proto-oncogenes during NPWT in a pig model. The negative pressure environments produced