NEGATIVE PRESSURE WOUND THERAPY; EVIDENCE BASED RECOMMENDATIONS

Review Article

NEGATİF BASINÇLI YARA TERAPİSİ; KANITA DAYALI ÖNERİLER

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ABSTRACT

Negative pressure wound therapy is a useful management tool in the treatment of acute or chronic wounds. This treatment has revolutionised acute and chronic wound treatment especially in the last 25 years. This article provides a brief summary on the use of NPWT by reviewing the available data.

Key words: acute wound, chronic wound, vac, vacum assisted wound therapy

ÖZET

Negatif basınçlı yara terapisi akut yada kronik yaraların tedavisinde faydalı araçlardan birisidir. Özellikle son 25 yıldır akut ve kronik yaranın tedavisinde bu sistemler devrim yaratmıştır.Bu makale mevcut veriler ışığında negatif basınçlı terapisinin kullanımına ilişkin kısa bir özettir.

Anahtar kelimeler: Akut Yara, Kronik Yara, VAC, negatif basınçlı yara terapisi

INTRODUCTION

When asked what the most important development for wound treatment has been in the last century, it is not a coincidence that many of us think of negative pressure wound therapy (NPWT). This treatment has revolution Mised acute and chronic wound treatment especially in the last 25 years.

NPWT or vacuum assisted wound closure (VAC) is a closed dressing system that provides subatmospheric or negative pressure. Literature on vacuum therapy date back as long as 1908. In a method described as hyperemic therapy by Bier, clinicians used an aspirator on all infective, chronic, post-traumatic and surgical wounds (1). There are similar Russian literature in 1970s (2-6). The earliest modern literature in the west appeared in the late 1980s (7-9). FDA approved NPWT in 1993. Initial animal studies showed that this method increased wound healing and granulation tissue formation and decreased bacterial load (10). Indications of use have increased since FDA approval in 1993. Although animal studies have demonstrated many benefits of negative pressure, there is no evidence of superiority of NPWT on wound healing when compared to other dressing methods or advantage of a any one NPWT method over others. Studies to date have been very heterogenious and it has not been

possible to make comparisons with these studies (11).

In this paper, we discuss the mechanism of NPWT system, indications and contraindications of clinical use and its efficiency.

Device

The most frequently used devices is V.A.C.™ therapy, KCI, San Antonio, Texas, USA. Studies in the literature have mostly reported using V.A.C.™ system. The system is basically composed of a negative pressure pump, polyurethane sponge, surgical drape, a hose and a collection container. However, with increase in indications, these systems have evolved into computers capable of changing many parameters such as pressure, time and continuity. Continuous or interval negative pressure held at -50 to -175 mmHg by a pump and delivered to the wound surface by a polyurethene sponge, helps collect secretions that are collected in a container.

Mechanism of action

Systemic and local factors can lead to delayed wound healing. NPWT impacts local factors. Local factors affecting wound healing are tissue edema, dryness, wound infection and severe exudation. Stagnant fluid in the wound is closely related to cytogenetic factors that prevent would healing (10,12,17). Animal studies have shown that negative pressure has direct and indirect effects on the local wound environment leading to increased speed of wound closure and decreased wound healing time (18,22).

Direct Effects

A semi-permeable surgical drape provides a moist and warm environment that promotes wound healing. The negative pressure generated by a closed system and delivered through the drape, collects wound fluid into a collection container, via a sponge placed on the wound field. The open porous structure of the sponge helps deliver the negative pressure to the wound surface. Vacuum brings the corners of the wound closer together and leads to wound deformation. If there is a graft or flap on the wound, their hold on the wound is increased (23,24).

NPWT has four primary basic mechanisms of action:

1)Macro-deformation: Leads to contraction of wound, depending on the flexibility of the wound.

2)Micro-deformation: Lengthening, division is seen on a cellular level and proliferation increases.

3)Fluid evacuation: Extracellular fluid that leads to exuda and edema is removed from the environment.

4)Protection of wound from external effects: A protected, closed, moist and warm wound environment is provided.

These primary effects lead to secondary impacts through cellular proliferation and modulation of inflammation (25,26). Fibroblasts are promoted and their migration is stimulated (27). Granulation tissue is formed, anjiogenesis is promoted and blood flow to wound increases (19,28,32). However, blood flow decreases after negative pressure of -175 mmHg (28).

The clinical use of NPWT is rooted in Morykwas et al's study published in 1997. According to this study, when its effect on local blood flow is taken into account, the optimal pressure for NPWT is -125 mmHg (19). However, newer studies have suggested that the best results for wound contraction, local blood flow increase, maximum biological effectiveness and formation of granulation tissue is acheived at pressure of -80 mmHg.

Negative pressure applied to wounds with bad blood flow can lead to ischemia of the wound edges leading to pain. The application of a couple of

days of -125 mmHg pressure to wounds that have discharge, poor blood flow or that are sensitive, followed by decrease to -40 mmHg after exuda has been brought under control is effective in providing treatment without increasing pain or leading to negative effects on blood flow (23,32).

Nowadays, polyurethane sponges or gauze dressings are used for NPWT. While sponges are more suitable for large wounds, smaller gauze tampon covers should be used in areas with pain or where scar development is not not wanted. In an experimental study, the application of -125 mmHg pressure with a sponge dressing lead to increased granulation tissue formation and increase bleeding and pain during sponge changes due to adherence of the sponge to the wound. On the other hand, gauze dressings can easily be changed with less adherence and therefore less granulation tissue. The application of paraffin, ointment or silicone containing protective layers are effective in preventing the adherence of sponge material to the wound and therefore preventing granulation tissue formation (24,32). NPWT can be used with continuous, intermittent or variable pressures. In intermittent treatments, negative pressure is ceased at certain intervals. In variable treatment applications, pressure is dropped to -10 mmHg at certain times, and then increased to maximum levels at a later time. In clinical setting, fixed pressure is usualy implemented. In intermittent treatment, the sudden decrease and increase in pressure may lead to pain, although this method is more advantageous for preventing granulation tissue formation. Variable pressure leads to a massage effect on the wound bed. Studies have shown that interval and variable pressure applications are better for preventing granulation tissue formation (32).

Indications

- Acute or chronic wounds after debridement
- Ulcers (diabetic, pressure, venous insufficiency)
- Fasciotomy wounds
- Open abdominal wounds
- Traumatic wounds
- Subacute wounds
- Surgical dehiscence
- Partial thickness burns
- Flaps and grafts
- Vascular surgical wounds
- Surgical infections
- Wounds where bone and joint or implants are exposed
- After irrigation and debridement of infected wounds

Advantages

- Converts complex wounds to simple wounds
- Decreases the requirement for complex reconstructive procedures
- Leads to less pain
- Easy to shape and retain shape
- Speeds up process of wound healing in diabetic patients, therefore increasing life quality

Disadvantages

- Requirement of carrying a pump is the biggest disadvantage for patients. However, smaller sized units are being produced.
- NPWT systems are expensive. However, they can be considered “cost-effective” when as they lead to early wound closure and less cost on other wound care. However, there is scarce data on this issue.

Contraindications

The presence of the following are contraindications for NPWT

Tissue erosion leading to exposure of important structures such as organs, vessels, vessel grafts, anastomosis, nerves etc.

- Active infections
- Necrotic tissue including scar tissue
- Presence of malignancy in tissue

- Presence of untreated osteomalacia
- Fragile skin; age, chronic corticosteroid use, collagen-vascular tissue diseases
- İschemic wounds: although this is not an absolute contraindication, NPWT's benefit has not been demonstrated. Tissue ischemia may increase with NPWT.
- Although producers do not encourage the use of treatment over oseos or tendinous structures, or at least suggest that protective layers be placed between dressing and wound, NPWT is clinically used for these areas.
- Patients with allergies to material used

Infection and NPWT:

One of the discussion points for NPWT is its effect on bacterial load in wounds. Although several studies have shown that NPWT does not decrease bacterial load of wounds, it creates an isolated protected area that is not in contact with neighbouring tissues (32).

Although initial experimental studies showed a decrease of bacterial overload (19). further studies showed a significant increase in bacterial colonisation with NPWT (40-41). In infectious wounds, NPWT can lead to complications such as toxic shock syndrome, bleeding, empyema, uncontrollable sepsis (42). NPWT should be chaged, according to clinical status, every 48-72 hours (32).

Although the use of NPWT in infected wounds is controversial, the use of antimicrobial flush systems or silver containing sponges with negative pressure can lead to protection from infections. However, in the presence of infection, antibiotherapy and if necessary debridement of necrotic tissues and abscess drainage should be performed before NPWT. In the presence of ischemia, NPWT can lead to further tissue necrosis and infection (42). Therefore, NPWT is not suggested for use with ischemic or infected diabetic foot wounds (43).

In dressings with sponges including silver, silver has been demonstrated to ionise in wound fluid and shows to 99.9% bactericidal effect in vitro conditions. Silver containing sponges can slowly release silver for up to 72 hours (42).

There are systems including topical wound care capabilities that can provide NPWT and concomitant or alternate wound washing. Although there is no proof that these systems are effective, they provide the ability to include additional treatment such as antimicrobial solutions while providing NPWT (44).

Situations in which NPWT and flush/washing systems are suggested for use: (42).

- Postoperative infection after total joint arthroplasty
- Presence of exposed foreign materials such as implant or mesh
- Major risk of amputation due to infection
- Exposure of large areas of bone or joint surfaces after debridement
- Widespread osteomyelitis
- As an alternative to antibiotic including dressings
- Open wounds for prevention of infection or osteomyelitis
- Continued infection despite NPWT
- Decrease viscosity of wound exudate

NPWT system in acute wounds

Most acute wounds are traumatic although some may occur after the debridement of infected or necrotic tissues. NPWT systems can be used after all surgical debridements therefore easing postoperative wound care. The possibility of adjusting sponges to the volume and shape of wounds is an advantage. They may be used with skin grafts and flaps.

NPWT decreases the time required for closure of acute open wounds (40-45).

NPWT has a place in treatment of large and difficult to dress wounds including fasciotomy, degloving wounds, open amputations and in open wounds with exposed tendon, bone or orthopedic instruments. The general observation is that NPWT systems can be used as a safe alternative to standard methods in trauma patients.[46] The greatest advantage of NPWT systems in trauma patients is its ease of use, requirement of less dressing changes and simplification of required reconstructive procedures (47-51).

In animal models, NPWT systems have been shown to increase the perfusion of burn wounds and prevent these wounds from deepening (52). There are several small case series and case reports on this issue. The biggest advantage of NPWT in burn patients is the ability of positioning without requirement for additional splint. Preliminary studies have shown NPWT systems to be safe and effective in these patients.

Chronic Wounds;

Wounds located at the periphery of the extremities with good blood flow may benefit from NPWT systems. However, extremity vascular status must be evaluated before application of NPWT systems.

The use of NPWT systems for wounds secondary to diabetic foot ulcers or diabetic foot surgery is indicated. When compared to conventional methods, patients using NPWT systems required less time for wound closure, hospital stay, complications and costs were also decreased. In studies on pressure ulcers, when analysed according to wound surface area, no statistical benefit was seen. However, NPWT increased patient comfort and decreased manpower require for wound care (53).

Skin graft-flap fixation

When NPWT systems are used instead of traditional graft dressings they provide better fixation by opposing shearing forces, leading to better graft success (54-56).NPWT systems can also successfully be used in open abdominal and sternal wounds.

COMPLICATIONS

- Bleeding: Granulation tissue formation due to prolonged time without changing dressing leading to bleeding is the most serious complication of NPWT. Minor hemorrhage usually occurs during dressing changes but can be controlled through application of pressure. Serious hemorrhage may occur in patients using anticoagulants, or after removal of a sponge with prolonged use that has stuck to underlying tissue, vessel or vessel graft. Application of pressure and surgical intervention may be required.

- Infection: Usually occurs after NPWT applications before an infection has been brought under control. Small residual sponge particules may remain in the wound after dressing change, leading to foreign body reactions.
- Enterocutaneous fistula: NPWT can lead to enterocutanous fistulas if used above intestines.
- CutaneousProblems:

Maculopapular rashes may form around the wound perimeter. If the tissues around the wound are fragile, tears may occur in the skin (3).

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