

NEGATIVE PRESSURE THERAPY AS AN ALTERNATIVE IN THE MANAGEMENT OF INFECTION IN SPINAL SURGERY

TERAPIA COM PRESSÃO NEGATIVA COMO ALTERNATIVA NO TRATAMENTO DE INFECÇÃO EM CIRURGIA DE COLUNA

TERAPIA DE PRESIÓN NEGATIVA COMO ALTERNATIVA EN EL MANEJO DE LA INFECCIÓN EN CIRUGÍA DE COLUMNA

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ABSTRACT

To describe the indications and contraindications for negative pressure wound therapy (NPWT). We performed a review of the existing literature on negative pressure wound therapy on the OVID, PubMed, Cochrane and Medigraphic databases. This is a non-invasive and active healing system that uses controlled and localized negative pressure. It consists of a specialized dressing with a crosslinked sponge, and a tube through which the exudate flows into an airtight container. This system forms microdeformations on the bed of the wound, which have been demonstrated to be a major cause of fibroblast migration, resulting in the formation of better-quality tissue, granulation tissue formation, and angiogenesis. In relation to the infection, the main focus of treatment is to drain all the pus, removing debris, devitalized tissue, foreign bodies and the etiology of infection. The indications of NPWT are: acute wounds, chronic trauma, burns, diabetic ulcers, or decubitus and open abdomen. It is contraindicated in wounds with necrotic tissue, untreated osteomyelitis, and unexplored non-enteric fistulas, and its use is not recommended in areas of malignancy. This method is effective for the treatment of post-surgical infections of the vertebral spine, with an average time of use of 1 to 4 weeks.

Keywords: Negative-pressure wound therapy; Infection; Vertebral spine/surgery.

RESUMO

Descrever as indicações e contraindições do tratamento de ferimentos com pressão negativa. Foi realizada uma revisão da literatura existente nos bancos de dados OVID, PubMed, Cochrane e Medigraphic, referente à cicatrização assistida por pressão negativa. Trata-se de um sistema de cicatrização não-invasivo e ativo, que utiliza pressão negativa controlada e localizada, e consta de compressa especializada que inclui esponja reticulada que conduz o exsudado por uma cânula, até um recipiente hermético. Esse conjunto forma microdeformações no leito da ferida, que comprovadamente são a causa importante de maior migração fibroblástica e, assim, da formação de tecido de melhor qualidade, formação de tecido de granulação e angiogênese. Com relação à infecção, o principal enfoque do tratamento é drenar todo o material purulento, remover os detritos, o tecido desvitalizado, os corpos estranhos e eliminar a etiologia da infecção. As indicações do TPN são: feridas agudas, crônicas, por trauma, queimaduras, úlceras por diabetes ou de decúbito e abdome aberto, sendo contraindicado em feridas com tecido necrótico, osteomielite não tratada, fístulas não-entéricas não exploradas e não se recomenda seu uso em áreas de doença oncológica. Esse método é eficaz no tratamento das infecções pós-cirúrgicas profundas da coluna vertebral, com tempo médio de utilização de 1 a 4 semanas.

Descritores: Tratamento de ferimentos com pressão negativa; Infecção; Coluna vertebral/cirurgia.

RESUMEN

Describir las indicaciones y contraindicaciones de la terapia de cicatrización asistida por presión negativa. Se realiza una revisión de la bibliografía existente en las bases de datos de OVID, PubMed, Cochrane y Medigraphic en relación a la terapia de cicatrización asistida por presión negativa. Es un sistema de cicatrización no invasivo y activo que utiliza presión negativa localizada y controlada, que consta de un apósito especializado que incluye esponja reticulada que lleva a través de un tubo el exudado a un contenedor hermético. Este conjunto forma micro deformaciones en el lecho de la herida, que han demostrado ser causa importante de mayor migración fibroblástica y por consiguiente de tejido de mayor calidad, formación de tejido de granulación y angiogénesis. En relación con la infección, el principal enfoque del tratamiento es drenar todo el material purulento, quitar los desechos, el tejido desvitalizado, los cuerpos extraños y eliminar la etiología de la infección. Las indicaciones de la TPN son: heridas agudas, crónicas, por trauma, quemaduras, úlceras por diabetes o por decúbito y abdomen abierto y se contraindica en heridas con tejido necrótico, osteomielitis no tratada, fístulas no exploradas no entéricas y no se recomienda su colocación en áreas de malignidad. Este método es eficaz para el tratamiento de las infecciones post quirúrgicas profundas de la columna vertebral, utilizándose en promedio de 1 a 4 semanas.

Descriptores: Terapia de presión negativa para heridas; Infección; Columna vertebral/cirurgia.

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INTRODUCTION

Today, despite our knowledge of the biology of wounds and the new types of cures available, a large number of wounds still fail to heal and become chronic.¹⁻³

Negative pressure wound therapy (NPWT) is a way of acting positively in the environment of a wound that has stagnated in the inflammation and proliferation phases, and even in wounds in an acute state, to reduce their complexity and avoid complications by applying subatmospheric pressure. The treatment has various names including: subatmospheric dressing, subatmospheric therapy, vacuum sealing technique, vacuum assisted closure, and vacuum packing, among others.^{1,4-7}

Basically, its action mechanism is based on three levels of the wound healing process:

1. Removal of excess interstitial fluid;
2. Transmission of mechanical forces that stimulate tissue growth;
3. Maintenance of suitable moisture and temperature in the wound environment.^{1,4,8-10}

The first references to methods of curing wounds go back to the Egyptian "healers" (asu) who, in applying cures consisting of animal fat, honey, and flax, probably did not know that they were using a non-adhering, osmotic, antibiotic cure, with the capacity to absorb exudates.

Before 1960, wound management was aimed at preventing infection, so wounds were washed with antiseptic and covered with a dry cure that prevented bacterial growth.

It was found that wounds that were kept moist healed faster than those exposed to the air, and since then, the benefits of moist healing have been tested, and it is used in the day-to-day management of wounds.

As we have gained a better understanding of the biology of wounds, the characteristics of optimum healing have also been defined.^{1,7,9,11-13}

Negative pressure wound therapy (NPWT) is a non-invasive, active healing system that uses localized and controlled negative pressure and a specialized dressing consisting of a cross-linked sponge with specific porosity of 400 to 600 microns, which is sealed with a semi-occlusive dressing, the purpose of which is to maintain negative pressure at the site of the wound, removing exudates through a tube to an airtight container with an antibacterial and gellifying dressing. This combination forms microdeformations in the wound bed that various studies have shown to be the main cause of greater fibroblast migration, resulting in higher quality tissue, increased granulation tissue formation, and angiogenesis. (Figure 1)

The effectiveness of this process results from:

1. Removal of fluids:
 - a. Reduction of pro-inflammatory or degradation factors of the extracellular matrix;
 - b. The effective removal of microorganisms contained in the wound bed.
2. Four-fold increase in capillary blood flow;
3. Up to 103% increase in granulation tissue formation;
4. Promotion of a moist environment for healing;
5. Reduction of swelling at the site.

There is currently no cure that includes all these characteristics and with the goal of finding this optimum cure, various techniques and materials have been tested, such as: alginates, hydrogels, collagen, and skin replacement products, which have proven useful for certain wound types. (Figure 2)

There are several devices in the experimentation stage, and their use is not yet widespread. These include: growth factors, pharmacological agents, laser, hyperbaric oxygen therapy, and electrical stimulation, and most of these are considered to be advanced wound care technologies.^{1,10,12,14}

These are defined as those that affect the wound healing process actively and positively to counteract, eliminate, or significantly reduce at least two factors that can hinder this process.

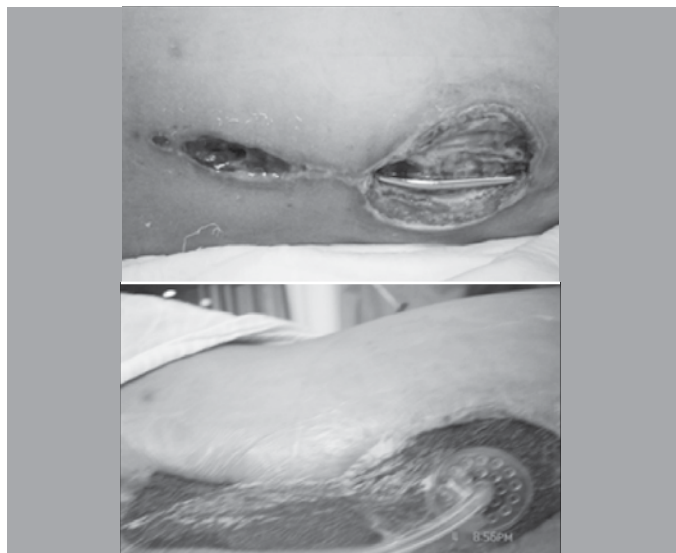


Figure 1. Female patient diagnosed with scoliosis and with placement of Luque rods with dehiscence and infection of the wound, treated with negative pressure wound therapy.

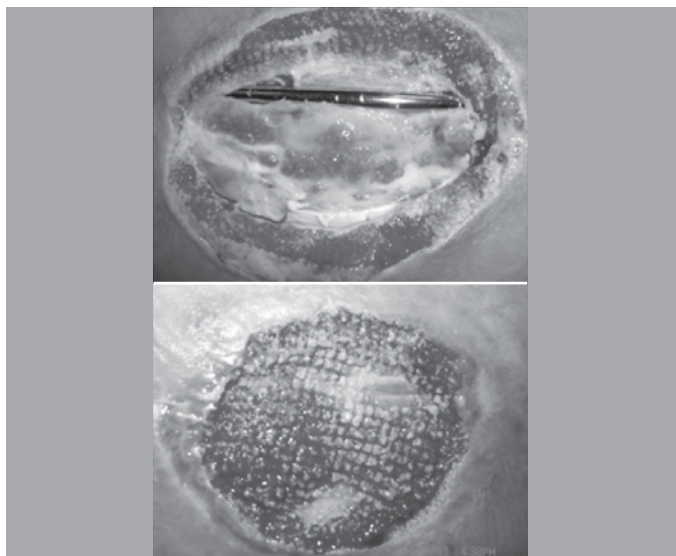


Figure 2. Female patient at 2 weeks of treatment and then at 22 days. Note the granulation tissue formation, and the covering of the instrumentation material.

Negative pressure wound therapy (NPWT) used alone or in association with other similar techniques, increases cure rates of wounds.^{3,7,10,15}

Given the increase in the number and life expectancy of the population with chronic wounds, for those who require additional local care to arrive at both an indication and chance for surgery, or for those for whom surgical procedures have failed, advanced wound care technologies, including NPWT, have become the primary and often the only treatment modality.^{3,6,7,9}

This type of wound is more likely to occur in the elderly and in people with multiple health issues. Because people are living much longer with more complex profiles and are being subjected to more extensive surgical treatments, the number of people with chronic wounds and wound complications continues to increase, and despite the attention of doctors or nurses, some of the wounds do not heal easily and cause great pain and discomfort.^{1,4,16}

Initial wound management is directed towards the prevention of infection by washing the wound with antiseptic and covering it with a dry sterile dressing. Research on wound healing in the 1950s and 1960s revealed that acute wounds heal more rapidly if they are kept

moist, as this allows the dermal and epidermal cells to divide and migrate to the surface of the wound.^{2,4,5,12}

Despite the use of modern dressings, a large number of chronic wounds are still difficult to heal. One way to manipulate the wound environment is to apply negative topical pressure (NPWT) (measured in mm Hg) to the surface of the wound by means of a dressing. The concept of negative pressure to create a suction force that makes draining of surgical wounds possible and stimulates wound healing is well documented.^{1,2,5,8,9,14,17}

It has long been suggested that if the excess fluid is not properly eliminated from the wound following an operation, its components can function as physical and chemical impediments to the healing of the wound.

The basic concept that mechanical forces influence the form and growth of tissues is also well documented. It is reported that NPWT has both properties, i.e. it removes excess interstitial fluid and transmits mechanical forces to the surrounding tissues with the resulting deformation of the extracellular matrix and of the cells.^{8-10,18,19}

It is assumed that both factors stimulate healing of the wound through a variety of mechanisms. The transparent adhesive dressing used to secure the bandage may also help to maintain a moist environment for the wound.

Various terms are used to describe treatment of a wound with NPWT, including subatmospheric treatment or dressing, vacuum sealing technique, negative pressure dressing, foam dressing with suction, vacuum compression, vacuum compress, or sealed surface wound suction, but for the purposes of this review, the term NPWT will be used for this procedure.^{8,10,12,13,20}

NPWT requires an open cell dressing (e.g., foam, felt, surgical toweling, gauze) to compress the wound, a tubular structure to connect the dressing to the suction pump, with an intermediate receptacle for collection of any exudates, and an airtight seal surrounding the dressing. However, there is enough evidence to demonstrate that dressings with specific porosity of between 400 and 600 microns are the only ones capable of achieving microdeformations in the tissue.

All nonviable tissues are removed beforehand. NPWT is generally considered to be contraindicated if the wound or surrounding tissues are cancerous, if there are fistulae connecting to organs or cavities, in cases of a suspected fistula of cerebrospinal fluid, or if there is necrotic tissue or untreated osteomyelitis.^{1,3,7}

Laboratory evidence on the effects of NPWT on the wound environment has been obtained in various animal studies. A series of studies using a model of acute wounds in pigs reported an increase in functional local blood perfusion, a significantly higher rate of granulation tissue formation, a significant reduction in tissue bacteria levels, and a significant increase in blood flow in wounds treated with NPWT compared to wounds treated with gauze soaked in physiological solution.^{9,2,12,20,21}

The use of NPWT in chronic human wounds has been described by a number of clinics and its use for home treatment of chronic wounds has been reviewed using trials with no-simultaneous control groups.

This review examines the impact of NPWT on chronic human wounds using trials in which the patients have been randomly assigned to coexisting control groups.^{4,12,13,16,19}

Regarding infection, the main focus of treatment is to drain all the pus, removing debris, devitalized tissue, and foreign bodies and eliminating the etiology of the infection.^{4,5}

For management of complicated wounds and of the factors mentioned above, various treatments are used, such as surgical cleaning, the use of more powerful drugs, hyperbaric oxygen, etc. with acceptable results. However, in many cases, a long period of in-hospital medical care is required with the consequent consumption of material and human resources: antibiotics, antiseptics, dressing materials, operating room hours, medical and paramedical personnel, etc.^{19,22,23}

The first function the computerized unit performs is to extract fluids from the wound via a collector tube placed over the sponge. This action accelerates the healing process by activating the signal for cell division and increasing blood flow. There are two types of sponges. The first is hydrophobic open cell polyurethane (400 a

600 μm), which is always indicated for granulation tissue formation when there are no exposed tendons, blood vessels, or nerves. In these cases hydrophilic polyvinyl alcohol sponges tend to be used. Both have the property of transmitting the suction force to the wound surface where it causes microdeformations. There is also another sponge with the same characteristics as the polyurethane one, but with the addition of silver for infected wounds.^{8,10,11,15}

The sponge is designed with open cells to facilitate the elimination of excess exudates from the wound. It transmits subatmospheric pressure to the wound, an action that causes changes to the surface of the tissue in contact with it, inducing acceleration of the healing process. The adhesive film maintains a moist environment and its permeability facilitates gas exchange, which together with the sponge, protects the wound from environmental contamination.^{1,12,24,25} (Figure 3)

Removal of excess fluid from the wound site reduces compression, which favors the lymphatic and circulatory systems, as higher pressure inhibits oxygenation and the flow of nutrients to the wound. Bacteria consume nutrients and oxygen and denaturalize proteins, negatively impacting the healing process. Isolating the wound eliminates or reduces the bacterial load. (Figure 4)

It has also been shown that negative pressure increases blood flow through reduction of swelling surrounding the wound and the reduction of harmful enzymes in the wound bed.^{1,12}



Figure 3. Patient, 56 years of age, with discitis following spinal surgery.



Figure 4. Patient with dehiscence of a surgical wound in the lumbar region, after 4 sponge replacements and 3 weeks of evolution.

Indications for NPWT therapy are: acute wounds, chronic wounds, traumatic wounds, burns, diabetic ulcers, bedsores, and open abdominal wounds. It is contraindicated in wounds with necrotic tissue, untreated osteomyelitis, and unexplored non-enteric fistulas, and its use is not recommended if in areas of malignancy.

This type of treatment has been accepted for spinal surgery. Its use is of great help if one considers the high costs of the instrumentation used in this type of surgery. One of the contraindications is the suspicion or presence of a dural rupture or tear with the possible leakage of cerebrospinal fluid.^{1,3,6,7,23}

FINAL CONSIDERATIONS

Deep infections that occur after spinal surgery are a very significant cause of mortality and morbidity, given that there is an incidence of from 0.9% to 13.4% for all surgical procedures, which represents a major problem for both the patient and for the health-care team and the different levels of care.

Negative pressure closure therapy is used with great success, primarily in abdominal surgery, sternal opening chest surgery, and open fractures of the lower limbs, as the negative pressure eliminates and absorbs swelling and fluids, improves blood circulation, and generates cell proliferation with granulation and local tissue growth.

It has also been demonstrated that the use of negative pressure therapy reduces the costs of patient care, since economic savings resulting from faster healing, less time dedicated by medical and paramedical personnel, shorter hospital stays, and reduced use of

antibiotics could offset the acquisition costs of equipment used in negative pressure treatment.

This method is effective for the treatment of deep postoperative infections of the spinal column, when used for an average of 1 to 4 weeks, depending upon whether inert material is exposed, and changing the sponge and the adhesive film three times a week. A significant success rate is achieved without removing the exposed implant, by performing repeated debridement and thorough cleaning until closure of the wound is complete.

NPWT is indicated mainly because of the increasing rate of patients with infections of surgical wounds following a spinal intervention.

This treatment also reduces the length of the hospital stay, reduces the duration of antibiotic therapy, reduces the costs of medical care, and restores the patient to his daily activities as quickly as possible.

Infection associated with health care, known as nosocomial, is localized or systemic infection resulting from an adverse reaction to the presence of an infectious agent.

In the United States, this type of infection causes more than 100,000 deaths per year with an estimated cost of around \$ 6.7 billion dollars annually.

In Mexico, the incidence of infection at the surgical site following a decompression laminectomy, discectomy, or fusion is less than 3%, but the incidence rises to 12% when the patient is instrumented.

All authors declare no potential conflict of interest concerning this article.

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