

## Original Research Article

# Use of negative pressure therapy in the management of complex wounds initial experience of 4 years

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## ABSTRACT

**Background:** Wound management with negative pressure therapy has been used in the treatment of complex wounds in both inpatient and outpatient settings, and is increasingly used in primary care and outpatient management, as it helps to reduce patient days of hospital stay. We describe the initial 4-year experience in the use of negative pressure therapy in the management of complex wounds.

**Methods:** A retrospective, cross-sectional and descriptive study of our experience of the use of negative pressure therapy for the management of complex wounds in 5 years.

**Results:** A total of 89 patients with complex wounds managed with TPN were analysed, of which 53 were men (62.9%) and 33 were women (37.1%). Suprafacial therapy was used in 64 cases (73%). The ABThera® system was used in 25 cases (27%). Among the etiology of complex wounds, vulvar abscess was recorded in 1 case (1.1%), firearm wound in 1 case (1.1%), Fournier's gangrene in 1 case (1.1%), septic arthritis in 1 case (1.1%), burn wounds in 1 case (1.1%), septic arthritis in 1 case (1.1%), and burn wounds in 1 case (1.1%). 1%), burn wounds in 5 cases (5.6%), pressure ulcer wound in 6 cases (6.7%), necrotizing fasciitis in 19 cases (21.3%), abdominal sepsis in 26 cases (29.2%), surgical wound infection in 29 cases (32.5%).

**Conclusions:** The use of negative pressure therapy and protocolized management has provided patients in our institution with a viable therapeutic option.

**Keywords:** Negative pressure therapy, Complex wounds, Surgical wound infection, VAC®

## INTRODUCTION

Wound management with negative pressure therapy has been used in the treatment of complex wounds in both inpatient and outpatient settings; also called vacuum-assisted wound closure, it refers to wound dressing systems that continuously or intermittently apply sub-atmospheric pressure to the system, which provides positive pressure to the surface of a wound and has become a generally accepted treatment modality for the treatment of many acute and chronic wounds.<sup>1</sup> It is increasingly used as primary care and outpatient

management, as it helps to reduce patient days of hospital stay. Negative pressure therapy began to be used in the middle of the last century, but it is only in last 2 decades that its application has become widespread in the hospital setting. The first description of this procedure was made in Germany in 1993 by Fleischman et al who treated 15 patients with exposed fractures and at end of the 1990s Argenta and Morykwas introduced it as a complementary treatment for chronic wounds and ulcers.<sup>2,3</sup>

Among the current surgical methods for treatment and management of complex wounds is the VAC® (vacuum

assisted closure) system which is composed of a porous polyurethane sponge that is connected to a vacuum pump and which is fixed and hermetically sealed with an adhesive dressing around the wound, a fluid collection system and a suction pump.<sup>4</sup> Silver containing sponges have been introduced for better control of the bacterial load of the treated wounds. With the vacuum pump we can control the application of negative pressure which will be evenly distributed by the sponge. The principle of negative pressure therapy is to create a suction effect that allows continuous wound drainage accelerating wound healing. Normal wound healing progresses through the following phases: hemostasis, inflammation, proliferation and remodelling. Both local and systemic wound factors can contribute to delayed wound healing; systemic factors should be identified and corrected as much as possible.<sup>5-8</sup>

Local wound factors that interfere with normal healing include desiccation, tissue edema, excessive exudate, poor tissue positioning (e.g., grafts and flaps), and wound infection. Stagnant fluid is associated with cytogenetic factors that impede wound healing.<sup>9-11</sup> The effects on wound healing and affected tissue resulting from applied suction are reduction in wound size due to edge retraction, stimulation of granulation tissue formation, and continued mechanical cleansing of the wound. Negative pressure therapy has been applied to a wide range of wounds including open abdomen, exposed fractures, resected necrotizing infection, pressure ulcer, diabetic foot ulcers, burns, dermo-epidermal grafting or flaps.<sup>12</sup>

The aim of this study is to describe the results of the treatment of complex wounds by including the negative pressure method in a series of successive cases.

## METHODS

We retrospectively analysed our experience with the use of NPT (negative pressure therapy) in the treatment of complex wounds in hospitalized patients between January 2015 and December 2019 in the general surgery department in the hospital Regional de Alta Especialidad de Oaxaca. For the development of the study, demographic data such as age, sex, diagnosis, number of therapies received, days of in-hospital stay, type of sponge, pressure used and wound resolution were obtained.

The inclusion criteria were patients over 18 years of age, in whom the negative pressure system was used for the management of complex wounds, regardless of the anatomical location. Exclusion criteria were patients whose records did not contain the necessary information for the study. The diagnosis of wound infection was established from the clinical conditions of the wound and the result of quantitative cultures with colony count.

In all cases the VAC ULTA® negative pressure machine was used and for this study 2 types of therapy were used; the suprafacial which consists of the use of negative pressure in wounds that maintain the integrity of the muscular fascia and without exposure of organs and the ABTHERA® device for the management of abdominal wounds with loss of muscular fascia and total exposure of intra-abdominal viscera and protection with omentum.

## Ethical responsibilities

Protection of humans and animals. The authors declare that no experiments on humans or animals have been performed for this research.

Confidentiality of data. The authors declare that they have followed their center's protocols on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the corresponding author.

Data recording and analysis was performed with IBM SPSS V 21 statistical software.

## RESULTS

A total of 89 patients with complex wounds managed with TPN over a period of 4 years in a third level hospital were analysed. Regarding the demographic variables of the 89 patients; 53 were men (62.9%) and 33 were women (37.1%), with an average age of 48.06 years with a range of 18-83 years. Suprafacial therapy was used in 64 cases (73%) in which sponge with silver salts was used in 55 cases (85.93%), the combination of sponge with silver salts and polyvinyl alcohol was used in 8 cases (12.5%) and only in 1 case (1.56%) only polyvinyl alcohol sponge was used. As for open abdomen management, the ABTHERA® system (Figure 1) was used in 25 cases (27%) (Table 1).



**Figure 1: ABTHERA® system for open abdomen management.**

**Table 1: General results, n=86.**

Variables	Results
Men (%)	53 (63)
Woman (%)	33 (37)
Age, average (IRC)	48.6 (18-83)
Suprafacial therapy (%)	64 (73)
Abthera system (%)	25 (27)
Sessions, average	2.7
In-hospital stay days, average	12
Closing for second intention (%)	35 (39.32)
Direct closing (%)	28 (31.46)
Closure by graft placement (%)	25 (28)
Clouse by flap rotation (%)	1 (1.12)

\*IRC: interquartile range

Negative pressure therapy in continuous mode was used in all cases (100%); the suction intensity was set at 125 mmHg but the effective suction observed fluctuated between 125 and 100 mm of mercury in all cases.

The average number of sessions was 2.7 and the average in-hospital stay was 12 days.

The final wound coverage was performed by second intention closure in 35 cases (39.32%), by direct closure in 28 cases (31.46%), by graft placement in 25 cases (28%), and flap rotation used in 1 case (1.12%) (Table 1).

Within the etiology of complex wounds (Table 2), vulvar abscess was recorded in 1 case (1.1%), firearm wound (Figure 2) in 1 case (1.1%), Fournier's gangrene in 1 case (1.1%), septic arthritis in 1 case (1.1%), burn wounds (Figure 3) in 5 cases (5.6%), pressure ulcer wound in 6 cases (6.7%), necrotizing fasciitis in 19 cases (21.3%), abdominal sepsis in 26 cases (29.2%), surgical wound infection (Figure 4) in 29 cases (32.5%).



**Figure 3 (A, B C and D): Suprafacial therapy with polyvinyl alcohol sponge in electrical burns.**



**Figure 2 (A and B): Use of negative pressure in gunshot wounds after 2 sessions.**



**Figure 4 (A and B): Use of negative pressure therapy in surgical wound infection after 1 session.**

**Table 2: Etiology of complex wound.**

Variables	Results
<b>Vulvar abscess (%)</b>	1 (1.1)
<b>Firearm wound (%)</b>	1 (1.1)
<b>Fournier's gangrene (%)</b>	1 (1.1)
<b>Septic arthritis (%)</b>	1 (1.1)
<b>Burn wounds (%)</b>	5 (5.6)
<b>Pressure ulcer wound (%)</b>	6 (6.7)
<b>Necrotizing fasciitis (%)</b>	19 (21.3)
<b>Abdominal sepsis (%)</b>	26 (29.2)
<b>Surgical wound infection (%)</b>	29 (32.5)

## DISCUSSION

Proper surgical management and the use of antimicrobials is the basis for the treatment of infected wounds and the use of negative pressure therapy has contributed significantly to the good outcome of the treatment. According to our study, negative pressure therapy offers comparable or, in some cases, superior results to those offered by traditional treatments; the effectiveness of the treatment seems to be conditioned to a previous correct surgical debridement of the wound.<sup>13</sup> Several studies have shown that the application of negative pressure therapy decreases the time to resolution of complex wounds more rapidly than moist dressings.<sup>14</sup> Increased tissue growth has been demonstrated in swine models with the application of negative pressure at 125 mmHg.<sup>15</sup> Blood flows were found to be four times higher in Doppler measurements when 125 mmHg pressures were applied to the wounds.<sup>15</sup> At the beginning of treatment, patients may experience wound discomfort referred to as pain caused by the suction pressure generated by the vacuum pump; this pain is usually controlled by decreasing the suction pressure. It is usually not severe enough to require discontinuation of treatment and no such action was required in any of our patients.<sup>13</sup>

Negative pressure-induced stress affects the cell surface three-dimensionally by the distribution of the sponge pores; mechanical stimulation causes cell proliferation. By reducing the length of hospital stay, it also reduces the risk of nosocomial infections, which are directly related to higher morbidity and mortality and increased cost per stay.<sup>16</sup> When there are tendon and bone exposures, polyvinyl alcohol sponges are available that prevent adhesion to the tissues. In these cases, vacuum therapy has been very effective in the attachment of cover grafts.<sup>17</sup>

The infection of the operative site represents an important health problem and one of the most feared surgical complications for the patient and the hospital center or health system where the patient receives care, due to the increase in the consumption of supplies as well as the number of days of hospitalization and disability and the morbidity and mortality associated with it.<sup>18</sup> The advantages of the use of negative pressure therapy in these cases has been demonstrated; however, in most

health institutions in Mexico this type of material is not available and consequently infected wounds are still treated in the traditional way, washing with soap and water or an antiseptic solution. In our study, patients with surgical wound infection and necrotizing fasciitis had a very good evolution, with faster cleaning and total wound closure (10 days), which facilitated discharge and subsequent management; Since we do not have a control group, we can only compare them with the historical and anecdotal background in our hospital, in which the traditional cleaning method was used for 3 to 4 weeks, after which the patient was discharged for outpatient management in the wound clinic of the same hospital, or in their family medicine unit, even with the wound open. Due to the fact that the VAC ULTA® machine is very portable and easy to use, certain patients have been able to be treated with these systems on an outpatient basis, without the need for hospital admission, requiring only periodic visits to the clinic to carry out the sponge changes until the time of the definitive surgical intervention.

Regarding the use of negative pressure therapy for the management of open abdomen there are some precedents regarding the use of negative pressure applied directly to the abdominal cavity, as reported by Barker and his group from Chattanooga at the university of Tennessee, who presented a publication in February 2000 regarding 112 patients over a period of seven years, in which they used a vacuum packing technique for the temporary closure of the open abdomen. They treated patients with severe abdominal trauma managed with damage control technique, reporting good results.<sup>19-20</sup>

In our study, good results were obtained in the group of patients treated with the ABTHERA® open abdomen technique whose effect allows temporary closure of the abdominal cavity and its access for successive explorations, protecting the intestinal contents, facilitating the management of exudate, allowing its quantification and preserving the edges of the incision in an optimal state for its subsequent approach and closure, avoiding retraction of the fascia.<sup>21</sup> Taking as a reference that before the introduction of negative pressure therapy in our hospital, conventional treatment in this group of patients represented prolonged hospital stays of 90 to 120 days or even more, with a very high mortality; therefore, the use of negative pressure therapy is a good option in this group. Our results show that there is cleaning of the surgical wound around 15 days, with the possibility of surgical closure approximately between 20 and 30 days and discharge of the patient days later. The negative pressure system is an expensive therapy in relation to the traditional methods used for wound treatment. However, there are several studies that have demonstrated with scientific evidence the clinical and economic advantages of this therapy.<sup>22-25</sup> So, it is necessary to make a global balance and take into account that negative pressure therapy facilitates wound management, with a device replacement every 2-3 days, with the consequent savings

in nursing time, healing material and above all the greatest benefit which is the reduction in hospital stays.

### Limitations

A limitation of the study is the relatively small size of the study population; a larger number of cases would have provided a population with a wide variety of demographic and clinical characteristics.

### CONCLUSION

Negative pressure therapy was developed as a therapeutic to assist or promote closure of complex wounds, not to close them completely, and it will never replace surgical procedures. In many of the cases presented here, negative pressure therapy served to generate granulation tissue and keep the surgical wound clean to later perform some surgery for definitive closure, minimizing the time of closure and hospitalization.

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### REFERENCES

1. Capobianco CM, Zgonis T. An overview of negative pressure wound therapy for the lower extremity. Clin Podiatr Med Surg. 2009;26:619.
2. Whitworth I. History and development of negative pressure therapy. In: Banwell PE, Teot L, editors. 1st International Topical Negative Pressure Focus Group Meeting. Faringdon, UK: TPX Communications. 2004;22-6.
3. Argenta LC, Morykwas MJ. Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. Ann Plast Surg. 1997;38(6):563-77.
4. Venturi ML, Attinger CE, Mesbahi AN, et al. Mechanisms and clinical applications of the vacuum-assisted closure (VAC) Device: a review. Am J Clin Dermatol. 2005;6:185.
5. Bucalo B, Eaglstein WH, Falanga V. Inhibition of cell proliferation by chronic wound fluid. Wound Repair Regen. 1993; 1:181.
6. Banwell PE. Topical negative pressure therapy in wound care. J Wound Care. 1999;8:79.
7. Wysocki AB, Staiano-Coico L, Grinnell F. Wound fluid from chronic leg ulcers contains elevated levels of metalloproteinases MMP-2 and MMP-9. J Invest Dermatol. 1993;101:64.
8. Sapico FL, Ginunas VJ, Thornhill-Joynes M. Quantitative microbiology of pressure sores in different stages of healing. Diagn Microbiol Infect Dis. 1986;5:31.
9. Hunt TK. The physiology of wound healing. Ann Emerg Med. 1988;17:1265.
10. Falanga V. Growth factors and chronic wounds: the need to understand the microenvironment. J Dermatol. 1992;19:667.
11. Genecov DG, Schneider AM, Morykwas MJ. A controlled subatmospheric pressure dressing increases the rate of skin graft donor site reepithelialization. Ann Plast Surg. 1998;40:219.
12. Bovill E, Banwell PE, Teot L. Topical negative pressure wound therapy: a review of its role and guidelines for its use in the management of acute wounds. Int Wound J. 2008;5:511.
13. Maitret-Velázquez RM y cols. Terapia de presión negativa. Rev Mex Angiol. 2018;46(1):9-18.
14. Zannis J. Comparison of Fasciotomy Wound Closures Using Traditional Dressing Changes and the Vacuum-Assisted Closure Device. Ann Plast Surg. 2009;62:407.
15. Morykwas MJ, Argenta LC, Shelton-Brown EI. Vacuum-assisted closure: A new method for wound control and treatment. Animal studies and basic foundation. Ann Plast Surg. 1997;38:553.
16. Buendía Pérez J, Vila Sobral A, Ruiz G. Tratamiento de heridas complejas con terapia de presión negativa. Experiencia en los últimos 6 años en la Clínica Universitaria de Navarra, Pamplona (España). Cir plást iberolatinoam. 2011;37:65-71.
17. Llanos S, Danilla S, Barraza C. Effectiveness of negative pressure closure in the integration of split thickness skin grafts. Ann Surg. 2006;244:700.
18. Robledo-Ogazón F, Díaz JMY, Sánchez-Fernández P. Uso del sistema de cierre asistido al vacío VAC® en el tratamiento de las heridas quirúrgicas infectadas. Experiencia clínica. Cir Ciruj. 2006;74:107-13.
19. Smith LA, Barker DE, Chase CW, Somberg LB, Brock WB, Burns RP. Vacuum pack technique of temporary abdominal closure: a fouryear experience. Am Surg. 1997;63(12):1102-07.
20. Barker DE, Kaufman HJ, Smith LA, Ciraulo DL, Richart CL, Burns RP. Vacuum pack technique of temporary abdominal closure: a 7- year experience with 112 patients. J Trauma Injury Infect Crit Care. 2000;48(2):201-6.
21. Brox-Jimenez A, Diaz-Gomez D, Parra-Membrives P. Sistema de cierre asistido por vacío en heridas complejas. Estudio retrospectivo. Cir Esp. 2010;87(5):312-7.
22. Olejnik J, Sedlak I, Brychta I, Tibensky I. Vacuum supported laparostomy-an effective treatment of intraabdominal infection. Bratisl Lek Listy. 2007;108:320-3.
23. Boele van Hensbroek P, Wind J, Dijkgraaf M, Busch O, Goslings J. Temporary closure of the open abdomen: a systematic review on delayed primary

fascial closure in patients with an open abdomen. *World J Surg.* 2009;33:199-207.

24. Alan de Costa A. Making a virtue of necessity: managing the open abdomen. *ANZ J Surg.* 2006;76:356-63.
25. Arigon JP, Chapuis O, Sarrazin E, Pons F, Bouix A, Jancovici R. Managing the open abdomen with vacuum-assisted closure therapy: retrospective

evaluation of 22 patients. *J Chir (Paris).* 2008;145:252-61.

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