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ORIGINAL RESEARCH

Topical Negative Pressure Therapy Recent Experience Of The Department of Plastic Surgery At Ibn Sina University Hospital, Rabat, Morocco

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ABSTRACT
Introduction: The topical negative pressure therapy (TNP) is a non-invasive method to treat chronic and acute wounds locally, using a continuous or intermittent negative pressure. The objective of this study is to present the first experience of this type of treatment used in clinical cases in our department. By presenting these cases, we highlight indication and efficiency of this new technique applied in relatively complicated situations, at the same time it also allows a significant improvement in treating injuries and chronic wounds.
Materials and methods: In this study, we present the recent experience of the Department of Reconstructive and Plastic Surgery of the University Hospital Center of Avicenne in Rabat. This therapy was used for the first time this year (2014), in three young patients who presented with chronic wounds associated with local and general factors that are unfavorable for the healing process.
Results: In all three of our cases, we obtained highly satisfactory clinical results. TNP allows wounds to bud in a shorter time, as well as a fast healing by second intention due to controlled wound healing or split-skin graft without using flaps. This enables to decrease the margin of error, the time and the number of dressing replacements, and to reduce the length of hospital stay.
Conclusion: This is an expensive and specific equipment. However, the cost-benefit ratio analysis shows that it is an essential method that should be part of our therapeutic strategies.

KEY WORDS: loss of substance, negative pressure, budding, healing.

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INTRODUCTION:
The principle of topical negative pressure therapy (TNP) or vacuum-assisted closure (VAC) is based on local application of depression on damaged tissues in order to stimulate the budding tissue and facilitating the drainage of serous fluid and the healing process. The VAC or TNP (topical negative pressure) is also known as SPD (sub-atmospheric pressure), VST (vacuum sealing technique) or SSS (sealed surface wound suction). It was suggested for the first time by Morykwas et al. in 1997 (1) for treating chronic cutaneous wounds, then the range of its indication increased.

In Morocco, using this therapy in hospitals is complicated due to the high cost of acquisition (buying or renting the pressure system) and exploitation (single use device), as well as because of the necessary training of its proper use.

The objective of this study is to present the first experience of this type of treatment applied in three cases in our department. By presenting these cases, we highlight the effectiveness of this technique in relatively complicated situations, allowing a proper treatment of wounds in order for them to heal and obtain a fast and definite coverage.

MATERIALS AND METHODS

In this study we present the experience of the Department of Plastic Surgery and Burns at the University Hospital Ibn Sina of Rabat. This center takes care of patients coming from the northwest of Morocco. The study presents three patients treated during a 6-month long period from January through June 2014.

In this study we included patients with loss of deep, cutaneous muscular, or cutaneous muscular and bone substance treated unsuccessfully with coverage methods ranging from controlled wound healing, graft, flaps to hyperbaric chamber. The failure was possibly due to reasons associated with the affected area (infection, insufficient vascularization, anemia).

Patients with financial problems, with an injury to a smaller area (less than 5 x 5 cm), damage only to superficial layers, or without exposed organs (bone, tendon, nerve) were not included in this study. In the latter cases, standard coverage methods brought sufficient improvement.

A favorable improvement is defined by fast reduction in size of the substance loss, both superficial and deep layers with good healing, especially in the budding phase. The granulation tissue should be red in color and bleed easily, and ready to receive a split-skin graft used in cases of large and deep substance loss, and in certain cases when the wound is located in specific areas.

RESULTS

Case 1

A 42-year-old Moroccan storekeeper, without significant medical history presented to our department with a varicose ulcer that had developed over a 2-year's period. First, we tried conventional dressings, such as tulles, interface dressings and proteolytic enzymes for debridement of fibrin in order to obtain the budding of the loss of substance before a skin graft. However, these attempts were unsuccessful (figure 1).

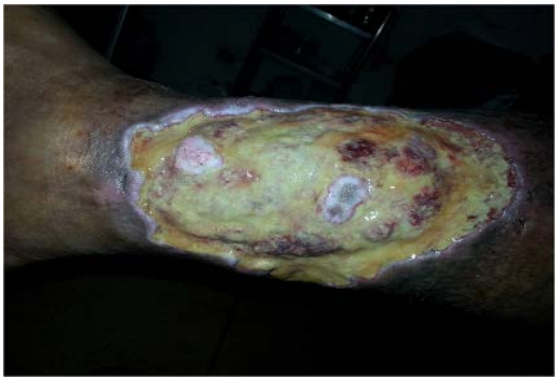

Figure 1: Loss of substance on the leg after a varicose ulcer.

The first examination of the lesion showed a loss of substance on the lateral surface of the left leg, approximately 20 x 9 cm in size with irregular edges. It was covered by a biofilm, fibrin and two little islands of healthy skin.

After 15 sessions of hyperbaric chamber treatment, we could obtain some budding on the edge but it was qualitatively still insufficient to ensure coverage with a split-skin graft (figure 2).

Due to the extended length of hospital stay (one month), the lack of efficiency and the high total cost of these procedures, we decided to use TNP.

After 2 TNP sessions at 5 days interval, a favorable evolution was observed with a good granulation tissue and without fibrin (figure 3) that was ready to receive a split-skin graft (figure 4).

Directly under spinal anesthesia, the patient received a split-skin graft, removed by electric dermatome from the frontal aspect of the contralateral thigh.

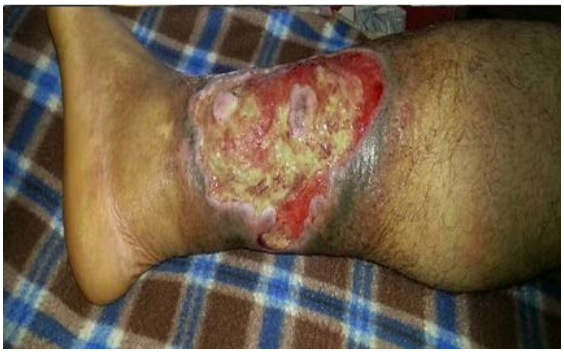

Figure 2: Aspect of budding after 20 sessions of hyperbaric oxygen therapy.

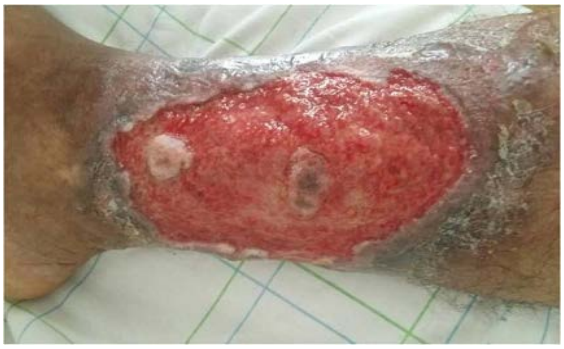

Figure 3: A budded loss of substance after 2 sessions of TNP.

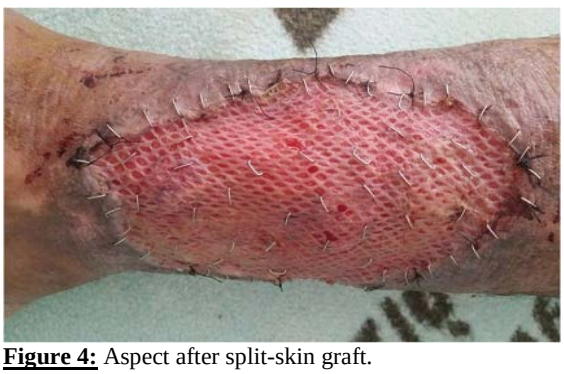

Figure 4: Aspect after split-skin graft.

The short term progress showed a skin graft that held firm, without infection, pain or necrosis.

The patient was discharged 5 days after the graft. Then he returned for consultation three times during which we observed good progress. He was able to return gradually to his normal daily activity.
The periodic follow-up of the wound is scheduled every three months for a year.

Case 2
A 24-year old Moroccan security officer, chronic smoker, who received a musculocutaneous
flap mobilization on the soleus muscle a year ago. He had suffered from an undocumented chronic osteomyelitis that was most probably the result of a traumatism on the leg caused by a foreign body that was neglected, according to the patient.
He presented to our department because of a fistula formation with discharge of pus on the anteromedial surface on the upper third of the leg.
We performed a debridement under local anesthesia that created a deep but small loss of substance of 5 x 4 cm, with bone exposure (figure 5). This was followed by 10 sessions of hyperbaric chamber treatment without visible improvements. In the light of favorable evolution in the first case, we proposed TNP for this patient.
After the first session of TNP, an important budding was observed which covered even the initial loss of bone substance (figure 6). It allowed us to make a total skin graft directly under spinal anesthesia. The skin was removed by scalpel from the inner surface of the left thigh (figure 7).
The patient was discharged 5 days after the graft. In the next month, three follow-up consultations were held. Both the graft and the motor recovery showed favorable evolution. The periodic follow-up of the wound is scheduled each three months during 1.5 years.

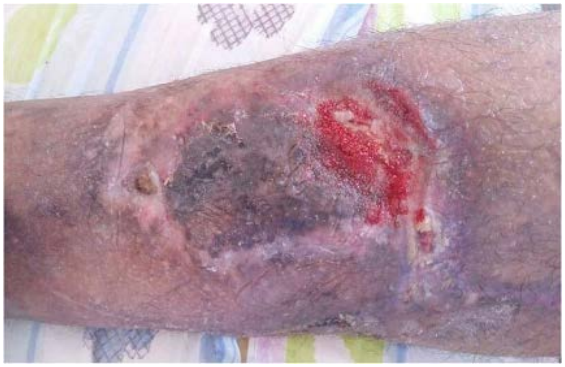

Figure 5: Loss of substance on the leg caused by chronic osteomyelitis.

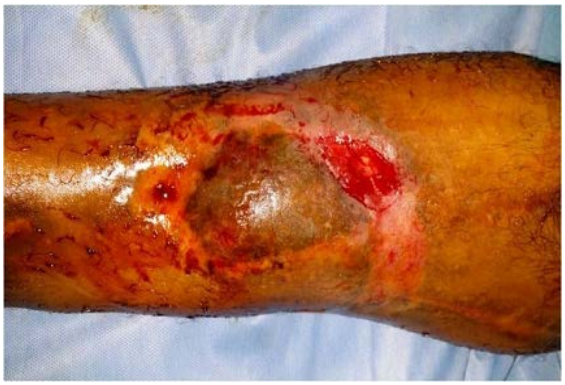

Figure 6: Aspect after only one session of TNP.

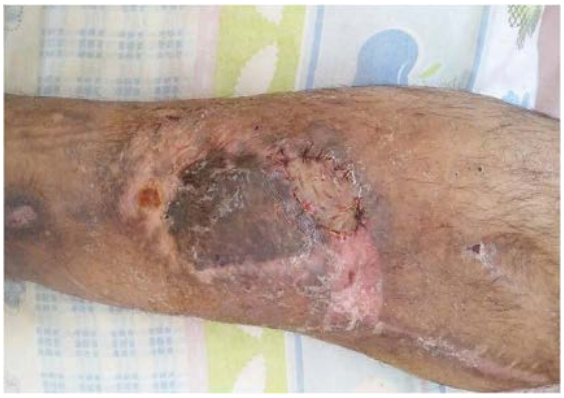

Figure 7: Aspect after coverage by a total skin graft.

Case 3
A 15-year old Moroccan high school student who had been treated since puberty with iron-deficiency anemia.
The patient presented to our department following a road accident, with post-traumatic sciatic-musculocutaneous chronic damage on the right side, 35 x 22 cm in size, with detached skin around the wound (figure 8). For this patient we proposed TNP as the first-line treatment, since the surface of the loss of substance was large and it would have required rigorous care and long stay in the hospital.

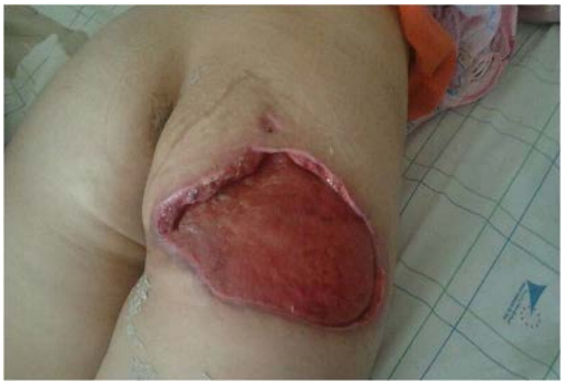

Figure 8: Post-traumatic sciatic-musculocutaneous chronic wound with detached skin around.

After 3 sessions of TNP at 3 days interval, we obtained red budding tissue that was able to bleed, and the space under the detached skin was filled (figure 9).

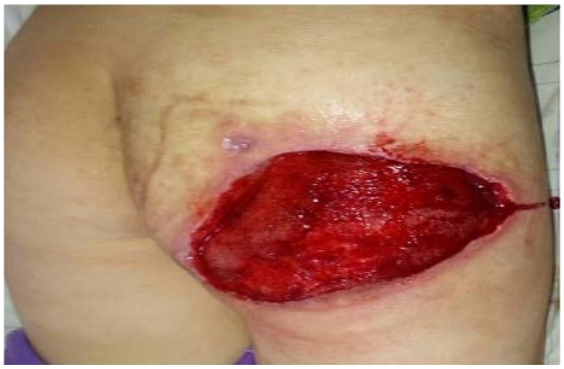

Figure 9: Aspect after three sessions of TNP.

The patient received directly under spinal anesthesia a split-skin graft removed from the buttocks using electric dermatome (figure 10).

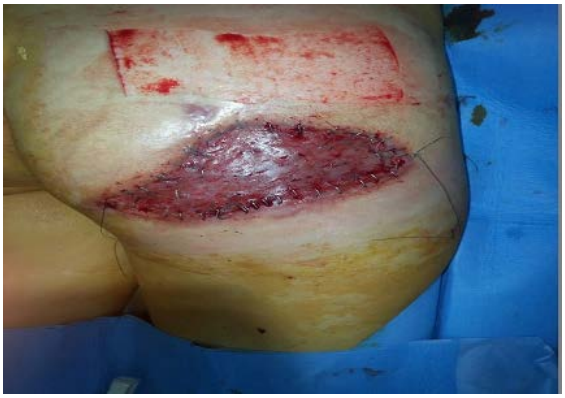

Figure 10: Aspect after coverage by a split-skin graft.

The patient was discharged 8 days after the operation.
2 months after the treatment, she came to a consultation. During the examination we observed a graft that held firm without pain or detachment.
The periodic follow-up of the wound is scheduled every three months during a year.

DISCUSSION

Although the topical negative pressure therapy (TNP) dates back to the 19th century (2, 3), it wasn't until the 1970s when Russian teams started publishing about its first clinical use. In 1989, Chariker et al. (4) published a negative pressure dressing technique using wall the cavity with a silicone drain attached to simple gauze compresses and a semi-permeable membrane covering the wound. Following the publication of Morykwas and Argenta in 1997, commercial use and exploitation of the procedure started on a global scale (3, 5).
TNP is based on the principle of suction. In addition to removal of excessive exudates, applying continuous or discontinuous depression increases blood flow in the affected area both in the healthy skin and the wound.
By improving the vascularization, it favors budding of the cutaneous substance, provided that the recipient bed is correctly vascularized.
Besides its indication to form granulation tissue using mechanical stress that stimulates mitosis and increases neovascularization, this technique is also known to reduce edema and exudates, to reduce bacterial colonization, to establish moisture balance that allows to have a humid environment (1, 6, 7), as well as to increase growth factors (VEGF, bFGF, etc.) (8).
Indications of its use are wide and include acute, subacute, chronic, traumatic wounds, with or without loss of substance, partial-thickness burns, (pressure, venous, diabetic) ulcers (9).
The TNP may be used on flaps and cutaneous grafts allowing the removal of exudates and elimination of hematoma formation or accumulation. Placing the graft in its place optimally by constant and uniform depression, it allows a better application of the graft even on an irregular recipient bed, while avoiding the phenomena of friction. Additionally, early mobilization is made possible, thereby limiting the complications of pressure ulcer (especially in patients with multiple tares). As the dressing is watertight, it maintains a humid environment that favors the healing, while decreasing bacterial colonization (10).
Some authors use successfully this technique to secure grafts to scrotal, penial (11) or vaginal (12) locations that are admittedly complicated (maceration, infection, etc.).

Regarding our three cases (venous ulcer, loss of chronic substance and post-traumatic deterioration), despite that we didn't apply TNP directly on the skin grafts, only on the wound, and that the location of the lesions on a regular surface was not risky, as well as the relatively high cost of the process, we obtained firm grafts with highly satisfactory functional results. These confirm the advantages of negative air pressure dressings.
According to directives of the Kinetic Concepts Inc. (KCI) and the Food and Drug Administration (FDA), TNP is contraindicated at the stage of debridement with discharge of pus, in case of necrotic tissue, tumor tissue or exposed organ (13). Our procedural protocol of the treatments is the one described in the literature (14):

→ **First step:** preparation of the wound, soaping and washing of the wound using physiological solution.
→ **Second step:** placing the TNP dressing.
- Rubbing the hands with hydroalcoholic solution.
- Putting on sterile gloves.
- Protecting the surroundings of the wound with hydrocolloid to avoid contact between healthy skin and polyurethane foam, as it may cause cutaneous lesions during suction.
- Cutting the foam aseptically to the dimensions of the lesion, leaving it thick enough to rise 2 cm above the wound.

Placing the foam into the wound. If necessary, it is possible to use more pieces of foam but it has to be counted and documented. Pieces of foam should be in contact with one another (figure 11).
- Covering the foam with polyurethane film without stretching it, to fit closely on the edges of the wound and to the height of the foam.
- Preparing an opening in the transparent film of a diameter of 2 cm and connecting the tank to the tube under sterile conditions.
- The tank has to be changed depending on the volume of exudates, but at least once a week (figure 12 and 13).
- Turning on the engine, programming the parameters according to the medical prescription. Studies have shown that optimal pressure should be 125 mmHg.
- Verifying that the foam is compressed on the wound.
- Change of dressing is performed 2 to 3 times per week depending on the state of the wound and the volume of exudates.
- Evaluating the pain. If necessary, painkillers may be administered 1 hour before changing the dressing.
- Stopping the device 1 hour before the replacing the dressing.
- It's not necessary to measure exudates every day.
- The (single-use) tank should be changed as many times as necessary.
- In case of leakage, the alarm is triggered. In that case, the system will have to be checked for leaks.

Patients with risks of hemorrhage, skin irritation or allergic reactions, pain, signs of infections and skin maceration around the lesion, should be monitored closely (13).
It's important to regularly evaluate the progress. This implies using a method to measure the size of the wound in a precise and reproducible way (15).
If the surface of the wound decreases (e.g. by approximately 15%) after one or two weeks (16), further treatment by TNP should be considered, with simultaneous clinical evaluation.

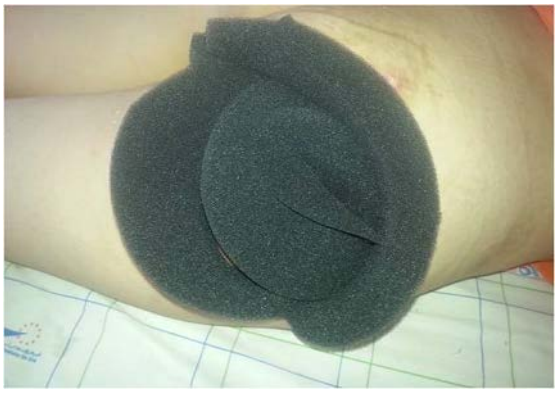

Figure 11: The foam is cut aseptically to the dimensions of the lesion, leaving it thick enough to rise 2 cm above the wound.

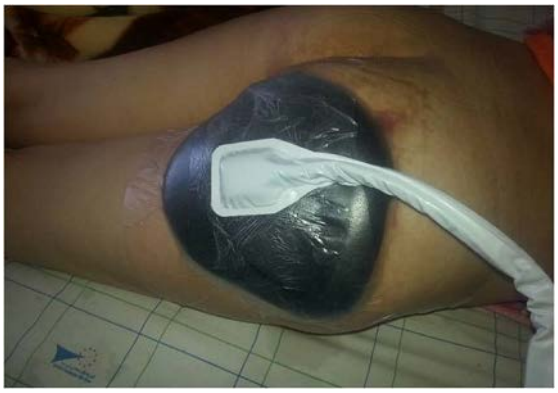

Figure 12: The foam is covered by a transparent film, and then connected to the tank by a tube.

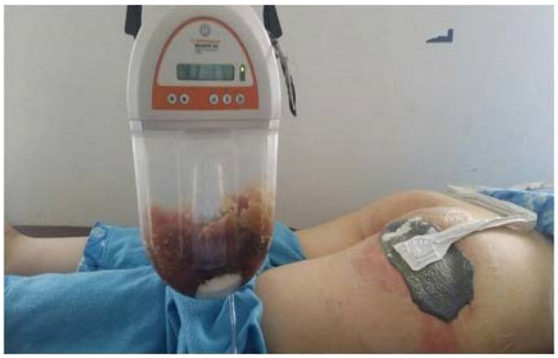

Figure 13: Depression of the foam as soon as the device is turned on and starts to remove the exudates.

If there is no improvement, TNP has to be stopped and another treatment should be started. TNP may be considered again at a later stage.
In case of chronic wounds, a generally efficient progress should allow:
- The examination of the edges of the wound in search of possible inflammation after the first use of TNP. In case of increased inflammation, discontinuation of treatment should be considered.

- The re-examination of the edges of the wound in search of white and thin epithelium after the second and further applications. This is an indicator of the healing process.
- The evaluation of the general aspect of the wound bed. A dark red and granulated aspect is a positive criterion, whereas a dark wound indicates inadequate tissue perfusion. The granulation tissue should grow by approximately 3 to 5% per day.

In our three patients we didn't observe any complications except for painful sensation of variable intensity that was eased with painkillers.
Evolution of the wounds was favorable during the treatment.
In general, TNP allows us to take advantage of the following benefits:
- Controlling the smell and exudates in several types of wounds (that is to say, social benefits) by changing the dressings more often.
- Ability to take part in activities of everyday life, physiotherapy and re-education.
- Faster return to normal life and reduced dependence.
- Better patient compliance (e.g. by discharging the patient).
- Reduction of anxiety and depression.

At the same time, it allows a good cost-efficiency ratio (17, 18) through the following benefits:
- Reduction in the use of resources and staff.
- Reduction in the complexity and the number of surgical interventions, as well as of undesired events.
- Reduction of treatment duration and in the length and the number of hospital stays.
- Better clinical results.

CONCLUSION

Treatment of wounds has always been of great concern for nursing staff.
Multiple and diverse treatments have been tested, adopted, and TNP is one of them. There is no doubt that TNP can have a positive impact on the life quality of a patient. It improves the cost-efficiency ratio in the treatment of wounds.

Nevertheless, in order to justify the use of this technique in day-to-day practice while resources are limited, practitioners should be able to present sound economic arguments in favor of its application. This is made even more complicated due to the apparently high costs of the acquisition of this system. It is recommended that practitioners focus on mentioning other factors that are not related to the costs per unit (e.g. reduction in the length of hospital stay, less work for hospital staff and reduction of undesired events) to measure economic benefits.

ABBREVIATION

bFGF: Basic Fibroblast Growth Factor.
FDA: Food and Drug Administration.
KCI: Kinetic Concepts Inc.
SPD: Sub-Atmospheric Pressure.
SSS: Sealed Surface Wound Suction.
TNP: Topical Negative Pressure.
VAC: Vacuum-Assisted Closure.
VEGF: Vascular Endothelial Growth Factor.
VST: Vacuum Sealing Technique.

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Declared none.

COMPETING INTERESTS
The authors declare no competing interests.

AUTHORS' CONTRIBUTIONS

The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript and provided approval for this final revised version.

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Declared none.

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