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Low-cost negative pressure wound therapy for gunshot traumatism in developing countries

A NAMUGUSHA KABAKULI[1,2,3], P. MUNGUAKONKWA BUDEMA[1], G. KUYIGWA TOHA[1], H. WILONJA TAWIMBI[1], C. SUDI MUSILIMU[1], PL DOCQUIER[3,4]

[1]Faculté de médecine, Université catholique de Bukavu, République démocratique du Congo; [2]Hôpital provincial général de référence de Bukavu; [3]Cliniques universitaires Saint-Luc, Service d'orthopédie et de traumatologie de l'appareil locomoteur, Brussels, Belgium; [4]Université catholique de Louvain, Secteur des Sciences de la Santé, Institut de Recherche Expérimentale et Clinique, Neuro Musculo Skeletal Lab (NMSK), Brussels, Belgium.

Correspondence at: PL. Docquier, Cliniques universitaires Saint-Luc, Service d'orthopédie et de traumatologie de l'appareil locomoteur, Avenue Hippocrate 10, B-1200 Brussels, Belgium, Email: Pierre-Louis.Docquier@uclouvain.be

Wounds from gunshots and other explosive devices are a source of loss of substances directly or secondary to a well-conducted debridement. In addition, these types of wounds are by definition contaminated. The major challenge in this context for any surgeon remains coverage. The use of flap-type plastic surgery is one of the options if feasible. Another option is the use of vacuum dressing.

VAC therapy gives better results than sugar and honey. In a humid environment, it ensures the drainage of exudates. It causes an increase in local blood flow by stimulating neoangiogenesis, it stimulates cell proliferation and also the granulation tissue. It leads to a decrease in bacterial colonization and tissue oedema.

Four observations are presented to illustrate the feasibility of this treatment in developing country and to show its beneficial effects.

Keywords: Gunshot wound, vacuum assisted closure, VAC therapy..

INTRODUCTION

Wounds from gunshots and other explosive devices provide high-energy wounds that devitalise and contaminate tissues, with a risk of immediate post-traumatic loss of substances or after a well-managed debridement. In addition, these wounds are by definition contaminated. Debridement, abundant cleaning with physiological serum and primary or delayed closure are fundamental principles for the treatment of these wounds. To fill the loss of substance, flap coverage is an option if feasible. Alternatively, progressive vacuum-assisted closure (VAC therapy) is an alternative. It involves applying negative pressure (suction) to a wound to treat and facilitate healing. In a moist environment, it ensures drainage of exudates, increases local blood flow by stimulating neoangiogenesis, stimulates cell and granulation tissue proliferation[1] and reduces bacterial colonization and tissue oedema[2].

Since its introduction in 1994 in Europe and 1995 in the United States, VAC therapy has changed the way wounds are treated.

In developing countries, porous polyurethane or polyvinyl alcohol foam is not available because it is too expensive. We use the much more affordable fluffy compress, although the superiority of foam has been demonstrated: the granulation tissue is thicker and more aerated[3].

MATERIALS AND METHODS

The present study took place at the Provincial General Reference Hospital of Bukavu located in the commune of Kadutu. This institution was founded in 1928 and is a state institution, but currently under the management of the Catholic Archidiocese of Bukavu. The study period was from 1 January 2016 to 31 December 2018. The study population consisted of a group of patients admitted to the hospital as part of the International Committee of the Red Cross (ICRC) project, which treats people injured by bullets and other explosive devices. The inclusion or exclusion criteria are as follows:

Patient inclusion criteria

Patients hospitalized during the study period for trauma caused by bullets, shrapnel, explosive devices with a large wound with loss of substance

Complete data in the medical file

Exclusion criteria

Refusal or abandonment of care

Incomplete data sheets

Suturable wounds with immediate primary closure possible

VAC therapy procedure

A primary dressing made of fluffy compresses was placed on the wound, followed by a silicon suction drain covered with compresses. A plastic film was applied circularly without tourniquet effect. The drain was connected to a portable hoover with a negative pressure varying between 75 and 125 mmHg (Fig. 1). We used two different suction machines alternating every other day so that they do not break down due to overuse. We use the same pressure cyclically with occasional breaks (not exceeding one and a half hours).

Cases report (4 cases)

Case 1

A 30-year-old patient with no prior history of injury was admitted for an open Gustillo-IIIb-fracture of the 2 bones of the right leg one week after trauma. He underwent debridement, removing necrotic soft tissue

Fig. 1. — Procedure for assembling the vacuum dressing

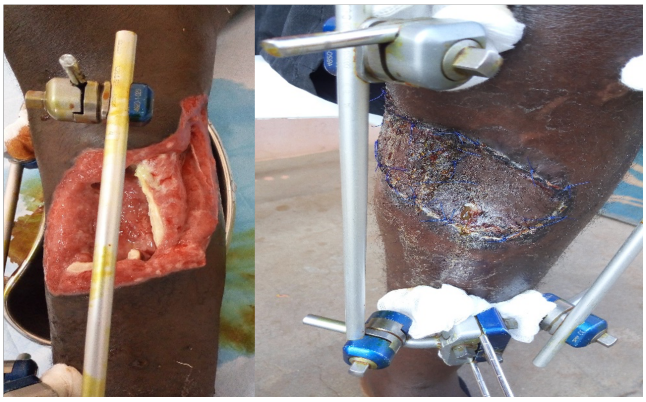

Fig. 2. — Total bone coverage after 12 days of vacuum dressing, followed by skin grafting.

Fig. 3 — The postoperative evolution of an olecranon fracture treated by cerclage wires was favorable under vacuum dressing.

leaving the medial half of the tibial bone exposed (Fig. 2). In addition to external fixation (Hoffman 2), he was placed under a vacuum dressing for 12 days with a change every two days. He underwent one additional bone debridement. The evolution was a total coverage of the bone and a filling of the cavity after 12 days, followed by a skin graft (Fig.2). A Sarmiento cast was placed after removal of the external osteosynthesis material.

Case 2

A 55-year-old patient with an open Gustillo-IIIb-fracture of the right olecranon by bullet. In emergency, a debridement of all wounds was performed and after 5 days, a tension band wiring was performed to maintain active elbow extension.

The post-operative course was marked by the lack of coverage of the cerclage wires and part of the olecranon (Fig. 3), which led to the use of a vacuum dressing. The evolution after 12 days (change every 2 days) was favourable (Fig. 3) and a simple skin graft was performed.

Case 3

An 18-year-old patient with an open Gustillo-IIIb right cervico-trochanteric fracture was admitted the same day to the hospital after having been shot in haemorrhagic shock. All wounds were debrided. The evolution was a septic necrosis of the femoral head needing resection of the femoral head and of the trochanteric area and debridement of the surrounding soft tissue (**Fig**.4).

The sugar dressing was tried without success due to the stagnation of serosity in the pseudo-articular cavity. The vacuum dressing after sixteen days (changed every 2 days) allowed not only the filling of the cavity but also the reduction of the wound surface (**Fig**.5) and a simple skin graft was performed at the end.

Case 4

A 21-year-old patient with a right gluteocrural transfixing gunshot wound, with a right Gustillo-IIIb gunshot iliac wing fracture transferred four days after injury. Surgical debridement was performed removing all necrotic tissue and leaving a large wound with a huge cavity (about 10 cm long axis) (**Fig**. 6). After 16 days of VAC therapy (changed every 2 days), the cavity was filled and surface was reduced. The wound was ready to receive a simple skin graft afterwards (**Fig**.7).

DISCUSSION

As seen in the different observations, the filling of the cavity was optimal in around two weeks. This delay is close to the international standards[4].

All studies are unanimous in their support for vacuum dressing regardless of wound location and especially when the wound is well debrided and without infectious stigma[5].

In our case series debridement was done, followed by sterile dressing for a few days if delayed closure was not possible given the extent and cavity of the wound, vacuum dressing was done and all patients benefited from antibiotic prophylaxis for 24 to 72 hours according to the international committee of the red Cross (ICRC) protocol[6].

All studies are unanimous in their support for vacuum dressing regardless of wound location. Argenta and Morykwas reported the results of their study of 300 patients, of whom 296 patients responded favourably to VAC therapy[2]. Similarly, many other articles have described the use of vacuum for the treatment of different types of wounds, including soft tissue injuries prior to surgical closure[7], extensive degloving injuries, various grafts or reconstructive surgeries[8,9,10] and infected sternotomy wounds[11,12].

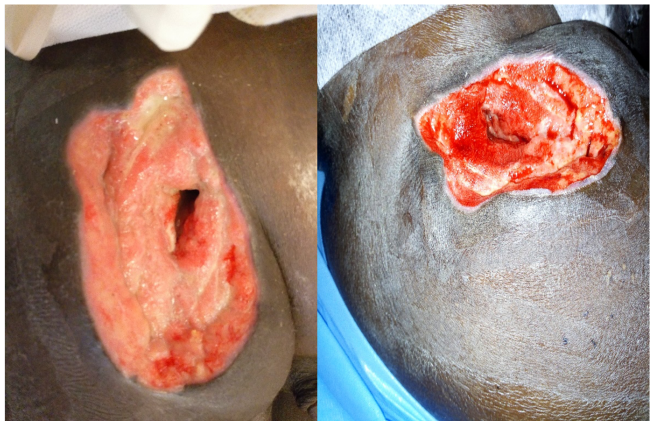

Fig. 4. — A large cavity after debridement of the wound next to the greater trochanter.

Fig. 5. — Filling the cavity and reducing the surface area of the wound after the vacuum dressing.

Fig. 6. — Large gluteal crural wounds with huge cavity after debridement.

Fig. 7. — Filling and reducing of the surface area of wounds with vacuum dressing.

Smith et al., in a retrospective review of the management of open abdomen and temporary abdominal closure, suggested vacuum as the treatment method of choice[13].

Vikatmaa et al. reviewed 14 randomized studies and reported that in all trials VAC therapy was at least as effective and, in some cases, more effective than control treatment[14].

The same has been reported in other parts of the world[15].

VAC therapy has also been used in the treatment of donor sites, particularly in areas difficult to manage using conventional techniques[16] such as those in the radial forearm[17].

Andrabi et al. in 2007, showed that the use of vacuum in laparotomy wound closure was far superior and faster than conventional methods[18].

VAC has also been used with different thickness skin grafts in the treatment of burns and would be particularly useful for body sites with irregular or deep contours such as the perineum, hand or armpit[19,20]. Numerous other cases of successful use of VAC have been reported including a recalcitrant pressure ulcer below the knee[21,22] and a suspected Brown Recluse Spider bite[23], leg ulcers and a group of 30 patients with long-standing wounds deemed unsuitable for reconstructive surgery, 26 of whom responded favourably to treatment[24].

However, late transfer aggravates the extension of lesions initially, in which case afterwards gangrene of the limbs is present, thus increasing the risk of amputation[25], and therefore vacuum dressing is no longer possible**.**

For bullet wounds Machen already reported in Iraq with more than 286 cases collected with the use of fluffy compresses and or sponges but without identifying the difference between these two procedures[26].

The procedure still poses huge problems of availability of polyurethane foam and adhesive polyurethane film but the results obtained are still far better than traditional dressing methods. The use of two alternating suction machines poses a great problem of machine wear and unpleasant noise for the patient. Wall suction or surgical vacuum bottle suction would be a great asset for these types of lesions.

The fluffy compresses may present several disadvantages. Aspiration can be sometimes stopped by clogging of the mesh. Allergic reactions to the film and the plasters could be another problem.

These materials remain expensive, but if we evaluate the efficiency and the short time of the vacuum dressing, compared to traditional dressings with nursing, the difference is in favour of VAC therapy. Reports on the cost-effectiveness of VAC are available in the scientific literature[27]. One of the reasons could be the shorter wound healing time compared to conventional methods.

But all the time its effectiveness for this purpose is still to be evaluated on a large number of patients because Iheozor- Ejiofor and al in a Cochrane review which proves that the difference in healing rate is not clear between the group treated with the vacuum dressing compared to those who received standard care and there is still doubt about its effectiveness in controlling the infection[28].

Nothings less Moues et al. showed that VAC therapy had significantly higher material costs ($p<0.001$), but significantly lower nursing costs ($p=0.043$)[29].

CONCLUSION

VAC therapy is one valuable method for the treatment of gunshot wounds in developing countries where the frequency of gunshot wounds and other explosive devices is quite high. However, it requires material, notably sufficient hoovers or either a wall-mounted suction unit. Given the cost of the recommended polyurethane foam and adhesive polyurethane film, the use of unexpansive gauze and cheaply available plastic film is recommended.

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Conflict of interest: The authors declare no conflict of interest.

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