

# Subatmospheric pressure therapy in the treatment of traumatic soft tissue injuries

## *Uso da terapia por pressão subatmosférica em feridas traumáticas agudas*

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### A B S T R A C T

**Objective:** To evaluate the use of subatmospheric pressure therapy in the treatment of acute traumatic injuries of the soft tissues, especially in the limbs. **Methods:** One hundred and seventy-eight patients with traumatic wounds were treated by the Center for Complex Wounds in the period from January 2010 to December 2011, and submitted to subatmospheric pressure therapy (SPT). **Results:** Of the 178 patients who underwent SPT, 129 (72.5%) were male and 49 (27.5%) were aged between 18 and 40 years. Degloving injuries to the limbs were the most common type of traumatic wounds, being responsible for the hospitalization of 83 (46.6%) patients. Mean hospital stay was 17.5 days. A total of 509 procedures were performed (average 2.9 per patient). SPT was used in 287 procedures, 209 (72.8%) on traumatic wounds and 78 (27.2%) of skin grafts. The number of exchanges of the SPT apparel per patient was 1.6 and the mean time of use, 8.5 days. **Conclusion:** SPT significantly reduced morbidity and healing time of injuries when compared with previously performed dressing treatments. The subatmospheric pressure therapy is a useful method in treating acute traumatic wounds, acting as a bridge between the emergency treatment and the final coverage of the skin lesions, being better when compared with more traditional methods of plastic surgery.

**Key words:** Therapeutics. Surgery, plastic. Occlusive dressings. Wound closure techniques. Negative-pressure wound therapy.

### INTRODUCTION

In polytrauma patients, the treatment of complex wounds to the limbs, defined as acute and extensive loss of cutaneous coverage, associated or not with fractures, should constitute a significant part of care<sup>1</sup>. Management of the simplest cases is often successfully carried out by trauma staff initial care. More extensive and deep lesions of the soft tissue form a particular group, with direct implications in the patient's systemic status - whether by bleeding, hydroelectrolytic imbalance or local infection. There may be need for specific treatments in the affected site, such as skin grafting, local flaps or microsurgical flaps, which require specialized care by the plastic surgeon.

The first studies on the negative pressure therapy, a new option for the treatment of wounds, were published in the 80s and 90s<sup>2-4</sup>. Since 2001, the Department of Plastic Surgery of HC-FMUSP has employed this method, more appropriately called subatmospheric pressure therapy (SPT)

<sup>5,6</sup>. It has been widely used in all the so-called complex wounds, especially in the lower limbs of acute trauma victims, when patients are hemodynamically unstable or when there are still doubts about the viability of the tissue after debridement of the lesions.

SPT assists in the evolution of the wound through several mechanisms: it reduces local edema<sup>7</sup>, provides wound contraction, stimulates neoangiogenesis, removes exudate<sup>8</sup>, improves blood flow<sup>9</sup> and reduces bacterial colonization<sup>10</sup>.

Many of these effects are desirable for the treatment of large traumatic wounds to the limbs, especially the reduction of edema and improvement of blood flow to the wound and to rotated flaps. While SPT has gained ground at the HC-FMUSP for the treatment of patients with complex wounds<sup>11</sup>, it is not widely used in other centers of the country. There are few studies with specific series of patients who used SPT in acute traumatic wounds, especially in the lower limb.

Study conducted at the Clinics Hospital – HC – of the Faculty of Medicine of the University of São Paulo – FMUSP, São Paulo, São Paulo State – SP, Brazil.

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The aim of this study was to evaluate the experience of the Center for Complex Wounds of the Plastic Surgery Division of Clinics Hospital of the Faculty of Medicine, University of São Paulo – HC-FMUSP – for the last two years in the surgical treatment of acute traumatic wounds with the aid of subatmospheric pressure therapy and compare it with the usual standard treatment.

## METHODS

We included patients with acute traumatic wounds, accompanied by the staff of the Division of Plastic Surgery of the Clinics Hospital, admitted to the Emergency Room in the period from January 2010 to December 2011 (24 months) who, at some point of their treatment, were subjected to subatmospheric pressure therapy. We considered acute care when the patient was seen up to 21 days after trauma. Patients seen over 21 days were excluded.

SPT, commonly known as vacuum therapy, comprises the use of a sponge of polyurethane applied on the wound, connected to a pump (vacuum) generating subatmospheric pressure continuously or intermittently (VAC-KCI®). The pressure is generally set between 70 and 125 mmHg and is distributed uniformly over the entire wound through the pores of the sponge. A plastic adhesive is applied to the sponge to allow the sealing of the wound (Figure 1). When applied to a skin graft, the graft must be secured to the edges of the wound (via stitches) and it should be prepared in mesh to allow (Figure 2) drainage through the graft.

Patients were examined and selected according to the classification of complex wounds of HC-FMUSP: detaching and/or degloving injuries (Figure 3 A and B); soft tissue trauma associated with crushing; fractures with loss of cutaneous coverage; soft tissue injuries with exposure of deep structures (nerves, vessels, tendons, bone, joint); traumatic amputations (stump treatment).

We recorded the procedures to which patients were submitted and the time of duration of SPT, with the results obtained.

## RESULTS

Of the 178 patients, 129 (72.5%) were male and 49 (27.5%) female, 23 (12.9%) of the patients were under 18 years of age, 100 (56.2%) between 18 and 40 years, 41 (23%) between 41 and 65 years, and 14 (7.9%) were older than 65 years.

When analyzing the time elapsed between trauma and care by the Plastic Surgery team, we found that 128 (71.9%) patients were seen in less than 24 hours of evolution, and in 29 (16.3%) patients care occurred between 24 hours and seven days of evolution. In 21

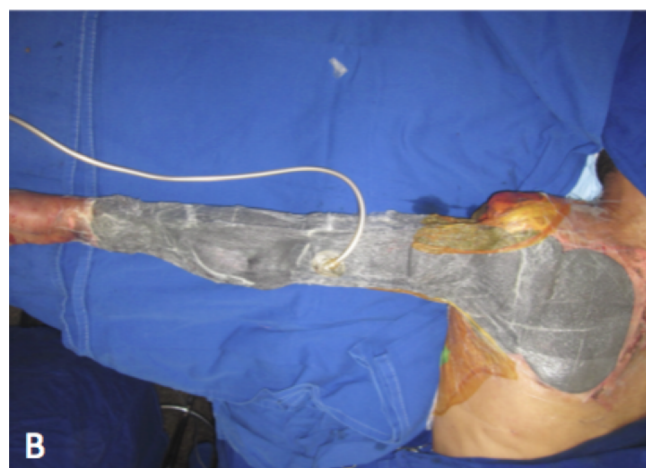
(11.8%) patients, the lesions occurred between one and three weeks prior to the Plastic Surgery assessment (Table 1).

As for the body segment affected, eight (4.5%) patients had lesions to the head segment, 54 (30.3%) to the upper limbs, 103 (57.9%) to the lower limbs, and 13 (7.3%) to the trunk.

Degloving injuries were the most prevalent, occurring in 83 (46.6%) patients, followed by injuries with exposure of noble structures in 40 (22.5%), soft tissue crushing in 24 (13.4%), traumatic amputation in 18 (10.1%) and limb fractures in 13 (7.3%) individuals (Table 2).

All patients were hospitalized during treatment of the acute traumatic wound. The average time of hospitalization between initial assessment and discharge by the Plastic Surgery was 17.5 days; 34 patients (19.1%) required hospitalization exceeding 30 days.

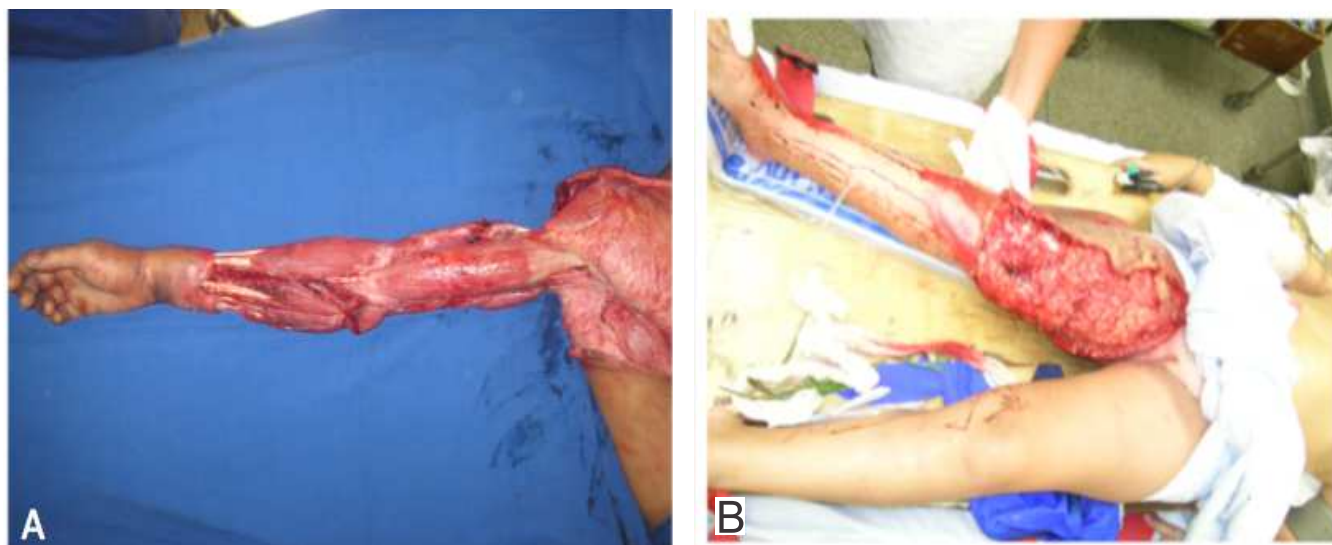
All patients underwent surgical treatment. We performed 509 surgical procedures in the study period, with an average of 2.9 procedures per patient followed. There



**Figure 1 -** Subatmospheric pressure system placed over the wound.



**Figure 2 -** Immediate mesh skin grafting in the first operation (donor area: degloved flap).



**Figure 3** - Detaching injuries: A - to the upper limb; and B - to the lower limb.

were 84 debridements not accompanied by the use of SPT. Other 209 debridements were followed by SPT. (Table 3).

The total number of SPTs, calculated as the sum of procedures, was 287, 209 (72.8%) being over traumatic wounds and 78 (27.2%) over skin grafts. The number of exchanges of negative the pressure therapy system per patient was 1.6 and the mean time was 8.5 days (ranging between 3 and 14 days).

There was no significant complication with the use of SPT. We observed local wound infection in 21 (11.8%) patients, without systemic repercussions and without apparent relation to the negative pressure therapy. Partial loss of skin grafting greater than 20% occurred in 20 patients (11.2%), requiring complementary skin grafting. There was no flap loss and there were five re-explorations of microsurgical anastomoses all successful. There was no extremity amputation observed in the evolution of wound treatment.

## DISCUSSION

The treatment of acute traumatic wounds to soft tissues is a relevant theme in discussions about the initial care to polytraumatized patients. This is due not only to the wide variety of wounds and treatments available, as well as to the different approaches according to the systemic conditions of the patients treated<sup>12</sup>, and especially to the limited availability of therapeutic resources of greater complexity in most emergency hospitals in our country. Although we have no specific data on the usual treatment of these wounds in most Brazilian hospitals, we know from common experience that the treatment of most of extensive wounds is based solely on the daily exchange of a simple dressing on raw areas. The most commonly used dressings consisted of rayon or gauze with petrolatum, covered with

**Table 1** - Time of injury.

Time of injury	n	%
<24 hours	128	71.9%
24h to 1 week)	29	16.3%
1 to 3 weeks	21	11.8%
TOTAL	178	100%

**Table 2** - Type of injury.

Types of Injury	n	%
Detaching wounds	83	46,6%
Noble structures exposition	40	22,5%
Crushing	24	13,4%
Amputations	18	10,1%
Open fractures without coverage	13	7,3%
Total	178	100,0%

**Table 3** - Surgical Treatment.

Surgical treatment	Procedures (n)
Debridement	84
Debridement associated SPT	209
Direct closing	22
Skin grafting	43
Skin grafting associated with SPT	78
Local flap	26
Microsurgical flap	16
Re-implantation	6
Amputation /stump treatment	18
Microsurgical re-exploration	7
Total of procedures	509
Average of procedures per patient	2.9

gauze and bandages. Made by nurses once or twice a day, dressings were laborious, time consuming, sometimes painful, undoubtedly uncomfortable for the patient. Treatment and hospitalization were prolonged, there was no progression to spontaneous healing of the wound and, due to the superimposition of severe infection, some extremities progressed to amputation. Even in cases where the preparation of the wound was obtained and the plastic surgeon was called to reconstruct the extremity with skin grafts and skin flaps, this happened only after several months, causing a considerable cost to the system.

SPT had an increasing development in the last years<sup>11</sup>, gaining new applications, and is today one of the main options as a bridge to the surgical treatment of acute traumatic wounds<sup>13</sup>, facilitating the diagnosis of ischemic areas and ensuring better integration of the skin graft. The SPT system is a comfortable cover (dressing) option for the patient, with less frequent exchanges (3 to 7 days) and it serves as a bridge for the final treatment of the wound, as occurs with skin grafting. The use of SPT facilitates care by medical and nursing teams.

The available literature on this therapy in acute soft tissue trauma is still scarce and mainly deals with specific situations, such as fasciotomies<sup>14</sup> or open fractures with significant loss of soft tissue<sup>15</sup>, not showing the actual extent of the application of the method in a reference center for complex trauma.

The Division of Plastic Surgery of HC-FMUSP has been using SPT system for more than a decade in the treatment of complex wounds. Of the 178 patients presented in this article, most were male (72.5%) and young (56.2% between 18 and 40 years old), which is consistent with the epidemiological profile already outlined by the World trauma statistics<sup>16</sup>.

The average follow-up by the plastic surgery team during hospitalization was 17.5 days, sufficient for the resolution of the wound. In a study we did with<sup>17</sup> patients treated between 2003 and 2007, the average hospital stay was 32 days for patients with degloving injuries of the lower limbs, which shows an evolution in the treatment of these patients in the cohort presented.

Trauma patients with extensive wounds demand a prolonged hospital stay, not only due to skin lesions, but also to the frequent association with injuries to other organs.

Treatment with SPT is one of the most important adjuvants in an attempt to minimize the length of hospitalization, and therefore the costs involved<sup>18</sup>. It is necessary to mention that the use of negative pressure therapy is not a definitive treatment, but a measure intermediate to final skin coverage through grafts and flaps.

In this series, degloving injuries were the most frequent, being found in 83 (46.6%) patients. This type of injury is a therapeutic challenge, as they are often extensive and present exposure of deep structures and large defects of skin coverage. This higher incidence of degloving injury was observed probably due to the small number of trauma centers in the region of São Paulo with available plastic surgeons that appropriately treat soft tissue injuries in a timely manner. The protocol for detaching injuries used in our service<sup>17</sup> advocates the placement of the SPT system on the lesions of more severe patients (unstable) in order to allow the approach of the systemic problems that threaten their lives. After the patient's stability, we proceed to the reconstruction of the soft tissue injuries.

The SPT is an important adjunct in the treatment of all complex wounds<sup>17</sup>. Its increasing use in recent years is based, among other reasons, on the favorable results in the acute treatment of patients with multiple trauma wounds. Particularly in complex wounds of the lower extremities, the decreased frequency of extremity amputations, today still required where there is no complete and early treatment, was one of our main and most significant results of the use of this method.

Our results were deemed satisfactory, significantly reducing the morbidity and time of healing of these lesions when compared with other treatments performed by us<sup>17</sup>, such as dressings.

The subatmospheric pressure therapy is a useful method in treating acute traumatic wounds, acting as a bridge between the emergency treatment and the final coverage of skin lesions compared with more traditional methods of plastic surgery.

The versatility and importance of the negative pressure therapy are very significant for us and the current trend is that access to this therapeutic method is magnified, greatly contributing to the appropriate care of patients with extensive traumatic wounds.

## R E S U M O

**Objetivo:** avaliar a experiência com o emprego de terapia por pressão subatmosférica no tratamento das lesões traumáticas agudas das partes moles, em especial nos membros. **Métodos:** cento e setenta e oito pacientes com feridas traumáticas foram tratados pelo Centro de Feridas Complexas no período de janeiro de 2010 a dezembro de 2011 e, submetidos à terapia por pressão subatmosférica. **Resultados:** dos 178 pacientes submetidos à terapia por pressão subatmosférica, 129 (72,5%) eram do sexo masculino e 49 (27,5%) apresentavam idade entre 18 e 40 anos. Os ferimentos descolantes nos membros foram o tipo de ferida traumática mais comum, sendo responsáveis pela internação de 83 (46,6%) pacientes. O tempo médio de internação hospitalar foi 17,5 dias. Foram realizados 509 procedimentos cirúrgicos (média de 2,9 por paciente). A terapia por pressão subatmosférica foi utilizada em 287 procedimentos, sendo 209 (72,8%) sobre feridas traumáticas e 78 (27,2%) sobre enxertos de pele. O número de



trocas de terapia por pressão negativa por paciente foi 1,6 e o tempo médio de utilização foi 8,5 dias por paciente. **Conclusão:** os resultados foram considerados satisfatórios, diminuindo consideravelmente a morbidade e o tempo de cicatrização dessas lesões em comparação com tratamentos anteriormente executados como curativos. A terapia por pressão subatmosférica é um método útil no tratamento de feridas agudas traumáticas, atuando como ponte entre o tratamento de urgência e a cobertura cutânea definitiva destas lesões, em comparação com métodos mais tradicionais da cirurgia plástica.

**Descritores:** Terapêutica. Cirurgia plástica. Curativos oclusivos. Técnicas de fechamento de ferimentos. Tratamento de ferimentos com pressão negativa.

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