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VACUUM THERAPY FOR THE TREATMENT OF CHRONIC AND LONG-TERM NON-HEALING WOUNDS IN CHILDREN

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ВАКУУМ-ТЕРАПИЯ В ЛЕЧЕНИИ ХРОНИЧЕСКИХ И ДЛИТЕЛЬНО НЕ ЗАЖИВАЮЩИХ РАН У ДЕТЕЙ

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The development of chronic wounds is linked to disturbed tissue reparation or their poor activity, which impedes the recovery of the anatomic and functional integrity of the skin and soft tissues. Our study focused on using advanced vacuum therapy systems to treat children suffering from chronic or long-term non-healing wounds. The entire study included 39 patients aged 1.5–17, both males and females, where the pool of participants was divided into two overall similar groups: Group 1 (main group) – 22 children who received VAC therapy, and Group 2 (control group) – 17 patients who were given standard treatment.

The outcomes obtained through the treatment offered in each group revealed that vacuum therapy used for treating chronic and long-term non-healing wounds in children significantly shortened the healing period and in-patient treatment; other benefits implied better anatomic, functional, and aesthetic effects. In Group 1, on average, complete wound epithelialization was observed early than in Croup 2. The duration of inpatient treatment in Group 1 was an average of 15.6±2.1 days, the same indicator in Group 2 being 23.3±2.5 days. None of the patients was seen to develop any surgical complications.

Keywords: vacuum therapy, chronic wounds, long-term non-healing wounds, wound treatment, autografting, children

Возникновение хронических ран связано с нарушением процессов репарации тканей или недостаточной их активностью, в связи с чем анатомическая и функциональная целостность кожи и мягких тканей не восстанавливается. Нами проведено исследование эффективности применения современных систем вакуум-терапии в лечении детей с хроническими или длительно не заживающими ранами. Всего в исследование включено 39 пациентов от 1,5 до 17 лет обоего пола, которые были разделены на две сравнимые группы: группа 1 – основная, 22 ребенка, которым проведена ВАК-терапия, и группа 2 – контрольная, 17 пациентов, получавших стандартное лечение.

Анализ результатов лечения в обеих группах показал, что применение вакуум-терапии в лечении длительно не заживающих и хронических ран у детей приводит к значительному сокращению сроков заживления и стационарного лечения, оптимальному анатомическому, функциональному и косметическому результату. Полная эпителизация раны в группе 1 наступала раньше, чем в группе 2. Сроки стационарного лечения в группе 1 в среднем составили 15,6±2,1 суток, а в группе 2 – 23,3±2,5 суток. Хирургических осложнений не выявлено ни у одного пациента.

Ключевые слова: вакуум-терапия, хронические раны, длительно не заживающие раны, лечение ран, аутодермопластика, дети

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CW – chronic wounds
LNHW – long-term non-healing wounds
T.I.M.E. – Tissue debridement. Infection. Moisture balance. Edge of wound
VAC (WOUND VAC) – vacuum-assisted closure of a wound, a device used to facilitate wound treatment

Chronic wounds (CW), just like long-term non-healing wounds (LNHW), are those that stay non-healing during a period that is normal for the conventional physiological period, typically given the respective injury type, localization, and age; the reparation of such wounds takes on a lengthy course due to unfavorable external conditions, whereas the duration of the wound process differs. This is the definition adopted at a special meeting of the European Society for the Repair of Tissues (Cardiff, Wales; September 1996) [1, 2]. Chronic wounds develop due to disturbed reparation of tissues or their lack of activity, which entails failure to recover the anatomic and functional integrity of the skin and soft tissues [3].

Speaking globally, CW affects up to 3 % of the world's population, and the prevalence is growing fast, with the total annual growth rate exceeding 2–3 times similar values for all the other types of wounds [4].

CW and LNHW involve a high risk of provoking infectious complications and wound sepsis, lengthy in-patient hospitalization, as well as significant labor and economic costs. Once the treatment is completed, cosmetic and functional deficiencies often are left, which require their correction [5, 6]. All of the above proves the degree of the issue that CW and LNHW pose for global healthcare. No temporal criteria were available to identify wounds as chronic or long-term non-healing during that time. Some authors believe a wound can be considered chronic if it remains for more than four weeks, revealing no signs of active healing. In contrast, others think that the diagnosis of a chronic wound could be set in cases where a wound fail to heal for six weeks, provided the patient receives due treatment. Yet another opinion claims that it should be viewed as chronic if it will not heal for eight weeks [7].

Despite being more than urgent, no commonly accepted standards have been adopted for selecting the right treatment tactics when dealing with CW and LNHW cases. The most acknowledged practices to be mentioned are the Wound Bed Preparation aimed at turning a CW into an acute one with further closure of the wound defect and the T.I.M.E. concept, which implies treating wounds in a moist environment [1]. These two practices have raised to numerous current wound management methods, where one of the safest and most effective approaches is treating a wound defect with negative pressure (vacuum therapy), which, however, is most commonly used to treat adult groups of patients.

This study aims to identify vacuum therapy's effectiveness in treating CW and LNHW in children.

Material and Methods. From 2017 to 2023, 39 children with CW and LNHW of various etiologies stayed under our supervision. The study was conducted at the Children Regional Clinical Hospital (Krasnodar), in Surgical Department № 1, and at the Regional Children Clinical Hospital (Stavropol) in the Department of Purulent Surgery. The patients' ages ranged from 1.5 to 17; 21 were boys (53.8 %), and another 18 (46.2 %) were girls (Table). The average size of the wound defect accounted for 2.9 % of the body surface.

Inclusion criteria: decubitus ulcers (Degree III–IV); trophic ulcers of various genesis; microsporidia; age 1.5 to 17; consent agreeing to join the study.

Table

Comparative details of patients depending on their age group

Age group	Sex		Wound defect size
	Boys	Girls	
1–3 y.o.	1 (2.6 %)	–	0.9 %
3–5 y.o.	5 (12.8 %)	3 (7.7 %)	2.1–2.9 %
6–12 y.o.	9 (23.1 %)	5 (12.8 %)	2.7–4.3 %
12–18 y.o.	7 (17.9 %)	9 (23.1 %)	2.5–4.9 %

Exclusion criteria: acute surgical wound; extensive wound defects featuring signs of active reparation; decompensated neurotrophic disorders and vascular issues; age under 1.5 and above 17; lack of consent to join the study.

All the patients were divided into two groups, revealing similar parameters. Group 1 was the main group, which included 22 (56.4 %) children treated using advanced VAC systems, whereas Group 2 was the control group and included 17 (43.6 %) children who were given standard treatment. The most commonly identified comorbidities included connective tissue dysplasia, neurotrophic disorders, endocrine diseases, and peripheral vascular disorders.

Twelve (30.8 %) of the children had their lower extremities affected by wounds. In comparison, the upper extremities were affected in 6 cases (15.4 %), the lumbosacral area – in 7 (17.9 %) cases, the body trunk – in 9 (23.1 %) cases, other localizations of wounds to be observed in 5 (12.8 %) patients.

All the patients in both groups underwent physical examinations, including calculating the wound defect. They were also given a standard clinical and laboratory examination and a bacteriological examination of the wound discharge microflora to identify antibiotic sensitivity. In some cases, following respective indications, an immunograms was obtained.

The wound defect size calculation relied on the non-contact Cees L. method, which implies measuring the skin defect parameters with photographic equipment producing instant images. The grid application design obtained full-size photos of the wounds, where 25 calculated squares stood for 1 cm^2. Further, the wound area was calculated manually as a percentage of the entire body surface [7, 8].

Following the examination, both groups had their wounds treated surgically, including removal of necrotic accumulations and granulation tissue, dissection of so-called pockets, if any, as well as ultrasonic cavitation of the wound. The ultrasound treatment was performed with a SONOCA 190 ultrasonic dissector (Soering, Germany).

In Group 1, the children had a VAC bandage applied. A VivanoTec device (ATMOS Medizintechnik GmbH KG, Germany) was used to create a medical vacuum and a VivanoMed Foam Kit dressing kit (Paul Hartmann AG, Germany), S size. The exudate was collected into a Canister container (300 ml). The VivanoMed vacuum bandage consists of 3 layers: a Foam polyurethane sponge, a Hydrofilmadhesive polyurethane film, and a Port silicone vacuum port. Vacuum therapy was applied in a continuous (80–125 mm Hg) mode, to be further

switched into a variable (60–80 mm Hg) mode. The ressing was changed every three days, with the wound discharge taken for bacteriological examination, thus seeking to identify pathogens and their sensitivity to antibacterial drugs to control the treatment dynamics.

In Group 2, wounds were treated with conventional methods, implying bandages using modern wound remedies, such as alginate, mesh dressings, and antiseptic solutions.

Besides, all the patients received antimicrobial therapy, given the bacteriological study outcomes, immune-corrective, vascular, and neurotropic treatment, physiotherapy, hyperbaric oxygenation, and immobilization based on specific indications.

The statistical analysis was carried out using the STATISTICA v.10.0. (StatSoft, USA) and StatTech v. 2.1.0 (Stattech LLC, Russia). The quantitative indicators were evaluated for average distribution compliance using the Shapiro – Wilk criterion. The comparison of the two groups based on a quantitative indicator, whose distribution differed from the normal one, was done using the Mann – Whitney U-test. The Wilcoxon criterion was employed in two related groups when comparing quantitative indicators where the distribution differed from the normal one. The Cox – Mantel criterion was used to assess the treatment outcomes. The statistically significant differences were considered at $p<0.05$.

Results and Discussion. Along with using VAC therapy in the above-described modalities, rapid relief of local inflammation was observed in the main group. In Group 1, as early as 4.1±1.2 days into the treatment, there was softening of the defect edges noted, as well as a decrease in the edema affecting the area around the wound and smaller volumes of the wound discharge with a change in its nature – from purulent to serous; active granulation and marginal epithelialization was appearing. In Group 2, where the patients were given standard treatment with wounds managed under bandages, a decrease in inflammation as well as the appearance of active granulations was observed on 7.4±1.8 days.

In the main group, the general blood test showed elimination of the neutrophilic shift to the left on average 3–4 days into the treatment, while the leukocyte intoxication index dropped down to 1.31±0.17; in the control group, however, a significant decrease in infectious inflammation was to be seen on average after 9–11 days only.

The wound defect closure with stable healing was finally reached in both groups, yet the timeline and the methods employed to arrive at the said effect, taken in quantitative terms, differed significantly. In Group 1, for instance, 8 (36.4 %) patients experienced spontaneous epithelialization on 12±1.2 days, and in the control group, wounds healed independently in only 3 (17.6 %) patients on 18±1.4 days of treatment. Reduced wound defect before ensuring a possibility for wound repair with local tissues using VAC systems in the study group was registered in 7 (31.8 %) patients.

In Group 2, it proved possible to perform plastic surgery with local tissues in 2 (11.8 %) patients, which, however, was done not by reducing the wound area during the treatment, but by giving the initial shape, size of the wound, and tissue mobility. Healing through surgical treatment by autografting with a free split flap was performed in 7 (31.8 %) patients of Group 1 and 12 (70.6 %) patients of Group 2. In contrast, in the first group, due to a significant reduction in the wound surface and granulation tissue rapid proliferation in the wound cavity, the defect closure in 5 out of 7 cases was done with a graft with no perforation on 7–9 days of the treatment, using VAC bandages; in Group 2, though, wounds were closed with a single thin-layer flap only in 6 out of 12 patients on 13–16 days after the wound was entirely cleaned of necrotic tissues with its cavity filled with granulation tissue. In Group 1, vacuum therapy was performed after surgical treatment at apressure set individually to ensure due adjustment of the graft.

Analysis of the presence and type of wound flora indicated that microbial associations should be detected during this study in 21 (53.8 %) cases: St. aureus – 16 (41.0 %), fungal flora – 2 (5.2 %). Eliminating the pathogen in Group 1 was achieved faster – on 5.1±1.2 days, whereas in Group 2, a similar effect could be reached by 9.3±1.2 days.

The inpatient treatment in Group 1 lasted 15.6±2.1 days and in Group 2 – 23.3±2.5 days (Figure). No patient was registered with any surgical complications. When analyzing the anatomical and functional tissue repair, it was noted that three months after healing the injured area, mobility was higher in Group 1, where VAC bandages were used. A less pronounced wound scarring area was also seen. In Group 2, similar values proved to be worse, evidenced by decreased quality of life due to long-term persisting itching, tension and discomfort at the injury area, and excessive scars. A statistical analysis relying on the Cox – Mantel method revealed significant differences in the treatment outcomes between the groups involved in the study (p=0.0110).

A B C

Figure. The process of treating patient M. using VAC:
A – chronic necrotic ulcer, popliteal surface preceded by microbial eczema;
B – interim stage – autografting; C – treatment outcome following three sessions of VAC therapy

Nowadays, vacuum therapy is viewed as an effective method to treat wounds of various origins, areas, and depths [9–11]. The technique offers effects like preserving and maintaining an optimal moisture level, which facilitates wound cleansing, angiogenesis, and better functioning of growth factors, as well as promotes the removal of excess wound discharge, including decomposition products, and tissue edema elimination; wound decontamination, more extensive local blood flow and lymph circulation, which improves the wound bed perfusion and increases tissue granulation development rate (data is showing that variable vacuum therapy is the best way to enhance blood circulation and granulation tissue growth [12, 13], as well as to reduce the wound area, which is due to the tightening effect and stimulation of proliferation cells). Finally, due to the lack of daily dressing, the vacuum bandage helps cut the economic and labor costs required [14–16].

The analysis carried out by russian and foreign experts has proven the effectiveness of vacuum therapy when employed for treating various types of wounds and localizations. Budkevich L. I. et al. have successfully used the method when treating wounds of different etiologies in 22 children; Kozlov Yu. A. et al. offered the outcomes obtained through the treatment of 14 children, providing proof of complete wound healing [17, 18].

Conclusion. Vacuum therapy, if employed for treating CW and LNHW in children, has proven to be a safe and highly effective option, leading to rapid and high-quality healing and bringing around benefits like shorter treatment time and lower labor and economic costs. The proper conditions, if created, allow for the elimination of bacterial growth while reducing the local inflammatory mediators' activity. Besides, VAC therapy stimulates cell proliferation and granulation development, promotes rapid convergence of the wound edges, and secondary closure of the wound defect. Using vacuum therapy followed by wound defect plastic treatment with local tissues or through autografting with a free flap will allow arriving at complete closure of wound defects, which, in turn, will minimize the risk of developing functional defects and offer an excellent esthetic result.

Disclosure: The authors herewith declare no conflict of interest.

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THE OUTCOMES OF EMPLOYING A SPECIALIZED ALGORITHM FOR FORECASTING AND COMPREHENSIVE PREVENTION OF PURULENT-DESTRUCTIVE DISEASES AFFECTING THE CHEST WALL IN CARDIOTHORACIC SURGERY

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РЕЗУЛЬТАТЫ ПРИМЕНЕНИЯ СПЕЦИАЛИЗИРОВАННОГО АЛГОРИТМА ПРОГНОЗИРОВАНИЯ И КОМПЛЕКСНОЙ ПРОФИЛАКТИКИ ГНОЙНО-ДЕСТРУКТИВНЫХ ЗАБОЛЕВАНИЙ ГРУДНОЙ СТЕНКИ В КАРДИОТОРАКАЛЬНОЙ ХИРУРГИИ

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The article offers a view of the outcomes of an integrated approach employed for forecasting and preventing purulent-destructive diseases of the chest wall (PDDCW) pertaining to cardiothoracic surgery. The data obtained through the study point to the high effectiveness of the approach in question while allowing for a lower PDDCW incidence (up to 10 %) in patients going through the postoperative period and to shorten the hospitalization period.

Keywords: thoracic surgery, purulent surgery, cardiovascular surgery, sterno-mediastinitis, osteomyelitis, result

Представлены результаты комплексного подхода в прогнозировании и профилактике гнойно-деструктивных заболеваний грудной стенки (ГДЗГС) в кардиоторакальной хирургии. Полученные в исследовании данные показали высокую эффективность предложенного подхода, позволяя снизить частоту развития ГДЗГС у пациентов в послеоперационном периоде до 10 % и сократить сроки госпитализации.

Ключевые слова: торакальная хирургия, гнойная хирургия, сердечно-сосудистая хирургия, стерномедиастинит, остеомиелит, результат

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