APPLICATION OF NEGATIVE PRESSURE WOUND THERAPY IN THE TREATMENT OF PYOINFLAMMATORY COMPLICATIONS AFTER SPINAL SURGERY

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Objective. To analyze the first experience of negative pressure wound therapy in the treatment of patients with infectious complications after surgical interventions on the spine.

Material and Methods. Clinical cases of negative pressure wound therapy (NPWT) in patients with peri-implant infection developed after decompression and stabilization interventions for degenerative disease (n = 2), and injury (n = 1) of the spine are presented.

Results. Good results were achieved in all three patients. Average length of hospital stay was 33 days. Implants were successfully preserved in two patients. The average time of wound closure before cutaneous suturing was 10.3 days.

Conclusions. The use of NPWT objectively reduces the number of surgical debridements and shortens drainage and healing of the wound.

Key Words: spine, discitis, spondylitis, paravertebral abscess, vacuum dressing, NPWT, VAC-therapy, TLIF.

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In the modern vertebrology, instrumental stabilization is an integral part of the treatment of patients with various spinal diseases and injuries. However, despite the improvement of the implants, including the use of minimally invasive and less traumatic methods to install them, the problem of infectious complications after spinal surgery is still clinically and economically significant. Their incidence ranges from 0.4 to 10%, and development depends on many objective and subjective factors: the type of spinal pathology and the presence of neurologic deficit; extent and technique of the surgery; duration of the surgery and extent of blood loss; patient's management during preoperative and postoperative period and the number of surgical team members [1, 6, 9, 11, 12, 16, 20, 22, 28, 31]; comorbidity, i.e. the presence of chronic infection foci, diabetes, coronary heart disease, chronic obstructive pulmonary disease, primary and secondary immunodeficiency, smoking, alcohol and drug abuse [2–4, 7, 9, 10, 19, 20, 25, 27, 28, 31]. Furthermore, the cost of treatment of infectious complications resulting from spinal surgery may be several times higher than the cost of primary intervention [5]. The presence of the aforementioned risk factors cannot be the reason to refuse the use of spinal implants in a given patient. The doctor predicting the possibility of peri-implant infection can only inform the patient about this fact and select the appropriate treatment strategy.

The diagnosis of infectious complication at the early stages has no strictly specific characteristics, most complications develop and are diagnosed within the period 10–14 days to 1 month after surgery [3, 13, 20, 29, 31]. It is currently believed that in the case of active and adequate treatment of the early peri-implant infection along with stable metal structure, there is no indications for its removal. However, such a need arises in the future in more than a half of cases due to recurrent infection. In the case of late peri-implant abscesses, removal of the structures is an unavoidable integral component of the treatment. At the same time, removal of a previously implanted structure in patients with spinal instability is associated with the risk of severe neurological impairments, complicates the care for the patient, leads to the development of secondary complications, and, therefore, dramatically worsens the prognosis for recovery and patient's ability to return to previous physical activity.

In this context, the negative pressure wound therapy (NPWT), which was proposed in its present form by the American scientists Argenta and Moryk-

was [2], i.e. vacuum wound therapy (VAC-therapy), looks totally innovative. The use of NPWT localizes the process and provides favorable environment to control infection and prevent wound reinfection by another hospital flora. Active development of managed negative pressure techniques in recent years is associated with improvement of the method and expansion of the list of its possible indications [14, 15, 18, 21, 23, 26]. The first articles on the use of this method in vertebrology were published in the mid-2000s. However, there are still only scarce case studies and the largest series include no more than two dozen patients [8, 11, 13, 17, 24, 28, 30]. Since there are no high-evidence randomized studies, definitive conclusions about the role of this method in the vertebrology cannot be made. However, a complete lack of Russian publications on the subject allows us to present our own experience.

The research was aimed at analyzing the first experience of using the method of negative pressure wound therapy in the treatment of patients with infectious complications after spinal surgery.

Material and Methods

We report the results of treatment of three patients (mean age 37 years) with peri-implant infection at the surgical area, where NPWT method was used as one of the treatment components (Table).

Two patients previously underwent planned decompression and stabilization surgery using the immersion systems for degenerative-dystrophic diseases of the spine up to 1 month before the abscess was detected. One patient underwent emergency operation with instrumental stabilization of the spine for traumatic injury 36 month earlier.

Clinical and anatomical classification and terms proposed by Calderone and Larsen and presented by E.V. Ulrikh and A.Yu. Mushkin in the Russian-language version [1] were used to describe infectious processes in the spine and paravertebral tissue.

In the first case, the indications for hospitalization to the Research Institute of Emergency Medicine n.a. I.I. Dzhanelidze included the signs of chronic spinal osteomyelitis, development of paravertebral and paraspinal abscesses complicated by systemic inflammatory response with implant migration to the surface of the skin. In the second patient, the early postoperative period was complicated by superficial wound infection. The third patient was admitted to the hospital with a deep paraspinal abscess.

Suppurative complications at the site of preceding surgical intervention were diagnosed at admission based on the external examination of the wound (suppuration, redness, swelling, palpatory tenderness), clinical and laboratory data, and radiodiagnosis (CT, MRI). The collective decision on the application of NPWT method was made by multidisciplinary team, which included a neurosurgeon, orthopedic trauma surgeon, septic center surgeon, resuscitation specialist, and clinical pharmacologist.

The total severity of patient's condition, which placed in question the possibility of simultaneous implementation of the procedures recommended in these situations, i.e. maximum resection of destroyed tissue and wound closure, was the main indication for the use of NPWT method.

The criteria used to analyze the effectiveness of patients' management included the period of hospital treatment after abscess detection, wound healing time, the number of repeated surgical treatments (change of NPWT-dressing), the possibility to preserve previously implanted system, the presence or absence of disease recurrence.

NPWT system was placed as follows:

1) wound debridement was carried out, including opening of pockets, purulent leakage site, and cavities, communicating them with the main wound;

2) the wound was washed with an antiseptic solution, careful hemostasis was carried out with special attention;

3) particular attention was paid to the leak-tightness of the dura mater, since otherwise system installation was contraindicated;

4) the wound, including all its pockets and cavities, was filled with a sterile dressing sponge from the kit so as to be connected to the main wound with spongy material;

5) the wound filled with sponge was sealed using cutaneous incisional film with cut window matching the drainage port size;

6) the port was fixed to the prepared window and connected to the container for collecting wound exudate, placed in the active suction device;

7) the apparatus was switched on and 120/80 intermittent operation mode was set (Vivano Athmos Hartman, Smith & Nephew PICO, and RENASYS instruments were used).

The first change of dressings was carried out in 24 hours in the case of pronounced exudation, and in 48 hours in the case of moderate exudation; the second change was carried out in 72 hours. In all the cases, no more than three NPWT-dressing changes were required. The NPWT-dressing was removed 24–48 hours after the last change and the wound was tightly sutured. Change of NPWT-dressing took no more than 20 minutes and patients often underwent it without general anesthesia, even in the dressing room. The day, when the wound was tightly sutured, was considered as wound closure time.

All patients received etiotropic antibiotic therapy according to the results of bacteriological culture of wound drainage (Table); oral drug intake was continued for 6–8 weeks after discharge from the hospital. The effectiveness of the treatment was controlled using weekly clinical and laboratory monitoring, as well as CT and (or) MRI over time. The patients were followed for 12 to 18 months.

Results and Discussion

Good outcomes were obtained in all patients: the average time of wound closure with cutaneous suture was 10.3 days from the beginning of NPWT, which is twice faster compared to the normal wound closure time in the treatment of these patients.

The average hospital stay of the patients was 33 days, but this value can-

TABLE
Characteristics of patients with peri-implant infections, who were treated with NPWT

Patient	Sex	Age	Main diagnosis	Surgery type	Time of abscess detection after the first surgery	Reoperation	Culture result	Sensitivity	Repeated surgical treatments, n	Duration of using the method, days	Hospital stay, days
1st	M	43	Degenerative-dystrophic diseases of the spine, stenosis of the L5–S1	TLIF L5–S1	30 days	Debridement + NPWT	*S. aureus* 10^8 в 1,0	Ceftriaxone, doxycycline	3	10	14
2nd	F	39	Degenerative-dystrophic diseases of the spine, herniated discs at L4–L5, L5–S1, stenosis of the spinal canal.	TLIF L4–L5	7 days	Debridement + NPWT	*S. aureus* 10^8 в 1,0	Levofloxacin	3	13	36
3rd	M	30	Closed vertebrospinal injury, fracture of L1 body in 2013	Transpedicular fixation at T12–L2 (2013 г.)	The patient was admitted 36 month after surgery with sepsis, paravertebral and psoas abscesses	Removal of metal structure, drainage of psoas abscess + NPWT	*S. aureus* 10^3в 1,0; *Corynebacterium* 10^4 d 1,0	Cubicin, vancomycin, meronem. Further, the patient was administered with doxycycline and rifampicin tablets	2	8	50

not be an objective criterion of the effectiveness of NPWT method, since the severity of patient's condition and duration of inpatient treatment was determined by the severity of concomitant septic states.

The implants were preserved in two patients; in one patient, the implanted systems was removed before admission, at the stage of the initial surgical treatment and wound debridement because of the development of septic instability and transdermal migration of the structure.

In all patients, the characteristics of systemic inflammatory response normalized within 6–8 weeks with underlying antibacterial therapy. Control SCT and MRI studies were carried out within the same period and confirmed the effectiveness of the treatment, primarily in the form of stability of preserved metal structures and absence of bone destruction progression. All patients returned to their previous level of physical activity and occupation within the period from 3 to 18 months. No cases of abscess recurrence were observed.

No complications of NPWT described in the literature (bleeding, clinically significant loss of electrolytes and protein) were observed in our cases.

Case 1. A 43-years-old male complained of back pain after surgery for a herniated intervertebral disc. MRI signs of spondylodiscitis at L5–S1. The first stage included surgical field revision and debridement. A polymer film used to prevent scarring process was the inflammation source. The second stage, after stopping the infection process, included transforaminal interbody fusion (TLIF). The patient was discharged on day 15 with recommendations to continue antibacterial therapy for 8 weeks. The patient did not followed recommendations and 30 days after surgery he experienced pain, hyperemia, and swelling at the area of the surgical wound. The patient was hospitalized again. Revision and debridement of the purulent inflammation site was carried out, preserving previously implanted stabilizing structure. NPWT system was installed. The patient received a course of antibiotic therapy according to the results of bacterial culture. The patient was discharged on day 14 in a satisfactory condition with recommendations to continue antibiotic therapy (Fig. 1, 2).

Case 2. A 39-years-old female was admitted with complaints of recurrent pain after preceding decompression and stabilization surgery (TLIF). On day 5, the patient started complaining of pain at the area of the postoperative wounds, erythema, and swelling. Wound revision detected copious sanioserous and purulent discharge with extensive leakage, which did not extend below aponeurosis. Conventional open wound care for 10 days did not result in the desired effect, there still was exudation, which precluded secondary suturing of the wound. We decided to apply NPWT system. Ambulatory variant of the system, i.e. a pocket-size device, was used.

Fig. 1
Picture of the wound in a 43-years-old patient at admission **(a)**, during debridement **(b)**, and during application of NPWT system with a pump **(c)**

The patient was discharged in good condition on day 36 (Fig. 3).

Case 3. A 30-years-old male was harmed due to fall from a height in 2013. He underwent stabilizing operation for closed unstable spinal fracture at a hospital in St. Petersburg. After a while, the patient underwent abscess opening and drainage with underlying pain and fever. Then, he was discharged to outpatient treatment. The patient periodically observed wound discharge accompanied by formation of fistulas. He observed migration of screws on the skin surface for 3 months. The patient last visited a doctor for fistulous drainage 2 weeks before admission. At admission, he had clinical presentation of psoas abscess with severe systemic inflammation syndrome. We decided to remove metal structure, drain the paravertebral abscesses and psoas abscess followed by placement of NPWT system on the wound.

The patient was discharged on day 36 in a satisfactory condition for outpatient treatment (Fig. 4).

Conclusion

We can conclude (although with some caution) that NPWT method can effectively control the infection, reduce the number of surgical treatments, draining and wound healing time. In contrast to the inlet-outlet drainage, this method does not limit patient's motor activity, which has a positive impact on the psycho-emotional background and the entire treatment process.

It should be noted that plastic surgery wound closure with flap displacement and loosening incision was required in patients with a long history due to the larger area of tissue necrosis before primary surgical treatment and application of NPWT.

In our view, the small number of cases and extremely complicated selection of matching control group in term of pathology characteristics prohibits full statistical analysis of the effectiveness of NPWT method. Nevertheless, the first successful outcomes suggest that the study of this method within the context of infectious vertebrology as an interdisciplinary pathology at the junction of purulent surgery and reconstructive spinal surgery may be recommended.

Fig. 2
Picture of the wound in a 43-years-old patient before primary and secondary suturing

Fig. 3
Wound view in a 39-years-old patient after application of NPWT system **(a)**, after debridement before suturing **(b)** and with secondary suture **(c)**

Fig. 4
Picture of the wound in a 30-years-old patient at admission **(a)**, after removal of metal structure, debridement, and application of NPWT system **(b)**, after debridement of psoas abscess **(c)**, after plastic repair with displaced muscle flap, loosening incisions, and secondary suturing **(d, e)**

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