USE OF VACUUM SYSTEMS FOR EARLY IMPLANT-ASSOCIATED INFECTION AFTER DECOMPRESSION AND STABILIZATION SURGERY FOR LUMBAR SPINAL STENOSIS

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Objective. To analyze the results of treatment of patients with implant-associated surgical site infection after decompression and stabilization surgery performed for lumbar spinal stenosis.

Material and Methods. Results of treatment of 43 patients with early (up to 90 days after the operation) suppuration of the surgical wound after decompression and stabilization operations for lumbar spinal stenosis were analyzed.

Results. A total of 4033 operations for lumbar spinal stenosis with implantation of stabilization systems were performed from 2015 to 2019. There were 43 (1.06 %) cases of early suppuration of the surgical wound with the installed instrumentation. Out of them seven (16.27 %) cases were superficial and 36 (83.78 %) — deep. In all cases, the wound revision, surgical debridement and installation of a vacuum assisted closure (VAC-dressing) were performed. The treatment of superficial suppuration was accompanied by a single installation of a VAC-dressing before wound closure, and in deep suppuration from 2 to 8 (on average 4.10 ± 1.73) VAC-dressings were changed. Wound healing was achieved in all patients within 14—55 (average 29.10 ± 10.06) days. Timely diagnosis of the complication and application of negative pressure therapy allowed arresting the inflammatory process and preserving the implants in all patients with a follow-up period of 12 months.

Conclusion. In the case of development of early suppuration of the surgical wound, the patient needs an urgent sanitizing operation. Negative pressure treatment with VAC-dressings is an effective and safe way to relieve this complication. This method combined with etiotropic antibiotic therapy makes it possible to quickly cleanse and heal the wound while preserving the implanted instrumentation.

Key Words: postoperative wound suppuration, purulent complications, surgical site infections, early suppuration, vacuum dressing, negative pressure therapy, VAC-dressing.

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A decompression and stabilization surgery in the lumbar spinal stenosis treatment is the best technique of modern vertebrology [1–3]. This surgery type is associated with a considerable number of diverse complications. Their rate ranges from 0.7 to 20.0 % [4–8], and the share of infectious ones is 1.3–3.9 % [9–11]. The corresponding complications considerably worsen the overall results, lengthening the duration treatment and increasing its cost several times compared with the primary surgery [12, 13].

An early suppuration of wounds is the most common in the period from a few days to three weeks after surgery. Nevertheless, in some cases they can develop within up to 90 days, while their diagnosis is not strictly specific and is based on clinical and laboratory data, as well as ultrasound, CT and MRI findings [14–17].

Today, a suction-irrigation system is used for the treatment of spinal wound infections [18, 19]. Also, the surgeons apply VAC-dressings [20], as well as their modified combinations [21].

A negative pressure therapy for wounds is based on the papers of Dersch et al. [22]. According to the findings, this method results in a perfusion pressure increase in the wound. The positive effects of the treatment proposed are the following: removal of the wound fluid, deformation and reduction of the total volume of the wound cavity, improvement of local blood flow, increased fibrinolysis, stimulation of angiogenesis, and formation of granulations.

The negative pressure therapy technology for wounds has been actively used in spinal surgery in recent years, and there is an increase in the range of indications for its application [23–26]. The first papers in Russia concerning the successful use of VAC-dressings in spinal surgery date back to 2014–2017 [27–29].

The objective is to analyze the results of treatment of patients with implant-associated surgical site infection after decompression and stabilization surgery performed for lumbar spinal stenosis.

Material and Methods

Type of study: an observational retrospective analysis of a series of cases (n > 10).

The study object: patients with early suppuration of the surgical wound after decompression and stabilization interventions performed for lumbar spinal stenosis.

The study subject: the treatment of implant-associated infection of the surgical site using controlled negative pressure.

Criteria for inclusion in the study group:

1) primary surgical treatment of degenerative spinal stenosis applying a stabilizing transpedicular system (TLIF/PLIF operations);

2) early suppuration of the surgical wound (no later than 90 days after intervention);

3) an application of a vacuum drainage system (VAC-system) for the treatment of complications;

4) the follow-up period after the infection resolution is at least 12 months.

Exclusion criteria: patients with non-infectious wound complications (seroma, hematoma, dry necrosis of the cutaneous wound edges).

A total of 43 patients operated on in 2015–2019 were analyzed based on these criteria. All of them initially underwent PLIF and TLIF surgeries according to the standard technique. The interventions were performed by 6 surgeons of the same unit at one, two and three levels in the lower lumbar spine. The surgical intervention time averaged 114.0 ± 26.9 minutes. Redon drainage technique was used in all cases after the operation. The reason for the drainage removal from the surgical site was the presence of hemorrhagic extravasate less than 50 ml per day.

The wound suppuration in 27 (62.79 %) patients was diagnosed in the immediate (up to 1 week) postoperative period, in the remaining 16 (37.21 %) – after hospital discharge (within 7 to 90 days).

The main preoperative clinical and laboratory characteristics of patients, including risk factors and co-morbidities, are given in Table 1.

For an objective evaluation of the patient's condition, neurological and clinical examinations were used; for pain intensity assessment and impairment of the patient's vital activity – VAS and the Oswestry questionnaire (ODI); for visualization of the pathological substrate – MRI, Ultrasound, CT, fistulography; to assess laboratory data – white blood cell count and differential blood count, CRP, ESR, procalcitonin test; to identify microflora – bacterial culture tests.

The data obtained was processed using Statistica for Windows. Criteria of nonparametric statistics were used to evaluate the significance of differences in set samples; the level of statistical reliability $p < 0.05$ was adopted as the lower limit of reliability.

The control examinations were performed in terms of 3 and 12 months after discharge.

The diagnosis of "early suppuration" was established on the basis of clinical, instrumental and laboratory findings (leukocytosis, increased ESR and C-reactive protein, fever, tenderness in the site of operating sutures, wound drainage, local hyperthermia, redness and swelling of the area of the wound, ultrasound of the wound site, MRI) that is the basis for urgent surgical treatment immediately after the diagnosis of complications.

The following protocol was used in the treatment of patients:

– surgical revision and debridement of wound;

– placement of the vacuum dressing;

– antibacterial therapy with broad-spectrum drugs until bacterial culture is obtained, then a change of drugs according to the antibiotic susceptibility of the flora;

– disease-management therapy.

The VAC system was used in 43 cases. It was consisted of a polyurethane foam sponge with a pore size of 800–1500 microns, a silicone drainage tube, surgical operation film, as well as a vacuum source with a liquid-collecting container. The volume of wound treatment depended on the infection process depth, which was determined using ultrasound data of the surgical wound area, fistulography, MRI, as well as intraoperative picture. In case of superficial suppuration (no deeper than aponeurosis), debridement was done within the lesion area, no deeper than the native fascia of the lumbar segment. The placed vacuum dressing operated for 48–72 hours, after the wound was sutured with Redon drainage.

If there was deep suppuration, the wound was opened to the full depth, debridement was done in all pockets, including the spinal canal. The surgery was completed by installing a vacuum dressing.

A careful debridement of wounds was performed in sterile conditions, and the wounds were rinsed with antiseptic solutions. A small curet was used to treat the edges, walls, and bottom of the wound. Foam and drainage tubes were placed in the wound. Foam was modeled so as to completely fill the infected wound, after which the wound surface was sealed with an adhesive film. The drainage tubes were removed through additional incisions and connected to a vacuum source. As a rule, negative pressure in the wound of 100–110 mm Hg was used for therapeutic purposes. The dressing was changed once every 48 or 72 hours, depending on the efficiency of the VAC system. After visual wound cleansing and granulations, it was sutured with Redon drainage.

Results

A total of 4033 operations for lumbar spinal stenosis with implantation of stabilization systems were performed from 2015 to 2019. There were 43 (1.06 %) cases of early suppuration of the surgical wound with the installed instrumentation. Out of them seven (16.27 %) cases were superficial and 36 (83.78 %) – deep. Table 2 shows the development of infectious complications depending on the volume of surgeries performed.

An early suppuration most often developed during surgical treatment of stenosis on three spinal segments.

Among all patients with early suppuration, 26 (60.5 %) had a BMI > 30 kg/m^2, and 22 (51.2 %) were over 60.

The growth of microbial flora from the wound fluid was confirmed in 39 (90.70 %) patients. 30 (76.92 %) of them

had monomicrobial flora, 9 (23.07 %) – polymicrobial (Table 3).

All patients were prescribed bicomponent broad-spectrum antibacterial therapy (second generation cephalosporins + fluoroquinolones) before receiving bacterial culture test and determining the pathogen's susceptibility to antibiotics. After receiving the bacterial culture test results, a correction of therapy was performed with the participation of a clinical pharmacologist. The average antimicrobial therapy duration was 60.7 ± 8.6 days (Table 4).

The treatment of superficial suppuration was accompanied by a single installation of a VAC-dressing before wound closure, and in deep suppuration from 2 to 8 (on average 4.10 ± 1.73) VAC-dressings were changed. The maximum number of installations of VAC-dressings (7–8) was required for the elimination of mixed polyresistant flora *(Acinetobacter baumannii + Pseudomonas aeruginosa)* and low reparative regeneration of the body.

With the application of the presented treatment protocol, the implants were preserved in all patients.

Patients were discharged after the final wound healing and removal of sutures. Wound healing was achieved in all patients within 14–55 (average 29.10 ± 10.06) days.

There were no neurological complications in the postoperative period in any case. We observed a significant improvement in the ODI index and a decrease in local pain syndrome according to VAS after treatment (Table 5).

Laboratory blood tests were performed in all patients at the stages of complication diagnosis, during treatment and after recovery. The hemogram data at the stages of curation are presented in Table 6.

The trend of changes in peripheral blood parameters reflects the effectiveness of the complex treatment and alleviation of the infectious process during one year after the complication. Meanwhile, the preservation of the metal instrumentation in the site of the developed early suppuration does not result in process reactivation.

Table 1

Clinical and laboratory findings of patients (n = 43), risk factors and co-morbidities

Age and gender data	
Age, years	56.68 ± 11.26
Women, n (%)	25 (58.14)
Men, n (%)	18 (41.86)
Clinical manifestations of wound suppuration, n (%)	
Topoalgia	37 (86.0)
Fever	33 (76.7)
Local edema	28 (65.0)
Hyperemia of the wound edges	27 (62.7)
Local hyperthermia	19 (44.2)
Laboratory findings	
White blood cells, x109/l	11.2 (4.8–17.2)
CRP, mg/l	57.2 (3.3–117.2)
ESR, mm/h	47.2 (3.0–93.0)
Risk factors and co-morbidities, n (%)	
Patients over 60	22 (51.20)
Smoking	14 (32.55)
Obesity (BMI > 30 kg/m2)	26 (60.50)
Hypertension	21 (48.80)
Diabetes mellitus	17 (39.53)
Coronary heart disease	16 (37.20)
Rheumatoid arthritis	4 (9.30)
Drug addiction, alcohol abuse	1 (2.32)
Chronic infection foci (chronic pyelonephritis)	3 (6.97)
Chronic steroid administration (more than 6 months)	6 (13.95)

Discussion

The treatment of early postoperative wound suppuration in spinal surgery remains a significant challenge, especially in cases after iatrogenic destabilization during full decompression with subsequent surgical hardware installation. The frequency of early postoperative wound suppuration on the lumbar spine is 1.3–3.9 % [5, 8–10, 12]. The minimum level was found in the study by Park et al. [30] and it was 0.37 %. The authors paid great importance to the combined prevention of infectious complications during primary surgery. It includes preoperative antibiotic therapy (cefazolin I.V. or gentamicin I.V.) and local administration of vancomycin powder.

During our 4-year observations, the frequency of early suppuration after decompression and stabilization surgeries for degenerative spinal stenosis was 1.06 %. The achievement of such an indicator became possible due to a set of measures for the active prevention of postoperative wound suppuration [31] and the following managerial activities:

1) maximum preparation of the patient for surgery (rehabilitation of foci of chronic infection, reduction of excess weight, and correction of anemia, hypoproteinemia and glucose levels in diabetes mellitus);

2) adherence to specifications of sterility and infectious safety in the operating room (control of the sterility of the room, instruments and implants, the number of operating room staff, the presence of laminar flows);

3) improvement of perioperative parameters (reduction of the surgery duration, blood loss reduction, careful approach to soft tissues);

4) performing pre- and intraoperative activities (treatment of the skin with soap solutions before surgery, and before incision with alcohol–containing antiseptics, pre- and perioperative administration of an antibiotic every 120 minutes, maintenance of intraoperative normothermia, wound lavage with two or more liters of saline every hour intraoperatively);

5) treatment of patients with primary and secondary infectious processes outside the neurosurgical unit (spatial presence in the purulent surgery department, surgeries in the purulent operating room, curation by an experienced spinal surgeon who does not face with "clean" patients).

The choice of the surgical technique for the treatment of early infectious complications after decompression and stabilization surgeries depends on the preferences of the surgeon and the hospital capabilities. While comparing the effectiveness of the suction-irrigation system and negative pressure therapy, Zhang et al. [32] argue for the effectiveness of both techniques and the identity of the results obtained. Nevertheless, they note that suction-irrigation systems are more sustainable financially, and VAC-dressings are more portable and practical to operate, including for junior and middle medical staff. We have solely used negative pressure therapy for the surgical treatment of early postoperative wound suppuration. The wound healing has been achieved in all cases of using VAC-dressings, even in patients with reduced reparative regeneration and if they have mixed polyresistant flora. Meanwhile, we managed to preserve the installed surgical hardware in all cases, which is especially significant in the conditions of fusion that has not yet formed.

Table 2
The dependence between the suppuration development and the operation extent

TLIF/PLIF (1 level)		TLIF/PLIF (2 level)		TLIF/PLIF (3 level)	
total number of surgeries	early suppuration	total number of surgeries	early suppuration	total number of surgeries	early suppuration
2831	19 (0.66 %)	965	15 (1.55 %)	237	9 (3.79 %)

Table 3
Distribution of microbial flora in patients with surgical site infection, n (%)

Distribution of microbial flora in patients with surgical site infection, n (%)	
Without growth	4 (9.30)
Monomicrobial	30 (76.92)
Polymicrobial	9 (23.07)
Gram-positive pathogens	27 (55.10)
Staphylococcus aureus	18
Staphylococcus epidermidis	9
Gram-negative pathogens	22 (44.90)
Acinetobacter baumannii	6
Escherichia coli	5
Corynebacterium striatum	3
Pseudomonas aeruginosa	3
Enterobacter cloacae	2
Enterococcus faecalis	2
Citrobacter freundii	1

No cases of purulent process recurrence within a year after the sanitizing surgery specifies the quality of purification of the infected cavity, which is provided by a vacuum dressing.

Therefore, considering the absence of complications described in the literature related to the use of negative pressure therapy, the application of VAC-dressings in the treatment of patients with early postoperative wound suppuration is an effective and safe technique. It may be used in a surgical hospital for the pathology under consideration.

Conclusions

Active surgical tactics with the use of VAC dressings and complex antibacterial therapy enable to eliminate the resulting complication within 14–55 (on average 29.1 ± 10.06) days, even in cases with mixed polyresistant flora. Meanwhile, it is possible to preserve the previously implanted pedicle screw system, which is vital in patients with iatrogenically destabilized spine during primary surgery.

The postoperative follow-up of patients with the considered type of complications for a year demonstrates the absence of signs of process reactivation as well as a significant improvement in VAS and ODI indicators ($p < 0.001$).

No cases of purulent process recurrence specify the quality of purification

Table 4
Summary data of patients' treatment with deep and superficial early postoperative wound suppuration

Antibacterial therapy, days	60.7 ± 8.6
Intravenous therapy	28.6 ± 8.3
Oral administration	31.2 ± 3.3
Total therapy days	60.7 ± 8.6
Number of vacuum dressing changes, n	4.1 ± 1.7
Hospitalization duration excluding primary surgery, days	29.1 ± 10.1
Surgical hardware removal	0

Table 5

Dynamics of VAS and ODI indicators in patients with early postoperative wound suppuration (M ± SD)

ODI		
On admission to hospital	48.30 ± 11.05	–
3 months after discharge (n = 43)	24.10 ± 5.35	Z = -2.967, p < 0.001*
12 months after discharge (n = 39)	16.10 ± 3.16	Z = -3.833, p < 0.001*
VAS		
On admission to hospital	7.47 ± 1.03	–
3 months after discharge (n = 43)	4.10± 0.94	Z = -3.813, p < 0.001*
12 months after discharge (n = 39)	2.20 ± 0.41	Z = -3.945, p < 0.001*

*Mutationes sunt peraeque significant.

of the infected cavity, which is provided by a vacuum dressing.

The treatment of implant-associated infection of the surgical site applying vacuum systems is an effective and safe technique allowing to achieve good clinical results.

The study had no sponsors. The authors declare that they have no conflict of interest.

Table 6

Dynamics of changes of blood condition of patients with early postoperative wound suppuration (mean value)

Value	During complication diagnosis	2 weeks after	A month after	3 months after	A year after
White blood cells, units/l	15.41 x 10^9	10.40 x 10^9	8.70 x 10^9	6.90 x 10^9	7.10 x 10^9
CRP, mg/l	41.2	7.7	1.1	0.7	0.8
ESR, mm/h	47.2	19.7	11.3	8.5	8.3

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