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VACUUM THERAPY APPLICATION IN SURGICAL TREATMENT OF SPINAL EPIDURAL ABSCESSES

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Цель. Улучшить результаты хирургического лечения пациентов со спинальными эпидуральными абсцессами.

Материал и методы. Хирургическое удаление спинальных эпидуральных абсцессов, включающее интерламинэктомию с применением вакуум-дренирующей системы, было выполнено 5 пациентам. Медиана возраста пациентов составила 58 [52; 64] лет, мужского пола было 3 человека, женского − 2. При поступлении был изучен неврологический статус, выполнены лабораторные, бактериологические и инструментальные методы исследования (компьютерная и магнитно-резонансная томография, остеосцинтиграфия). Интенсивность болевого синдрома определяли по визуальной аналоговой шкале (ВАШ). Сепсис был подтвержден у 3 пациентов.

Результаты. Положительный клинический результат был достигнут у 5 пациентов. Выраженность болевого синдрома до лечения и на 2-3-и сутки после операции значительно снизилась с 8,0 [8,0; 9,0] баллов до 5,0 [4,0; 5,0] по шкале ВАШ. На момент выписки болевой синдром у 4 пациентов практически полностью регрессировал, однако у 1 пациента сохранялась легкая болезненность (4 балла по шкале ВАШ) в области послеоперационной раны. У всех пациентов наблюдался регресс неврологического дефицита: увеличение силы и объема активных движений в нижних конечностях до 4 баллов, нормализация функций тазовых органов. Послеоперационной кифотической деформации позвоночника ни у одного пациента не было. Рецидива гнойно-воспалительного процесса, потребовавшего проведения повторных операций, не наблюдалось. Несмотря на положительную неврологическую симптоматику, регресс болевого синдрома и увеличение объема активных движений, в анализируемой группе имелся один летальный исход ввиду крайне тяжелого септического состояния пациента еще при поступлении в стационар.

Заключение. Разработанный способ хирургического лечения спинальных эпидуральных абсцессов, включающий интерламинэктомию на протяжении гнойного очага и установку вакуум-дренирующей системы, обеспечивает адекватное санирующее воздействие, быструю ликвидацию отека прилежащих мягких тканей, невральных структур и качественную репарацию тканей.

Ключевые слова: спинальный эпидуральный абсцесс, вакуумная терапия, дренирование, интерламинэктомия, поясничная боль, послеоперационный период

Objective. To improve the surgical treatment results in patients with spinal epidural abscesses.

Methods. Surgical removal of spinal epidural abscesses, including interlaminectomy using a vacuum-draining system, was performed in 5 patients. The median age of patients was 58 [52; 64] years, 3 patients were males, 2 -females. On admission, the neurological status was studied, laboratory, bacteriological and instrumental methods of examination (computed and magnetic resonance imaging, bone scintigraphy) were carried out. The intensity of the pain syndrome was determined by the visual analogue scale (VAS). Sepsis was confirmed in 3 patients.

Results. A positive clinical outcome was achieved in 5 patients. The severity of pain before treatment and 2-3 days after surgery significantly decreased from 8.0 [8.0; 9.0] points to 5.0 [4.0; 5.0] on the VAS scale. On discharge, pain in 4 patients had almost completely regressed, but 1 patient still had a mild pain (4 points on the VAS scale) in the postoperative wound area. All patients had a regression of neurological deficit − an increase in the strength and volume of active movements in the lower limbs up to 4 points, the normalization of the functions of the pelvic organs. There was no postoperative kyphotic spinal deformity in any patient. Recurrence of inflammatory process, requiring re-operations was not observed. Despite the positive neurological symptoms, regression of pain and an increase in the volume of active movements in the analyzed group, there was one death due to the extremely severe septic condition of the patient which had been already on admission.

Conclusions. The developed method of the spinal epidural abscesses surgical treatment, including interlaminectomy throughout the purulent focus and the installation of a vacuum-draining system, provides adequate sanitizing effect, rapid elimination of edema of the adjacent soft tissues, neural structures and high-quality tissue repair.

Keywords: spinal epidural abscess, vacuum therapy, drainage, interlaminectomy, lumbar pain, postoperative period

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Научная новизна статьи

Разработан способ хирургического лечения спинальных эпидуральных абсцессов с использованием вакуум-терапии, положительный эффект которого заключается в том, что происходит отток гнойного отделя-

емого и интерстициальной жидкости из всех отделов гнойной полости, что позволяет достичь адекватного санирующего воздействия, быстрой ликвидации отека прилежащих мягких тканей и невральных структур, качественной репарации тканей.

What this paper adds

A surgical technique of spinal epidural abscesses treatment using vacuum therapy has been developed, the positive effect of which is that there is an outflow of purulent discharge and interstitial fluid from all parts of the purulent cavity, which allows achieving adequate sanitizing effects, rapid elimination of edema of the adjacent soft tissues and neural structures as well as high-quality tissue repair.

Introduction

Spinal epidural abscess (SEA) (ICD-10: G06.1) is an inflammatory process in the epidural space, located between the dura mater of the spinal cord and the periosteum lined surface of the spinal canal [1].

Before putting into practice the neuroimaging techniques (magnetic resonance imaging (MRI) and computed tomography (CT)), about 50% of patients (including 25% of those operated on) with SEA died of the occurrence of trophoparalytic and septic complications [2, 3].

Nowadays there are many causes of the SEA. Various purulent foci: boils, subcutaneous abscesses, panaritiums, phlegmons or purulent complications of surgical interventions and penetrating injuries of the spine and spinal cord are the infection source. [3, 4]. Expressed venous anastomotic network of the spinal canal tissues and visceral organs is a prerequisite for anatomical hematogenous and lymphogenous penetration of the infection to the epidural space from the primary suppurative focus. [5, 6].

SEA treatment, regardless of the severity of clinical manifestations, should be carried out as intensively as possible according to the sepsis treatment regimen from the moment of patient's admission to hospital [2, 7]. Administration of antibiotics, including modern ones, often leads to the transition of epiduritis to a chronic stage [2]. The opinion about the demand for active surgical intervention of the SEA was expressed as early as in 1926 by W.E. Dendy [8].

Currently, surgical treatment of SEA includes a classical laminectomy over the site of purulent focus localization at one or several levels, removal of purulent contents with subsequent drainage of the wound [3, 9].

The disadvantage of the classical laminectomy is the disturbance of the posterior support complex structure. This is accompanied by instability of the spine, especially in the lumbar region when performing "fenestrated" laminectomy in extended epiduritis, which in turn may lead to the risk of postoperative kyphotic spinal deformity [10].

M.Yu. Goncharov et al. have developed the surgical access to the epidural space through translaminar openings or interlaminar windows throughout the entire epiduritis zone. In the epidural and subfascial space above the vertebral arches, the inflow-outflow washing system is installed in the form of two hollow, single hollow polyvinyl chloride tubes with perforations with the output of the ends through the skin contraceptives to the aspirator [11]. The disadvantage of this method is the high risk of damage to the dural sack when installing the inflow-outflow washing system through the epidural space due to the presence of swelling of soft tissue and neural structures. In addition, the method used does not allow adequate drainage of intermuscular and subcutaneous abscesses.

High-quality wound drainage plays an important role in the treatment of any purulent process. Not sanitized purulent effusions, poor growth of granulations and poor cleansing of the postoperative wound lead to relapses, repeated hospitalizations and disability of the patient. Today, negative pressure wound therapy (NPWT) is an innovative method of treating wounds of various etiologies [12, 13].

NPWT main positive effects are [14, 15]:

- Macrodeformation – reduction of the wound area;
- Microdeformation of the wound bed tissue, due to the porous structure of the sponge, which in turn stimulates cell migration and proliferation, enhances the local lymph and blood circulation, improves transcapillary oxygen transport and increases the rate of formation of young granulation tissue;
- Active evacuation of wound discharge, reducing interstitial edema, accelerating wound healing;
- Controlled maintenance and preservation of a moist wound environment, stimulating angiogenesis, enhancing fibrinolysis and contributing to an effective effect on tissue growth factors;
- Progressive reduction of bacterial contamination of tissues in the wound area.

Reducing the degree of the operation trauma, which does not lead to stability violation of the supporting complexes of the spinal column, and the introduction into practice of modern methods of the suppurative focus debridement will help improve the results of treatment in SEA patients.

Objective. To improve the surgical treatment results in patients with spinal epidural abscesses.

Methods

There were 5 patients with SEA at the thoracic purulent surgical department of Vitebsk Regional

Clinical Hospital (ME "VRCH"), in 2017-2018; their median age was 58 [52; 64] years, including three men and two women.

On admission, general somatic, neurological and local statuses were studied in all patients (n=5), laboratory tests (general and biochemical blood tests, urinalysis, coagulogram, C-reactive protein, immunogram, plasma procalcitonin) and instrumental methods of examination (X-ray of the spine, CT and MRI of the lumbar spine, bone scintigraphy, abdominal ultrasound (US) were carried out.

Neurological examination of patients included the study of the motor and sensitive areas, the function of the pelvic organs, as well as the severity of pain syndrome on the visual analogue scale (VAS), which was subsequently taken into account in the postoperative period and at the time of patient's discharge from the hospital.

To exclude extraneural purulent processes, patients were consulted by the following specialists: maxillofacial surgeon, otorhinolaryngologist and gynecologist. Additionally, some patients were examined by therapist, endocrinologist, neurologist, rheumatologist and cardiologist.

Bacteriological analysis of the purulent contents of the paravertebral abscesses, SEA was carried out in the Republican Scientific and Practical Center "Infection in Surgery" and the bacteriological laboratory of the ME "VRCH". Identification and evaluation of the microorganisms' sensitivity to antibacterial drugs was performed using test systems on the ATB Expression microbiological analyzer (France) and using the method of standard paper discs (Becton Dickinson (USA)). To determine the sensitivity, the strips of «bioMerieux» company were used: ATB STAPH - for staphylococci, ATB STREP - for streptococci, ATB PSE - for pseudomonads (France). Also, the purulent contents of abscesses were examined with BACTEC and GeneXpert for the presence of M. tuberculosis.

All patients (n=5) were operated on by one and the same team of surgeons according to the method developed by us (notification of a positive result of preliminary expert examination for the grant of patent for the invention No. a 20180015 (2018.01.18) "Method of treating non-specific epiduritis with paravertebral abscess").

Surgery was performed under the endotracheal intubation anesthesia with the patient's face down position.

After cleaning the surgical field in the projection of a purulent focus, the incision was made in the skin and subcutaneous tissue along the posterior midline. Laterally from the supraspinal ligament, the fascia and muscles were dissected, preserving the integrity of the supraspinal ligament bundle. Paraspinal muscles were skeletonized from the spinous processes, the arms and the transverse processes on both sides with the obligatory preservation of the capsule of the facet joints.

During the operation, all paravertebral soft tissue abscesses were opened and sanitized. Interlaminectomy was performed throughout the purulent process with the excision of the yellow ligament for revision of the epidural space, as well as decompression of the dural sac and roots (Fig. 1).

During the revision of the epidural space SEA was removed. Ultrasonic cavitation of fibrinous overlays on the dura mater and in the area of remote paravertebral soft tissue abscesses was performed. The postoperative cavity was treated with antiseptic solutions. Next, the hydrophilic polyurethane sponge was placed paravertebrally on one or both sides of the spinous process, depending on the localization of soft tissue abscesses, as well as in the zone of the interlaminectomy performed. A perforated polyvinyl chloride (PVC) drainage tube was passed through the thickness of the porous material and fixed to it with a separate suture (Fig. 2).

The perforated PVC drainage tube was taken out through counter opening, fixing to the skin with a separate suture. The edges of the wound were sutured tightly for complete cavity pressurization, an aseptic dressing was applied (Fig. 3A, 3B).

The drainage tube was connected to the aspirator to create a permanent vacuum aspiration.

After 3-4 days, the wound was inspected. If purulent contents were detected in the wound, the growth of granulations was inactive, replacement of the hydrophilic polyurethane sponge was performed together with PVC tube. If purulent discharge was not detected, the wound surface actively granulated, the porous material with PVC tube was removed, the bottom of the wound was drained with a double-lumen medical multichannel tube or Chaffin-Kanshin drainage. Drainage was removed after 3-5 days.

Statistics

The analysis of the data obtained was performed by nonparametric methods of research in the program Statistica 10.0 and is represented by the median, upper and lower quartiles Me [LQ; UQ].

Results

Hospitalized patients (n=5) before the operation complained of persistent pain in the spine, the severity of which on the VAS scale was 8.0 [8.0; 9.0] points.

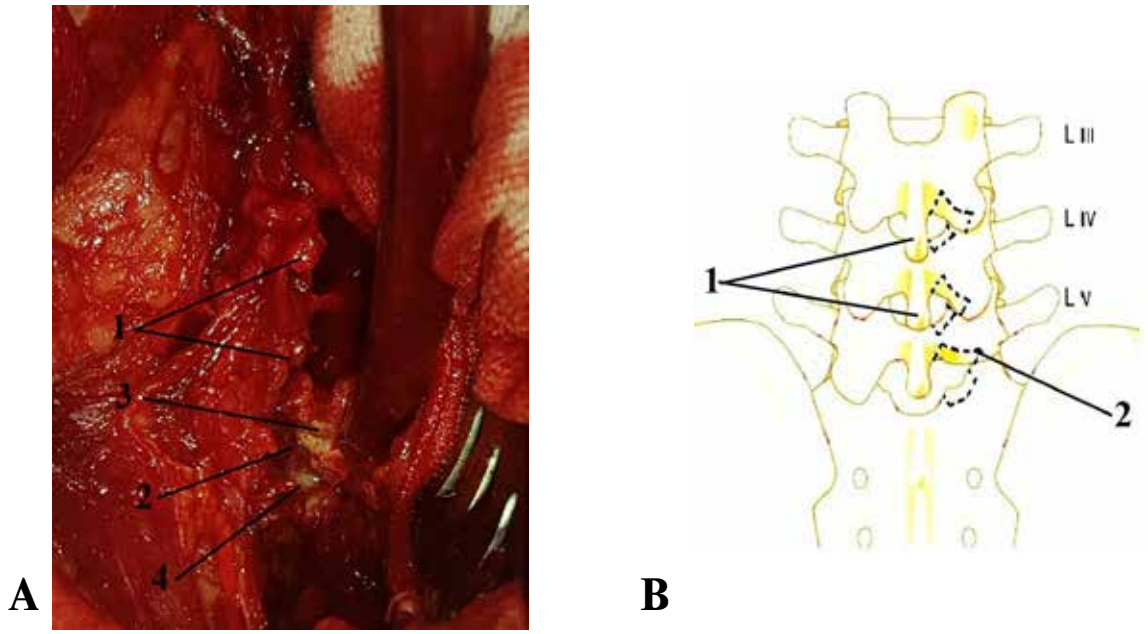


Fig. 1. Surgical access in the spinal epidural abscess.
(A – intraoperative image, B – scheme of the operation). 1 – spinous processes and supraspinal ligament, 2 – zone of interlaminectomy, 3 – yellow ligament, 4 – spinal epidural abscess.

While studying the neurological status, 1 patient was diagnosed with the lower spastic paraplegia, pelvic organs dysfunction by urinary and feces incontinence, in 2 patients lower spastic paraparesis was detected (3-4 points), in 1 patient neurological deficit included hypesthesia along the way of L4-S1 spines on the right.

When performing MRI of the spinal column in 4 patients, SEA was detected at the lumbar level, in 1 patient – at the lower thoracic and sacral parts of the spinal column. Paravertebral abscesses were found in 2 patients. In 1 patient, except for CEA, the purulent spondylodiscitis with predominant lesion of the intervertebral disc at the level of L4 - L5 vertebrae was diagnosed on CT.

Leukocytosis was observed in the peripheral blood – 13.17 [11.2; 15.5] $\times 10^9$/l, with a shift of the leukocyte formula to the left: stab neutrophils 6% [4; 7], segmented neutrophils 75.2% [70.5; 79.1], lymphocytes 13.4% [11.3; 15.0], accelerated ESR - 43.2 [34.1; 52.2] mm/hour. The body temperature of patients was 37.4 [36.6; 37.8] ºC see above, moderate tachycardia was observed – 95-115 beats/min.

Sepsis was clinically confirmed in 3 patients.

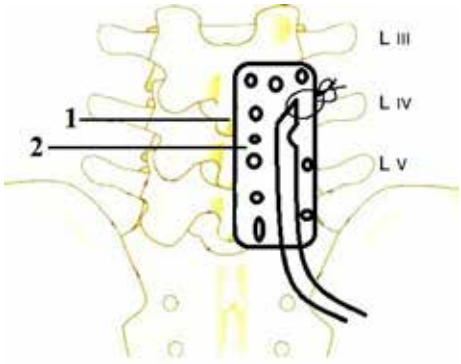
During the microbiological study of biological material obtained intraoperatively from the purulent foci, in 3 cases S. aureus was isolated, in 1 – K. pneumoniae. In 1 patient, the inoculation was sterile. Tests for M. tuberculosis were negative in all 5 cases.

In the postoperative period, a positive clinical result was achieved in 5 patients (100%). The intensity of pain by 2-3 days after surgery had significantly decreased to 5.0 (4.0; 5.0) points on the VAS scale. On discharge, the pain syndrome had almost completely regressed, however, 1 patient had a slight pain on discharge (4 points) in the postoperative wound area, which was due to the presence of residual spondylodiscitis.

In the study group (n=5), the regression of the neurological deficit was observed - an increase in the strength and volume of active movements in the lower limbs up to 3-4 points. None of patients had the postoperative kyphotic spinal deformity.

Despite the active surgical tactics in the analyzed group, there was one lethal outcome. The patient was hospitalized in a critical condition with the following diagnosis: Extensive SEA of the lower thoracic and lumbosacral spine. Diabetes mellitus type 2, diabetic polyneuropathy, diabetic nephropathy. Chronic renal failure, intermittent

Fig. 2. The location of the hydrophilic polyurethane sponge in the zone of interlaminectomy performed and paravertebrally (scheme of operation). 1 – spinous processes and supraspinal ligament, 2 – hydrophilic polyurethane sponge.



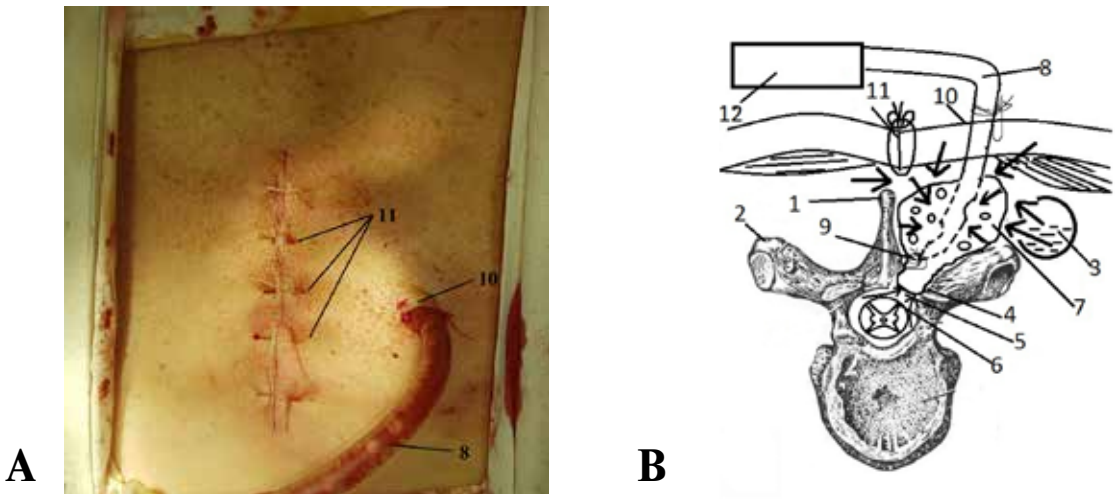


Fig. 3. The final stage of the operation. (A – intraoperative image, B – scheme of the operation). 1 – spinous process, 2 – transverse process, 3 – paravertebral abscess cavity, 4 – interlaminectomy zone, 5 – epidural space, 6 – dural sac, 7 – hydrophilic polyurethane sponge, 8 – PVC tube, 9 – fixing suture, 10 – counteropening, 11 – stitches on the skin, 12 – aspirator.

stage. Sepsis. Purulent resorptive cachexia. Bilateral polysegmental pneumonia. Bilateral pleurisy. RF1-2. Secondary myelopathy, inferior paraplegia. Dysfunction of the pelvic organs - incontinence of urine and feces. Antibiotic-associated enterocolitis. IHD: cardiosclerosis. Paroxysmal atrial fibrillation. Hypertension II, risk 4. H II A. NYHA FC 3.

Surgical treatment of SEA was performed according to the above method with two-stage debridement. In the postoperative period, rational antibacterial, intensive detoxification and symptomatic therapy was performed. Positive neurological dynamics and regression of the inflammatory process according to MRI and CT data were registered. However, the intensity of manifestations of hypermetabolism did not decrease, purulent resorptive cachexia progressed and the patient died on the 26 day.

Patients (n=4) were discharged from the hospital in a satisfactory condition. Weakness in the lower limbs and fatigue was registered in 1 patient when walking for a long time. On the control MRI after 1 and 3 months, signs of inflammatory processes relapse and the formation of epidural cicatrices - adhesions were not detected. Hospitalization for re-surgical treatment was not required.

Discussion

The proposed method of SEA surgical treatment, in contrast to the classical methods, has several advantages.

Unlike the classical method, which includes access to the epidural space by laminectomy, according to our method, SEA debridement is carried out through interlaminar windows, which does not disturb the posterior spinal column support and does not increase the risk of its severe postlaminectomy deformity.

The use of a hydrophilic polyurethane sponge and vacuum drainage of the wound allows achieving adequate sanitizing effect, quick elimination of edema of adjacent soft tissues and neural structures, high-quality tissue repair due to the fact that there is a constant outflow of purulent discharge and interstitial fluid from all parts of the purulent cavity filled in with porous material.

Programmable debridement of purulent cavities allows controlling the degree of its purification from purulent overlays and the course of the repair process.

However, in case of the staged wound debridement, the rules of asepsis and antisepsis should be strictly observed to avoid nosocomial multi-resistant microflora and superinfection occurrence in the wound.

The use of ultrasound cavitation of the walls of the wound cavity during the sanitation operation contributes to the formation of granulation tissue, and the soft treatment with ultrasound of the dural sac removes residual fibrinous layers from the dura mater without damaging it, which helps prevent liquorrhea in the postoperative period.

Thus, the proposed version of the SEA surgical treatment allows avoiding serious complications in the spinal neurosurgery while treating inflammatory diseases of the nervous system.

Conclusions

The method of surgical treatment of spinal epidural abscesses developed and tested in the clinic allows getting access to the epidural space without

stability violation of the posterior anterior spinal column complex, performing high-quality debridement of the suppurative focus and completing repair of the damaged structures of the spinal column.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical aspects
Ethics Committee approval

The work was approved by the Committee on the Ethics of Educational Establishment "Vitebsk State Medical University".

ЛИТЕРАТУРА

1. Деконенко ЕП, Куприянова ЛВ, Тропихин ИМ, Головатенко-Абрамов КВ. Спинальный эпидуральный абсцесс – клинические особенности и сложности дифференциальной диагностики. *Альм Клин Медицины*. 2001;(4):55-57. https://cyberleninka.ru/article/n/spinalnyy-epiduralnyy-abstsess-klinicheskie-osobennosti-i-slozhnosti-differentsialnoy-diagnostiki
2. Фадеев БП, Карабаев ИШ. Диагностика и лечение гнойных спинальных эпидуритов. Санкт-Петербург, РФ: ВМедА, 2004. 25 с.
3. Moritani T, Kim J, Capizzano AA, Kirby P, Kademian J, Sato Y. Pyogenic and non-pyogenic spinal infections: emphasis on diffusion-weighted imaging for the detection of abscesses and pus collections. *Br J Radiol.* 2014 Sep;87(1041):20140011. doi: 10.1259/bjr.20140011
4. Снопко СВ, Фирсов СА, Корнилова ИВ, Тумурин ЛС. Гнойные спинальные эпидуриты: скрытая угроза. *Тихоокеан Мед Журн*. 2015;(4):92-94. https://tmj-vgmu.ru/index.php/ru/2015-god/4-62/1023-gnojnye-spinalnye-epidurity-skrytaya-ugroza
5. Reihsaus E, Waldbaur H, Seeling W. Spinal epidural abscess: a meta-analysis of 915 patients. *Neurosurg Rev*. 2000 Dec;23(4):175-204; discussion 205. doi: 10.1007/PL00011955
6. Manoso MW, Cizik AM, Bransford RJ, Bellabarba C, Chapman J, Lee MJ. Medicaid status is associated with higher surgical site infection rates after spine surgery. *Spine (Phila Pa 1976)*. 2014 Sep 15;39(20):1707-13. doi: 10.1097/BRS.0000000000000496
7. Rigamonti D, Liem L, Sampath P, Knoller N, Namaguchi Y, Schreibman DL, Sloan MA, Wolf A, Zeidman S. Spinal epidural abscess: contemporary trends in etiology, evaluation, and management. *Surg Neurol.* 1999 Aug;52(2):189-97. https://doi.org/10.1016/S0090-3019(99)00055-5
8. Dandy WE. Abscesses and inflammatory tumors in spinal epidural space (*so-called pachymeningitis externa*). *Arch Surg.* 1926;13(4):477-94. doi:10.1001/archsurg.1926.01130100021002
9. Nuttall J, Evaniew N, Thornley P, Griffin A, Deheshi B, O'Shea T, Wunder J, Ferguson P, Randall RL, Turcotte R, Schneider P, McKay P, Bhandari M, Ghert M. The inter-rater reliability of the diagnosis of surgical site infection in the context of a clinical trial. *Bone Joint Res.* 2016 Aug;5(8):347-52. doi: 10.1302/2046-3758.58.BJR-2016-0036.R1
10. Колесов СВ. Хирургическое лечение тяжелых постламинэктомических деформаций позвоночника. *Хирургия Позвоночника*. 2006;(2):29-32. https://doi.org/10.14531/ss2006.2.29-32
11. Гончаров МЮ, Сакович ВП, Данилов ЕП, Черепанов АВ, Волков ИВ, Левчик ЕЮ. Ближайшие результаты лечения гнойных неспецифических заболеваний позвоночника. *Хирургия Позвоночника*. 2005;(2):70-72. https://www.spinesurgery.ru/jour/article/view/1138/965
12. Гаин ЮМ, Бордаков ПВ, Бордаков ВН, Шахрай СВ, Гаин МЮ, Елин ИА. Вакуум-терапия ран при хирургической инфекции мягких тканей. *Военн Медицина*. 2016;(4)):64-72. https://www.mil.by/ru/smi/medicine_magazine/922
13. Оболенский ВН, Никитин ВГ, Семенистый АЮ, и др. Использование принципа локального отрицательного давления в лечении ран и раневой инфекции. Новые технологии и стандартизация в лечении осложненных ран. С-Петербург-М, РФ; 2011. с. 58-65.
14. Anagnostakos K, Mosser P. Bacteria identification on NPWT foams: clinical relevance or contamination? *J Wound Care*. 2012 Jul;21(7):333-4, 336-39. doi: 10.12968/jowc.2012.21.7.333
15. Orgill DP, Bayer LR. Negative pressure wound therapy: past, present and future. *Int Wound J*. 2013 Dec;10 (Suppl 1):15-9. doi: 10.1111/iwj.12170

REFERENCES

1. Dekonenko EP, Kupriianova LV, Tropikhin IM, Golovatenko-Abramov KV. Spinal'nyi epidural'nyi abstsess – klinicheskie osobennosti i slozhnosti differentsial'noi diagnostiki. *Al'm Klin Meditsiny*. 2001;(4):55-57. https://cyberleninka.ru/article/n/spinalnyy-epiduralnyy-abstsess-klinicheskie-osobennosti-i-slozhnosti-differentsialnoy-diagnostiki (in Russ.)
2. Fadeev BP, Karabaev ISh. Diagnostika i lechenie gnoinykh spinal'nykh epiduritov. Sankt-Petersburg, RF: VMedA, 2004. 25 p. (in Russ.)
3. Moritani T, Kim J, Capizzano AA, Kirby P, Kademian J, Sato Y. Pyogenic and non-pyogenic spinal infections: emphasis on diffusion-weighted imaging for the detection of abscesses and pus collections. *Br J Radiol.* 2014 Sep;87(1041):20140011. doi: 10.1259/bjr.20140011
4. Firsov SA, Snopko SV, Kornilova IV, Tumorin LS. Purulent spinal epiduritis: a latent threat. *Tikhookean Med Zhurn*. 2015;(4):92-94. https://tmj-vgmu.ru/index.php/ru/2015-god/4-62/1023-gnojnye-spinalnye-epidurity-skrytaya-ugroza (in Russ.)
5. Reihsaus E, Waldbaur H, Seeling W. Spinal epidural abscess: a meta-analysis of 915 patients. *Neurosurg Rev*. 2000 Dec;23(4):175-204; discussion 205. doi: 10.1007/PL00011955
6. Manoso MW, Cizik AM, Bransford RJ, Bellabarba

C, Chapman J, Lee MJ. Medicaid status is associated with higher surgical site infection rates after spine surgery. *Spine (Phila Pa 1976)*. 2014 Sep 15;39(20):1707-13. doi: 10.1097/BRS.0000000000000496
7. Rigamonti D, Liem L, Sampath P, Knoller N, Namaguchi Y, Schreibman DL, Sloan MA, Wolf A, Zeidman S. Spinal epidural abscess: contemporary trends in etiology, evaluation, and management. *Surg Neurol.* 1999 Aug;52(2):189-97. https://doi.org/10.1016/S0090-3019(99)00055-5
8. Dandy WE. Abscesses and inflammatory tumors in spinal epidural space (*so-called pachymeningitis externa*). *Arch Surg.* 1926;13(4):477-94. doi:10.1001/archsurg.1926.01130100021002
9. Nuttall J, Evaniew N, Thornley P, Griffin A, Deheshi B, O'Shea T, Wunder J, Ferguson P, Randall RL, Turcotte R, Schneider P, McKay P, Bhandari M, Ghert M. The inter-rater reliability of the diagnosis of surgical site infection in the context of a clinical trial. *Bone Joint Res.* 2016 Aug;5(8):347-52. doi: 10.1302/2046-3758.58.BJR-2016-0036.R1
10. Kolesov SV. Surgery for severe postlaminectomy spinal deformities. *Khirurgiia Pozvonochnika.* 2006;(2):029-032. https://doi.org/10.14531/ss2006.2.29-32 (in Russ.)
11. Goncharov MY, Sacovich VP, Danilov EP, Cherepanov AV, Volkov IV, Levchik EY. Immediate results of treatment for pyogenic nonspecific spine desease. *Khirurgiia Pozvonochnika.* 2005;(2):070-072. https://www.spinesurgery.ru/jour/article/view/1138/965 (in Russ.)
12. Gain JuM, Bordakov PV, Bordakov VN, Shakhrai SV, Gain MJu, Elin IA. Vacuum-therapy at the surgical infection of soft tissues. *Voen Meditsina.* 2016;(4)):64-72. https://www.mil.by/ru/smi/medicine_magazine/922 (in Russ.)
13. Obolenskii VN, Nikitin VG, Semenistyi AIu, i dr. Ispol'zovanie printsipa lokal'nogo otritsatel'nogo davleniia v lechenii ran i ranevoi infektsii. Novye tekhnologii i standartizatsiia v lechenii oslozhnennykh ran. S-Petersburg-M, RF; 2011. p. 58-65. (in Russ.)
14. Anagnostakos K, Mosser P. Bacteria identification on NPWT foams: clinical relevance or contamination? *J Wound Care.* 2012 Jul;21(7):333-4, 336-39. doi: 10.12968/jowc.2012.21.7.333
15. Orgill DP, Bayer LR. Negative pressure wound therapy: past, present and future. *Int Wound J.* 2013 Dec;10 Suppl 1:15-9. doi: 10.1111/iwj.12170

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