ANALYSIS OF EARLY INFECTIOUS COMPLICATIONS IN PATIENTS AFTER SPINAL SURGERY

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Objective. To assess the incidence of early infectious complications after spine surgery and to study the structure of risk factors in patients with surgical site infections.
Material and Methods. Early infectious complications after spine surgery were evaluated in 77 patients. The underlying pathology, comorbidities and surgical factors that caused the infection were analyzed.
Results. Over the 10-year observation period, the frequency of early postoperative infectious complications was 1.4 %. The main microorganisms causing infectious complication after spine surgery are methicillin-resistant *S. aureus* and *S. epidermidis* strains. The study revealed a direct correlation between obesity and surgical site infections. Such surgical factors as metal fixation, duration of operation and spinal fusion also contributed to the development of the inflammatory process in the early postoperative period.
Conclusion. Difficulties with the arrest of the infectious process require the development of methods for predicting the risk of complications and measures to reduce it. For this it is necessary to conduct comparative analysis of the frequency of occurrence of various risk factors in groups of patients with surgical site infections and of those with normal course of the postoperative period.
Key Words: deep surgical site infection, spine surgery, implant-associated infection, revision surgery

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Spinal cord injuries and diseases are a common and complicated problem of the modern medicine. The number of spinal operations steadily increases every year. This is due to significant expansion of indications and possibilities for both ordinary and complicated hours-long operations. The number of postoperative complications also increases. Surgical site infections (SSIs) are the most common complications after spinal surgery. The situation is compounded by the fact that the most common microorganisms causing these complications are highly virulent and resistant to antibiotic therapy [1].

The study was aimed at estimating the incidence of early infectious complications after spinal surgery and studying the structure of the risk factors in patients with SSIs.

Material and Methods

We analyzed early infectious complications after spinal surgeries performed at the Department of Neuro-orthopedics and Bone oncology of the RITO n.a. R.R. Vreden in 2005—2015. The total number of operated patients was 5,328, they underwent 5,564 operations. A total of 77 patients were diagnosed with SSIs in the early postoperative period. SSIs that occurred no later than 30 days after the operation were classified as early infectious complications. The most numerous group of patients, 25 (32.4 %) consisted of females aged 45 to 65 years. Age and sex distribution of patients is shown in Fig.

In SSI patients, primary operation was carried out for spinal injury, 17 (22.1 %) of cases, cancer — 23 (29.8 %), scoliosis — 18 (23.4 %), degenerative diseases of the spine — 19 (24.7 %). Distribution of infection localization in patients was as follows: cervical spine — 2 (2.6 %), thoracic spine — 26 (33.7 %), and lumbosacral spine — 49 (63.6 %). Thirty one (40.2 %) patients previously underwent spinal surgery.

Clinical and laboratory criteria of SSIs included systemic (fatigue, fever, leukocytosis, increase in CRP, ESR) and local (swelling, redness, local hyperthermia, wound discharge) signs of infection. Etiology of SSIs was established based on the results of bacteriological studies of tissue and bone bioptates, elements of removed metal structures, and postoperative discharge. The study evaluated the somatic state, constitutional findings, pain intensity, localization of the disease, nosology and extent of the process, operational data, etc.

All patients with infectious complications underwent revision surgery. Necrotic soft tissues and bone grafts (if any) were removed followed by postoperative wound washing with a large volume of antiseptic in order to

stop the infectious process. If there were no unstable fixation elements, metal structure was not removed, preserving stability of the spinal column and post-surgical correction value and preventing formation of pseudarthrosis with secondary spine deformity.

Results

During the 10-year observation period, the incidence of early postoperative infectious complications was 1.4 %. Patients were followed for an average of 4.3 ± 2.4 years. The average time elapsed between the operation and manifestation of postoperative complications was 13.5 ± 3.8 days.

In 77.9 % of cases, the infection was monobacterial, in 11 (14.3 %) patients the detected complication was caused by microbial association, which was represented by two pathogens in 9 cases and three pathogens in 2 cases. In 6 (7.8 %) cases, pathogen was not detected during the bacteriological examination.

Representatives of Staphylococcus spp. *(S. aureus, S. epidermidis)* were the main pathogens, which accounted for 50.6 % of the overall structure of SSI pathogens in the test population (Table 1). At the same time, 75.0 % of all staphylococci strains were methicillin resistant isolates. Gram-negative pathogens were isolated in 29.6 % of cases, and the leading position was occupied by *P. aeruginosa* and *E. coli*, wherein five of the seven strains were producers of extended-spectrum beta-lactamases (ESBL). A large proportion of multiresistant bacterial strains (MRSA, MRSE, *P. aeruginosa*, and *E. coli*, ESBL producers) indicates that these infections are nosocomial.

The vast majority of complications arose after open multi-level operations on posterior spinal structures. Only 3 (3.9 %) patients were diagnosed with SSI after minimally invasive spinal surgery (MISS), without installing the fixation system. Postoperative liquorrhea was observed in 23 (29.8 %) patients. Liquorrhea was caused by intraoperative damage to the dural sac in 13 (16.8 %) of these patients, in 10 (13.0 %) of them liquorrhea was fixed postoperatively within the period from 3 to 11 days.

The most common risk factors associated with patient's condition in the test population included obesity and urinary tract infections. Significant proportion of patients had various degrees of obesity. Body mass index (BMI) from 25 to 30 was found in 31 (40.2 %) patients and BMI greater than 30 was found in 18 (23.4 %) patients. Almost every fourth patient who developed SSIs after spinal surgery had underlying urinary tract infection. Diabetes, as well as rheumatoid arthritis, occurs in less than 10.0 % of SSI patients (Table 2).

All SSI patients received infusion and detoxification therapy during preoperative and postoperative periods. Antimicrobials were selected with allowance for the obtained antibiogram results. Typical duration of therapy was 12—14 days of parenteral drug administration followed by oral intake for 6—8 weeks. A total of 102 operations were performed in 77 patients. In connection with preservation of metal structure and, consequently, possible infection, 22 (28.6 %) patients underwent multiple revisions of the postoperative wound (each of 19 patients underwent 2 operations, 3 patients — 3 revisions within a single hospital stay). However, removal of the metal structure was required in 6 (7.8 %) patients, who underwent multiple revision surgeries on the spine. Two (2.6 %) patients developed multiple organ failure with underlying generalized infection (sepsis), which resulted in patients' death.

Discussion

The factors contributing to the development of SSIs can be divided into three categories: microbiological, patient-related, and surgery-related [7].

Infections caused by methicillin-resistant *S. aureus* (MRSA) and *S. epidermidis* (MRSE) strains [10] and multiresistant *E. faecalis* and *P. aeruginosa* strains are the most difficult to treat [9, 14]. The difficulties in the treatment of SSIs after spinal operations are to a large extent due to the pathogenesis of the infectious process, namely formation of a microbial biofilm on the metal surface. The existence of microorganisms in the biofilm complicates the diagnosis and reduces the effectiveness of antibiotic therapy [4].

Patient-related risk factors include systemic inflammatory diseases, diabetes, obesity, urinary tract infections, bad habits (smoking, alcohol abuse), as well as long-term use of corticosteroids [2]. Patients with excessive weight have a greater layer of adipose tissue with poor vascular perfusion, which can lead to tissue necrosis, resulting in formation of infection site. Diabetes and smoking predispose to infection due to microcirculation disorders followed by tissue ischemia, particularly at the surgical site. Patients with oncological disease and elderly patients demonstrate signs of immunosuppression, which result in slow healing of postoperative wounds and increased risk of surgical site infection [2, 6].

Additionally, the development of the early inflammatory changes is strongly affected by duration and severity of surgical intervention. According to the data obtained at various clinics, the incidence of infectious complications in the last 10 years varies from 1.9 to 4.4 % [7, 11, 13, 15]. Multiple-stage spinal surgeries significantly increase the risk of infectious and inflammatory complications [5]. According to some authors [7, 12], early infectious complications include surgical site infections arising during the period from 3 days to 3 months after the operation.

Reconstructive and plastic spinal surgeries are associated with installing various transpedicular, laminar, and other fixation systems. The implanted metal structure significantly increases the risk of SSI [16] and in the case of generalized infection can lead to sepsis and even patient's death. There are studies showing significantly lower incidence of infectious complications in minimally invasive spinal surgeries. Thus, when comparing the minimally invasive transforaminal lumbar interbody fusion (TLIF) with open decompression,

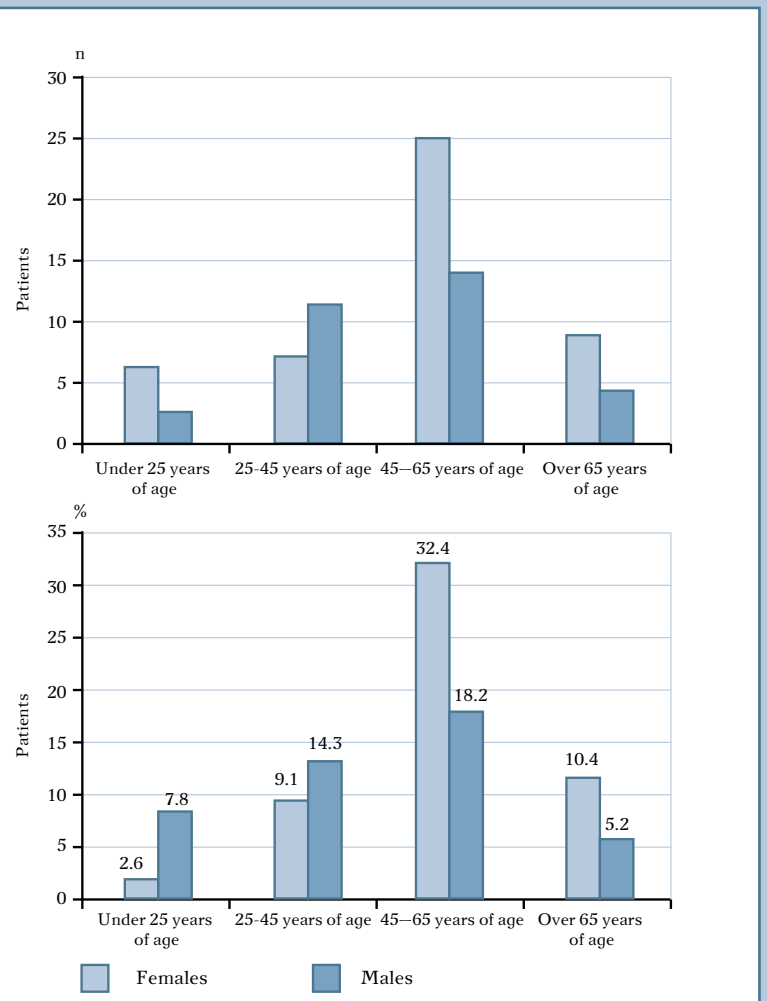

Fig.
Age and sex distribution of patients

the incidence of SSIs was 0.6 and 4.0 %, respectively [3, 12]. The study reported by Koutsoumbelis et al. [8] mentioned four major causes of infection: the duration of surgery, intraoperative blood loss, damage to the dura mater associated with the development of postoperative liquorrhea, and large number of personnel in the operating room [6, 14, 16].

Our results show a fairly low percentage of inflammatory complications in the early postoperative period as compared to the global statistics.

Despite the low percentage of early SSIs after the spinal surgery (1.4 %), they are caused by multidrug-resistant strains (MRSA, MRSE, *P. aeruginosa*, and *E. coli*, ESBL producers) in a significant proportion of cases, which apparently indicates that these are nosocomial infections and affects treatment efficacy.

To a lesser degree, the incidence of postoperative infections increased in the case of decompensated somatic and neurological pathologies. Despite the data reported by international authors, the impact of diabetes and systemic diseases on the development of inflammatory changes was not significant. This is due to the planned preoperative preparation aimed at the compensating patients' somatic diseases. At the same time, our study showed a direct correlation between the overweight and SSIs. The main surgery-related factors of the development of infectious process also included metal fixation, which was carried out in the vast majority of patients, as well as spinal fusion and duration of the surgery.

Conclusion

Infectious processes are difficult to manage and therefore the methods to predict the risk of complications and measures to reduce it should be developed, which nessessitates a comparative analysis of the occurrence of various risk factors in SSI patients and those with uneventful postoperative period. These issues will be covered in further research.

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Table 1

Quantitative characteristics of SSI pathogens

Pathogen	No. of cases, n (%)
S. aureus/MRSA	5/10 (21.1)
S. epidermidis/MRSE	4/17 (29.5)
P. aeruginosa	9 (12.7)
E. faecalis	8 (11.3)
E. coli/producers ESBL	2/5 (9.8)
K. pneumoniae	5 (7.1)
Other	6 (8.4)

Table 2

Patient distribution by major risk factors for development of SSI following spine surgery

Risk factors	Patients, n (%)
Surgical	
Related to metal fixation	74 (96.1)
Spinal fusion	43 (55.8)
Operation time more than 240 min	40 (52.1)
Number of fixed segment more than 5	34 (44.1)
Blood loss volume more than 1,500 ml	32 (41.5)
Reoperations	31 (40.2)
Liquorrhea	23 (29.8)
Somatic	
Obesity	49 (63.6)
Urinary tract infection	21 (27.3)
Diabetes	7 (9.1)
Rheumatoid arthritis	5 (6.5)

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