A CENTRALIZED SYSTEM OF SPECIALIZED SURGICAL CARE FOR PATIENTS WITH ACUTE NON-TRAUMATIC SPINE PATHOLOGY IN THE MODERN METROPOLIS

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Objective. Comparative assessment of the effectiveness of the centralized system of specialized surgical care for patients with acute non-traumatic spine pathology in the modern metropolis.
Material and Methods. The results of treatment of 1336 patients with acute spine pathology of degenerative-dystrophic, tumorous metastatic and infectious nature were analyzed. Patients of the control group (n = 471) were treated in several multidisciplinary hospitals in St. Petersburg, and 865 patients included in the study group — in a specialized city centre for emergency spine surgery. A comparative analysis of a number of medico-statistical and clinical indicators was performed using nonparametric statistics methods.
Results. The centralized system of treatment provided statistically significant ($p < 0.05$) increase in the level of surgical activity and stabilization of the spine, reduced length of stay in a hospital, as well as higher values of all indicators characterizing the results of treatment.
Conclusion. In large cities, the creation of a centralized system for the delivery of specialized medical care to patients with acute non-traumatic spine pathology is an effective organizational solution.
Key Words: spinal disorders, specialized medical care, emergency surgery, metropolis.

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Emergency specialized surgical care delivery to patients with acute conditions caused by degenerative, tumorous metastatic and infectious spinal diseases associated with severe pain syndrome and an increasing compression of the spinal cord, its nerve roots and blood vessels, remains unsolved challenge in local and foreign health care services [3–5]. Leading specialized health care professionals of Russia have indicated and provided substantiation for the crucial directions in improving the organization of specialized medical care delivery to these patients through the creation of specialized departments of emergency spinal surgery in metropolises and industry centers [2].

A decentralized system of surgical care provision for patients with spinal injuries and diseases was active in St. Petersburg before 2010. It consisted of the city five large multidisciplinary hospitals and the St. Petersburg I.I. Dzhanelidze Research Institute of Emergency Medicine. In these settings, patients with acute non-traumatic vertebral pathology were admitted to a neurosurgical department at the closest medical institution where emergency care was provided by neurosurgeons who mostly had no sufficient training and practical experience in the field of spinal surgery. As to the logistic support, only two of these hospitals had enough special equipment and instrumentation. Other medical institutions had fewer facilities.

In 2010, following a reform on the specialized medical care delivery to patients with urgent surgical spinal pathology, the specialized St. Petersburg Center for Emergency Spinal Surgery (SPCESS) was created on the basis of the I.I. Dzhanelidze Research Institute of Emergency Medicine. The center works on a 24-h schedule and offers a complete range of necessary diagnostic and therapeutic procedures and emergency specialized medical care for patients with traumatic and non-traumatic spinal injuries. This type of medical care was supported with government funding within the federal or regional quotas for high-tech medical care, as well as by the obligatory medical insurance scheme, including high-tech medical care (OMI-HT funds). In addition, a chief external expert in spine surgery was recruited and the organizational structure of medical care delivery to patients with emergency surgical spinal pathology was approved by law on the territory of St. Petersburg.

The accumulated experience of this system operation was the basis for this study.

The aim of the study was a comparative evaluation of the effectiveness of a centralized system of specialized medical care for patients with acute non-traumatic spinal pathology in the modern metropolis.

Material and Methods

The outcomes of treating 1336 patients with acute spinal pathology of degenerative, tumorous metastatic, and infectious nature have been analyzed. All patients were divided into two gender and age matched groups. The control group (decentralized system of specialized medical care) included 471 patients treated in neurosurgical departments of St. Petersburg medical institutions during 2009. The study group (centralized medical care) included 865 patients treated in SPCESS in 2010–2015.

Degenerative spinal diseases were present in 394 (83.7 %) patients, tumorous metastatic diseases – in 39 (8.3 %), and infectious diseases – in 38 (8.1 %) in the control group. The numbers of patients with these types of spinal pathology were 474 (54.8 %), 183 (21.2 %), and 208 (24.0 %), respectively, in the study group.

The effectiveness of specialized medical care delivery to these patients was evaluated using a complex approach, which included an analysis of several medical statistical and clinical indicators. The treatment outcomes for patients were assessed according to the assessment scales and parameters relevant to each of the three types of non-traumatic spinal pathology. Patients with degenerative and infectious diseases were evaluated using the ODI scale (Oswestry Disability Index) version 2.1a [1] and the modified Macnab scale. In patients with tumorous metastatic genesis, we used the numerical rating scale (NRS) for the assessment of pain intensity, the Karnofsky scale for the assessment of general performance status, and the Frenkel grading system to classify the extent of neurological deficits into grades.

Statistical processing of the study results was performed using the Microsoft Excel and Statistica for Windows 6.0 software packages. The normality of dataset distribution was assessed using the Shapiro – Wilk test. The trait distribution was regarded as non-normal at a value of the false rejection of the null hypothesis $p < 0.05$. The indicators characterizing the treatment outcomes of patients in both groups and performance indicators of hospitals providing specialized medical care were compared using an ordinary Pearson's chi-squared test, Yates-corrected chi-square statistics, and one-tailed and two-tailed Fisher's exact tests. The exact probability of the false rejection of the null hypothesis (p) was indicated in description of the results. The differences were considered significant at value $p < 0.05$.

Results

The level of surgical activity increased in total by 4.0 times ($p = 0.0001$) in patients with acute non-traumatic spinal pathology in a specialized center for emergency surgery. The level of surgical activity increased to the greatest extent for patients with degenerative diseases (by 9.4 times; $p = 0.0001$; Fig. 1). The level of surgical activity increased to a much lesser extent in patients with tumorous and infectious diseases, but the increase was statistically significant compared to the control group (by 0.7 times; $p = 0.0019$ and 1.3 times; $p = 0.0028$, respectively).

The total rate of surgical spinal stabilization was 2.2 times greater ($p = 0.0001$) among the operated patients of the study group than in the control group. Its maximum increase (by 6.4 times; $p = 0.0001$) was characteristic for the patients with degenerative diseases. In patients with tumorous diseases, the value of this indicator increased by 1.8 times ($p = 0.0001$) and infectious – by 2.7 times ($p = 0.0001$; Fig. 2).

A comparative analysis of medical statistical indicators of treating patients with acute non-traumatic spinal pathology showed that medical care in a specialized center was associated with reduced length of stay in hospital (Fig. 3). Hospital stay reduced to the greatest extent for patients with degenerative (by 3.7 days; $p = 0.0341$) and infectious (by 3.8 days; $p = 0.0097$) diseases. The length of hospital treatment reduced insignificantly in patients with tumorous diseases (by 0.2 days; $p = 0.6749$). In terms of this aspect, it is necessary to admit that almost all patients were discharged from SPCESS with incompletely healed operative wounds. However, taking into account the high anatomic functional outcomes of treatment this tactics of postoperative care should be considered reasonable.

An evaluation of the dynamics of changes in the quality of life of patients with acute degenerative spinal diseases, postoperative using the ODI scale revealed slightly better outcomes in the control group one month after surgery than in the study group ($p = 0.1338$; Fig. 4). In our opinion, this is largely related to the smaller extent and less traumatic character of operations performed in the city multidisciplinary hospitals (the prevalence of discectomy in this group with sporadic cases of surgical spinal stabilization). In the study group, the rate of spinal stabilization operations was higher; the lower outcome is logically associated with a limited rehabilitation period after such interventions. Three months after surgery the quality of life in the control group patients remained at the same level and improved significantly ($p = 0.0368$) in the study group patients. In 6 months, these differences remained significant ($p = 0.0041$), this trend continued over the entire follow-up period (in 12 months, $p = 0.0038$; in 18 months, $p = 0.0069$; in 24 months, $p = 0.0073$).

Comparison of treatment outcomes using the modified Macnab scale 24 months after surgery showed that the total proportion of good and perfect outcomes (93.2 %) was significantly higher ($p = 0.0097$) in the study group than in the control group (71.4 %; Fig. 5).

In patients with tumorous spinal diseases in both groups the surgical treatment favored to alleviation of pain syndrome intensity (Fig. 6). However, the extent of this alleviation was significantly

higher in the study group at each stage of questionnaire survey than in the control group (p = 0.0001 for all times of control examinations).

The quality of life of patients according to the Karnofsky scale was significantly lower in the control group over the entire follow-up period (in 1 month, p = 0.0003; in 3 months, p = 0.0001; in 6 months, p = 0.0001; in 12 months, p = 0.0008; Fig. 7).

A comparative analysis of surgical outcomes in relation to the correction of neurological deficits showed that the proportion of patients with mild neurological deficits (D and E levels on the Frenkel scale) was 37.9 % postoperatively in the control group and 71.5 % – in the study group (p = 0.0231; Fig. 8).

The control group patients with acute infectious spinal diseases were characterized by a high recurrence rate of local infectious process in the first year after surgery (34.6 %) compared to the study group patients (4.1 %; p = 0.0013). The quality of life of patients in the control group was worse than in the study group patients (in 12 months, p = 0.0024; in 18 months, p = 0.0013; in 24 months, p = 0.0036) and also gradually deteriorated in the second year of follow-up (Fig. 9). These significant differences were also associated with the worst outcomes on the modified Macnab questionnaire: the total proportion of patients with perfect and good outcomes was 57.2 % in the control group and 92.9 % – in the study group (p = 0.0025; Fig. 10).

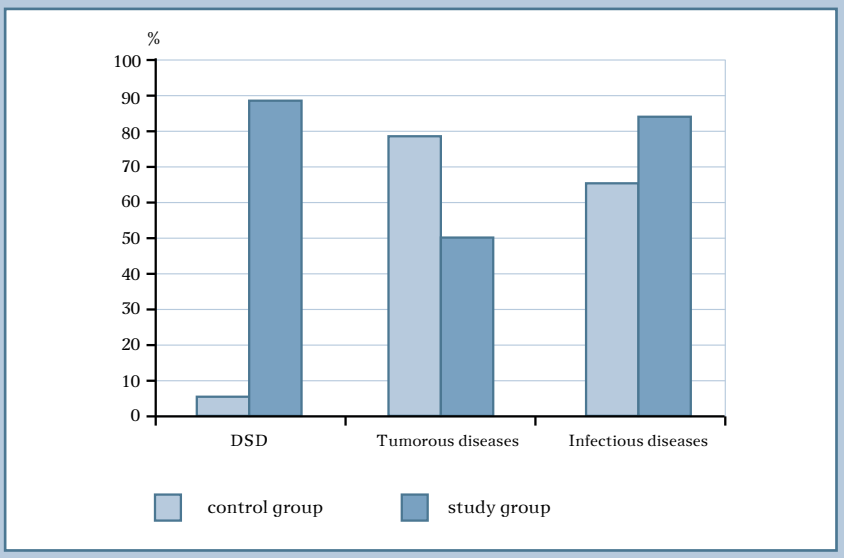

Fig. 1
Surgical activity in patients with acute non-traumatic spinal pathology: DSD – degenerative spine diseases

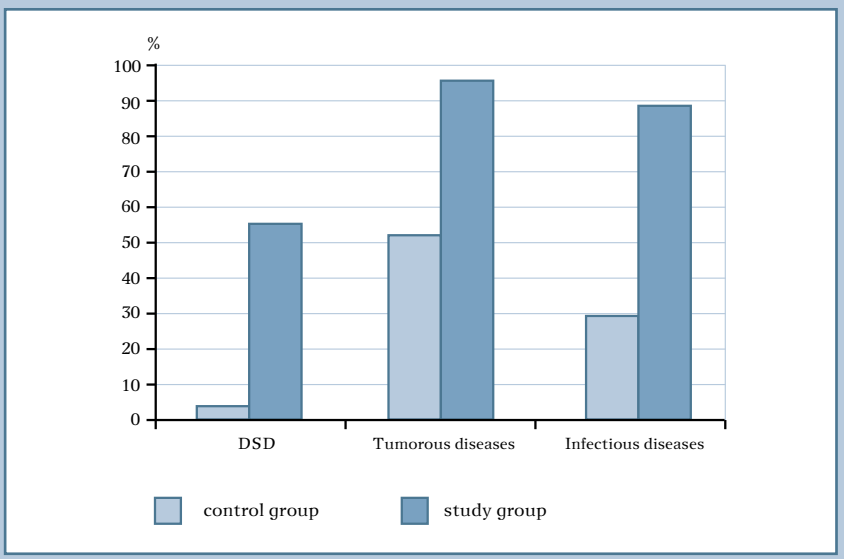

Fig. 2
The rate of surgical stabilization surgery among the operated patients: DSD – degenerative spine diseases

Discussion

It is necessary to note when analyzing the treatment outcomes of patients with acute non-traumatic spinal pathology in a decentralized system of specialized medical care that in most cases the outcomes were found to be quite unfavorable, regardless of the type of pathology.

Thus, in degenerative diseases the major reason for such outcomes was an unreasonable restriction of the extent of primary operations generally performed using discectomy. This situation could be caused by organizational limitations and logistics drawbacks in the treatment process as well as by frequent ignorance of orthopedic and some neurosurgical principles when treating such patients concerning the elimination of segment instability, identification of compression and decompression of all types of the neural elements, spinal column shape and balance restoration.

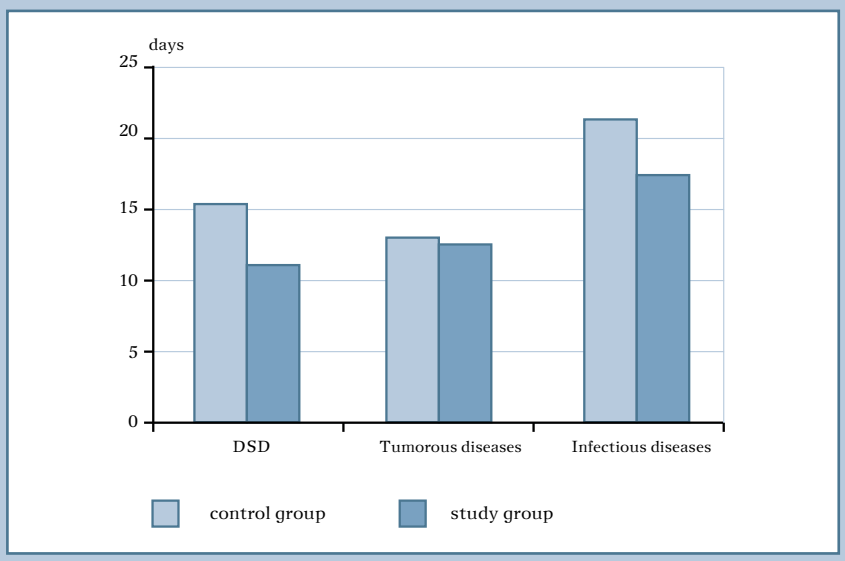

Fig. 3
An average bed day in patients with acute non-traumatic spinal pathology: DSD – degenerative spine diseases

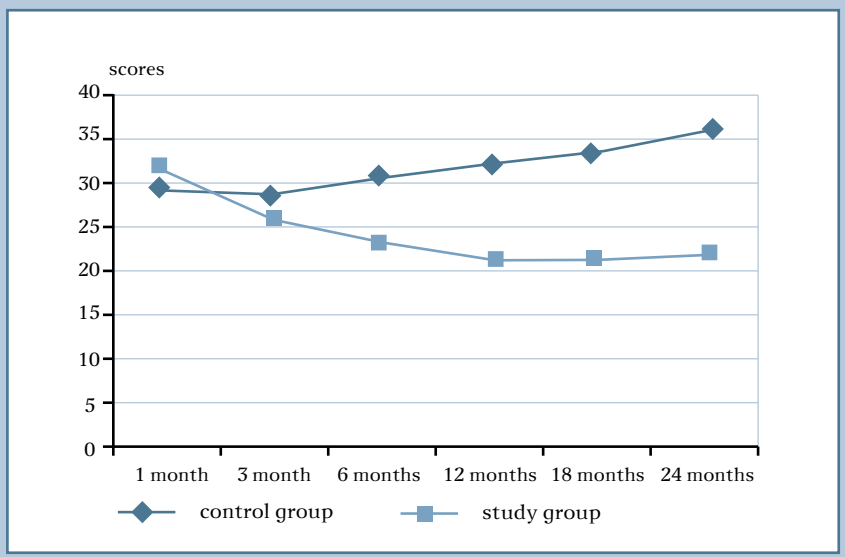

Fig. 4
Dynamics of changes in the quality of life of patients with acute degenerative spine diseases after surgical treatment according to the ODI scale, median and scores are used

In tumorous spinal diseases two major groups of factors can lead to unfavorable outcomes. On the one hand, insufficient attention to the orthopedic and tumorous constituents in the treatment (biopsy and tumor resection, the replacement of vertebral body defects, spinal column shape and balance restoration, application of biomechanically suitable internal fixators). On the other hand, an increase in the length of preoperative period which appears unreasonable and unacceptable for patients with pathological vertebral fractures associated with destructions by the tumor, especially in situations with persisting adverse neurological status after surgical treatment.

In acute infectious spinal diseases, which are indications for surgical treatment, the leading cause of adverse outcomes was an unreasonable decrease in the extent of operations with refusal of adequate debridement, bone grafting, and surgical stabilization of the injured region of the spine.

Thus, in the setting of a metropolis, the main disadvantage associated with a decentralized system of specialized medical care delivery to patients with acute non-traumatic spinal diseases is that many constituent neurosurgery departments of the city multidisciplinary hospitals of emergency care within the decentralized system fail to provide an up-to-date level of patient care. Any of these medical institutions have a quite small annual number of patients admitted with this pathology, a low level of surgical activity, long-term hospital stay, insufficient facilities in operating units, very low funding to ensure full medical assistance, as well as healthcare specialists have no well-reasoned views and approaches to selecting diagnostic and therapeutic tactics. The effectiveness of a decentralized system is insufficient to achieve favorable anatomical functional treatment outcomes in patients of these categories.

The study results showed that the centralization of specialized medical care and well-reasoned choice of diagnostic tactics and tactics of emergency treatment appear the most important conditions for high effectiveness of treatment process and favorable treatment outcomes in patients with acute non-traumatic spinal pathology in the settings of the modern metropolis.

The centralization of specialized medical care refers to the concentration of field-specific patients, highly qualified dedicated specialists, equipment, implants and other consumables for spinal surgery, including relevant funding

volumes, in individual multidisciplinary hospitals of emergency medical care. Moreover, for appropriate formation and distribution of the arriving stream of patients with acute non-traumatic spinal pathology, alongside the principle of territory-based healthcare provision in a hospital, it is necessary to follow the syndrome-based principle of medical patient sorting by ambulance crews. A critical moment of such sorting is the presence of acutely developing pain syndrome and/or syndrome of complete or partial impaired conduction in the spinal cord or cauda equina roots.

In the settings of metropolis in Russia, it will be optimal to concentrate patients with acute vertebral pathology in two or three multidisciplinary hospitals that have modern diagnostic and therapeutic facilities, available around the clock and able to admit, examine and perform early complete surgical treatment, including a wide range of new surgical procedures on the spine and neural elements. The most important criteria for selecting such hospitals is access for ground transport associated with natural and anthropogenic factors specific to each city; the widest area of competence of the hospital in terms of providing all kinds of emergency specialized medical care in various therapeutic and surgical pathologies; current facilities in a medical institution; the experience of spinal surgery, which is indirectly graded with indicators of surgical activity and outcomes. Additionally, taking into account the typical organization and staffing structure of multidisciplinary hospitals of emergency care in metropolis it is reasonable at the initial stage to separate field-specific sites in trauma orthopedic and neurosurgical departments in order to create functional units specializing in the field of surgical vertebrology.

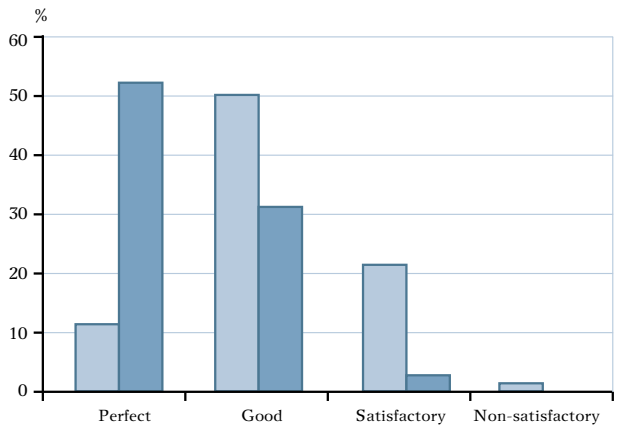

Fig. 5
The outcomes of treating patients with acute degenerative spine diseases 24 months after the operation according to the modified Macnab scale

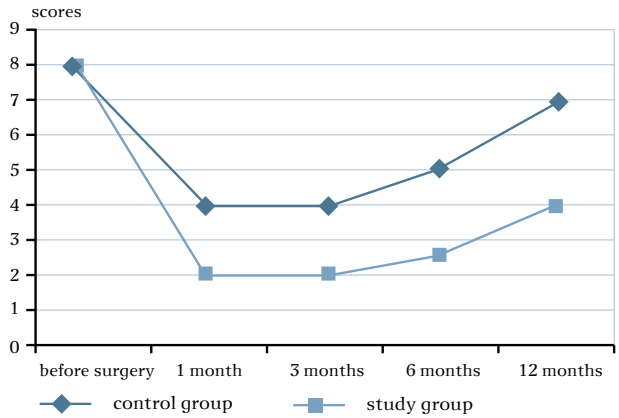

Fig. 6
Dynamics of changes in the intensity of pain syndrome in patients with tumorous spinal diseases after surgical treatment according to the numerical rating scale

Conclusion

In the settings of metropolis and rapid development of industrial centers in Russia, specialized medical care delivery to patients with acute non-traumatic spinal pathology within a centralized organizational system is advantageous over traditional treatment in neurosurgical departments of an emergency care hospital. These positive differences concern every aspect without exception. The most important issues are highly effective administration of specialized vertebrology departments or centers, effective management of human and material resources, and the high quality of medical care delivery.

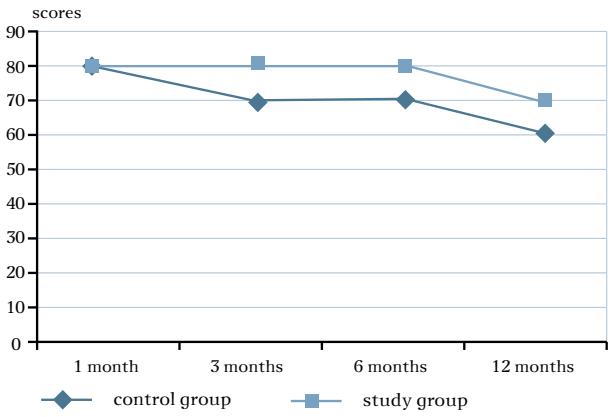

Fig. 7
Dynamics of changes in the quality of life of patients with tumorous spinal diseases after surgical treatment according to the Karnofsky scale

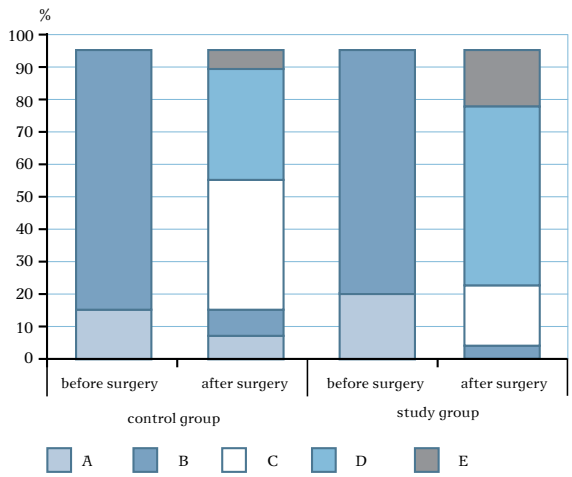

Fig. 8
Dynamics of changes in neurological status in patients with tumorous spinal diseases after surgical treatment according to the Frenkel scale

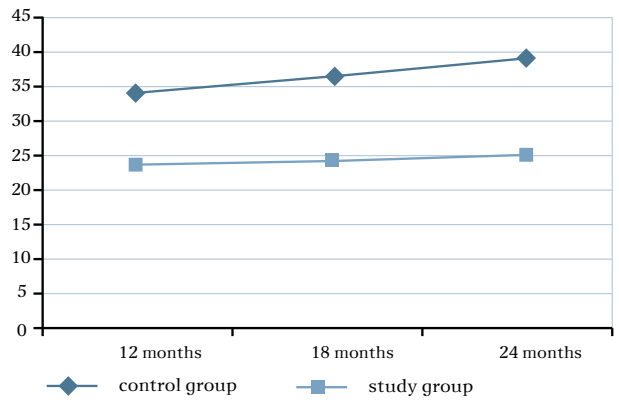

Fig. 9
Dynamics of changes in the quality of life of patients with acute infectious spinal diseases after surgical treatment according to the ODI scale

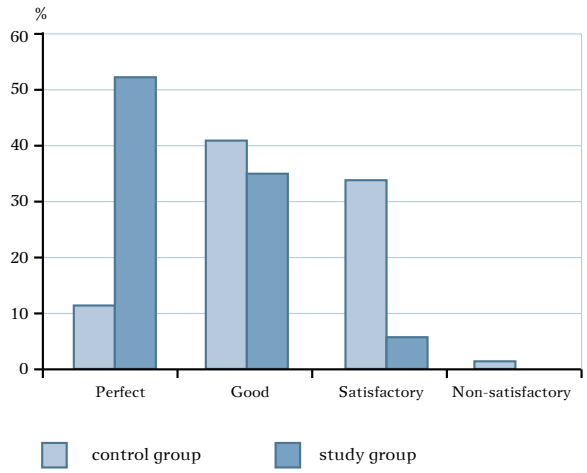

Fig. 10
The treatment outcomes of patients with acute infectious spinal diseases 24 months after surgery according to the modified Macnab scale

This study is not a sponsored research project. The authors claim that they have no competing interests.

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