REOPERATION AFTER HERNIATED DISC REMOVAL IN PATIENTS WITH LUMBAR DEGENERATIVE DISC DISEASE

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Objective. To analyze the reasons for and to evaluate the results of repeated surgery in patients with lumbar degenerative disc disease after the removal of herniated discs.
Material and Methods. The results of surgical treatment in 186 patients (mean age 48.7 years) treated between 2013 and 2014 at the Federal Center for Neurosurgery in Novosibirsk were analyzed. All patients previously underwent surgery for lumbar disc herniation in different hospitals. Primary intervention at one level was performed in 171 patients (92.0 %), and at two levels – in 15 patients (8.0 %).
Results. Progression of degeneration at the operated segment was detected in 155 patients (83.3 %). Out of them, recurrent disk herniation was diagnosed in 92 patients (49.5 %) and instability at the operated level was found in 63 patients (33.8 %). Adjacent segment degeneration was diagnosed in 31 patients (16.7 %). After surgery, positive results in pain regression were achieved in 87.1 % of cases, and unsatisfactory results with preserved pain intensity were observed in 12.9 %.
Conclusion: The main causes of reoperation after primary microdiscectomy were recurrent disc herniation and instability of the operated segment. In 16.7 % of cases, repeated surgery was performed for the adjacent segment degeneration, which must be regarded as a sequela of primary disease. The use of differential surgical treatment strategy based on the identification of the dominant clinical and neurological syndrome provides good and satisfactory results in patients undergoing reoperation after primary microdiscectomy.
Key Words: recurrent disc herniation, adjacent segment degeneration, Modic classification.

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The rate of operations for degenerative diseases among all spine surgeries has been shown to be 59.9–71.4 % [1, 16]. Of these, revision surgeries reach 10–44 % of the cases [9]. The rate of reoperations has been shown to be 5–15 % within the first two years [4, 20]. According to Hakkinen et al. [9], the rate of recurrent disc herniation at the same site as the primary herniation is about 7.4 % and the probability of herniation at a site other than of their primary location is about 3.1 %.

The purpose of this study is to analyze the reasons and evaluate the outcomes of repeated surgeries in patients with degenerative lumbar disease after herniated disc removal.

Material and Methods

A total of 186 patients, including 98 (52.7 %) males and 88 (47.3 %) females, who had undergone previously lumbar disc herniation surgery, underwent reoperations at the Spinal Department of the Federal Center of Neurosurgery in Novosibirsk in 2013–2014 (Fig. 1). The mean patients' age was 48.7 ± 11.1 years. The average body mass index (BMI) was 30.7.

The most common operated spinal segments were L4–L5 – 81 (43.5 %) and L5–S1 – in 76 (40.3 %) cases, rarer – L3–L4 – 15 (8.1 %) cases. Surgery involved two levels in 4 (2.2 %) patients and bilateral primary surgery was performed in 12 (7.6 %).

Most patients (87.1 %) reported favorable outcomes after primary surgery, with complete (100 %) regression (24 patients) or partial (80 %) regression (138 patients) of the main clinical signs. An insignificant effect or absence of the effect after surgery was noted in 24 (12.9 %) patients. The median value of a stable remission period was two years (the interquartile range from 0.7 to 6 years; Fig. 2), with complex conservative treatment over 3 months being ineffective.

A complex of essential preoperative examination included neurological status assessment, overview spondylography in frontal and lateral views, functional spondylography, HCT or HCT-myelography, MRI, and questionnaire survey.

Radiculopathy was a dominant clinical neurologic syndrome in 175 (94.1 %) cases. Radiculopathy of one rootlet was revealed in 153 (85.0 %) patients and of two or more rootlets –in 22 (11.8 %). The severity of pain syndrome was assessed by questionnaires using the VAS scale before surgery and 6 months after. The L5 (n = 106) and S1 (n = 91) rootlets were the most frequently affected, rarer –

L4 (n = 15). The syndrome of neurogenic intermittent claudication was diagnosed in 7 (3.8 %) patients, vertebral pain syndrome without radiculopathy symptoms – in 4 (2.1 %).

Vertebral-motor segment (VMS) instability was evaluated using functional spondylograms with the White and Panjabi classification [29, 30]. Instability (5 scores or greater) was identified in 67 (36.0 %) patients.

A condition of the cortical layer of vertebral endplates was assessed using MRI findings of T1-WI and T2-WI weighted magnetic resonance imaging series in the sagittal view with a slice thickness of 3–5 mm in order to determine the type of Modic changes [17]. The pathomorphological substrate that causes the disc-radicular conflict was identified on T1- and T2-weighted MR-images with a slice thickness of 1–3 mm in the sagittal, axial and coronal views.

The severity of stenosis was graded according to the classification of Schizas et al. [25] based on the content of cerebrospinal fluid, cauda equina rootlets, and epidural fat as seen on T2 axial MR-images. Grade C stenosis was revealed in 7 (3.8 %) patients.

In 124 (65.0 %) patients, spinal rootlet compression was visualized using HCT-myelography with three-dimensional or multiplanar reconstruction enabling reliable verification of the radicular conflict.

In the postoperative period, control spondylography in two views and HCT of the lumbar spine were performed in the patients who underwent stabilization surgery and MRI was performed only when radicular symptoms remained.

Catamnesis was followed in all patients with a follow-up period of 6 months. Quality of life was assessed using the Oswestry Disability Index (ODI) reflecting patient adaptation [5].

The results of clinical and diagnostic examination methods were evaluated in two groups: 155 (83.3 %) patients with a progression of degeneration at the operated segment and 31 cases (16.7 %) – with adjacent segment degeneration.

This paper describes the findings in the following format: mean ± mean-square deviation for the normal distribution of variables and the mean/median (lower and upper quartiles) for the non-normal variables. The normality of distribution was assessed using the Shapiro – Wilk test.

The groups with normal variable distribution were compared using the Student's t-test. The rest variables were compared using the Mann – Whitney or Fisher's exact tests. The findings were defined as statistically significant at p = 0.05.

The estimations were performed using the R software version 3.2.2 (gmodels package) [23].

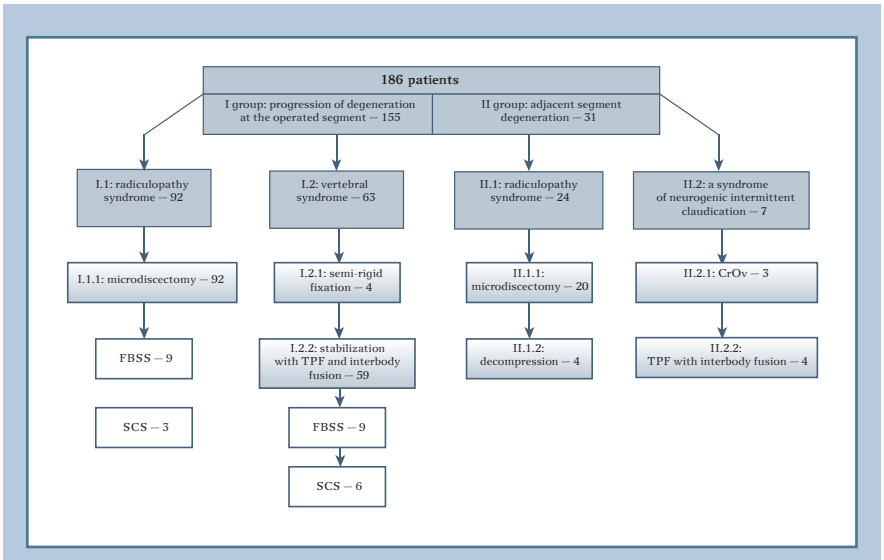

Fig. 1
Description of patients included in the study: FBSS – failed back surgery syndrome, SCS – spinal cord stimulation (a system for chronic epidural stimulation), TPF –transpedicular fixation, CrOv – crossover (two-sided decompression using a unilateral approach)

Results

The level of surgery was planned and an option of surgery was selected based on a principle of clinical morphological relevance, which states that the operation should be aimed at removing the pathological substrate, which is involved in the development of clinical symptoms.

The first group consisted of 155 patients with a progression of degeneration at the operated segment: 79 (51 %) men and 76 (49 %) women, the mean age was 47.5 ± 10.8 years, the average BMI was 30.8.

Of them, 136 (87.7 %) patients had microsurgical discectomy as the primary operation and 19 (12.3 %) underwent discectomy with an addition of an interspinal fixation system.

Radiculopathy was a dominant clinical neurologic syndrome in 92 cases (59.3 %). Ten patients (6.3 %) developed recurrent disc herniation in a period of up to 6 months after the primary surgery and 82 (91.8 %) patients – later than 6 months. The average VAS scale value for leg pain before surgery was 8.0/8.0 (7; 9) and for back pain – 5.7/6.0 (4; 7) scores. The quality of life measured by ODI was 60.7/63.0 (49.5; 68.0) in this group.

During an examination, White and Panjabi scoring of less than 5 scores was noted in all patients of this group. Modic I type changes were revealed in 28 (30.4 %) and Modic II – 12 (13.0 %) cases.

An indication for reoperation was radiculopathy signs.

Surgery in this group of patients was aimed at eliminating compression of

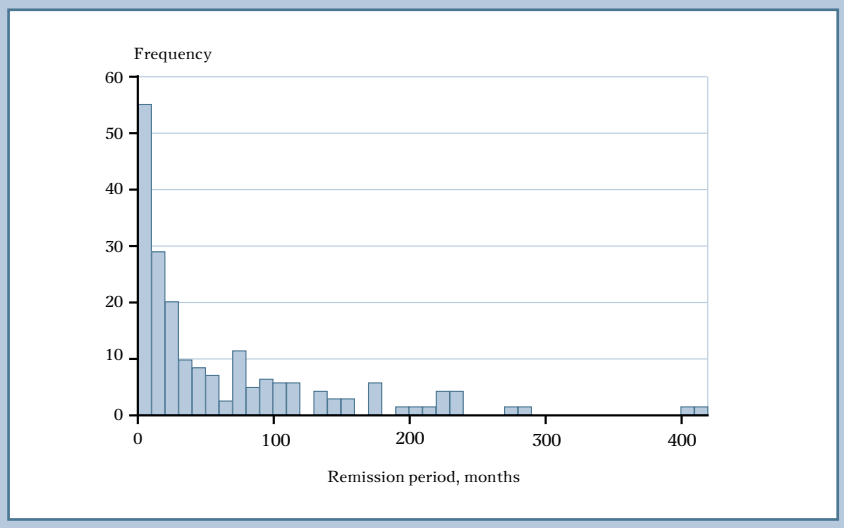

Рис. 2
Histogram of the long-term remission period

the neurovascular structures occurred because of recurrent disc herniation. A bed-day was 6.8/5.0 (4; 7).

After 6 months, the average VAS value for back pain was 3.7/3.0 (2; 5) scores, for leg pain – 2.4/2.0 (0; 3.2), ODI – 29.8/25.0 (15.8; 42.5). Regression of pain syndrome was achieved in 83 patients (90.2 %); pain syndrome in leg remained in 9 (9.8 %), with VAS – 6.2/7.0 (5; 7) scores. Compression and signs of instability were not identified using neuroimaging examination methods of the pathomorphological substrate. Patients in this group developed neuropathic drug-resistant pain syndrome. Based on the results of test epidural stimulation, a system for chronic epidural stimulation was implanted in 3 (3.3 %) cases.

Vertebral syndrome dominated in 63 (40.6 %) cases. The VAS value for back pain was 7.5/8.0 (7; 8) scores. Of these, 59 patients reported radiculopathy, VAS for leg pain – 7.8/8.0 (7; 9), which led to a noticeable violation of social adaptation. ODI before surgery was 66.1/64.0 (60; 71) in this group of patients.

The White and Panjabi scoring of greater than 5 scores was identified in 37 patients. Modic type I – in 43 and Modic type II – in 12 patients.

In 58.7 % of cases, vertebral pain syndrome was due to instability (according to the White and Panjabi scoring) and there were Modic I and II type changes in 87.2 %, which was an indication for stabilization surgery.

Thus, in 59 (93.7 %) cases, the patients underwent decompression with removal of recurrent herniated disc and transpedicular fixation in conjunction with interbody fusion. Semi-rigid transpedicular fixation was performed in 4 (6.3 %) patients due to absence of the pathomorphological substrate of compression, clinical and radiographic signs of segmental instability, and Modic I (n = 3) and II (n = 1) changes as well as at young age.

The bed-day number was 9.1/8 (7; 11). After 6 months, patients rated the pain at 3.4/3.0 (1; 5) VAS scores for leg pain – 3.0/3.0 (1; 4), adaptation index ODI was 33.6/34.0 (16.5; 45.0). Pain syndrome regressed in 53 (88.3 %) out of 60 patients.

In 9 (14.3 %) patients, pain syndrome was noted to remain in leg – VAS was 4.2/5.0 scores (2; 6). Neuroimaging examination methods showed absence of the pathological substrate of compression and signs of instability in these patients. In terms of neuropathic drug-resistant pain syndrome, the epidural stimulation test was performed and according to obtained results a system for chronic epidural stimulation was implanted in 6 (9.5 %) cases.

The second group consisted of 31 (16.7 %) patients: 19 (61.3 %) males and 12 (38.7 %) females with adjacent segment degeneration (ASD). The mean age of patients was 54.7 ± 11.0 years and the mean BMI was 30.2.

The morphological features of adjacent segment degeneration include disc herniation, formation of degenerative lateral and central stenosis due to yellow ligament and facet joint hypertrophy.

In 24 (77.4 %) patients, radiculopathy was a dominant clinical neurologic syndrome.

The average VAS score for leg pain before surgery was 7.6/8.0 (7; 8), for back pain – 4.8/4.0 (3; 7). ODI was 61.4/64.0 (51.0; 68.5) in this group of patients. The indication for surgery was the disc-radicular conflict, which occurred because of recurrent disc herniation in 20 (64.5 %) patients and lateral stenosis – in 4 (12.9 %).

The White and Panjabi scoring of less than 5 scores was noted in all patients of this group. Modic type I changes – 3 (10.3 %) cases, Modic II – 3 (10.3 %).

An above level to the primary operated was affected in 15 (48.4 %) patients and a level below the primary operation site – 9 (29.0 %).

Surgery in the patients of this group was aimed to eliminate compression of the neurovascular structures occurred because of disc herniation and lateral stenosis caused by facet joint hypertrophy. The bed-day number was 6.3/6.0 (4; 9).

The VAS value after 6 months for back pain was 3.0/2.0 (1; 5), for leg pain – 2.1/2.0 (1; 2.2), ODI – 27.2/24.0 (17.5; 36.5). Regression of pain syndrome was achieved in 23 (95.8 %) patients, pain syndrome was noted to remain in leg in 1 (4.2 %) case: VAS score was 6.

Symptoms of neurogenic intermittent claudication were observed in 7 (22.6 %) patients in this group, 3 (9.6 %) patients had a combination of neurogenic intermittent claudication with radicular syndrome. VAS value for leg pain before the

operation changed from 7 to 8, for back pain – from 1 to 4 scores; ODI – from 44 to 64. An above level to the primary operation site was affected in 100.0 % cases.

An indication for surgery was developed central stenosis because of facet joint and yellow ligament hypertrophy.

The White and Panjabi value of less than 5 scores was observed in all patients, there were no Modic changes. Stenosis grade C according to the classification by Schizas was revealed in all patients.

Compression of the neurovascular structures was eliminated by bilateral decompression using a unilateral approach. The bed-day number varied from 3 to 7.

After 6 months, VAS value for back pain changed from 2 to 4 scores, for leg pain – from 1 to 3 scores, ODI – from 12 to 36. Regression of pain syndrome was achieved in 100.0 % of cases.

In 4 (12.9 %) cases, signs of intermittent neurogenic claudication were accompanied by a marked vertebral pain syndrome. The VAS value for back pain before surgery was 7.8/7.5 (6.8; 8.5), for leg pain – 5.8/5.5 (5.0; 6.2) scores. ODI was 75.8/74.5 (70.2; 80.0) in this group. An above level to the primary operated site was affected in 100.0 % of cases.

The White and Panjabi value of greater than 5 scores was detected in 4 (12.9 %) patients. Modic type I changes were observed in 2 (6.4 %) cases, Modic II – in 1 (3.2 %). Stenosis grade C based on the classification of Schizas was observed in 4 (12.9 %) patients.

Four (12.9 %) patients required transpedicular fixation in conjunction with interbody fusion because of developed instability. The bed-day number was 11/10 (9; 12). After 6 months, average VAS value for back pain was 3.2/3.0 (2.2; 4.0) scores, for leg pain – 2.8/2.5 (1.8; 3.5), ODI – 38.2/37.5 (21.5; 54.2).

Regression of pain syndrome was achieved in 3 (9.6 %) patients. In 1 (3.1 %) case, back pain with a VAS score of 7 remained, ODI – 64. During the examinations, no failed metallic fixation and substrate were revealed in order to perform revision surgery.

Among 186 operations, the most significant intraoperative complication was an injury to the dural sac in 9 (4.7 %) patients as well as postoperative hematomas with clinical sings that required surgical wound revision in 5 (2.6 %) patients.

Table and Fig. 3 show the results of comparing groups of patients according to the following criteria: age of the primary admission, a period between the primary and repeated surgery, BMI, VAS for back pain, VAS for leg pain before and after surgery, and Modic changes.

Primary surgeries in patients of groups 1 and 2 were performed at about the same age. Later, patients with a progression of degeneration at the operated segment addressed to hospital significantly earlier than patients of group 2.

Discussion

About 2/3 revision spinal surgeries were performed in a period from 4 to 11 years after the primary operation [15]. In the study group, reoperations were performed on average after 4.75 years.

According to research findings, outcomes of reoperations in patients with degenerative-dystrophic disease of the lumbar spine after herniated disc removal are contradictory. Patel et al. [22] reports that the outcomes of revision surgery and primary surgery are similar. Other authors, however, believe that revision surgery has outcomes not as good as primary microdiscectomy [6, 21].

Recurrent lumbar disc herniation is one of the most common reasons for repeated surgery, especially, within the first three years [24]. According to Swartz and Trost [26], it is diagnosed in 5–15 % of patients after primary surgery. In 2013–2014, at the Federal Center for Neurosurgery, 938 primary microdiscectomy operations were performed and repeated surgeries were performed in 23 cases (2.45 %). The real outcomes can be judged in 2–3 years.

According to various data, risk factors for recurrent disc herniation are stages of disc degeneration [2]. Other factors include a higher intervertebral disc height and sagittal range of segment motion indicating segmental instability, anamnestic data of trauma, middle age, smoking, gender and overweight [10, 11, 13, 31]. Urquhart et al. [27] have identified high BMI as a significant factor predicting relapse. In our study, BMI was almost similar in both groups – 30.7/30.0 (27.0; 34.1), which is significantly higher than the normal values.

Based on literature data, the common reasons for reoperations include a syndrome of adjacent disc injury, spinal canal restenosis, spondylolisthesis and degenerative scoliosis [15].

Adjacent segment degeneration develops within two years in 5.6% of patients after surgery and over the next two years – in 45.0 %. This syndrome is not always evident clinically. In most cases it is revealed by radiography [12].

Adjacent segment degeneration is the natural process for a patient with disc degeneration. Surgical interference triggers or accelerates the process but does not cause it and that is why dynamic stabilization aids in diminishing the probability of transitional syndrome, slows the process but does not eliminate it [12]. The progression of adjacent segment degeneration can be considered as a part of the normal aging process and spinal degeneration, but generally this process is potentiated by interferences on the lumbar spine [8].

Patient groups differ statistically significantly in terms of such parameters as age, length between the primary and repeated surgery. There were no statistically significant differences as to the age of the primary surgery in both groups (group 1 – 43.7 ± 11.1 years, group 2 – 45.3 ± 10.4 years).

Subsequently, patients with a progression of degeneration at the operated segment addressed to hospital much earlier for repeated surgery than patients in group 2.

Thus, the time interval between the primary and repeated surgeries was statistically significantly less in patients of group 1 (Table) and can indicate adjacent disc degeneration as an independent process.

The risk factors also include Modic I and II type changes [17, 18]. In particular, Modic MRI signal is an indirect sign of biomechanical segment failure [25]. In the group of patients under study, Modic

type I changes were identified in 40.9 % of cases, Modic II – in 15.1 %, Modic type III changes were not observed; Modic changes were absent in 38.37 % of patients (Fig. 3b).

Creation of conditions for bone block formation is necessary in the case of segmental instability or foraminal stenosis resulting from narrowing of disc space [14].

Osterman et al. [19] studied 35 309 patients from the national registry of Finland in 1987–1998, who underwent initial microdiscectomy. In the result, 14.0 % (4 943) patients had one reoperation and 2.3 % (803) had two or more reoperations [19]. Based on this, revision surgeries involved microdiscectomy in 63 % of cases, decompressions in relation to stenosis – in 23 %, and fusion – 14 % [19]. According to our data, the percentage of stabilization surgery in group 1 was 40.6 % (63 patients), including the use of semi-rigid fixation system in 2.6 % (4 patients) of the cases.

According to Glenn et al. [7], an addition of fusion to discectomy should be considered after the third episode of disc relapse. In our study, there are 6 patients with the third episode, 1 – with the fourth episode of revision surgery. All patients underwent transpedicular fixation in conjunction with interbody fusion.

The outcomes after revision surgery are generally less favorable compared to primary operations and with each further interference results in the reduction of success rates [28]. Revision surgery in patients with recurrent disc herniation involves a high risk of complications and lower success probability [7]. Thus, in the study group, reoperations were ineffective in 24 (12.9 %) patients and based on the results of test epidural stimulation, a system for chronic epidural stimulation was implanted in 9 (4.8 %) cases.

The most common complications of revision microdiscectomy are dural tear and nerve root injury because of adhesion scars and granulation tissue [13]. According to Palma et al. [21] dural tear during revision surgery occurs in 4.2 % of cases on average while during primary discectomy – 0.9 %. In our study, dura mater injury was observed in 9 (4.8 %) patients.

An analysis of surgical outcomes for patients of both groups using VAS scoring (back pain, leg pain) has shown that there were no statistical differences, thus the outcomes of treatment can be considered similar.

Conclusions

1. The reasons for reoperations in patients after primary microdiscectomy were recurrent disc herniation – in 92 (49.5 %) cases, instability at the operated segment – in 63 (33.8 %).

2. In 16.7 % of cases of repeated surgery, the reason for reoperation was adjacent disc degeneration, which must be regarded as a sequela of primary disease, but not than adjacent segment disease.

3. Application of differentiated surgical tactics of treating patients after primary microdiscectomy based on a dominant clinical neurologic syndrome provides good and satisfactory outcomes of treatment in 87.1 % of cases; 12.9 % of unsatisfactory outcomes were associated with the occurrence of chronic drug-resistant neuropathic pain syndrome. Of these, in 5.8 % of cases, implanted systems for chronic epidural stimulation can relieve pain syndrome.

4. BMI is a predictor of recurrent disc herniation and an adverse prognostic factor for adjacent segment degeneration.

Table

Results of group comparison

Parameter	Group 1	Group 2	Comparison
Number of patients, n	155	31	–
Age at the primary operation, years*	43.7 ± 11.1	45.3 ± 10.4	No statistically significant differences (p = 0.45)
Time between admissions, months**	45.9/20.0 (8; 61)	113.4/96.0 (36; 168)	p < 0.0001
BMI**	30.8/30.0 (27,0; 34,9)	30.2/30.1 (28,1; 32,4)	No statistically significant differences (p = 0.93)
VAS for back pain before surgery**	6.4/7.0 (5; 8)	5.0/4.0 (3; 7)	p = 0.003
VAS for leg pain before surgery**	7.8/8.0 (7; 9)	7.4/8.0 (7; 8)	No statistically significant differences (p = 0.07)
Modic changes (absence, I, II), %	38; 46; 16	71; 16; 13	p = 0.002
VAS for back pain after surgery**	3.6/3.0 (1.5; 5.0)	3.1/3.0 (1.0; 4.5)	No statistically significant differences (p = 0.24)
VAS for leg pain after surgery**	2.7/2.0 (1; 4)	2.2/2.0 (1; 3)	No statistically significant differences (p = 0.61)

*mean ± mean-square deviation.

**mean/median (lower quartile; upper quartile).

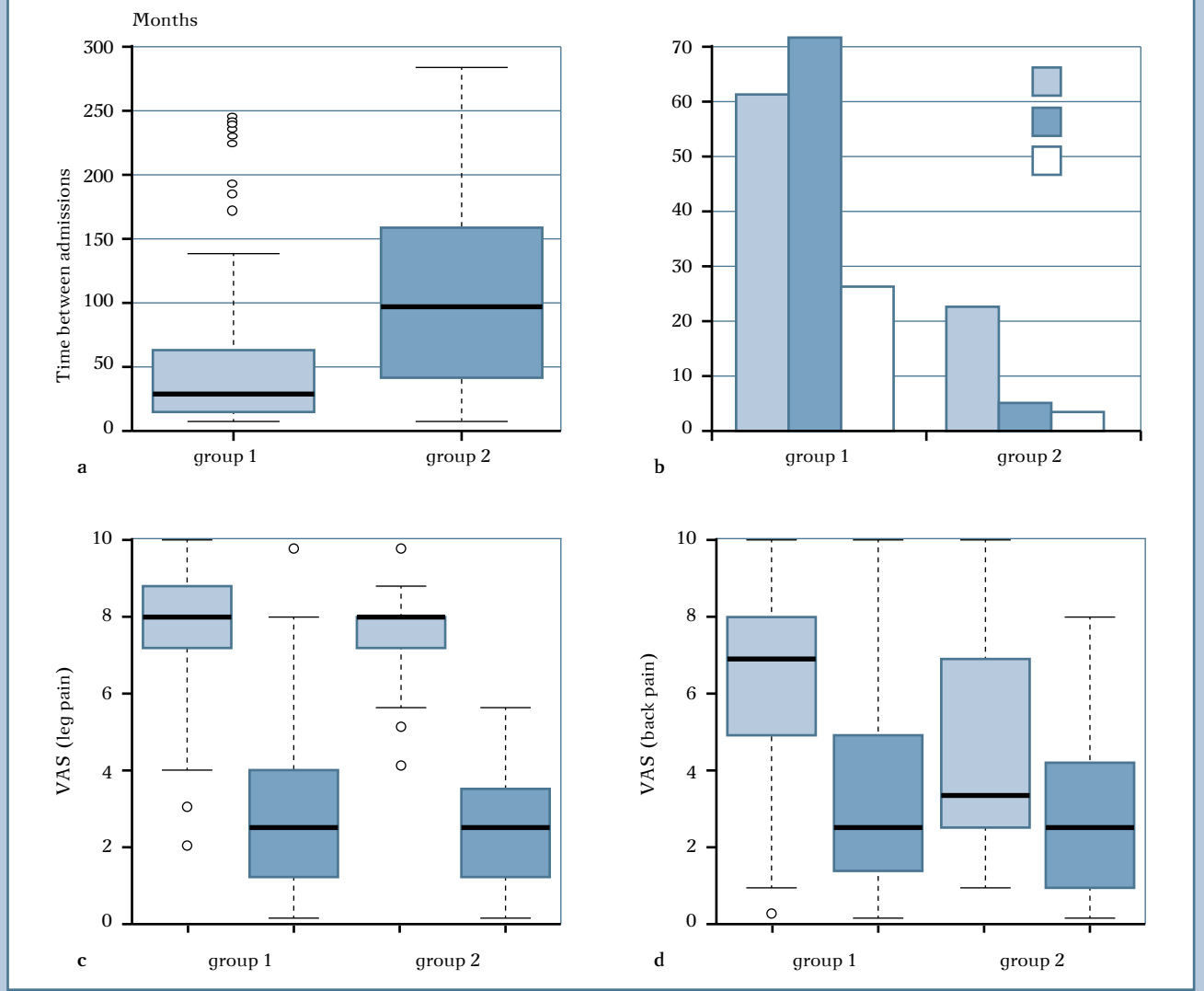

Рис. 3
Results of graphical comparison of the patients groups 1 and 2: **a** – time between admissions, months; the data are not given for two patients with admission times of 408 and 420 months; **b** – patient distribution according to Modic changes; **c** – VAS ranges (leg pain); **d** – VAS ranges (back pain)

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