EVALUATION OF THE EFFECTIVENESS OF SURGICAL METHODS FOR THE TREATMENT OF RECURRENT LUMBAR DISC HERNIATION: A COHORT RETROSPECTIVE STUDY

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Objective. To compare the effectiveness of surgical methods for treating patients with recurrent lumbar disc herniation.

Material and Methods. The sample consisted of 160 patients operated on in 2014—2019 for recurrent lumbar disc herniation by percutaneous endoscopic discectomy (Group 1), microsurgical discectomy (Group 2), single-level transforaminal interbody fusion (Group 3) and single-level total intervertebral disc replacement (Group 4). The effectiveness of surgical treatment was evaluated using the NRS-11, ODI, and MacNab questionnaires.

Results. Assessment of the pain syndrome severity and the vital activity level of patients revealed significant ($p < 0.05$) differences in favor of total intervertebral disc replacement. Excellent and good outcomes after arthroplasty according to MacNab criteria were noted in all patients in this group. Similar outcomes were reported in 77.5 % (31/40) of patients in the TLIF group, in 75.1 % (24/32) of patients in the percutaneous endoscopic discectomy group and in 72.6 % (45/62) of patients in the microdiscectomy group. The operation time and length of hospital stay were shorter in the endoscopic and microsurgical discectomy groups ($p < 0.001$). However, the lower incidence of complications and reoperations was observed in groups of posterior interbody fusion and arthroplasty ($p > 0.05$).

Conclusion. Arthroplasty with the M6-L implant expands the possibilities of surgery for recurrent lumbar disc herniation. Total intervertebral disc replacement and posterior interbody fusion for recurrent lumbar disc herniation are more effective in comparison with decompressive operations, which is reflected in the improvement of clinical treatment outcomes, reduction of perioperative complications and frequency of repeated interventions.

Key Words: recurrent lumbar disc herniation, full-endoscopic lumbar discectomy, microdiscectomy, transforaminal lumbar interbody fusion, total disc replacement, arthroplasty.

Please cite this paper as: *Kravtsov MN, Kruglov IA, Mirzametov SD, Seleznev AS, Alekseyeva NP, Manukovskiy VA, Gaidar BV, Svistov DV. Evaluation of the effectiveness of surgical methods for the treatment of recurrent lumbar disc herniation: a cohort retrospective study. Hir. Pozvonoc. 2021;18(2):34—43. In Russian. DOI: http://dx.doi.org/10.14531/ss2021.2.34-43.*

Despite the continued efforts to improve the methods of lumbar discectomy, it is impossible to fully prevent the development of a recurrent lumbar disc herniation [1]. The recurrent lubmar disc herniations occur in 2.0–27.3 % of cases [2–4]. Their part in the composition of the postdiscectomy syndrome ranges from 16.0 to 76.8 % [2, 5, 6]. The greatest number of recurrent pain syndromes resulting from the recurrent herniation occurs in 2.5–4.3 years after the procedure [2, 5, 6]. Approximately 20 % of patients operated for lumbar disc herniation later need reoperations. More than half of them are performed at the previously operated level [8]. Surgical treatment for recurrent lumbar disc herniation mainly involves decompression or decompression and stabilization interventions through posterior approaches. It has been established that this approach is associated with technical difficulties due to postprocedure cicatricial changes [9]. The risk of poor outcomes of hernia recurrence surgery grows by 25 % in comparison with primary discectomy [10]. The possibility of using decompression and stabilization techniques through anterior approaches, including arthroplasty, for the recurrent degenerative process in the lumbar spine is reported in the publications. Separate studies and a series of observations indicate the advantages of this technique in ensuring a more radical lumbar discectomy, the absence of additional injury of the back muscles, the recovery of the normal interbody height and the

range of motion in the spinal motion segment, as well as a positive effect on the sagittal balance of the trunk [11–16].

The purpose of the study is to compare the effectiveness of various surgical treatment techniques in patients with recurrent lumbar disc herniation.

Study design: cohort and retrospective.

Inclusion criteria: recurrent lumbar disc herniation at the levels of L3–S1. It was confirmed by MRI as well as by a neurological deficit or an intractable pain during four weeks of conservative treatment.

Exclusion criteria: hernias above the level of L3–L4, multilevel secondary hernias, spinal stenosis, spondylolisthesis, instability, spinal deformity, chronic neuropathic pain, inflammatory conditions, and severe medical comorbidity.

Material and Methods

A total of 160 patients with recurrent lumbar disc herniation were operated on at the following hospitals: Neurosurgery Hospital of the Kirov Military Medical Academy, I.I. Dzhanelidze Research Institute of Emergency Medicine (St. Petersburg) and Military Clinical Hospital No. 1586 (Podolsk, Moscow Region). All the procedures were performed in 2014–2019. The intergroup distribution was based on the methods of surgical treatment: Group 1 – percutaneous endoscopic discectomy (n = 32); Group 2 – microdiscectomy (n = 62); Group 3 – posterior interbody fusion by the TLIF method (n = 40); and Group 4 – arthroplasty with the Spinal Kinetics M6-L implant (TDR – total disc replacement; n = 26). Follow-up period: from 12 to 68 months (Me = 20.0; IQR: 13.5–29.0). The intergroup differences in the evaluation time of surgical treatment outcomes were statistically insignificant (p = 0.42; Kruskal – Wallis test).

The treatment outcomes were analyzed using commonly known evaluation tools (NRS-11, ODI, MacNab). We used statistical data processing software: IBM SPSS Statistics Version 23 and R Version 3.5.0. Statistical hypotheses were verified using nonparametric criteria and analysis methods. The results were considered statistically significant at $p < 0.05$. We used multiple regression and a general linear model (Analysis of covariance (ANCOVA)) to determine the significant influence of various factors. A written voluntary informed consent was given by all the patients involved in the study. The study was carried out according to the requirements of the Helsinki Declaration of the World Medical Association (as amended in 2013).

Surgical technique. The percutaneous endoscopic discectomy was performed in Group 1 with SpineTip – KarlStorz and Tessys – Joimax® instrumentation and equipment. Transforaminal endoscopic approaches were used in 15 patients. The technique helped to perform a safe approach to a recurrent lumbar disc herniation, bypassing the area of cicatricial changes, as well as interspinous stabilizers after the original surgeries (Fig. 1). In the remaining cases, inter- and translaminar approaches were used.

In Group 2, the Caspar microdiscectomy was performed through the posterior approach. In Group 3, transforaminal lumbar interbody fusion with cage with transpedicular fixation was carried out using open or minimally invasive technique. In Group 4, the anterior discectomy and intervertebral disc replacement with the M6-L implant were done from a left-sided retroperitoneal approach using special retractors (Fig. 2).

Results

The main features of the study groups are given in Table 1. Significant intergroup differences were observed in the age of patients and in the number of surgeries performed previously. The patients of Group 4 were rather younger as specified by the guidelines for the arthroplasty [17, 18]. In the TLIF and TDR groups, 80 and 31 % of patients, respectively, had a history of 2–3 discectomies at the concerned level.

The time of recurrent lumbar disc herniation onset after the first discectomy was evaluated in 79.4 % (127/160) of patients included in the studied sample. The values of this indicator varied between 0.5 and 312.0 months. Moreover, 50 % of recurrences happened in less than a year (Me =11.0 mon.; IQR: 4.0–45.0 mon.). There were no statistically significant differences between the timing of the first recurrence in the considered groups (p = 0.61; Kruskal – Wallis test). The timing of the second recurrence after discectomy was investigated in 26 patients in the TLIF and TDR groups. The median time of repeated recurrences was 18.5 mon. (IQR: 8.0–36.0 mon.). The identified differences in the time of the first and second recurrences of lumbar disc herniations were statistically insignificant (p = 0.23; Mann – Whitney U test).

The surgical findings of lumbar disc herniations are presented in Table 2.

It was not available to evaluate the amount of peroperative blood loss retrospectively due to information gap. There were no significant inter-group differences in the incidence of complications and reoperations (Table 3).

The lowest pain index in the back and lower extremities (Fig. 3) were observed in patients who underwent anterior discectomy with subsequent intervertebral disc replacement (p < 0.01; Kruskal – Wallis test).

The identified intergroup differences in life quality indicators were statistically significant: p < 0.001, Kruskal – Wallis test (Fig. 4).

Like in the severity assessment of the pain syndrome, the best ODI values were achieved after total intervertebral disc replacement.

The percentage of patients satisfied with the outcome of percutaneous video endoscopic removal of a recurrent lumbar disc herniation ("excellent" and "good" results according to MacNab criteria) was 75.1 % (24/32). A similar indicator in the microdisectomy group was 72.6 % (45/62), in the instrumented fusion group carried out using the TLIF method – 77.5 % (31/40). The same indicator in the microdiscectomy group was 72.6 % (45/62); in the instrumented fusion group carried out by the TLIF method – 77.5 %. All individuals who underwent anterior discectomy with an intervertebral disc replacement by M6-L implant rated the result of treat-

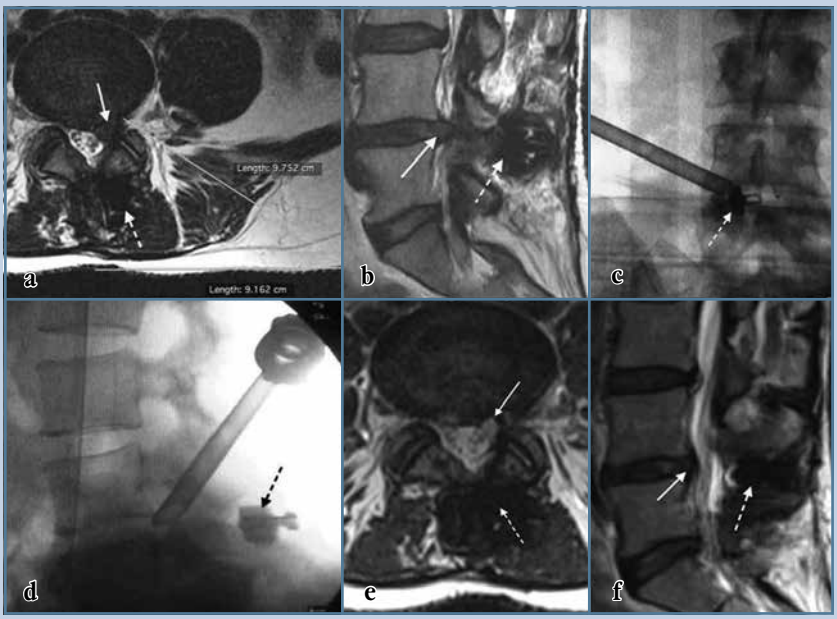

Fig. 1
Data of 46-year-old patient P: **a, b** – MRI picture of the condition after discectomy at L4–L5 level with stabilization by an interspinous implant (arrows – recurrent lumbar disc herniation; dotted arrow – interspinous implant); **c, d** – perioperative spondylography: the position of the operating cannula in the left intervertebral foramen of L4–L5; **e, f** – MRI picture 3 months after the operation (arrow – the area of hernia localization; dotted arrows – an interspinous implant)

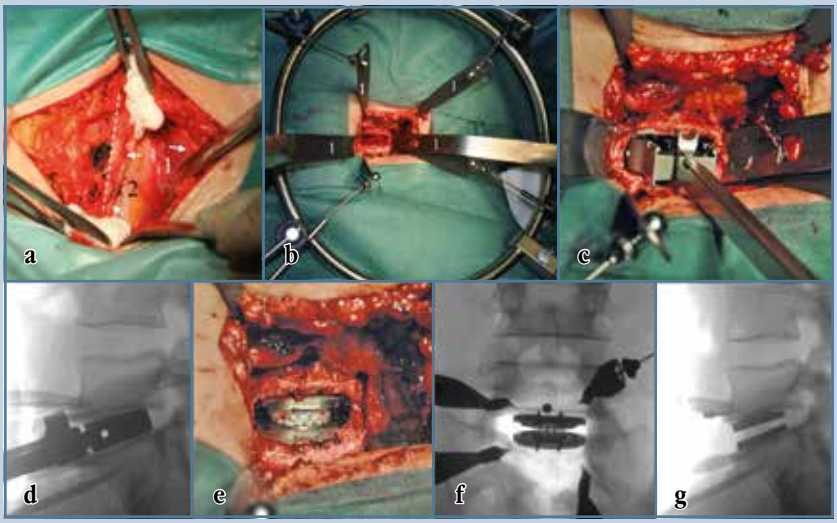

Fig. 2
Stages of anterior discectomy and arthroplasty of L5–S1 from a transverse incision in the iliac region: **a** – release of the left rectus abdominis muscle (*1* – left rectus abdominis muscle is laterally dislocated; *2* – peritoneum; arrow – the edges of the dissected aponeurosis of the left rectus abdominis muscle, the dotted line is a projection of the white line of the abdomen); **b** – general view of the surgical area and the retractor system; **c, d** – a photo and a lateral X-ray of the stage of insertion of the artificial disc probe into the interbody space; **e** – the stage of insertion of the artificial disc probe into the interbody space (surgical wound view); **f, g** – the same stage in radiography in frontal and lateral projections

ment according to the MacNab criteria as "excellent" (n = 18) and "good" (n = 8). The statistical analysis proved the significance of the differences in the results obtained: $p < 0.0001$; Kruskal – Wallis test (Fig. 5).

The Tukey's multiple comparison showed significant ($p < 0.05$) differences in the results of lumbar disc replacement in comparison with similar indicators of other study groups (Table 4).

The covariation statistical analysis revealed that the statistically significant difference between Group 4 and other test groups for NRS-11, ODI, MacNab did not rely on gender and age. It means that despite the age the comparison of clinical outcomes in the groups would be identical for both men and women. If the age of the patients in all groups was the same, the result would be similar respectively.

Discussion

A retrospective assessment of the time of the first and repeated recurrent lumbar disc herniations showed that these cases occur in the majority of patients within the first 2 years after discectomy. These findings are not compatible with the results of other researchers indicating a more distant time frame [7].

We tried to solve the up-to-date issue of choosing the most effective strategy for surgical treatment of recurrent lumbar disc herniations [11, 14, 16, 19]. We conducted a comparative analysis of the outcomes of several types of decompression and decompression and stabilization surgeries, including arthroplasty. The

Table 1
Characteristics of patient groups with recurrent lumbar disc herniation before the start of surgical treatment

Characteristics	Patient groups				p
	1 (n = 32)	2 (n = 62)	3 (n = 40)	4 (n = 26)	
Average age, years	45.6	47.7	50.4	35.3	<0.001*
Male, %	56.3	71.0	47.5	69.2	0.100**
Body mass index					
Me	26.2	27.2	30.4	22.7	0.170*
IQR	22.9–28.6	23.5–28.7	25.9–31.0	21.4–28.2	
Number of previous surgeries, %					
1	100.0	100.0	20.0	69.2	<0.001**
2	–	–	65.0	30.8	
3	–	–	15.0	–	
Lateralization of hernia and symptoms, %					
Ipsi-	90.6	87.1	97.5	84.6	0.350**
Contra-	9.4	9.7	2.5	7.7	
Ipsi-/contra-	–	3.2	–	7.7	
Levels of hernia localization, %					
L3–L4	10	2	–	–	0.070**
L4–L5	50	55	62	46	
L5–L6	9	–	–	–	
L5–S1	31	43	38	54	
The time of the first recurrence onset, mon.					
Me [IQR]	16 [6.0–38.0]	7.5 [2.0–48.0]	43[2.0–80.0]	12 [4.5–24.0]	0.610*
Range	1.0–312.0	0.5–180.0	1.0–147.0	1.0–204.0	

Me – median; IQR – interquartile range; * Kruskal – Wallis test; ** Fisher's exact test.

grouping of patients was not random. It was determined by certain concepts concerning the pathogenesis, diagnosis, and options for surgical treatment of recurrent lumbar disc herniations:

1) a recurrent lumbar disc herniation is a consequence of the degenerative processes in the spine. The discectomy damages the biomechanical integrity of the spinal motion segment and can result in instability [20];

2) today, there is no generally accepted criteria of instability associated with symptomatic recurrent disc herniation. Moreover, there is no clear correlation between the clinical signs of segmental instability and the changes identified by the functional imaging [20, 21];

3) we can conclude from the above that lumbar spine stabilization or arthroplasty can be a treatment option for patients suffering from recurrent lumbar disc herniations. These techniques are more efficient in comparison with microsurgical or endoscopic methods of decompression [11, 19, 20, 22];

The obtained results confirmed that percutaneous endoscopic discectomy for recurrent hernias is the least invasive technique. It extends the possibilities of the approach to the surgical substrate in comparison with the microsurgical technology [1, 23, 24]. An alternative transforaminal approach to the discoradicular conflict area enables to bypass the area of postoperative scar changes, effectively perform a discectomy and visually test the decompression suitability [23]. Nevertheless, in comparison with similar surgeries performed for primary hernias, both according to our studies [25] and to the results of other works [9, 26, 27], the share of surgical complications during endoscopic and microsurgical treatments raised significantly: 15.6 and 17.7 % versus 7.3 and 9.0 % [25]. The dura mater damage predominated in the structure of complications, which is consistent with previously published papers [26]. There was also an increase in the frequency of repeated recurrences after endoscopic discectomy. We should note that this result was higher than indicated by other researchers [24, 26, 28].

We have proved that the stabilization performed by the TLIF technique has advantages over repeated microsurgical and percutaneous endoscopic discectomies. These advantages are not only in the approach to the discoradicular conflict area bypassing fibrotic changes (through the intervertebral foramen area), but also in performing spinal fusion, which excludes the development of another hernia recurrence. The share of good and excellent clinical outcomes according to the MacNab criteria after TLIF was 77.5 %, which is more significant than in the groups of endoscopic and microsurgical discectomies. Moreover, this result is slightly higher than the performance indicators of spinal fusion

Table 2

Assessment of the treatment efficiencyin patients of the studied groups

Characteristics	Groups of patients				p
	1	2	3	4	
Surgery duration, min					
Me	70	105	120	150	<0.001*
IQR	60.0–98.7	85.0–130.0	107.0–240.0	125.0–170.0	
Bed day					
Me	7	11	15	11	<0.001*
IQR	4.0–10.5	9.0–14.0	10.0–21.0	8.0–16.0	
Complications, n (%)	5 (15.6)	11 (17.7)	7 (17.5)	2 (7.7)	0.910**
Recurrent hernias, n (%)	4 (12.5)	3 (4.8)	–	–	0.080**
Reoperations, n (%)	2 (6.2)	4 (6.4)	1 (2.5)	1 (3.8)	0.680**

Me – median; IQR – interquartile range; * Kruskal – Wallis test; ** Fisher's exact test.

Table 3

The structure of perioperative complications in patients of the studied groups, n (%)

Types of complications	Group 1	Group 2	Group 3	Group 4
Damage of the dura mater	5 (15.6)	9 (14.5)	1 (2.5)	–
+ damage of the root	–	–	2.5 (1)	–
+ liquor hypotension syndrome	2 (6.2)	1 (1.6)	1 (2.5)	–
External liquorrhea	–	1 (1.6)	1 (2.5)	–
Surgical site infection	–	2 (3.2)	5 (12.5)	–
Abdominal hernia	–	–	–	1 (3.8)
Retrograde ejaculation	–	–	–	1 (3.8)
Total	5 (15.6)	12 (19.3)	7 (17.5)	2 (7.7)

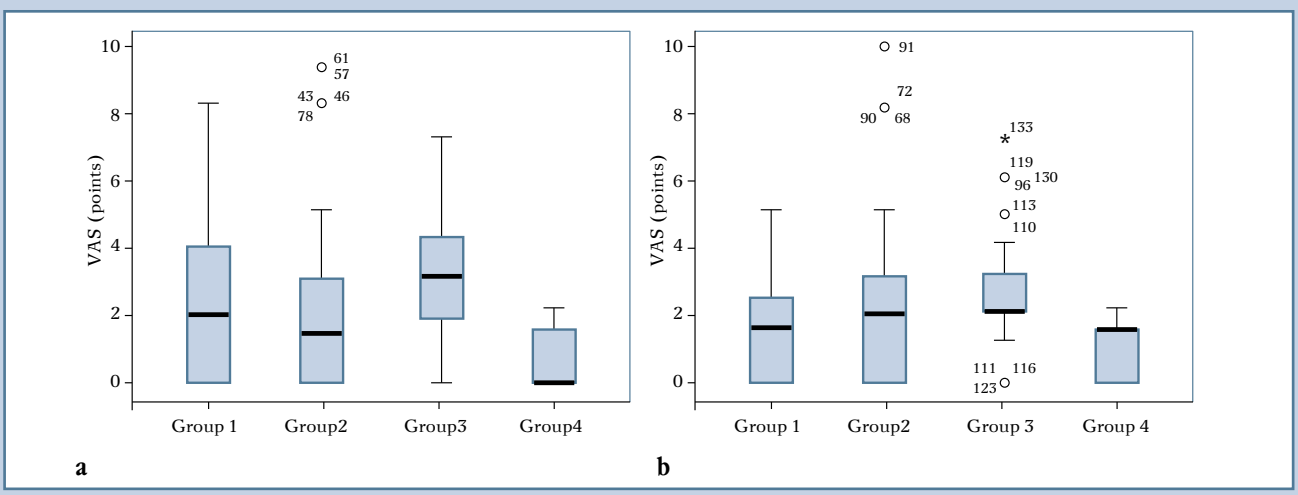

Fig. 3

Intergroup differences in the indicators of back and lower limb pain in patients of groups 3–4, rated on the NRS-11 scale: **a** – Back pain severity; **b** – severity of nerve root pain in the legs

demonstrated in other studies [29]. Additionally, spinal stabilization significantly decreased the frequency of reoperations in comparison with repeated discectomy [29]. This indicator was the lowest in the compared groups.

Some papers contain data on various complications of posterior spinal fusion [11]. As for our study, infectious complications prevailed in 12.5 % of patients. Generally, the share of complications was about the same in groups 1–3.

We should emphasize that the advantage of treatment outcomes in the TLIF group over the microsurgical and endoscopic groups was achieved despite the two or even three previous discectomies at the same level in most patients of Group 3. Previously performed interventions complicated the current procedures and potentially affected the development of postoperative pathomorphological changes in the lumbar spine.

The study findings allowed us to make an important conclusion: the replacement of the intervertebral disc through the anterior left retroperitoneal approach can be an effective technique to treat patients with recurrent hernias. This method is superior in the efficiency of lumbar discectomy and posterior interbody fusion. There are very few papers on the effectiveness of arthroplasty in recurrent lumbar disc herniations [14, 16, 22]. Anterior approaches to the lumbar area are a fundamentally different way to treat recurrent lumbar disc herniations [11, 14, 16]. Due to this, it is possible to perform the most radical discectomy, to remove the hernia and to ensure the dynamic stabilization of the spinal motion segment. This is evidenced by the results of previous papers as well as our data. Additionally, this technique does not have an extra traumatic effect on the back muscles and completely recovers the disc height and lumbar lordosis. The arthroplasty, like spinal fusion, prevents the risk of recurrent hernia. However, it enables to preserve motion in the spinal motion segment, reduces the potential risk of degenerative lesions and hernia formation at the adjacent level and improve the life quality of patients [22].

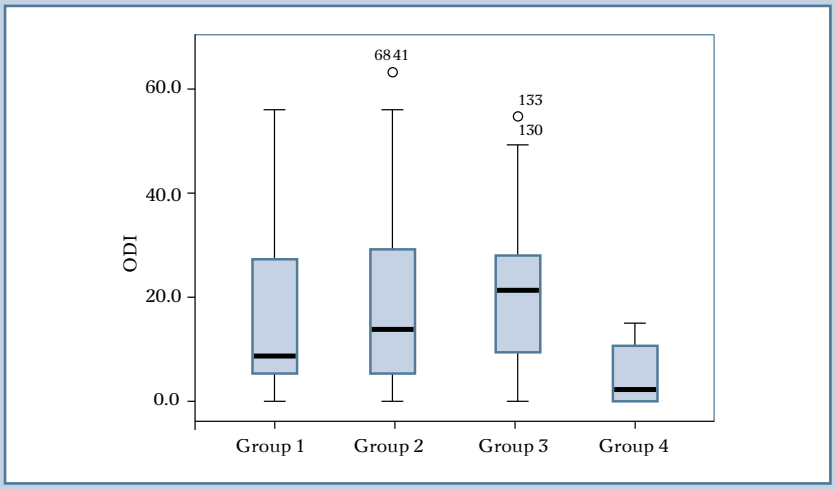

Fig. 4
Intergroup differences in the life quality indicator ODI in patients of groups 1–4

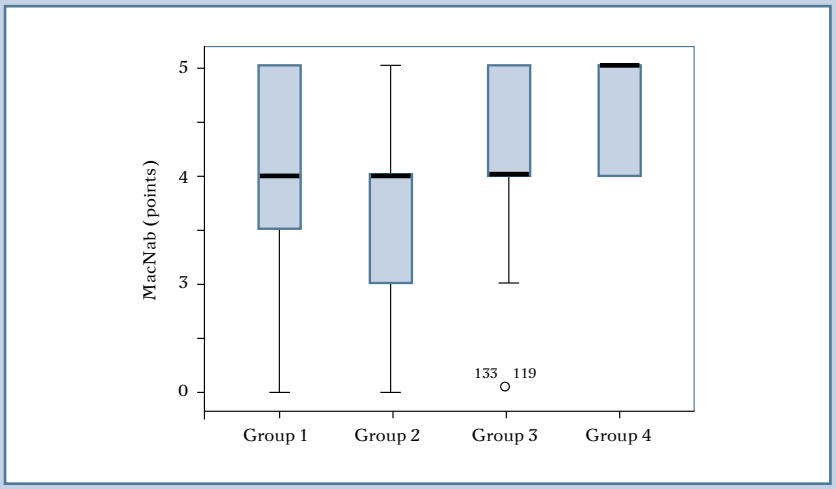

Fig. 5
Intergroup differences in the treatment outcomes of recurrent lumbar disc herniation, depending on the surgery technique, evaluated according to MacNab criteria

Since the recurrences arise most often at the L4–L5 and L5–S1 levels, then retroperitoneal approach to this area of the spine is quite acceptable [11]. In comparison with the posterior approaches to recurrent hernias, the anterior approach implies a smaller extent of peroperative blood loss, a low level of complications and a reduction in the time of surgery [30, 31].

It has to be remembered that the arthroplasty outcomes are largely determined by the type of intervertebral disc replacement. [18]. In our research, we used M6-L, one of the most advanced implants.

The potential complications of anterior approach to the lumbar spine, regardless of the technique, are the following: postoperative hernias of the an-

Table 4
The findings of multiple comparisons of treatment outcome indicators in patients with recurrent disc herniation

Treatmentoutcome indicator	Comparison groups					
	2–1	4–1	3–1	4–2	3–2	3–4
Back pain by NRS-11 (p value)	0.983	0.083	0.929	0.099	0.688	0.021
Leg pain by NRS-11 (p value)	0.404	0.675	0.150	0.097	0.850	0.035
Life quality by ODI (p value)	0.740	0.209	0.507	0.027	0.950	0.014
Treatment outcome by MacNab (p value)	0.606	0.009	0.998	0.000	0.679	0.004

terior abdominal wall, retrograde ejaculation, injury to large vessels and ureters, infections, pseudoarthrosis, etc. [31]. The group of patients after TDR in the presented study had a smaller number of perioperative complications. A case of retrograde ejaculation occurred in the postoperative period had a temporary nature.

The contraindications to total replacement of lumbar discs are obesity, previously performed surgeries on the abdominal cavity and retroperitoneal space, osteoporosis, spinal canal stenosis, spinal deformities, spondylolisthesis, spondyloarthrosis, the condition after laminectomy and facetectomy [18]. If there are contraindications to arthroplasty in case of recurrent hernia, it is reasonable to perform interbody fusion [16].

The limitations of our study are the retrospective nature of the study, the absence of patients after anterior fusion and the small number of individuals in each clinical group. These facts increase the risk of type II errors.

Conclusion

1. The median time of the recurrent lumbar disc herniation was 11.0 mon. (IQR: 4.0–45.0 mon.).

2. The surgery duration and the length of hospital stay of patients with symptomatic recurrent lumbar disc herniation after percutaneous endoscopic discectomy and microdiscectomy are significantly shorter in comparison with the groups of posterior stabilization and arthroplasty ($p < 0.001$).

3. Total replacement of the intervertebral disc and posterior interbody fusion in recurrent lumbar disc herniations are more effective compared to decompressive surgeries. It is reflected in improving the clinical treatment outcomes, reducing the level of perioperative complications and the frequency of reoperations ($p > 0.05$).

4. Anterior discectomy at the L3–S1 level through the left-sided retroperitoneal approach with subsequent arthroplasty with M6-L implant may be recommended for treatment of patients with recurrent disc herniations.

Acknowledgement

The authors express their gratitude to P. V. Zhelnov (ORCID: 0000-0003-2767-5123) for his assistance in this study.

The study had no sponsorship. The authors declare no conflict of interest.

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Received 20.11.2020
Review completed 01.03.2021
Passed for printing 15.03.2021

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