



THE INFLUENCE OF THE LUMBAR SPINAL STENOSIS SEVERITY AND EXTENT ON CLINICAL SYMPTOMS AND FUNCTIONAL OUTCOMES OF SURGICAL TREATMENT

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Objective. To evaluate the influence of the grade and extent of lumbar spinal stenosis on the severity of clinical symptoms before surgical treatment and the functional status of patients after surgery.

Material and Methods. A retrospective monocentric study was conducted including 380 patients with clinically significant degenerative central lumbar stenosis. The grade of spinal canal stenosis was determined using MRI data (according to the Schizas and Lee – Guen classifications). The number of affected spinal segments was also studied. The functional status before and after surgery was assessed using the ODI questionnaire, and pain – using the VAS. The dynamics of clinical changes after surgery was followed-up in 76 patients from the general cohort who agreed to participate in a survey or came for a follow-up examination.

Results. After comparing the Oswestry and VAS scores in groups of patients with different grades of Schizas and Lee – Guen stenosis severity, no statistically significant differences were noted ($p = 0.325$, $p = 0.498$, and $p = 0.634$, respectively). Statistically significant differences in the number of affected segments were also not revealed ($p = 0.281$ for Oswestry and $p = 0.664$ for VAS). When assessing the correlation between the extent of stenosis and questionnaire scores, a weak direct relationship was found between Oswestry scores after surgery and the number of affected segments ($\rho = 0.357$, $p = 0.015$). Construction of linear regression revealed that patients with one and two affected segments vary significantly in outcomes ($p = 0.039$, 95 % CI [0.734; 2.65]), while other cases showed no statistically significant difference.

Conclusion. The conducted study showed no statistically significant relationship between the severity of lumbar stenosis, as assessed according to the Schizas and Lee – Guen classifications, the number of affected segments and clinical symptoms in patients. It was also found that the severity of the stenosis does not affect the outcome of surgery, while the functional outcomes after surgery for patients with one or two affected segments may differ significantly in terms of statistics.

Key Words: lumbar spine stenosis; surgical treatment; outcomes; stenosis classification; magnetic resonance imaging.

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Degenerative lumbar stenosis is a condition wherein the space for nerve and vascular structures in the spinal canal is reduced because of secondary degenerative changes. Symptoms include pain of various severity in the lumbar, gluteal regions and legs, the intensity of which is triggered by physical activity [1]. Symptomatic lumbar stenosis is one of the most frequent indications for surgery for spine pathology in patients over the age of 65 [2].

The set of symptoms, history of disease and neurological disorders may be nonspecific, similar to widespread

osteoarthritis or peripheral vascular disease of the lower extremities. Therefore, the selection of patients for surgical treatment is determined both by symptoms and ineffectiveness of conservative treatment and by the data of imaging studies [3]. Currently, MRI is the gold standard for diagnosis. The reliability of the technique for the detection of lumbar stenosis is confirmed by the studies of many authors [4, 5], although the clinical significance of the changes detected by MRI is not completely clear. Is it possible to use imaging studies to predict the severity

of manifestations of lumbar stenosis or the functional status of patients after the surgery? The results of these studies are often rather contradictory [2, 6]. Furthermore, the correlation between the extent of stenosis and the functional status of patients has not been determined because of the insufficient number of studies.

The objective is to evaluate the influence of the grade and extent of lumbar spinal stenosis on the severity of clinical symptoms before surgical treatment and the functional status of patients after surgery.

Material and Methods

A retrospective monocentric study including 380 patients with degenerative central lumbar stenosis was conducted. The study was approved by the Biomedical Ethics Committee of the institution (protocol No. 10 dated December 20, 2023).

The inclusion criterion was a diagnosed clinically significant degenerative central spinal canal stenosis. Non-inclusion criteria: no MRI performed before surgery (diagnosis was established by CT images), previous spine surgery, inflammatory diseases of the spine, traumatic injuries, neoplasms, significant comorbidity (rheumatoid arthritis, Parkinson's disease), and disc herniation at one or more levels.

The patients received treatment in the neurosurgical unit in 2020–2022. Prior to surgery, all patients included in the study underwent MRI using 1.5 to 3.0 Tesla devices. All images were stored in an internal database and used only for the purpose of the study. Patients signed informed voluntary consent for storage and processing of personal data, including MRI findings. Two authors (B.R. Kinzyagulov and V.B. Lebedev) independently evaluated the grade of spinal canal stenosis. In case of discrepancy, another author (A.A. Zuev) made the decision. The classifications of Schizas et al. and Lee-Guen et al. [7, 8] were used in order to define the grade of stenosis. Moreover, the number of affected segments was studied to identify the correlation between the extent of stenosis and clinical manifestations. Considering the large number of patients with degenerative spondylolisthesis, we calculated the largest dislocation of vertebra value to further search for the dependence of functional status on this index. The course of clinical changes after surgery was evaluated in 76 patients who underwent surgery in 2020 and 2021, agreed to be interviewed or came for follow-up examination, and had not undergone surgery for musculoskeletal disorders, cancer, or significant comorbidities during this period. All patients in this group underwent decompression or decompression and

stabilization surgery, including interbody fusion through an open or minimally invasive approach and transpedicular fixation of the affected segment.

The magnitude of functional maladaptation of patients was evaluated using the Russian version of the Oswestry questionnaire [9]; VAS was used to assess the severity of back pain [10].

Statistical data processing was performed using Jamovi software version 2.3.0.0. The p value < 0.05 was considered as the level of statistical significance. In order to define the normality of the distribution of quantitative variables, we applied the Shapiro–Wilk test, as well as data plots. Quantitative values with normal distribution were described as mean and standard deviation, with non-normal distribution – as median and interquartile range. Quantitative data in more than two groups were compared using the Kruskal–Wallis test; non-normally distributed values in two groups were compared using the Mann–Whitney U-test. For pairwise comparison of values in the selected groups, the Dwass–Steel–Critchlow–Fligner (DSCF) test was used. The Spearman's rank correlation coefficient was used to construct a correlation matrix. Linear regression was used to test the hypothesis of correlation.

Results

The study included 380 individuals with stenosis of different severity. Among them, 238 (62.6 %) were women. The median age was 65.0 (11.0) years. According to the Schizas classification, there were 40 (10.5 %) patients in our sample with grade B stenosis, 186 (49.0 %) with grade C, and 154 (40.5 %) with grade D. There were no patients with grade A. After studying the tomographic images to determine the grade of stenosis according to Lee–Guen, 146 (38.4 %) patients were found to have stenosis of grade 2 and 234 (61.6 %) patients with grade 3. In addition, 172 (45.2 %) patients had single-level stenosis, 150 (39.5 %) patients had two-level stenosis, 36 (9.5 %) patients had three-level stenosis, and 22 (5.8 %) patients had four-level stenosis. The

questionnaire scores in the groups of patients subdivided by severity are given in Table 1.

After comparing the Oswestry and VAS scores in the groups of patients with different severity of stenosis according to Schizas, no statistically significant differences were observed ($p = 0.325$ and $p = 0.498$, respectively). Pairwise comparison also did not reveal any significant difference in scores (Table 2).

The degree of impairment of functional adaptation and pain severity in patients with different grades of stenosis according to Lee–Guen were not significantly different ($p = 0.634$ and $p = 0.796$, respectively).

We have also studied the influence of the number of affected segments on the severity of pain and the degree of functional maladaptation. The mean values are summarized in Table 3.

No statistically significant differences in the obtained outcomes could be identified ($p = 0.281$ for Oswestry and $p = 0.664$ for VAS). Pairwise comparison also failed to reveal significant differences (Table 4).

Moreover, a search for a correlation between questionnaire scores with the number of affected segments ($\rho = 0.095$, $p = 0.243$ for Oswestry; $\rho = 0.031$, $p = 0.669$ for VAS) and the greatest dislocation of vertebra ($\rho = 0.009$, $p = 0.915$ for Oswestry; $\rho = 0.012$, $p = 0.872$ for VAS) did not contribute for revealing statistically significant direct or inverse correlation.

The treatment outcomes of 76 patients were analyzed. The median follow-up period was 23 (6.0) months. The mean Oswestry score was 16.6 ± 19.6 ; the mean VAS score was 2.72 ± 2.86 . After comparing the indices in the groups with different grades of stenosis according to Schizas and Lee–Guen, no statistically significant differences were found (Table 5).

Assessment of the correlation between the extent of stenosis and questionnaire scores showed a weak direct correlation for the Oswestry score and the number of affected segments ($\rho = 0.357$, $p = 0.015$), while there was no statistically significant connec-

tion with the VAS score ($\rho = 0.176$, $p = 0.241$).

Building linear regression revealed that patients with one- and two-segment defects differed significantly from each other in terms of outcome ($p = 0.039$, 95 % CI [0.734; 2.65]), while there was no statistically significant difference in the other cases.

Discussion

We performed a statistical analysis of the correlation between the severity of central lumbar stenosis according to the Schizas and Lee–Guen classifications and clinical manifestations evaluated by VAS and Oswestry. There were no statistically significant differences in impairments of functional status and pain severity in patients with different grades of stenosis according to MRI.

The prevalence of degenerative stenosis of various severity among patients aged over 40 years can be up to 77.9 % [11]. Nevertheless, only 9.3 % of people in overall population are concerned with clinically significant stenosis, according to the study by Ishimoto et al. [12]. Various imaging techniques are necessary to confirm the diagnosis. MRI is the recommended technique because of the high resolution of soft tissue reflections and the determination of the severity of compression of nerve and vascular structures [13]. Despite the high validity of this technique, there are only a small number of classifications of the severity of central lumbar stenosis. The most popular among them are the classifications by Schizas et al. [7] and Lee–Guen et al. [8]. Considering the importance of imaging studies in the diagnosis of degenerative lumbar stenosis, we studied the influence of stenosis severity and the extent of this pathology on back pain and functional status both before and after surgery. The correlation between the data of imaging studies and the clinical picture of the disease has already been the subject of numerous studies. Meanwhile, the results of these studies often had significant contradictions. Thus, Haig et al. [13] showed that electrophysiological data could correlate with the size of the spi-

nal canal (according to MRI) and clinical manifestations. The same point of view was expressed by researchers who stated that the width of the spinal canal might influence the severity of symptoms in patients with degenerative stenosis [6, 14, 15]. Conversely, Sigmundsson et al. [16] and Weber et al. [2] note that there is no statistically significant correlation between the severity of back pain, functional status, and imaging data. We were able to show that the grade of stenosis evaluated by the two classification systems did not affect the severity of back pain and functional maladaptation of patients.

The world literature currently contains a limited number of studies on the influence of spinal canal stenosis extent on symptoms. Sigmundsson et al. [16]

showed that multilevel stenosis is associated with less severe back pain. We have not found a statistically significant correlation between the number of affected segments and the severity of pain or functional status of the patients.

The impact of various factors on the outcome after surgical treatment of lumbar stenosis has been discussed in several studies [17, 18]; nevertheless, it was impossible to determine the correlation between the changes identified on MRI and the functional status of patients after surgery because of the contradictory outcomes of the performed studies. For instance, in one of the study, the authors state that the severity of stenosis is inversely proportional to the severity of pain after surgery, while the number of operated segments, on the contrary,

Table 1

Survey results of patients with different grades of stenosis according to Schizas et al. [7] and Lee–Guen et al. [8]

Scale	Grades of stenosis according to Schizas			Grades of stenosis according to Lee–Guen	
	B	C	D	2	3
VAS	6.17 ± 1.20	6.23 ± 1.22	6.21 ± 1.37	6.28 ± 1.21	6.20 ± 1.32
Oswestry	41.90 ± 17.70	41.40 ± 16.90	45.20 ± 17.30	41.90 ± 17.70	43.70 ± 16.70

Table 2

Pairwise comparison of VAS and Oswestry scores in patients with different grades of stenosis according to Schizas

Grade of stenosis		p*	
		VAS	Oswestry
B	C	0.980	0.989
B	D	0.920	0.994
C	D	0.658	0.990

* Dwass–Steel–Critchlow–Fligner test.

Table 3

Oswestry and VAS scores in patients with different extent of degenerative stenosis

Extent of stenosis	Oswestry	VAS
One segment	40.60 ± 16.20	6.13 ± 1.29
Two segments	44.60 ± 17.90	6.33 ± 1.22
Three segments	44.40 ± 16.70	6.50 ± 1.10
Four segments	44.20 ± 21.00	5.45 ± 1.75

Table 4

Pairwise comparison of Oswestry and VAS scores in patients with different extent of degenerative stenosis

Number of segments		p*	
		Oswestry	VAS
1	2	0.655	0.741
1	3	0.876	0.751
1	4	0.963	0.581
2	3	0.984	0.987
2	4	0.981	0.394
3	4	0.991	0.392

* Dwass—Steel—Critchlow—Fligner test.

Table 5

Comparison of Oswestry and VAS scores in patients with different grades of stenosis

Classification	p*	
	Oswestry	VAS
Schizas	0.066	0.434
Lee—Guen	0.634	0.697

* Kruskal—Wallis test.

may be directly proportional to the clinical manifestations [19]. In another similar study, the authors state that there is no statistically significant correlation between the grade of stenosis and the functional status of patients after surgery [2]. We did not find a statistically significant correlation between preoperative stenosis severity and postoperative outcome in our study; however, we identified a slight direct correlation between the number of operated segments and

functional status evaluated by the Oswestry technique. After building linear regression, it was found that outcomes differed in patients with one or two affected levels, while there were no statistically significant differences among other patients. Nonetheless, given the wide confidence interval, this result should be interpreted cautiously, and further research should be performed on a larger sample.

Limitations of the study. This study has several limitations. The design is ret-

rospective, monocentric, and the sample size is important to consider, especially for the second part of the study, which is focused on the surgical outcomes. In order to increase the level of evidence, a multicenter prospective study with a larger number of patients and an increased emphasis on the type of surgery should be undertaken to possibly evaluate the correlation between the grade of stenosis and outcome in different types of surgery.

Conclusion

According to the retrospective study, there was no statistically significant association between the severity of central lumbar stenosis evaluated according to the Schizas and Lee—Guen classifications, the number of affected segments, and clinical signs in patients. It was also shown that the stenosis severity does not affect the postoperative outcome, while the functional outcomes after surgery in patients with one and two affected segments can be statistically significantly different.

The study had no sponsors. The authors declare that they have no conflict of interest.

The study was approved by the local ethics committees of the institutions.

All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

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