DOI: https://doi.org/10.17816/vto623807

Success predictors of decompressive surgical treatment for lumbar degenerative spinal canal stenosis

Aleksandr V. Krutko, Anton G. Nazarenko, Gleb E. Balychev, Evgenii S. Baykov, Olga N. Leonova

Priorov National Medical Research Center of Traumatology and Orthopedics, Moscow, Russia

ABSTRACT

BACKGROUND: Decompressive surgical treatment for degenerative lumbar stenosis significantly improves patient clinical status. However, in some cases, patients are not satisfied with the outcomes. Various studies have examined clinical and morphological factors to improve the results of surgical interventions.

AIM: To identify clinical and morphological predictors of the success of decompressive surgical interventions for lumbar degenerative stenosis.

MATERIALS AND METHODS: This retrospective study included 61 patients who underwent surgery for mono- and postsegmental lumbar degenerative stenosis. Clinical and demographic data and the stage of degenerative changes in the functional spinal unit and sagittal balance of the spine were assessed. The success of surgical treatment was defined as simultaneous compliance with three criteria after 6–18 months: achievement of MCID for ODI (⩾12%), recalibration of the spinal canal at the level of intervention according to MRI data (Schizas regression to ⩾1 stage), and improvement of the patient's subjective feeling (4–5 on the Likert scale). Logistic regression analysis was used to identify predictors of treatment outcome.

RESULTS: A significant decrease in the intensity of pain syndrome (VAS in back and leg) and an improvement in the quality of life (ODI) after surgery (p <0.001) were found in all patients. In 73.8% of cases, the MCID threshold exceeded for ODI, whereas in 75.41%, patients were satisfied with surgical treatment. The success rate of surgical intervention was 65.57%. In one-factor regression analysis of clinical, demographic, and morphological parameters, the only independent predictor of surgical treatment was neuropathic pain before surgery according to the DN4 questionnaire (OR=1.52; p=0.011).

CONCLUSION: Decompressive surgical treatment for degenerative lumbar stenosis is an effective treatment method, regardless of the extent and degree of degenerative changes in the spinal–motor segments and concomitant degenerative pathology, including disruption of sagittal balance. The predicting factor of the success of decompressive intervention is the severity of preoperative neuropathic pain.

Keywords: degenerative stenosis; lumbar spine; decompressive surgery; neuropathic pain syndrome.

To cite this article:
Krutko AV, Nazarenko AG, Balychev GE, Baykov ES, Leonova ON. Success predictors of decompressive surgical treatment for lumbar degenerative stenosis. *N.N. Priorov Journal of Traumatology and Orthopedics*. 2024;31(1):67–80. DOI: https://doi.org/10.17816/vto623807

Received: 24.11.2023 **Accepted:** 12.12.2023 **Published online:** 21.02.2024

DOI: https://doi.org/10.17816/vto623807

Предикторы успеха декомпрессивных хирургических вмешательств при дегенеративном поясничном стенозе

А.В. Крутько, А.Г. Назаренко, Г.Е. Балычев, Е.С. Байков, О.Н. Леонова

Национальный медицинский исследовательский центр травматологии и ортопедии им. Н.Н. Приорова, Москва, Россия

АННОТАЦИЯ

Обоснование. Декомпрессивные хирургические вмешательства при дегенеративном поясничном стенозе значимо улучшают клинический статус пациентов. Однако в ряде случаев последние не удовлетворены исходом лечения. В настоящее время в литературе ведётся поиск модифицируемых клинико-морфологических факторов, с помощью которых возможно улучшить результаты хирургических вмешательств.

Цель. Выявить клинические и морфологические предикторы успеха декомпрессивных хирургических вмешательств у пациентов с дегенеративным поясничным стенозом.

Материалы и методы. Проведён анализ данных 61 истории болезни пациентов, оперированных по поводу моно- и полисегментарного дегенеративного поясничного стеноза. Выполнена оценка клинико-демографических данных, а также степени, характера и протяжённости дегенеративных изменений позвоночно-двигательных сегментов и сагиттального баланса позвоночника. Под успехом хирургического лечения понимали одновременное соблюдение через 6–18 месяцев трёх критериев: 1) достижения минимальной клинически значимой разницы MCID для индекса Освестри ODI (⩾12%); 2) рекалибрации позвоночного канала на уровне вмешательства по данным магнитно-резонансной томографии (регресс Schizas на ⩾1 стадию); 3) улучшения субъективного ощущения пациента (4–5 по шкале Ликерта). Для выявления предикторов исхода лечения использовалась логистическая регрессия.

Результаты. Все пациенты отметили значимое уменьшение интенсивности болевого синдрома (визуально-аналоговая шкала боли, спина и нога) и улучшение качества жизни (ODI) после операции (p <0,001). В 73,8% случаев отмечено преодоление порогового значения MCID для ODI; в 75,41% пациенты были удовлетворены оперативным лечением. Успех хирургического вмешательства был достигнут в 65,57%. При однофакторном регрессионном анализе клинико-демографических и морфологических параметров единственным независимым предиктором успеха оперативного лечения был нейропатический болевой синдром перед операцией по данным опросника DN4 (OR=1,52, p=0,011).

Заключение. Декомпрессивные хирургические вмешательства при дегенеративном поясничном стенозе являются эффективным методом лечения вне зависимости от протяжённости и степени дегенеративных изменений позвоночно-двигательных сегментов, сопутствующей дегенеративной патологии, в том числе с нарушением сагиттального баланса. Предиктором успеха декомпрессивного вмешательства является степень выраженности дооперационного нейропатического болевого синдрома.

Ключевые слова: дегенеративный стеноз; поясничный отдел позвоночника; декомпрессивное хирургическое вмешательство; нейропатический болевой синдром.

Как цитировать:
Крутько А.В., Назаренко А.Г., Балычев Г.Е., Байков Е.С., Леонова О.Н. Предикторы успеха декомпрессивных хирургических вмешательств при дегенеративном поясничном стенозе // Вестник травматологии и ортопедии им. Н.Н. Приорова. 2024. Т. 31, № 1. С. 67–80. DOI: https://doi.org/10.17816/vto623807

Рукопись получена: 24.11.2023 **Рукопись одобрена:** 12.12.2023 **Опубликована online:** 21.02.2024

BACKGROUND

Degenerative lumbar stenosis, despite its widespread occurrence in the population, has different degrees, forms, and mechanisms of development, which present in a variety of clinical manifestations. Intense pain syndrome, neurogenic intermittent claudication, and peripheral paresis, often detected in patients with spinal stenosis, worsen significantly the quality of life and functional capabilities of patients [1]. Although various modern conservative methods are available, surgical treatment techniques are more effective and predictable [2, 3]. The standardized approach to treatment is currently replaced by a more personalized one, with a tendency toward less traumatic techniques, less use of immobilizing structures [4, 5], and relatively higher safety, with predictable outcomes [3, 4].

Spinal stenosis affects several spinal motion segments, the patient's condition, and their function [1, 6]. To improve the clinical condition, neural structures must be decompressed. The decompression volume is assessed by magnetic resonance imaging (MRI) based on a decrease in the severity of stenosis according to the Schizas classification [7]. Moreover, competing conditions, such as degenerative scoliosis and spondylolisthesis, can independently affect the condition of patients by reducing the success rates of interventions, discouraging the technique.

The regression of the Oswestry disability index (ODI) is the main feature in assessing the improvement of functional indicators of patients with degenerative spinal diseases. To determine whether improvement is achieve after surgery or not, the minimum clinically important difference (MCID) is used.

In some cases, despite achieving the ODI threshold, patients remain dissatisfied with the surgical outcomes. The reasons may be the persistence and occurrence of postoperative neuropathic pain syndrome, high levels of anxiety and depression, which can decrease the quality of life of the patients, and sagittal balance disorders that cannot be eliminated because of the unsatisfactory quality of bone tissue.

Thus, studying the treatment outcomes by identifying success predictors and patient satisfaction is the key to achieving optimal treatment and diagnostic algorithms.

This study aimed to identify clinical and morphological predictors of the success of lumbar decompression surgery in patients with degenerative lumbar stenosis.

MATERIALS AND METHODS

Study design

This retrospective cohort study considered the STROBE recommendations.

Compliance criteria

The inclusion criteria were as follows:

- Primary surgical intervention involving microsurgical decompression of neural structures without using stabilizing structures
- Preoperative MRI, computed tomography, postural radiography of the spine, and postoperative MRI (not earlier than 1 month and up to 12 months)
- Central spinal canal stenosis in the lumbar spine
- ODI quality of life scales, Likert scale, DN4 neuropathic pain syndrome scale, and pain intensity scale (visual analog scale [VAS]) completed before and after surgery (up to 18 months).

The non-inclusion criteria were as follows:

- Repeated decompressive or decompressive-stabilizing interventions on the spine
- Clinically significant foraminal, unilateral lateral spinal canal stenosis
- Nondegenerative lesions of the spine
- Inability to undergo clinical assessment and completion of clinical questionnaires at follow-up

The exclusion criteria were as follows:

- Refusal to participate in the clinical study (three clinical cases)
- Concomitant pathology in the acute stage, significantly affecting the general clinical condition of the patient (one clinical case)

Study conditions

data from adult patients who underwent surgery for degenerative spinal lesions between May 2021 and December 2022 were analyzed. Surgical treatment was indicated for vertebrogenic compression syndrome (radicular or neurogenic intermittent claudication) in combination with or without neurological deficit resistant to conservative therapy for at least 3 months. The morphological risk factors of the clinical manifestations include mono- or polysegmental degenerative lumbar stenosis with or without other degenerative lumbar pathologies (spondylolisthesis, scoliosis, and sagittal imbalance). All patients who had sagittal balance disorders had a marked decrease in bone tissue density based on the results of computed tomography at the level of interest in Hounsfield units (HU≤110), which was a contraindication for corrective surgical interventions with implantation of metal structures.

Study duration

the study design included two visits: (1) before and (2) after surgery (from month 6 to month 18).

Description of the medical intervention

surgical treatment was performed in accordance with the principles of clinical and morphological correspondence and minimal sufficiency. Microsurgical bilateral decompression of neural structures was performed from a unilateral approach at clinically significant levels using the "over-the-top" technique proposed by Mayer et al. [8]. From a unilateral approach, interlaminectomy was performed on the most clinically significant side with medial facetectomy, ligamentum flavum resection, and ipsi- and contralateral decompression of neural structures at the involved levels. Sufficient decompression was considered the simultaneous achievement of certain criteria, namely, absence of compression from the bone and other dense formations with possible free displacement of neural structures, distinct pulsation, and nonconstriction of the dural sac.

Clinical and demographic data included sex, age, body mass index (kg/m^2), ODI, DN4 neuropathic pain scale, and numerical back and lower limb pain-rating scale scores.

Main study outcome

to assess the success of surgical treatment, simultaneous compliance with three criteria was used: (1) achievement of MCID for ODI at the follow-up examination, (2) recalibration of the spinal canal at the intervention level according to MRI data of the lumbar spine, and (3) improvement of the patient's subjective sensation (on the Likert scale). For the ODI scale, the outcome was considered successful if the score decreased after 1 year (MCID by ⩾12%) [9–11]. Because the "spinal canal recalibration" category was achieved in all patients (100%), the identification of treatment success predictors was based on the achievement of MCID according to ODI and patient satisfaction.

Additional research outcomes

Subgroup analysis

Patients were distributed to binary groups according to the achievement of MCID based on ODI regression (⩾12) and satisfaction (4–5 and 1–3 points). Surgical success was assessed based on a combination of achieving MCID according to ODI and satisfaction with surgical treatment.

Methods for recording outcomes

Lumbar MRI was performed to assess the stage of intervertebral disc degeneration according to the Pfirrmann classification, Modic-type changes (MC), endplate defects (total endplate score [TEPS]), and spinal canal stenosis according to the Schizas classification before and after surgery [12–15]. Progression of the spinal canal stenosis to the symptomatic level was considered significant when the degree of stenosis decreased by at least 1 grade according to the Schizas classification. The study included patients with types C and D according to the above classification. Patient satisfaction was assessed using a Likert scale; patients with scores of 4 ("a little better than before surgery") and 5 ("much better than before surgery") were considered satisfied with the treatment outcomes, whereas those with scores of 1 ("much worse than before surgery"), 2 ("a little worse than before surgery"), or 3 ("condition unchanged") were considered dissatisfied with the outcomes. Using spinal postural radiography, the Roussouly type and sagittal balance parameters (pelvic incidence [PI], pelvic tilt [PT], sacral slope [SS], segmental angles LL [L1–S1] at each lumbar level, low LL (L4–S1), sagittal vertical axis [SVA], sacrum–bicoxofemoral distance, Barrey index, and PI-LL) were assessed. Global imbalance was assessed using the Barrey index. If the score was <1, balance was considered not impaired, and if the score was ⩾1, balance was considered impaired.

Ethical considerations

the study was approved by the local ethics committee of the N.N. Priorov National Medical Research Center of Traumatology and Orthopedics (Meeting No. 1/23 of 05/05/2023).

Statistical analysis

Sample size calculation

The sample size was not precalculated, and all patients meeting the inclusion criteria were selected.

Statistical data analysis

For quantitative variables, mean values, mean-square deviations, medians, quartiles, minimum and maximum values, and number of valid observations are presented as descriptive statistics. For categorical variables, frequencies and percentages relative to the number of valid observations are given. Pre- and postoperative scores were compared using paired t-tests, as well as the nonparametric Wilcoxon matched-samples test as a supporting analysis, showing consistent results. Groups formed according to predefined criteria, namely, ODI achievement, satisfaction, treatment success (a combination of spinal canal recalibration, clinical success, and satisfaction), were compared using analysis of variance (as well as the Mann–Whitney test as a supporting analysis, with consistent results) for quantitative attributes and the Pearson chi-square test for categorical attributes. Logistic regression models were also created for binary indicators, namely, ODI achievement, satisfaction, and treatment success.

RESULTS

Study participants

From May 2021 to December 2022, in Department 12 of the N.N. Priorov National Medical Research Center of Traumatology and Orthopedics, 98 decompressive surgeries were performed on patients with clinical signs of degenerative lumbar spinal stenosis. In total, 61 (62.24%) patients met the inclusion criteria for the study.

The median age of the patients was 67.0 [61.0; 71.0] years. Most patients were female (43/61, 70.49%), were overweight, and had grade I–II obesity (29.697 [25.6; 33.1]). In addition, 42.62% (35/61) of the patients had clinical signs of neurogenic intermittent claudication, and 36.1% (22/61) had compression-ischemic radiculopathy. In 18/61 (29.51%) patients, grade D spinal canal stenosis according to the Schizas classification was detected preoperatively at any level, and the remaining

70.49% had grade C spinal canal stenosis before surgery. The most common types were Roussouly types III and IV (83.6%). Sagittal profile abnormalities (Barrey index ⩾1) were detected in 19/61 (31.15%) patients.

Regarding the prevalence of intervertebral disc degeneration, Pfirrmann stage IV was detected most often at all lumbar spine levels (180/305, 59.02%). At all lumbar spine levels, in MC 0 and 2 changes were identified in comparable proportions (259/610 and 333/610 [42.46 and 54.59%]), respectively, whereas MC 1 and 3 were quite rare (13/610 and 5/610 [2.13% and 0.82%], respectively). Endplate defects (TEPS) were distributed evenly with a tendency toward moderate and significant changes, that is, grade 3 in 159/610 (26.07%) measurements, grade 4 in 180/610 (29.51%), grade 5 in 164/610 (26.86%), and grade 6 in 107/610 (17.54%).

Main study results

after surgical treatment with the implementation of all three intraoperative components to ensure sufficient decompression in the postoperative period, lumbar MRI revealed recalibration of the spinal canal at the intervention level. In 62.29% (38/61) of cases, the degree of stenosis decreased by one grade, that is, from grade C to B in 47.54% (29/61) of cases and from grade D in C in 6.56% (4/61) of cases. In 37.70% (23/61) of the patients, the degree of stenosis decreased by two or more grades, that is, from grade C to A in 14.75% (9/61), from grade D to B in 19.67% (12/61), and from grade D to A in 3.28% (2/61).

All patients included in the study noted a significant decrease in pain intensity and improvement in the quality of life after surgery, with back pain VAS score of 8.0 [5.0; 10.0] versus 4.0 [2.0; 6.0] points (p <0.001), leg pain VAS score of 7.0 [8.0; 4.0] versus 3.0 [2.0; 6.0] points (p <0.001), and ODI of 55.00 [42.22; 62.22] versus 28.00 [11.11; 42.22] (p <0.001). The intensity of neuropathic pain also significantly regressed, that is, DN4 5.0 [3.0; 6.0] versus 2.0 [1.0; 4.0] (p <0.001).

In addition, 45/61 (73.8%) patients had exceeded the MCID threshold value for ODI; in 16/61 (26.2%) patients, no significant improvements were registered. Based on the achievement of MCID by ODI, patients were distributed into those who achieved success (n=45) and those who did not achieve success (n=16).

Moreover, 46/61 (75.41%) patients were satisfied with surgical treatment, and 15/61 (24.59%) patients had either no subjective improvement or deterioration.

Surgical success was defined as objective improvement in the functional state based on spinal canal recalibration and satisfaction with surgical outcomes. Surgical success was achieved in 40/61 (65.57%) patients. Failure to achieve MCID and dissatisfaction with surgical treatment were registered in 11/61 (18.03%) patients, and 10/61 (16.39%) patients were included in the intermediate group, where the patients were dissatisfied with the treatment despite significant improvement in function according to the ODI and recalibration of the spinal canal.

Additional study results

Achieving the MCID

When comparing clinical and radiological parameters between patients who achieved and did not achieve clinical success, those who achieved MCID experience greater pain intensity in the leg and back before surgery and a lower pain intensity after surgery, that is, 8 [7; 10] versus 7 [4.5; 8.5] for leg pain before surgery (p=0.024), 3 [1; 5] versus 5.5 [4; 7] for leg pain after surgery (p=0.003), 7 [5; 9] versus 4 [2; 7] for back pain before surgery (p=0.002), and 3 [2; 4] versus 5.5 [3; 6] for back pain after surgery (p=0.007) and greater functional disability before surgery (57.8 [51.1; 64.4] for the successful treatment group versus 42.4 [35.3; 55.9] for the unsuccessful treatment group, p=0.001). The analysis also revealed differences in morphological characteristics. Patients who achieved MCID had more pronounced lumbar lordosis, corresponding to Roussouly type III, whereas in the other group, patients with Roussouly type I were predominant (p <0.05). The success group had less severe endplate lesions (p <0.05) (Table 1).

All other parameters, including demographics, MRI findings, and sagittal balance parameters, were not significant between the groups (p >0.05).

According to the univariate regression analysis between patients who reached and did not reach the MCID threshold values, preoperative VAS scores of the leg (OR=1.67, p=0.005) and back (OR=1.47, p=0.026) pains were identified as predictors of clinical success when performing lumbar decompression surgery.

Table 1. Comparison of instrumental and radiological parameters of patients who achieved and did not achieve clinical success, significant differences (p >0.05).

Parameter	Success	Failure	p
LL (L1-L5)	48 [41; 56]	39 [35,5; 49,5]	0.044^F
$EP\text{-}L1_{lower}$	4 [3; 5]	4 [3; 4]	0.015^P
$EP\text{-}L2_{lower}$	4 [3; 5]	4 [3; 4]	0.017^P
$EP\text{-}L3_{upper}$	4 [3; 5]	4 [3; 4]	0.026^P
$EP\text{-}L5_{upper}$	5 [4; 6]	4 [3; 5]	0.010^P

Note. ^{F} — Fisher's exact test (two-tailed), ^{P} — Pearson's chi-square test.

Treatment satisfaction

In a detailed assessment of the clinical and radiological parameters of patients satisfied and dissatisfied with treatment, patients satisfied with treatment had a greater leg pain intensity before surgery and lower intensity after surgery (8 [7; 10] versus 6.5 [4.0; 8.0] before surgery, 3.0 [2.0; 5.0] versus 6.0 [4.0; 7.0] after surgery, p=0.027 and p <0.001, respectively), lower back pain intensity after surgery (3.0 [2.0; 5.0] versus 6.0 [3.0; 7.0], p=0.003), lower neuropathic pain intensity after surgery (6.0 [3.0; 7.0] versus 4.0 [3.0; 7.0], p <0.001), greater regression of functional disability and its lower value after surgery (ODI change for patients satisfied with treatment −35.3 [−44.4; −20.0] versus 0.9 [−15.5; 6.7] for those dissatisfied with treatment, both p <0.001), and these patients also had less pronounced endplate defects on preoperative MR images ($L3_{Upper}$ — 4 [4; 4] versus 4 [3; 5], p <0.05).

According to the univariate regression analysis, predictors of satisfaction with lumbar decompression surgery were determined by the VAS scores of the leg pain before surgery (OR=1.32, p=0.045) and the severity of neuropathic pain according to DN4 scale scores before surgery (OR=0.61, p=0.003); the higher the intensity of leg pain before surgery and/or the lower the intensity of neuropathic pain, the more probable the patient's satisfaction with surgical treatment.

Treatment success

In the comparison of patients who achieved MCID and were satisfied with surgical treatment with those who did not achieve MCID and were dissatisfied with treatment, the results revealed that the former group had higher leg and back pain intensity before surgery than after surgery (8 [7; 10] versus 7 [4; 8] for leg pain; 7 [5; 8] versus 4 [2; 7] for back pain, p=0.027 and p=0.015, respectively), greater functional disability according to ODI (57.50 [47.50; 62.22] in patients who achieved MCID and were satisfied versus 42.22 [35.00; 57.78] in patients who did not achieve MCID and were dissatisfied with treatment, p=0.034), lower leg pain intensity leg at the control examination (2 [1; 5] versus 6.5 [4; 7], p=0.000), lower back pain intensity after surgery (3 [2; 4] versus 6 [2.5; 6.5], p=0.009), and lower neuropathic pain intensity after surgery (2 [0; 3] versus 4.5 [2; 7], p=0.003), and these patients also had less severe endplate defects on preoperative MR images (p=0.015).

According to the univariate regression analysis, the predictor of surgical outcome of lumbar decompression is neuropathic pain before surgery based on DN4 (OR=1.52, p=0.011); if the DN4 neuropathic pain questionnaire score was high, the surgical outcome was highly probably negative.

Adverse events

No adverse events were registered in this retrospective study.

DISCUSSION

Summary of main study result

Surgical treatment of patients with clinical manifestations of degenerative lumbar stenosis can significantly improve their quality of life [3, 4]. Advance age is associated with a high comorbidity index, decreased bone density, and other conditions that limit the permissible scope of surgical treatment, mainly associated with the use of implants [16, 17].

Discussion of the main study result

The extent of degenerative lumbar stenosis (number of levels) and its severity increase with age [4]; however, these parameters do not affect the treatment outcomes. In patients with different severities and durations of degenerative spinal canal stenosis, M. Minetama et al. obtained identical results when they analyzed the treatment outcomes of 325 patients with single-level stenoses and 260 patients regardless of the number of levels [18, 19].

The effect of other degenerative changes in spinal motion segments remains controversial. The negative effect of MC on the surgical outcomes of degenerative spinal stenoses [20, 21] is refuted by current multicenter studies and meta-analyses [22–24]. According to A. Lawan et al., the effect of MC, in contrast to endplate defects, was insignificant. Endplate defects are one of the causes of intense lumbar pain, which was identified in a meta-analysis that included 26 original studies [18, 25], which agrees with our results, that is, patients who did not achieve MCID had more severe changes in the endplates $L1_{lower}$, $L2_{lower}$, $L3_{upper}$, $L5_{upper}$ than patients who achieved success; however, these indicators were not independent predictors of success.

The elimination of the risk factors of neural structure compression at clinically significant levels improves the condition in up to 80% of patients when sufficient anteroposterior size of the spinal canal is achieved [26]. Decompression is considered sufficient when recalibrating the spinal canal by one grade or lower according to the Schizas classification, which enables us to predict surgical success [7]. Moreover, excessive decompression, as reported by R.V. Khalepa et al. who studied the treatment outcomes of 107 older patients who underwent surgery for single-level stenoses, did not improve the medium-term treatment outcomes [26]. In the present study, recalibration of the spinal canal was noted in all patients using the minimally invasive "over-the-top" method, which technique is described in detail by A.A. Grin [27]. The degree of stenosis decreased by one grade in 62.29% of the cases, and in 37.71% of the patients, a decrease by two or more grades was noted. This result helped achieve morphological success in 100% of cases; however, with a higher degree of decompression, no differences in clinical manifestations and improvement in condition were found.

Several studies have reported that spinal sagittal balance had major contributions to the quality of life of the patients

[28, 29]. Sagittal imbalance influences clinical success. Patients operated on using metal fixators without correction of sagittal imbalance are susceptible to intense pain, worse functional results, and proximal transitional kyphosis [30]; however, the influence of impaired sagittal parameters on the outcomes of isolated decompressions remains controversial. Based on the results of a retrospective analysis of 109 patients who underwent surgery for degenerative spinal stenosis, distributed into groups with (SVA ⩾50 mm) and without (SVA <50 mm) impairment of the global sagittal balance, in the presence of compensated disorders, the SVA decreased after decompression, and in patients with severe disorders (SVA >80 mm), sufficient correction was not achieved, which affected the quality of life and functional outcomes of the patients [31, 32]. According to the results of the present study, sagittal imbalance, as well as SVA parameters, Barrey index, and other criteria, did not affect the outcomes of decompression in the mid-term follow-up (p >0.05). A representative case of treating a patient with severe sagittal imbalance is presented in Fig. 1.

K. Ikuta et al. analyzed the treatment outcomes of 69 patients who underwent endoscopic decompression for degenerative spinal stenosis and identified the “vacuum phenomenon” as a predictor of an unsatisfactory outcome. Outcome assessment was performed upon achievement of MCID according to ODI [33]. Moreover, Z.O. Knio et al. evaluated 68 patients who underwent surgery using the “over-the-top” technique and found that 24.5% of the patients had poor outcomes, and predictors, according to the results of the multivariate analysis, were female sex and smoking [34]. However, the effect of smoking on treatment outcomes at 1-year follow-up was refuted in a study of 195 patients [35].

Chronic preoperative pain (>3 months) and persistent back pain after decompression (>2 months) negatively influence the clinical outcomes of treatment [36]. Psychological, social, and many other characteristics of the patient can also

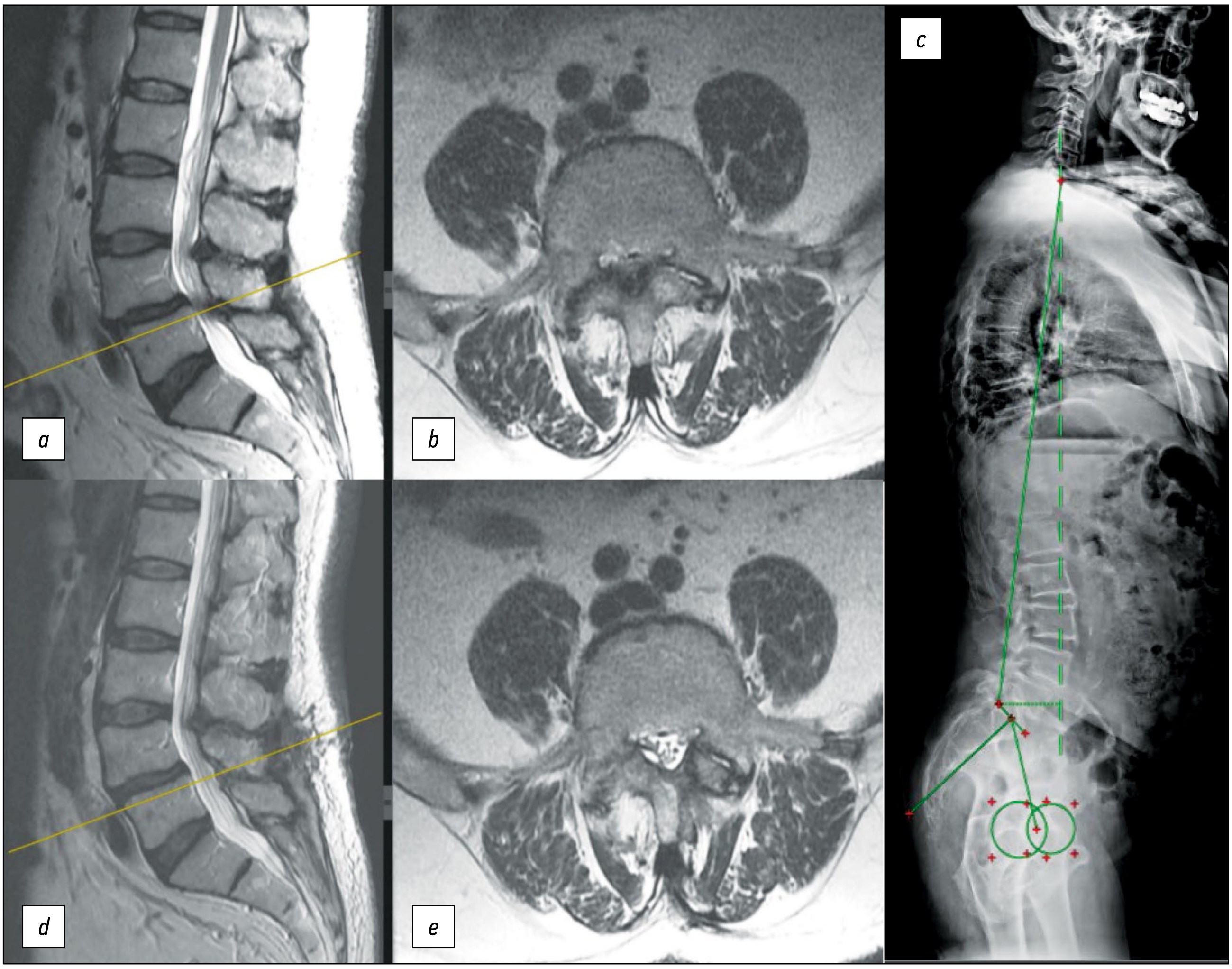

Fig. 1. Patient B., 83 years old. VAS in back — 5 points; VAS in leg — 8 points. ODI=47.5%. DN-4 — 2 points. MRI of the lumbar spine — degenerative stenosis L4-L5 Schizas grade D, degenerative spondylolisthesis L4 grade I. (Fig. 1, *a*, *b*). Postural radiography of the spine — Barrey Index = 1.76 (Fig. 1, *c*). Surgical treatment — microsurgical “over-the-top” decompression at L4-L5. Lumbar spine MRI after 1 year — recalibration of the spinal canal to Schizas grade A4 (Fig. 1, *d*, *e*). ODI — 4.0%, VAS in leg — 0 points, VAS in back — 3 points. Regression according to ODI by 43.50%, recalibration of the spinal canal confirmed, satisfaction with surgical treatment on the Likert scale: 5 — “Much better than before the surgery”. Treatment success achieved.

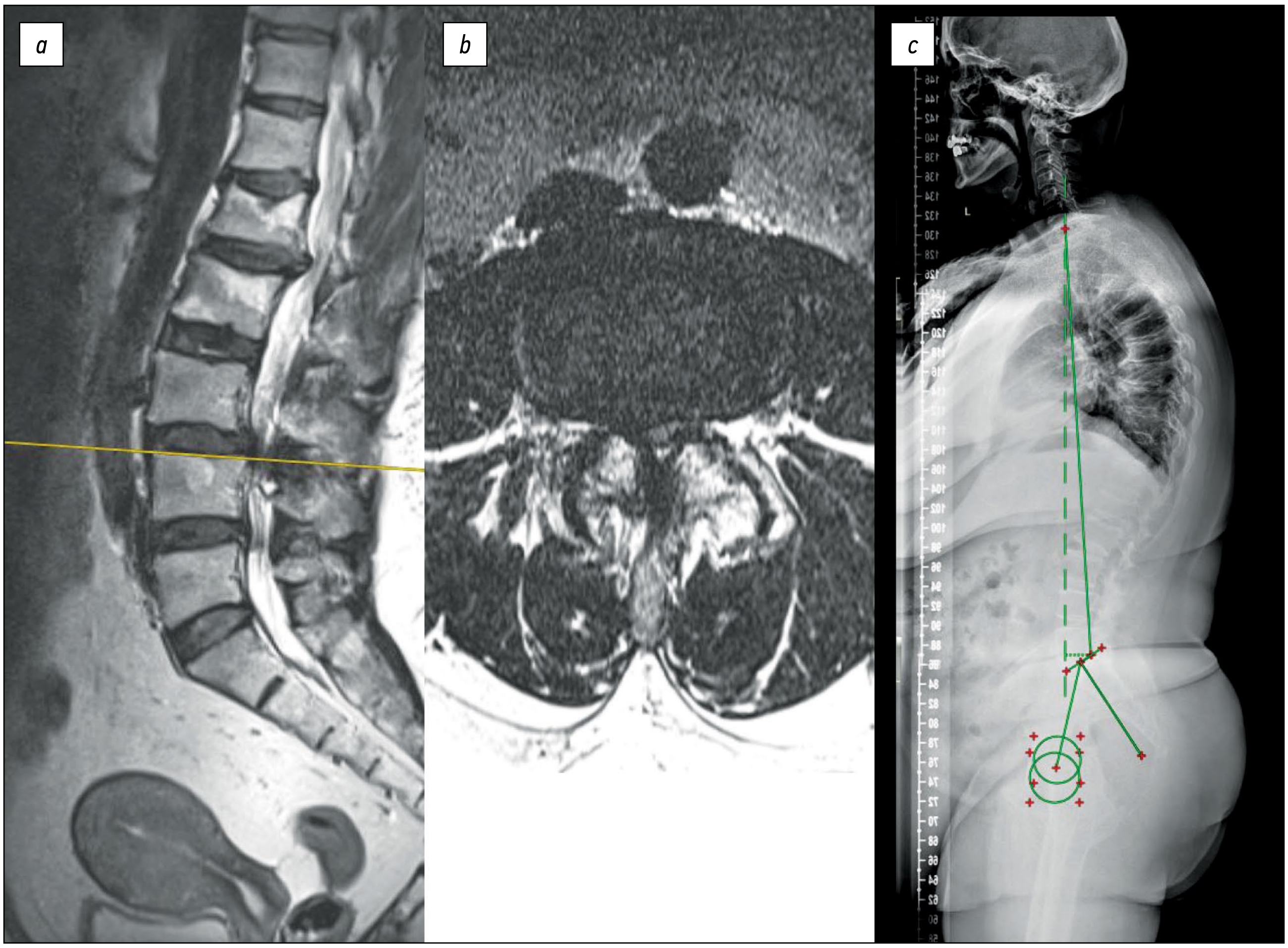

Fig. 2. Patient I., 62 years old: VAS in back — 4 points, VAS in legs — 5 points, ODI=64.44%, DN4 before surgery — 7 points; *a*, *b* — MRI lumbar spine — degenerative stenosis L3-L4, Schizas grade C (Fig. 2, *a*, *b*); Postural radiography of the spine — Barrey Index =0.71 (Fig. 2, *c*). Surgical treatment — microsurgical "over-the-top" decompression at L3-L4. Despite the achieved recalibration to Schizas grade B, the patient continues to have pain in the lower extremities. ODI — 48.89%, VAS in legs — 4 points, VAS in back — 3 points. Clinical success achieved — ODI regression by 15.5% recalibration of the spinal canal, but the patient is not satisfied with the result of surgical treatment — 3 on the Likert scale ("state without change"). The high value of neuropathic pain remains: DN4=7 points. Surgical treatment defined unsuccessful.

significantly affect the surgical outcomes [37, 38]. However, our study did not aim to analyze the above parameters, so they should be considered in other works.

A. Hiyama and E. Vagaska analyzed the intensity of pain syndrome in patients who underwent surgery for degenerative spinal diseases with nociceptive and neurogenic pain; they revealed that with greater pain intensity before surgery, the incidence of neuropathic pain syndrome was higher, with a tendency for persistently higher pain scores after surgery [39, 40]. In the analysis of predictors of neuropathic pain development, two independent factors, namely, sex and pain intensity, were identified. Pain syndrome with VAS score >4.5 points during the last 4 weeks and female sex were associated with a higher incidence of neurogenic pain syndrome, whereas the nature and degree of lumbar degenerative changes had no effect [40]. According to S.Y. Park et al., who analyzed 86 patients distributed into groups depending on the prevailing type of pain, neuropathic pain often developed in patients with compression radiculopathies (in approximately 1/3 of clinical cases), which must be considered in patients with degenerative spinal stenoses [41]. A representative case of treating a patient with neuropathic pain is presented in Fig. 2.

In certain clinical cases, post-decompressive neuropathy develops, characterized by non-dermatomal pain that differs from the initial one, mainly in the legs, which often disrupts sleep and can cause persistent pain that significant affects surgical outcomes [42]. The present study revealed an association between patient satisfaction with treatment and neuropathic pain as the only independent predictor of surgical success, which can be due to the development of post-decompression neuropathy. The wide distribution of the timing of neuropathic pain emergence and the ambiguity of symptoms complicate significantly the diagnostics and may underestimate an important predictor of a negative outcome. The need for antidepressants, anticonvulsants, and other therapies that affect neurogenic pain is justified at all stages of treatment to reduce the influence of this factor on the treatment outcomes of patients with high risks identified before surgery.

The intermediate group of patients, who achieved clinically significant improvement in their condition, but were dissatisfied with surgical treatment, is of particular interest. No factors differed significantly between the groups. This can be explained by patients' inflated expectations, sagittal profile disorders, and psychological, social, and many other characteristics, which may have led to the formation of a group of patients with successful clinical outcomes but were not satisfied with their health status after surgery. The study of such parameters requires more data.

Study limitations

- This retrospective study did not evaluate the comorbidity index, depression and anxiety (CES-D, GDS, HADS), which excluded the analysis of the psychological component of patients' health and its effect on the surgical outcomes.
- Concomitant diseases of patients, such as diabetes mellitus and its complications, particularly diabetic polyneuropathy, which could potentially affect the clinical manifestations and treatment outcomes, were not considered.
- The duration of pre- and postoperative pain syndrome was not assessed, which could be a predictor of the development of chronic pain syndrome and increased anxiety levels.
- The identified higher value of the Barrey index before surgery in patients with severe stenosis indicates the presence of sagittal imbalance; however, this parameter can be both functional and structural, which was not differentiated in this study, and its dynamics after surgery were not analyzed.

The level of evidence for the study according to the Oxford system is “–2.”

CONCLUSION

Lumbar decompression surgery for degenerative lumbar stenosis is an effective treatment method with predictable positive results, including degenerative sagittal deformities. A comprehensive standardized examination of patients before surgery, identifying risk factors such as neuropathic pain syndrome, will help reduce the incidence of complications and unsatisfactory outcomes.

ADDITIONAL INFO

Author contribution. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work. A.V. Krutko, A.G. Nazarenko, G.E. Balychev, E.S. Baykov, O.N. Leonova — designed the study; A.V. Krutko, A.G. Nazarenko, E.S. Baykov — surgical treatment; G.E. Balychev, E.S. Baykov, O.N. Leonova — analyzed data; G.E. Balychev, E.S. Baykov, O.N. Leonova — wrote the manuscript with input from all authors; A.V. Krutko, A.G. Nazarenko — oversaw the project.

Funding source. This study was not supported by any external sources of funding.

Competing interests. The authors declare that they have no competing interests.

Consent for publication. Written consent was obtained from the patient for publication of relevant medical information and all of accompanying images within the manuscript.

ДОПОЛНИТЕЛЬНО

Вклад авторов. Все авторы подтверждают соответствие своего авторства международным критериям ICMJE (все авторы внесли существенный вклад в разработку концепции, проведение исследования и подготовку статьи, прочли и одобрили финальную версию перед публикацией). Наибольший вклад распределён следующим образом: А.В. Крутько — хирургическое лечение пациентов, сбор и анализ литературных источников, написание и редактирование текста статьи; А.Г. Назаренко — хирургическое лечение пациентов, ревизия и редактирование текста статьи; Г.Е. Балычев — сбор и анализ литературных источников, подготовка и написание текста статьи; Е.С. Байков — хирургическое лечение пациентов, сбор и анализ литературных источников, написание и редактирование текста статьи; О.Н. Леонова — сбор и анализ литературных источников, подготовка, написание и редактирование текста статьи.

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования и подготовке публикации.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с проведённым исследованием и публикацией настоящей статьи.

Информированное согласие на публикацию. Авторы получили письменное согласие пациентов на публикацию медицинских данных и фотографий.

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AUTHORS' INFO

Aleksandr V. Krutko, MD, Dr Sci. (Med.);
ORCID: 0000-0002-2570-3066;
eLibrary SPIN: 8006-6351;
e-mail: ortho-ped@mail.ru

Anton G. Nazarenko, MD, Dr Sci. (Med.),
professor of Russian Academy of Sciences;
ORCID: 0000-0003-1314-2887;
eLibrary SPIN: 1402-5186;
e-mail: anazarenko@mail.ru

*** Gleb E. Balychev;**
address: 9 Novospasskiy per., 115172 Moscow, Russia;
ORCID: 0000-0001-7884-6258;
eLibrary SPIN: 9647-8748;
e-mail: balichev.gleb@gmail.com

Evgenii S. Baykov, MD, Cand. Sci. (Med.);
ORCID: 0000-0002-4430-700X;
eLibrary SPIN: 5367-5438;
e-mail: Evgen-bajk@mail.ru

Olga N. Leonova, MD, Cand. Sci. (Med.);
ORCID: 0000-0002-9916-3947;
eLibrary SPIN: 4907-0634;
e-mail: onleonova@gmail.com

ОБ АВТОРАХ

Крутько Александр Владимирович, д-р мед. наук;
ORCID: 0000-0002-2570-3066;
eLibrary SPIN: 8006-6351;
e-mail: ortho-ped@mail.ru

Назаренко Антон Герасимович, д-р мед. наук,
профессор РАН;
ORCID: 0000-0003-1314-2887;
eLibrary SPIN: 1402-5186;
e-mail: anazarenko@mail.ru

*** Балычев Глеб Евгеньевич;**
адрес: Россия, 115172, Москва, Новоспасский пер., 9;
ORCID: 0000-0001-7884-6258;
eLibrary SPIN: 9647-8748;
e-mail: balichev.gleb@gmail.com

Байков Евгений Сергеевич, канд. мед. наук;
ORCID: 0000-0002-4430-700X;
eLibrary SPIN: 5367-5438;
e-mail: Evgen-bajk@mail.ru

Леонова Ольга Николаевна, канд. мед. наук;
ORCID: 0000-0002-9916-3947;
eLibrary SPIN: 4907-0634;
e-mail: onleonova@gmail.com

* Corresponding author / Автор, ответственный за переписку