RESULTS OF STAGED SURGICAL TREATMENT OF PATIENTS WITH TANDEM STENOSIS OF THE CERVICAL AND LUMBOSACRAL SPINE

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Objective. To conduct a retrospective analysis of staged surgery in patients with tandem stenosis of the cervical and lumbosacral spine, to identify causes of poor outcomes.

Material and Methods. The study included 190 patients with tandem stenosis of the cervical and lumbosacral spine. Out of them 72 had symptomatic cervical and asymptomatic lumbosacral tandem stenosis (Group 1), 67 — symptomatic lumbar and asymptomatic cervical tandem stenosis (Group 2), and 51 — compression with neurological manifestations in both spine departments (Group 3). Patient's anthropometric data, initial clinical symptoms, and duration of disease were analyzed. The intraoperative characteristics of surgical interventions and features of the postoperative period, clinical parameters and the existence of complications were evaluated.

Results. Excellent and good postoperative outcomes were achieved in patients of Groups 1 and 2 with monosymptomatic tandem stenosis, in patients of Group 3 with symptomatic tandem stenosis, and in patients of all groups who underwent laminectomy and bilateral foraminotomy for bilateral symptomatic foraminal stenosis, and minimally invasive bilateral foraminotomy through unilateral approach in case of radiographic evidence of foraminal stenosis without symptoms.

Conclusion. Symptomatic tandem stenosis of the cervical and lumbosacral spine is a severe nosological entity requiring meticulous removal of pathological substrate primarily in the cervical spine. The early implementation of the second stage of surgery significantly reduces neurological symptoms, relieves pain and improves quality of life in patients.

Key Words: tandem spinal stenosis, diagnosis, surgical treatment.

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The term "tandem stenosis" refers to the combined reduction of the bone margins of the cervical and lumbosacral spinal canal [2, 15]. This pathology accounts for 0.12 to 28.0 % of all the degenerative diseases of the spinal column [1, 24]. Such a variance in the verification of simultaneous multiregional stenosis is associated with frequent absence of symptoms in one of the spinal segments along with the presence of morphological changes detected by neuroimaging [1, 17, 22].

Symptomatic stenosis of the cervical and lumbosacral spine is associated with various clinical symptoms, which complicates the diagnosis and selecting treatment strategy in these patients [12]. Meanwhile, the lack of instrumental data about the extensive pathological processes in several spinal segments in these patients may cause worsening of patients' state in the postoperative period due to prolonged unphysiological positioning with compression of neural structures in the initially asymptomatic segment [16].

Recent literature provides sufficient data about the surgical treatment of isolated stenosis of the cervical and lumbosacral spinal canal, but there is not enough information on the results of surgical treatment of patients with tandem stenoses [1, 4, 19]. There are contradictory approaches to the surgical tactics for symptomatic tandem stenoses: staged surgery, including primary operation on the cervical spine followed by lumbar surgery [8, 22] or, alternatively [5], one-stage decompression in all clinically relevant segments [9, 14, 22].

The study is aimed at retrospective analysis of the results of staged operations in patients with tandem stenosis of the cervical and lumbosacral spine and determining the causes of unsatisfactory results.

Material and Methods

A total of 1982 decompressive and decompressive-stabilizing operations on the cervical and lumbosacral spine was carried out at the Neurosurgical Center of the Railway Clinic at the Irkutsk Passazhirskiy station during the

period from January 2005 to December 2012. We analyzed 838 case records and medical cards of the outpatients, who underwent complex clinical and instrumental examination, including compulsory examination of neurological and orthopedic status, spondylography, MRI, and multislice CT.

Tandem stenosis of the cervical and lumbosacral spine was diagnosed in 190 examined patients: 72 of them had symptomatic stenosis of the cervical spine and asymptomatic stenosis of the lumbosacral spine (Group I), 67 —symptomatic lumbosacral stenosis and asymptomatic cervical stenosis (Group II), 51 patients had neurologic manifestations of compression in both spinal regions (Group III).

Anthropometric data (sex, age, body mass index), initial clinical symptoms, and duration of the disease were studied. We evaluated intraoperative characteristics and specifics of the postoperative period (duration of the operation, blood loss, activation time, length of hospital treatment), clinical parameters (VAS pain level, severity of motion restrictions in the cervical spine (NDI, neck disability index), quality of life according to the questionnaire for patients suffering from back pain (ODI), patient's satisfaction with the operation as assessed on the Macnab scale and objective dynamics of neurological outcome on the Nurick scale), and the presence of complications.

Staged decompression and stabilization were carried out in all patients with tandem stenosis (n = 190). In Groups I and II, the time elapsed between the stages was 18 (13; 25) months, which was associated with the appearance or worsening of clinical symptoms; in Group III, the time elapsed between operations was 19 (15; 28) days and depended on stabilization of somatic characteristics. In Group III, 29 patients primarily underwent cervical surgery, 22 — lumbosacral.

Discectomy or corpectomy, decompression of the spinal cord and its roots followed by interbody fusion with telescopic prosthesis placement was carried out in the cervical spine through the left-sided Cloward's retropharyngeal approach [7], in some cases supplemented by anterior cervical plate fixation. Some patients underwent posterior decompressive laminectomy with screw fixation of the lateral mass or laminotomy with laminoplasty in the area of stenotic process.

Laminectomy with unilateral or bilateral facetectomy, foraminotomy, posterior lumbar interbody fusion (PLIF), and open transpedicular fixation was carried out in the lumbar spine. In some cases, spinal canal reconstruction was carried out through the paramedian approach, including facetectomy with or without contralateral foraminotomy; interbody spinal fusion was performed using TLIF procedure in combination with transpedicular fixation [3, 4].

Statistical processing of the results was carried out using the Microsoft Excel and Statistica-8 software. The significance of differences in set samples was assessed using the nonparametric statistics criteria, where $p < 0.05$ was considered as the lower limit of significance. The data are represented by median and interquartile range in the form of Me (25; 75).

Results

General information about study group patients. General sex, age, and constitutional characteristics of the study groups are presented in Table 1. Data analysis showed that most of operated patients were middle age males (35–60 years), mainly overweight (>25 kg/m2).

Retrospective evaluation of neurological symptoms was carried out before the operative treatment of stenotic processes with allowance for various clinical manifestations of tandem stenosis of the cervical and lumbosacral spinal canal (Table 2).

The analysis showed that patients with symptomatic tandem stenosis of the cervical and lumbar spine had mutually exacerbating neurological symptoms with the most frequent clinical manifestations in the form of polyradicular syndrome (61 %) at the lumbosacral level; there were gait disorders (71 %), caudogenic intermittent claudication syndrome (62 %), movement disorders in the upper (61 %) and lower (59 %) limbs.

The study of disease duration from the onset of clinical symptoms to the first treatment stage showed that neurological symptoms manifested within the periods from one to three years in 56 (77.5 %) Group I patients and in 53 (79.0 %) Group II patients; more than three years — in 42 (82.0 %) Group III patients (Table 3).

Localization of the degenerative processes in the groups of operated patients as shown by MRI is summarized in Table 4. In all cases, multilevel process involving two or more spinal motion segments was detected.

MRI verified myelopathic lesions only in patients with symptomatic tandem stenosis (Group III) in 18 (35 %) cases, which required an extended reconstruction of the spinal canal for effective elimination of the compression of neurovascular structures.

According to the results of the multislice CT, the average anteroposterior size of the cervical spinal canal was 12.0 ± 1.2 mm, lumbar – 15.0 ± 1.9 mm, foraminal openings – 4.0 ± 0.8 mm.

Analysis of intraoperative characteristics of the surgery and specifics of the postoperative period. The data on the duration of surgery, the extent of blood loss, incision length, activation time, and length of hospital stay are summarized in Table 5.

The patients were activated after stabilization of general state of health, which depended on the volume of blood loss.

The extent of surgery on the cervical and lumbosacral spine is shown in Table 6.

Analysis of clinical outcomes. Operation resulted in significant decrease in the intensity of pain in the cervical spine and upper limbs. Assessment of VAS pain score demonstrated the positive dynamics in the form of significant decrease in pain intensity after surgery: from 74.5 mm (68; 86) to 15.5 mm (15; 22) in Group I; $p = 0.0072$; from 69.5 mm (65; 86) to 14.5 mm (12; 16) in Group II; $p = 0.0066$; from 75 mm (68; 86) to 16 mm (14; 22) in Group III; $p = 0.0077$ (Fig. 1).

Table 1

Sex, age, and constitutional characteristics distribution in studied groups of patients

Criteria	I (n = 72)	II (n = 67)	III (n = 51)
Age, years	56 (42; 60)	52 (45; 58)	55 (47; 5 9)
Males, n (%)	49 (68)	48 (72)	36 (70)
Body mass index (kg/m^2)	26,2 (23.3; 28.9)	25,8 (24.1; 30.2)	26,9 (23.6; 29.8)

Postoperatively, significant decrease in pain in the upper limbs was observed in all studied groups of patients: from 72 mm (65; 84) to 12 mm (12; 16); p = 0.0054; from 74 mm (66; 82) to 12 mm (10; 16); p = 0.0059; from 80 mm (72; 83) to 12 mm (12; 16); p = 0.0051, respectively (Fig. 2).

Assessment of VAS score of pain in the lumbar spine showed significant decrease in its intensity after surgery (pW <0.001): on the average, from 70 mm (64; 76) to 14 mm (14; 16) in Group I; p = 0.0072; from 68 mm (60; 74) to 14 mm (12; 16) in Group II; p = 0.0078; from 68 mm (60; 72) to 14 mm (14; 16) in Group III; p = 0.0076 (Fig. 3).

Decrease in pain in the lower limbs was also observed in all groups: from 68 mm (67; 72) to 15 mm (14; 18); p = 0.0056; from 68 mm (67; 74) to 14 mm (10; 18); p = 0.0061; from 67.5 mm (66; 72) to 15 mm (12; 18); p = 0.0050, respectively (Fig. 4).

Analysis of ODI values demonstrated significant positive dynamics of the functional state after surgery as compared to preoperative values: from 68 (64; 74) to 18 (16; 22) in Group I patients; pW = 0.0047; from 69 (64; 76) to 18 (16; 22) in Group II; pW = 0.0059; from 68 (66; 74) to 18 (16; 20) in Group III; pW = 0.0051 (Fig. 5).

Assessment of NDI showed the positive dynamic of the postoperative values as compared to preoperative level in all studied groups of patients: from 47 (44; 48) to 20 (16; 22); p = 0.0046; from 47.5 (42; 50) to 19 (15; 22); p = 0.0052; from 48 (46; 48) to 20 (14; 20); p = 0.0050, respectively (Fig. 6).

In the late period, the percentage of good and excellent outcomes assessed on the subjective satisfaction scale was 57 % (n = 41) in Group I, 58 % (n = 39) – in Group II, 55 % (n = 28) – in Group III (Fig. 7).

Complete regression of neurological symptoms and improvement of patients' state as assessed on the Nurick scale (an

Table 2

Distribution of clinical symptoms in the studied groups of patients with tandem stenosis of the cervical and lumbosacral spinal canal, n (%)

Symptom	Sign	I (n = 72)	II (n = 67)	III (n = 51)
Changes in the upper limb reflexes	Hyporeflexia, areflexia	25 (35)	–	7 (14)
	Hyperreflexia	15 (21)	–	18 (35)
	Pathological reflexes	22 (30)	–	21 (41)
Changes in the lower limb reflexes	Hyporeflexia, areflexia	6 (9)	23 (34)	13 (25)
	Hyperreflexia	24 (33)	12 (18)	11 (21)
	Pathological reflexes	18 (25)	8 (12)	16 (31)
Sensory disorders	Dermatomal	9 (13)	21 (32)	8 (16)
	Segmental disorder	14 (19)	14 (21)	13 (25)
	Conduction disorder	22 (31)	–	18 (35)
Movement disorders	In the upper limbs	26 (36)	–	31 (61)
	In the lower limbs	7 (10)	31 (46)	30 (59)
	Quadriparesis	17 (24)	–	11 (21)
Pain	Radicular pain in the arms	29 (41)	–	13 (25)
	Radicular pain in the legs	–	24 (36)	13 (25)
	Neck pain	17 (24)	–	11 (21)
	Lumbar pain	–	12 (18)	18 (35)
Polyradicular syndrome		11 (15)	13 (20)	31 (61)
Gait disturbance		27 (38)	–	36 (71)
Caudogenic intermittent claudication syndrome		–	47 (70)	32 (62)
Pelvic disorders		27 (37)	10 (15)	21 (41)

Table 3
Distribution of disease onset time in the studied groups of patients, n (%)

Duration of the disease	I (n = 72)	II (n = 67)	III (n = 51)
Less than 1 year	3 (4.0)	2 (3.0)	1 (2.0)
1 to 2 years	22 (30.5)	21 (31.0)	3 (6.0)
2 to 3 years	34 (47.0)	32 (48.0)	5 (10.0)
3 to 4 years	7 (10.0)	7 (11.0)	19 (37.0)
4 years and more	6 (8.5)	5 (7.0)	23 (45.0)

objective neurological outcome assessment scale) on the average 24 months after two-stage surgery was verified state in 10 % (n = 7) and 64 % (n = 46) of Group I patients, respectively, 7 % (n = 5) and 61 % (n = 41) of Group II patients, respectively, 8 % (n = 4) and 67 % (n = 34) of Group III patients, respectively (Fig. 8).

According to the results of the retrospective analysis, complications were classified as intraoperative, early and late postoperative related to surgery (Table 7).

Intraoperative complications include iatrogenic injury of the dura mater, dural sac, and/or the spinal root, wherein microsurgical durography was performed with additional application of fibrin glue.

The group of early postoperative complications included pathological conditions associated with the superficial infection of a postoperative wound with or without formation of intramuscular hematoma, which were effectively managed by conservative treatment. In this study, adverse cardiovascular effects have been avoided owing to strict adherence to the protocol for prevention of complications associated with deep vein thrombosis and pulmonary embolism due to elastic bandaging of the lower limbs and anticoagulant therapy.

In the late postoperative period, there were complications associated with herniation at the level adjacent to the operation site, formation of pseudarthrosis and instability of the fixation structure due to biomechanical load redistribution. In all cases, decompressive-stabilizing revision operations were carried out in the form of discectomy and isolated fusion

Table 4
Distribution of the location of cervical and lumbar spine lesions in the studied groups of patients, n (%)

Spinal segment	Involved level	I (n = 72)	II (n = 67)	III (n = 51)
Cervical	C4–C5, C5–C6	29 (40.0)	22 (33.0)	21 (41.0)
	C5–C6, C6–C7	39 (54.5)	38 (57.0)	27 (53.0)
	C4–C5, C5–C6, C6–C7	4 (5.5)	7 (10.0)	3 (6.0)
Lumbar	L2–L3, L3–L4	13 (18.0)	11 (16.0)	9 (18.0)
	L3–L4, L4–L5	19 (26.5)	20 (30.0)	12 (23.0)
	L4–L5, L5–S1	37 (51.5)	31 (47.0)	26 (51.0)
		3 (4.0)	5 (7.0)	4 (8.0)

Table 5
Distribution of intraoperative characteristics and postoperative management specifics in the studied groups of patients

Criteria	I (n = 72)		II (n = 67)		III (n = 51)	
	Cervical spine	Lumbar spine	Cervical spine	Lumbar spine	Cervical spine	Lumbar spine
Operation time, minutes	155 (130; 265)	210 (155; 240)	65 (135; 270)	215 (160; 235)	160 (135; 280)	205 (160; 220)
Volume of blood loss, ml	280 (180; 430)	330 (290; 520)	290 (175; 450)	325 (290; 510)	300 (190; 450)	350 (300; 550)
Activation time, day	2 (3; 4)	3 (3; 4)	2 (2; 3)	3 (3; 5)	2 (2; 4)	4 (3; 5)
Length of hospital stay, days	15 (12; 17)	13 (12; 17)	14 (13; 16)	14 (12; 16)	28 (21; 34)	28 (21; 34)

Table 6
Surgery type distribution in the studied groups of patients, n (%)

Segment	Operation	I (n = 72)	II (n = 67)	III (n = 51)
Cervical	Single-level corpectomy	62 (86.0)	56 (84.0)	40 (78.0)
	Two-level discectomy	6 (8.5)	4 (6.0)	2 (4.0)
	Two-level corpectomy	4 (5.5)	7 (10.0)	3 (6.0)
	Posterior decompression	–	–	6 (12.0)
Lumbar	Single-level laminectomy with unilateral facetectomy and foraminotomy	37 (52.0)	34 (51.0)	28 (55.0)
	Decompression through the paramedian approach with facetectomy and unilateral foraminotomy	32 (44.0)	28 (42.0)	19 (37.0)
	Decompression through the paramedian approach with facetectomy and bilateral foraminotomy	3 (4.0)	5 (7.0)	4 (8.0)

supplemented by posterior fixation in the cervical spine, discectomy, interbody fusion, and extension of posterior fixation system in the lumbosacral spine. In four cases, the absence of dynamics in neurological symptoms was verified. In the case of insufficient posterior decompression (arthrosis of the facet joints) in the cervical spine with preserved compression of the posterior portions of the spinal cord, single-level laminectomy provided positive effect in the postoperative period. In the case of incomplete primary decompression and the underestimated contralateral foraminal stenosis in the lumbar spine, isolated foraminotomy reduced radicular pain from the opposite side. The group of complications, which are not related to the aforementioned pathological conditions, was associated with formation of postoperative epidural fibrosis confirmed by MRI and/or MSCT-myelography.

The main clinical parameters directly correlating with postoperative clinical outcome and quality of life include VAS pain score, functional state (ODI), and the degree of motion restriction in the cervical spine (NDI). Correlation between the aforementioned clinical components and anamnestic data (duration of the disease), characteristic features of adopted surgical tactics (spinal segment priority in the surgery, the extent of decompression, time period between surgical stages), and postoperative adverse effects (cicatricial adhesive epiduritis, development of pseudarthrosis) was analyzed.

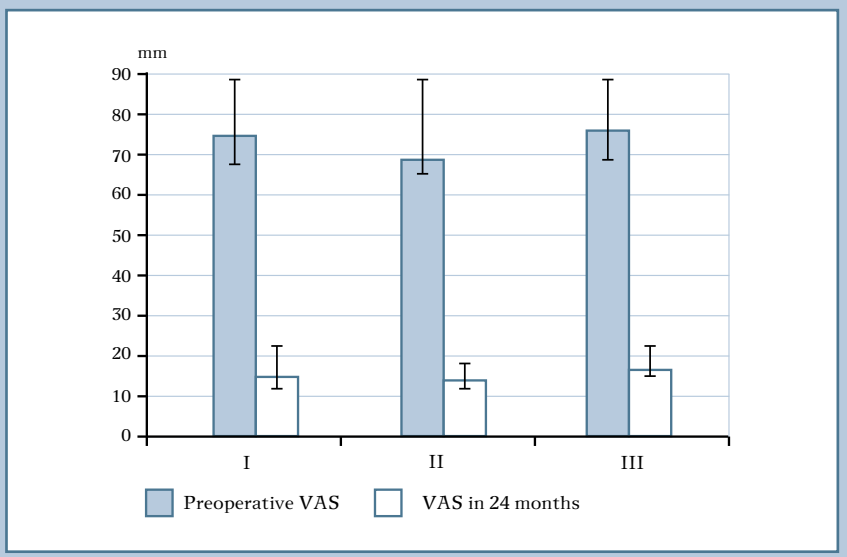

Fig. 1
Pain in the cervical spine in the studied groups of patients as assessed by VAS score over time

Significant positive nonparametric correlation between the value of long-term outcome of surgical treatment, as assessed by VAS, ODI, and NDI score, and investigated parameters was found (Fig. 9).

For the purpose of the detailed analysis of the impact of anamnestic data (duration of the disease), characteristics of the surgical treatment (priority of spinal region for primary intervention, extent of decompression, time period between surgical stages), and postoperative adverse effects (cicatricial adhesive epiduritis, development of pseudarthrosis) on the clinical outcome; as well as studying the possibilities to optimize treatment strategies in patients with tandem stenosis of the cervical and lumbo-

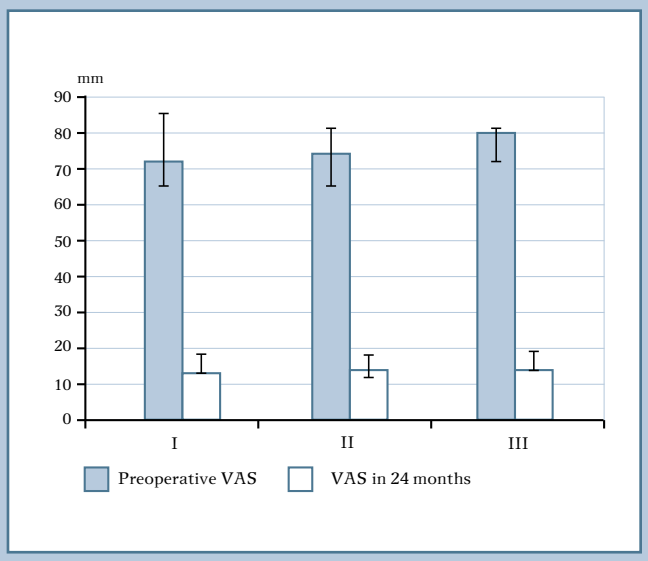

Fig. 2
Pain in the upper limbs in the studied groups of patients as assessed by VAS score over time

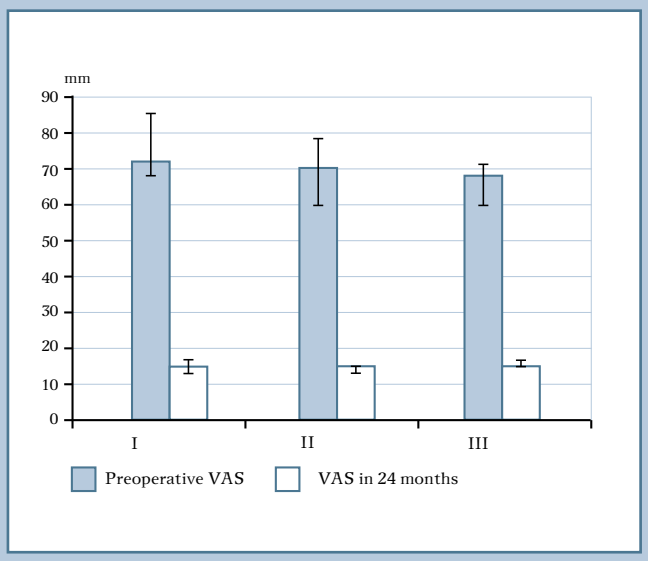

Fig. 3
Pain in the lumbar spine in the studied groups of patients as assessed by VAS score over time

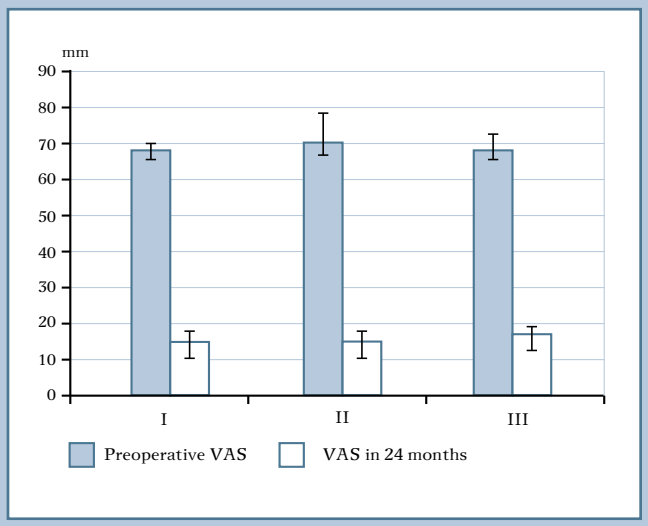

Fig. 4
Pain in the lower limbs in the studied groups of patients as assessed by VAS score over time

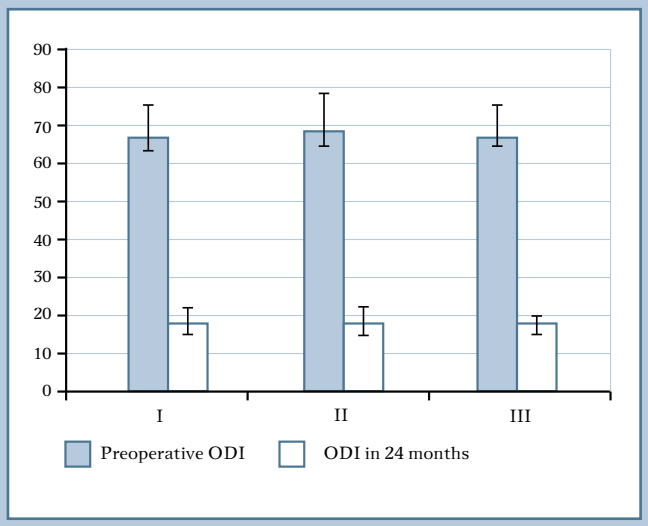

Fig. 5
Functional state of the study group patients as assessed by ODI score over time

sacral spinal canal, the result of the study were classified as follows:

– excellent and good postoperative outcome was determined as the VAS pain score up to 15 mm, ODI up to 15 points, NDI up to 20 points (as the minimum acceptable value that does not limit patient's daily activity);

– satisfactory and unsatisfactory postoperative outcome was determined as the VAS pain score of more than 15 mm, ODI more than 15 points, NDI more than 20 points (the values limiting daily motor activity).

The comparative analysis of clinical data depending on the postoperative outcome is shown in Table 8.

The analysis showed that excellent and good postoperative outcomes are associated with monosymptomatic tandem stenosis, disease duration of less than three years after the onset of symp-

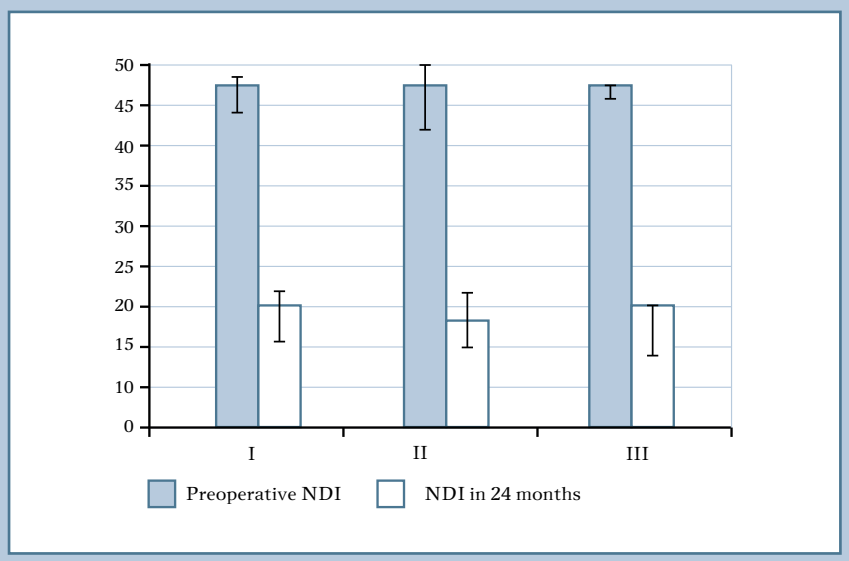

Fig. 6
The dynamics of movement restriction of the cervical spine in the studied groups of patients

toms, time between surgical interventions less than 6 months in Groups I (n = 72) and II (n = 67); symptomatic tandem stenosis with primary operations on the cervical spine, minimum time between stages (no more than 16 days), and decompression involving corpectomy, placement of distraction vertebral body replacement implant in the case of myelopathic lesion, and discectomy with interbody fusion in the case of its absence in Group III (n = 51); laminectomy and bilateral foraminotomy in the case of bilateral symptomatic foraminal stenosis and minimally invasive bilateral foraminotomy through the unilateral approach in the case of radiological signs of the foraminal stenosis without clinical symptoms in all groups.

Satisfactory and unsatisfactory postoperative outcomes directly correlate with duration of the disease, time elapsed between surgical steps, and characteristics of the adopted surgical tactics. In addition, these patients demonstrated clinically significant postoperative adverse effects in the form of insufficient decompression of the spinal roots, cicatricial adhesive epiduritis, cervical and lumbar pseudarthrosis.

The algorithm of the diagnosis and treatment shown in Fig. 10 was developed in order to optimize surgical outcomes of patients with tandem stenosis of the cervical and lumbar spine, taking into account the elimination of potential adverse effects.

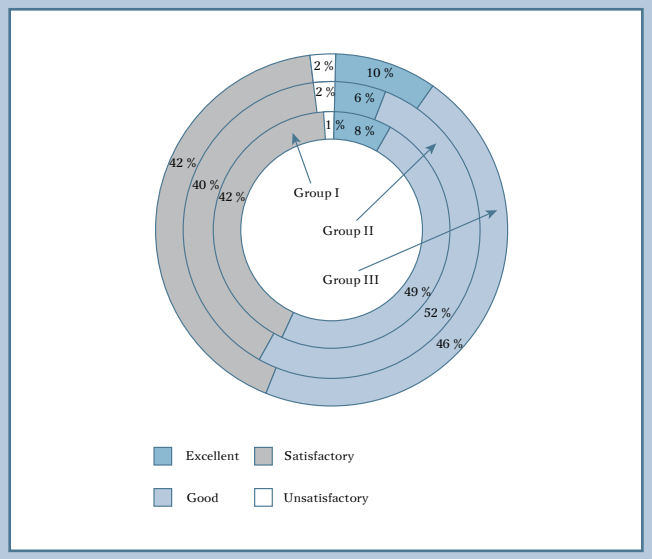

Fig. 7
Subjective satisfaction with operation in the late postoperative period as assessed by Macnab score in the studied groups of patients

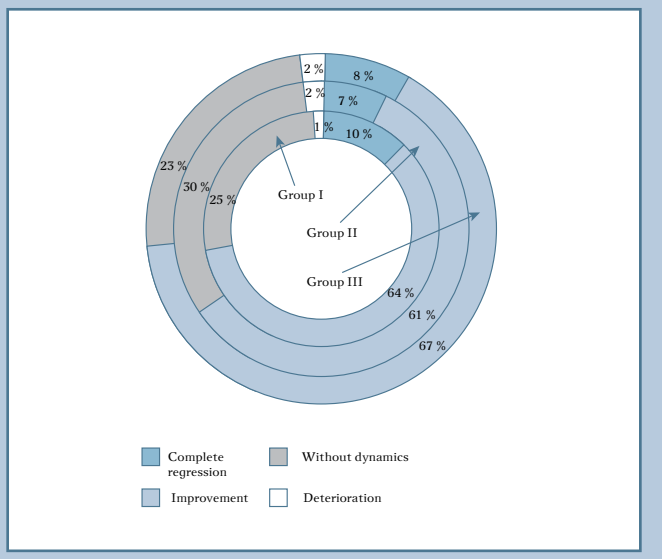

Fig. 8
The dynamics of neurological symptoms in the studied groups of patients in the late postoperative period as assessed by Nurick score

Table 7
Distribution of complications in the study group patients

Symptom	I (n = 72)		II (n = 67)		III (n = 51)	
	Cervical spine	Lumbar spine	Cervical spine	Lumbar spine	Cervical spine	Lumbar spine
Intraoperative complications, n (%)	3 (4.0)	4 (5.5)	3 (4.5)	3 (4.5)	3 (6.0)	3 (6.0)
Injury of the dura mater	3	2	2	1	3	1
Injury of the root	–	2	1	2	–	2
Early postoperative complications, n (%)	3 (4.0)	5 (7.0)	2 (3.0)	3 (4.5)	2 (4.0)	4 (8.0)
Formation of postoperative hematomas	1	3	1	1	1	2
Postoperative wound infection	2	2	1	2	1	2
Deep vein thrombosis, pulmonary embolism	–	–	–	–	–	–
Late postoperative complications, n (%)	13 (18.0)	8 (11.0)	11 (16.5)	13 (19.0)	11 (22.0)	12 (24.0)
Herniation of the disc adjacent to the operation level	2	1	2	2	1	2
Pseudarthrosis	3	3	4	3	3	4
Instability of the fixing implant	1	–	–	1	1	–
Persistence of symptoms due to inadequate decompression	2	1	2	2	2	2
Worsening of neurological symptoms due to cicatricial adhesive process	2	2	1	2	2	2
Worsening of neurological symptoms due to foraminal stenosis	3	1	2	3	2	2

Discussion

Tandem stenosis of the cervical and lumbar spine is a rarely diagnosed pathology (5–25 %). Moreover, clinical manifestations are verified even more rarely despite the neurovisualization data [14, 17, 18]. Thus, in 24–37 % of cases, there are asymptomatic neurovisualization signs of spinal canal stenosis [11, 20, 22, 25].

According to most authors, common neurological manifestations in case of symptomatic tandem spinal stenosis include movement disorders in the upper and lower limbs, polyradicular syndrome, gait disorders, and intermittent claudication syndrome [6, 17, 22]. This clinical polymorphism poses additional challenges in selecting the therapeutic and diagnostic tactics.

It was found that postoperative improvement of the symptoms in patients with tandem stenosis demonstrates inverse correlation with disease duration [8, 10, 15], but there is no information about the specific time intervals.

Some studies suggest that worsening of clinical symptoms after the initial intervention is possible, but there is no clear information about the time period between surgical stages [14, 19].

The lack of common approaches to the treatment of patients with tandem stenosis of the cervical and lumbosacral spine encourages researchers to discover diagnostic capabilities and optimal surgical correction methods [1, 17]. Currently, there are no observational data on the clinical course of monosymptomatic tandem stenosis and discussions of possible approaches to stage surgical interventions. At the same time, the difficulties in determining treatment strategy in patients with symptomatic extended stenosis of the spinal canal are associated with wide variety of neurological symptoms and polyetiologic pathological substrate [6, 22]. For example, in the case of degenerative narrowing of the cervical canal, even if there is neurovisualization evidence of the compression of the neurovascular structures in the lumbosacral spine, motor and sensory disturbances in

the lower limbs can be caused by compression of the cervical spinal cord, and therefore the operation on the lumbar segments will be ineffective or even lead to worsening of the clinical manifestations due to compression of the cervical spinal cord [12, 26]. Underestimated lumbar stenosis may be postoperatively complicated by caudal syndrome after the cervical surgery [24].

Based on the comprehensive evaluation of the anatomical, clinical, and instrumental characteristics, the authors developed a surgical algorithm to manage patients with tandem stenosis of the cervical and lumbar spine on the basis of factors, affecting the clinical outcome: anamnestic data (duration of the disease), features of the adopted surgical tactics (priority of spinal regions for primary intervention, the extent of decompression, and time period between surgical steps).

When analyzing the data of modern literature, it was found that most research on the results of the treatment of patients with tandem stenosis of the spinal canal are retrospective [13, 17, 21, 22] or describe individual clinical cases [12, 23, 24].

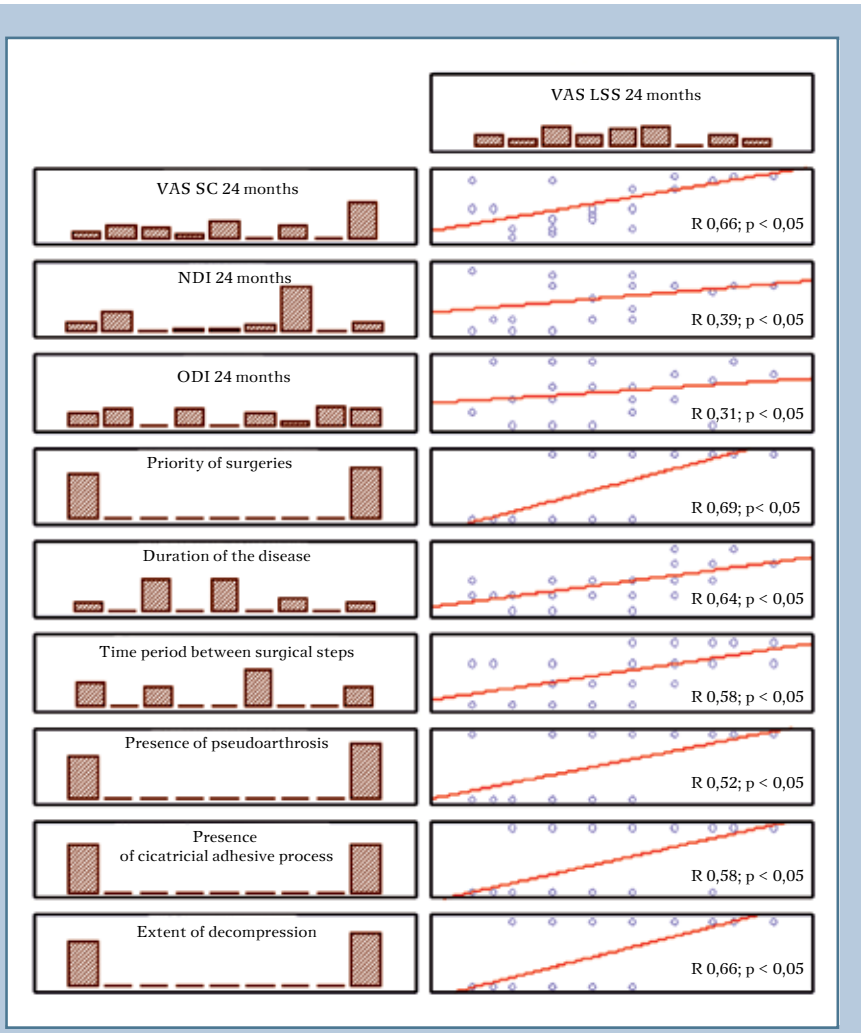

Fig. 9
General correlation relationships of the long-term clinical outcome: CS — cervical spine; LSS — lumbosacral spine

Conclusion

Additional MR imaging of the lumbar spine is indicated to all patients with symptomatic stenosis of the cervical spinal canal.

In the case of isolated symptoms associated with cervical or lumbar spine, surgery on the clinically relevant segment is indicated with allowance for the spread of the pathological process and primary localization of compressing substrate. Follow-up is required for rapid detection of symptoms associated with the other spinal segment and surgical intervention no later than 6 months from the time of onset of neurological manifestations.

Symptomatic tandem stenosis of the cervical and lumbosacral spine requires accurate elimination of the pathological substrate primarily in the cervical spine, while the early implementation of the second stage of surgical intervention significantly reduces neurological symptoms and pain and improves patient's quality of life.

Conducting the prospective multicenter studies of the effectiveness of surgical interventions in the treatment of patients with tandem stenosis of the cervical and lumbosacral spine, in particular the proposed algorithm, is the promising trend in the modern vertebrology.

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Table 8

Comparative analysis of clinical data vs postoperative outcomes in the studied groups of patients

Characteristic	I (n = 72)		II (n = 67)		III (n = 51)	
	good and excellent outcomes (n = 59)	satisfactory and unsatisfactory outcomes (n = 13)	good and excellent outcomes (n = 52)	satisfactory and unsatisfactory outcomes (n = 15)	good and excellent outcomes (n = 32)	satisfactory and unsatisfactory outcomes (n = 19)
VAS score of the cervical spine, the upper limbs in 24 months.	13 (12; 14)	24 (21; 27)	13 (11; 15)	25 (20; 26)	14 (12; 15)	23 (21; 26)
VAS score of the lumbosacral spine, lower limbs in 24 months.	13 (11; 14)	27 (20; 29)	12 (11; 13)	26 (22; 30)	13 (12; 15)	25 (20; 28)
NDI in 24 months.	16 (13; 18)	20 (18; 24)	16 (12; 18)	22 (18; 26)	16 (14; 18)	20 (16; 24)
ODI in 24 months.	12 (12; 14)	34 (26; 40)	12 (10; 14)	36 (30; 44)	12 (10; 14)	35 (28; 42)

Confidence coefficient $p < 0,01$.

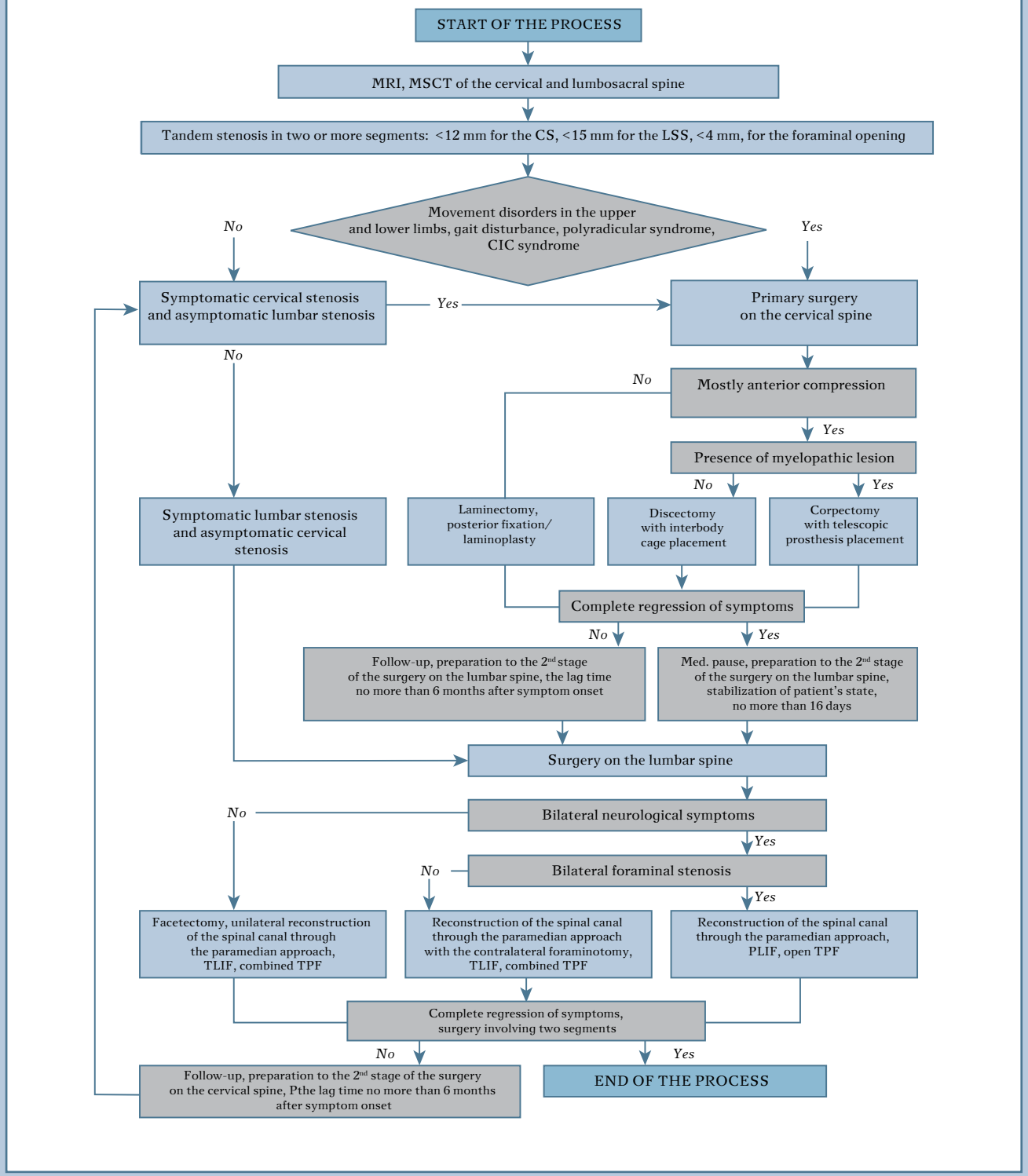

Fig. 10
The algorithm of surgical treatment of patients with tandem stenosis of the cervical (CS) and lumbosacral (LSS) spine: CIC — caudogenic intermittent claudication; TPF — transpedicular fixation

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