COMPREHENSIVE MANAGEMENT STRATEGY FOR PATIENTS WITH DEGENERATIVE-DYSTROPHIC SPINAL DISORDERS COMPLICATED BY CERVICAL MYELOPATHY WITH NEUROLOGICAL DEFICITS

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Relevance: Degenerative-dystrophic diseases of the spine complicated by spinal canal stenosis and chronic compression myelopathy are one of the leading causes of persistent disability. The combination of neurological deficit with neurogenic disorders of the lower urinary tract significantly reduces patients' quality of life and requires the development of comprehensive treatment approaches.

Objective: Assessment of the clinical effectiveness of a comprehensive management algorithm for patients with spinal canal stenosis complicated by cervical myelopathy and urological deficit.

Materials and methods: A prospective cohort study was conducted involving 250 patients (average age 43.1±14.2 years) who were treated at the Republican Center for Rehabilitation of Disabled Persons of the Republic of Uzbekistan during the period 2019-2023. Inclusion criteria were: verified diagnosis of vertebrogenic myelopathy/vertebral canal stenosis according to MRI/CT data, presence of neurological deficit (ASIA A-D) and pelvic organ dysfunction (USP scale). Patients were stratified according to disability groups (I-III). The treatment algorithm included differentiated conservative therapy, surgical decompression and stabilization (anterior spondylodesis with cage), correction of urological disorders, and multi-stage rehabilitation. The effectiveness was assessed using morphometry (CT/MRI), ASIA, VAS, MRC, mJOA, USP scales, and the EQ-5D-5L questionnaire. The statistical significance of the differences was taken at $p<0.001$.

Results: The application of the developed algorithm ensured a reliable decrease in the degree of spinal canal stenosis from an average of 81.06±0.53% to 51.93±0.49%. A pronounced positive trend in neurological status was noted: complete conversion of patients with complete transverse spinal cord injury (ASIA A) into incomplete lesions (categories B and C) was recorded. The proportion of patients with status B in the total sample increased from 3.9% to 57.8%. The intensity of pain syndrome decreased by 10.6 points on the VAS scale, muscle strength (MRC) increased from 3.33±0.06 to 3.93±0.06. A significant regression of lower urinary tract neurogenic dysfunction (a decrease in the USP scale indicator) and an improvement in the quality of life (an increase in the EQ-5D-5L index from 0.37 to 0.50) were revealed. The most pronounced clinical effect was achieved in group III of patients.

Conclusion: A comprehensive management strategy based on radical surgical decompression, targeted urological therapy, and individualized rehabilitation demonstrates high therapeutic effectiveness. The algorithm allows for a reliable reduction in the degree of stenosis, regression of neurological and urological deficit,

and a significant improvement in the quality of life of patients, which confirms its feasibility in clinical practice.

Keywords: vertebral canal stenosis, cervical myelopathy, neurogenic urinary tract dysfunction, spondylodesis, rehabilitation, quality of life.

Relevance. Degenerative-dystrophic diseases of the spine, accompanied by spinal canal stenosis and the development of chronic compression myelopathy, remain one of the most pressing problems in modern neurology, vertebrology, and rehabilitation. This is due not only to the widespread prevalence of this pathology among the working-age population but also to the severity of clinical manifestations leading to persistent disability [1, 2, 16, 25]. Neck myelopathy is characterized by progressive neurological deficit, pronounced pain syndrome, and profound impairment of patients' quality of life [3, 10, 18].</2

The problem of neurogenic disorders of the lower urinary tract (NURT), which are accompanied by vertebrogenic myelopathy, is of particular importance. Urinary disorders, often considered a secondary symptom, are a serious prognostic marker of spinal cord damage severity and significantly reduce patients' social adaptation [4, 5, 17]. Modern research indicates that isolated surgical removal of compression does not always guarantee complete regression of urological disorders, necessitating a comprehensive approach [6, 8, 21, 22].

In recent years, the management tactics for patients with spinal canal stenosis have significantly transformed: from aggressive surgical interventions to a differentiated approach, including staged conservative treatment, minimally invasive decompression, and multimodal rehabilitation [7, 15, 19]. However, the issues of optimizing the algorithm for managing patients with combined vertebrogenic and urological deficiencies remain insufficiently studied. The need to develop a unified strategy that allows not only to stop the progression of myelopathy but also to maximally restore pelvic organ function and somatic status determines the high significance of this study [9, 11, 12, 13, 14, 23, 24, 26].

Research objective. Improving the effectiveness of treating patients with degenerative spinal canal stenosis complicated by cervical myelopathy and neurogenic disorders of the lower urinary tract by developing and clinically justifying a comprehensive management algorithm, including surgical decompression, drug therapy, urological correction, and phased rehabilitation.

Material, research and treatment methods

A prospective cohort study was conducted with the inclusion of 250 patients with vertebrogenic myelopathy (VM) and spinal canal stenosis (SPC), who were treated at the Republican Center for Rehabilitation of Disabled Persons of the Republic of Uzbekistan during the period 2019-2023. All patients signed the informed consent.

Inclusion criteria: MRI/CT data confirmation of TM/CBC diagnosis; Presence of neurological deficit (ASIA A-D scale); Age ≥18 years; Presence of pelvic organ dysfunction according to the USP scale.

Exclusion criteria: Acute spinal injuries (less than 6 months); Oncological diseases; Tuberculous spondylitis; Mental disorders that prevent interaction.

Characteristics of the studied groups

The cohort included 250 patients (men - 79.6%, women - 20.4%; average age 43.1±14.2 years). Patients were stratified by disability groups: Group I (n=86): patients with Group I disability, average age 40.5±13.4 years; Group II (n=62): patients with Group II disability, average age 52.6±10.5 years; Group III (n=102): patients with Group III disability, average age 43.4±15.1 years.

Etiological structure of patients: Post-traumatic myelopathies (68%); Degenerative lesions (25%); Congenital/systemic diseases (5%); Consequences of inflammation (2%).

Patient examination methods

To objectively assess the effectiveness of the developed algorithm for managing patients with spinal canal stenosis, a comprehensive clinical and instrumental examination of 250 patients was conducted, divided into three study groups. The examination was carried out in two stages: at the initial treatment stage (before treatment) and after the completion of the therapy course.

Instrumental research methods

Morphometric assessment of the degree of spinal canal stenosis was carried out based on radiation diagnostic data (CT/MRI). The main quantitative criterion was the percentage of stenosis, determined by the ratio of the channel lumen area to normal values or by measuring the sagittal diameter at the lesions.

Clinical and neurological methods

Assessment of neurological deficit included the use of standardized scales:

The ASIA scale (American Association of Traumatologist-Orthodontists) was used to classify the degree of spinal cord conduction disorders. Patients were divided into categories from A to D depending on the preservation of motor and sensory functions below the level of damage (A - complete absence, D - minor impairment).

The MRC (Medical Research Council) scale was used to assess the strength of upper and lower limb muscles in points (0 to 5), allowing for the objectification of the degree of paresis.

Visual-analog scale (VAS): used to subjectively assess the intensity of the patient's pain syndrome (from 0 to 100 mm).

Assessment of functional status and quality of life

The following questionnaires were used to analyze the dynamics of pelvic disorders and the quality of life:

Modified Osaka University Scale (mJOA): used to assess the severity of myelopathic syndrome and the patient's functional state.

The USP scale was used to determine the severity of neurogenic disorders of the lower urinary tract (NURT) and the degree of urological disorders.

The EQ-5D-5L questionnaire was used for an integral assessment of patients' quality of life, taking into account mobility, self-care, daily activity, pain/discomfort level, and anxiety/depression.

Statistical data processing

The obtained data were subjected to statistical analysis. For each group and the general sample, the arithmetic mean (M) and error of the mean (m) were calculated. The reliability of the differences between the indicators before and after treatment

was assessed using statistical significance criteria. Differences were considered significant at a significance level of $p<0.001$.

Treatment methods

Neurological and vertebrological aspects

Treatment tactics were based on a differentiated approach, taking into account the degree of spinal canal stenosis, the severity of neurological deficit, and the effectiveness of the therapy. The first priority was the prescription of conservative treatment, which included both medicated and non-medicated components. Pharmacotherapy began with the use of non-steroidal anti-inflammatory drugs (NSAIDs); in case of chronic pain syndrome resistant to NSAIDs, the transition to gabapentinides was carried out. The treatment regimen was also supplemented with muscle relaxants and neuroprotective drugs. Physiotherapeutic influence and therapeutic exercises (TP) were aimed at suppressing inflammation and pain, strengthening the muscular corset, as well as correcting posture and movement biomechanics. Patients with moderate symptoms were under dynamic observation: control MRI/CT was performed every 12-24 months, and neurological status assessment was performed every 3-6 months.

Surgical intervention is indicated in cases of spinal canal stenosis greater than 50%, pronounced root or myelopathic syndrome, as well as in cases of progression of symptoms or ineffectiveness of complex conservative therapy for 3-6 months. The choice of surgical decompression and stabilization method was individualized based on CT/MRI data. In the study group (n=103), various types of anterior access were used: the most common methods were spondylodesis using a cone-shaped cage (46 patients, 44.7%) and spondylodesis with a cage (40 patients, 38.8%). Corporectomy with Z-plastics was performed in 14 patients (13.6%), other methods (including telescopic implants) - in 3 patients (2.9%).

Urological tactics were aimed at correcting neurogenic disorders of the lower urinary tract, taking into account their type and severity. It was recommended to consult a urologist when the first signs of disorders appear. As part of the primary conservative strategy, preventive measures were implemented: forced bladder emptying and constipation prevention. Patients with minimal dysfunctional manifestations were under dynamic observation. If urination is delayed, immediate correction was performed by periodic catheterization (if ineffective - permanent catheter). In the mixed type of neurogenic dysfunction, combined pharmacotherapy (alpha-blockers and anti-muscarinic drugs) was prescribed. In cases of urinary incontinence, behavioral therapy, biological feedback, and medication therapy were used. Invasive methods were considered when kidney function was threatened or conservative therapy was ineffective. Monitoring of kidney function every 6-12 months was mandatory.

The rehabilitation program was multi-stage and adapted to the severity of the patient's condition and the stage of the disease. In the acute period or with a pronounced deficit, an intensive program was used, including botulinum therapy (to alleviate spasticity), muscle relaxants, and intensive physical therapy, with primary attention to the prevention of contractures and bedsores. The comprehensive program in the recovery period combined modern methods such as biological feedback with

pelvic organ electrostimulation and physical therapy aimed at strengthening muscles, improving coordination, and restoring walking skills. Physiotherapy, massage, and traction were used as auxiliary methods to restore the biomechanics of the spine. The prophylactic program in the chronic stage focused on training the patient in ergonomics, physical therapy to strengthen deep back muscles and muscle corset, posture correction, as well as recommendations for regular aerobic exercises.

Research results

A comprehensive analysis of the clinical data presented in Table 1 indicates the high therapeutic effectiveness of the implemented algorithm for managing patients with spinal canal stenosis. Statistical processing of the material confirms the reliability of the obtained results in all studied cohort groups (I, II, III groups and general sample), demonstrating the achieved level of significance $p<0.001$ for all key indicators. This indicates that the observed improvements are not accidental, but are a direct consequence of the therapeutic effect.

Table 1.

Comparative assessment of treatment effectiveness in the studied groups

indicator	Group I (n=86) before / after (p)	II group (n=62) before / after (p)	Group III (n=102) before / after (p)	total for the algorithm (n=250) before / after (p)
Vertebral canal stenosis, %	83.39±0.74 60.04±0.56 < 0.001	78.07±1.05 53.08±0.68 < 0.001	80.12±0.96 41.66±0.50 < 0.001	81.06±0.53 51.93±0.49 < 0.001
Motor disorders (ASIA) abs. (%)	Before: A:75 (68.8), B:4 (3.7), C:24 (22), D:6 (5.5) Pos: A:0, B:68 (62.4), C:35 (32.1), D:6 (5.5)	Before: A:14 (24.6), B:3 (5.3), C:33 (57.9), D:7 (12.3) Pos: A:0, B:21 (36.8), C:29 (50.9), D:7 (12.3)	Before: A:38 (45.2), B:3 (3.6), C:23 (27.4), D:20 (23.8) Pos: A:0, B:59 (70.2), C:5 (6), D:20 (23.8)	Before: A: 127 (49.6), B:10 (3.9), C: 80 (31.3), D:33 (12.9) Pos: A:0, B:148 (57.8), C:69 (27), D:39 (15.2)
YOUR	55.12±0.85 45.28±0.76 < 0.001	54.11±0.42 42.11±0.42 < 0.001	48.10±0.42 38.10±0.42 < 0.001	52.44±0.42 41.83±0.42 < 0.001
Muscle strength (MRC)	2.49±0.07 3.30±0.06 < 0.001	3.60±0.10 4.00±0.10 < 0.001	3.90±0.10 4.50±0.10 < 0.001	3.33±0.06 3.93±0.06 < 0.001
mJOA	6.52±0.19 8.53±0.16 < 0.001	7.39±0.13 9.39±0.13 < 0.001	8.40±0.13 10.50±0.13 < 0.001	7.44±0.13 9.47±0.13 < 0.001
NFTOs (USP scale)	60.05±3.31 44.97±2.49	54.56±3.99 36.92±2.72	35.24±3.21 17.62±1.61	50.71±2.08 33.50±1.38

	< 0.001	< 0.001	< 0.001	< 0.001
Quality of Life (EQ-5D-5L)	0.34±0.01 0.42±0.01 < 0.001	0.40±0.02 0.53±0.02 < 0.001	0.37±0.02 0.55±0.02 < 0.001	0.37±0.01 0.50±0.01 < 0.001

Note: Before - indicators before treatment; Pos - indicators after treatment; p - level of statistical significance.

Morphometric assessment of radiological parameters revealed pronounced positive dynamics in relation to the degree of spinal canal stenosis. In group I (n=109), the stenosis index decreased from 83.39±0.74% to 60.04±0.56%. In group II (n=56), a decrease in the indicator from 78.07±1.05% to 53.08±0.68% was noted. The most significant decompression of nerve structures was recorded in group III (n=91): the degree of stenosis decreased more than twice, reaching 41.66±0.50% at the time of treatment completion compared to the initial 80.12±0.96%. Aggregated data for the entire patient population (n=250) show a decrease in the average percentage of stenosis from 81.06±0.53% to 51.93±0.49%, which confirms the radicalism and consistency of the applied surgical tactics.

Assessment of neurological status according to the ASIA (American Association of Traumatologist-Orthodontists) scale demonstrated a qualitative restoration of spinal cord conduction functions. In the preoperative period, the most severe category of disorders (status A - complete absence of motor and sensory functions below the level of damage) prevailed in group I (68.8% or 75 people). A critical factor is the complete reduction of patients with A status in all groups after treatment. Thus, in group I, the conversion of most patients to status B (62.4%) and C (32.1%) occurred. In group II, the number of patients with B status increased from 5.3% to 36.8%. In group III, a significant increase in the proportion of patients with B status was also recorded - from 3.6% to 70.2%. In the general sample, the proportion of the most severe lesions regressed to zero, and the proportion of incomplete spinal cord lesions (Status B) increased from 3.9% to 57.8%, indicating a transition of the clinical picture to a more favorable predictable course.

Analysis of subjective and objective indicators of the somatic status revealed a persistent trend towards a decrease in pain syndrome and restoration of muscle strength. The intensity of pain on the VAS scale decreased in all groups, with the highest absolute dynamics in group II (12 points decrease). The sample mean improved from 52.44±0.42 to 41.83±0.42. In parallel, a significant increase in muscle strength was noted on the MRC scale: in group I - from 2.49 to 3.30 points, in group II - from 3.60 to 4.00, in group III - from 3.90 to 4.50. The average value of muscle strength according to the algorithm increased from 3.33±0.06 to 3.93±0.06, reflecting the real restoration of skeletal muscle innervation.

The patients' functional state and quality of life underwent positive changes. Assessment on the modified Osaka University scale (mJOA) showed an improvement in neurological status by an average of 2.03 points (from 7.44 to 9.47). Manifestations of neurogenic impairment of the lower urinary tract (NIPT) on the USP scale significantly decreased, which indicates the effectiveness of urological tactics. The most pronounced regression of urological symptoms was noted in group III, where the indicator improved more than twice (from 35.24 to 17.62 points). The

integral quality of life indicator (EQ-5D-5L) demonstrated growth in all groups, with maximum growth in group III (0.37 to 0.55), which correlates with the best indicators of decompression and neurological recovery in this cohort.

Debate

The obtained results confirm the validity of a differentiated approach to treating patients with spinal canal degenerative stenosis, which meets modern international standards and national guidelines [1, 11, 21, 26]. A fundamental success factor is achieving adequate radiculomyelodecompression, which is clearly demonstrated by morphometric data. The decrease in the degree of stenosis in the population from an average of 81% to 52% (and in the third group to 41.66%) indicates that the volume of surgical intervention was sufficient to restore cerebrospinal fluid dynamics and eliminate mechanical compression of the spinal cord and nerve roots, which correlates with the data of Fehlings M.G. et al., as well as modern reviews on the importance of radical decompression for improving the neurological outcome [12, 23, 24].

The anatomical prerequisites created were the basis for the restoration of neurological deficit. The dynamics of the ASIA scale deserve special attention. The complete elimination of patients with category A (complete transverse damage) and their mass transition to categories B and C has key prognostic significance. In neurological practice, according to research by Tetreault L. et al. and other authors, the transition of complete damage to incomplete damage is considered a critical moment that opens up opportunities for further neuroplasticity of the spinal cord [3, 7, 13]. The redistribution of patients towards lighter categories of disorders, primarily to category B (57.8% in the general sample), serves as an objective marker of conduction disorders regression, which is confirmed by data from various clinical studies [2, 20].

The positive correlation between decreased compression, decreased pain (VAS), and increased muscle strength (MRC) confirms the pathogenetic relationship between mechanical factor (stenosis), nerve tissue ischemia, and clinical manifestations [14, 25]. Elimination of compression contributes to the reduction of inflammatory exudation and swelling, which leads to the suppression of nociceptive impulses. It should be noted that the III group demonstrated the best results in a whole range of indicators. This allows us to assume that the methodological approach used in this group provides the most favorable conditions for neural rehabilitation, which aligns with the works of domestic authors on the advantages of early activation, comprehensive conservative therapy, and specialized rehabilitation [15, 16, 22].

The effectiveness of the urological aspect of treatment, confirmed by a decrease in the USP index, especially pronounced in group III (a decrease of more than 2 times), emphasizes the importance of comprehensive management. Correction of neurogenic urinary dysfunction not only improves patient comfort but is also a vital measure for the prevention of ascending infection and chronic renal failure, which has been repeatedly indicated in urological literature during the management of patients with spinal cord injuries and diseases [4, 5, 17]. The close relationship

between NFTD regression and decreased stenosis degree confirms the leading role of the compression factor in the genesis of pelvic disorders in this pathology.

The increase in the EQ-5D-5L index, as an integral indicator of intervention success, demonstrates the transformation of clinical improvements into real improvements in patients' social well-being [18, 19, 10, 20]. Improving the quality of life means that reducing pain and restoring physical activity allows patients to return to daily life and reduce the level of disability, which is the ultimate goal of any rehabilitation process.

Conclusions

1. The application of the developed algorithm provides reliable and pronounced decompression of the spinal canal, as evidenced by a decrease in the degree of stenosis in the general group from an average of 81.06±0.53% to 51.93±0.49% ($p<0.001$). The most radical reduction in stenosis was noted in group III of the study, which emphasizes the effectiveness of the chosen surgical tactics.
2. Treatment contributes to a significant regression of neurological deficit: complete conversion of patients with complete transverse spinal cord damage (ASIA status A) into incomplete lesions (statuses B and C) has been recorded. In the overall sample, the proportion of patients with incomplete damage (Status B) increased from 3.9% to 57.8%, which significantly improves the rehabilitation prognosis.
3. A pronounced reduction in pain syndrome (reduction on the VAS scale by an average of 10.6 points) and restoration of muscle strength (increase in the MRC indicator from 3.33±0.06 to 3.93±0.06) were achieved, which indicates a qualitative improvement in the somatic status and restoration of musculoskeletal system function.
4. A comprehensive approach, including urological monitoring and therapy, ensures a reduction in the severity of neurogenic disorders of the lower urinary tract (USP scale), which is most pronounced in group III of patients and is a preventative measure for severe urological complications.
5. The cumulative effect of treatment leads to a significant improvement in the quality of life of patients (increase in EQ-5D-5L from 0.37 to 0.50), confirming the high clinical, social, and economic effectiveness of the proposed algorithm for managing patients with spinal canal stenosis.

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