



DIFFERENTIATED ANALYSIS OF ANTERIOR, CENTRAL AND POSTERIOR MEDULLARY SYNDROMES IN CERVICAL RADICULOMYELOPATHY

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<https://doi.org/10.5281/zenodo.20483640>

Abstract

Cervical spondylotic radiculomyelopathy (CSR) is one of the most common forms of degenerative spinal disorders, leading to compression of the spinal cord and nerve roots. The aim of this study was to investigate the clinical and neurological manifestations of various types of medullary syndromes and to identify patterns in their development depending on morphological and neurophysiological factors. A comprehensive analysis of 77 patients with various forms of radiculomyelopathy was conducted. Significant differences in clinical manifestations were identified for anterior medullary, centromedullary, and posterior medullary syndromes.

Keywords: *cervical spondylotic radiculomyelopathy, myelopathy, medullary syndromes, mJOA, Nurick, VAS, NDI.*

Relevance

Current understanding of the pathogenesis of spondylotic radiculomyelopathy is based on the interaction of mechanical, vascular, and neurodegenerative factors. Compression of the spinal cord and its roots due to degenerative changes in the cervical spine leads to the development of persistent neurological impairments, which often lead to patient disability. Despite the widespread prevalence of the disease, the clinical heterogeneity and multilevel nature of the lesions create difficulties in diagnosis and the selection of surgical treatment strategies.

The problem of adequately correlating clinical manifestations with radiological and neurophysiological diagnostic data remains a pressing issue in neurosurgery. Particularly important is the differentiated analysis of the three types of medullary syndromes—anterior, central, and posterior—each characterized by specific clinical and pathological features.

Purpose of the study

To conduct a differentiated analysis of clinical manifestations, neurophysiological changes, and surgical outcomes in patients with various types of medullary syndromes associated with cervical spondylotic radiculomyelopathy.

Materials and methods

The study included 77 patients (44 men [57.1%] and 33 women [42.8%], with a mean age of 52 ± 8 years) who were treated at the Department of Spinal and Spinal Cord Pathology at the RSNPMTSN between 2020 and 2021. All patients were diagnosed with cervical spondylotic radiculomyelopathy. The clinical examination included an assessment of neurological status,

motor and sensory deficits, and conduction symptoms, as well as the use of the Nurick, mJOA, VAS, and NDI scales to evaluate disease severity and quality of life.

Imaging studies included X-rays, CT scans, and MRI scans of the cervical spine, as well as electroneuromyography (ENMG). Neurophysiological studies identified three main clinical types of lesions:

- **anterior medullary syndrome – 41 (53.2%) patients,**
- **centromedullary syndrome – 25 (32.5%) patients,**
- **posterior medullary syndrome – 11 (14.3%) patients.**

The inclusion criteria were: evidence of spinal cord compression on MRI, clinical manifestations of radiculomyelopathy, and the absence of a traumatic or inflammatory cause of the disease.

Research findings

1. Anteromedullary syndrome

Motor deficits, primarily in the form of upper paraparesis and tetraparesis, were predominant, indicating involvement of the anterior spinal cord structures. Sensory deficits were moderate and less severe than the motor deficits.



Picture 1. A). Sagittal MRI. Canal stenosis at the C5-C6 level with an area of myelopathy. B). Postoperative sagittal MRI; microdiscectomy at the C5-C6 level via a left parapharyngeal approach and spondylodesis using a PEEK cage.

In the postoperative period, an improvement in neurological status was observed in 78% of patients, no change in 22%, and no deterioration was reported. Mean scores on the mJOA scale increased from 10.5 to 15 ($p \leq 0.0001$), and on the Nurick scale from 3 to 1.5.

Pain intensity on the VAS scale decreased from 7 to 2 points.

2. Centromedullary syndrome

It was characterized by a uniform distribution of motor and sensory impairments, with a predominance of segmental disorders.



Picture 1. A). Sagittal MRI of the cervical spinal cord. Canal stenosis at the C5-C6 level with spinal cord compression and myelomalacia. B). Postoperative sagittal MRI; Microdiscectomy at C5-C6 via left parapharyngeal approach and PEEK cage spondylodesis.

An improvement in condition was observed in 84% of patients, no change in 12%, and a worsening in 4%. The average mJOA score increased from 11 to 14, while the VAS score decreased from 6 to 2 points.

3. Posterior medullary syndrome

The main symptoms were sensory disturbances and ataxia resulting from damage to the posterior columns.

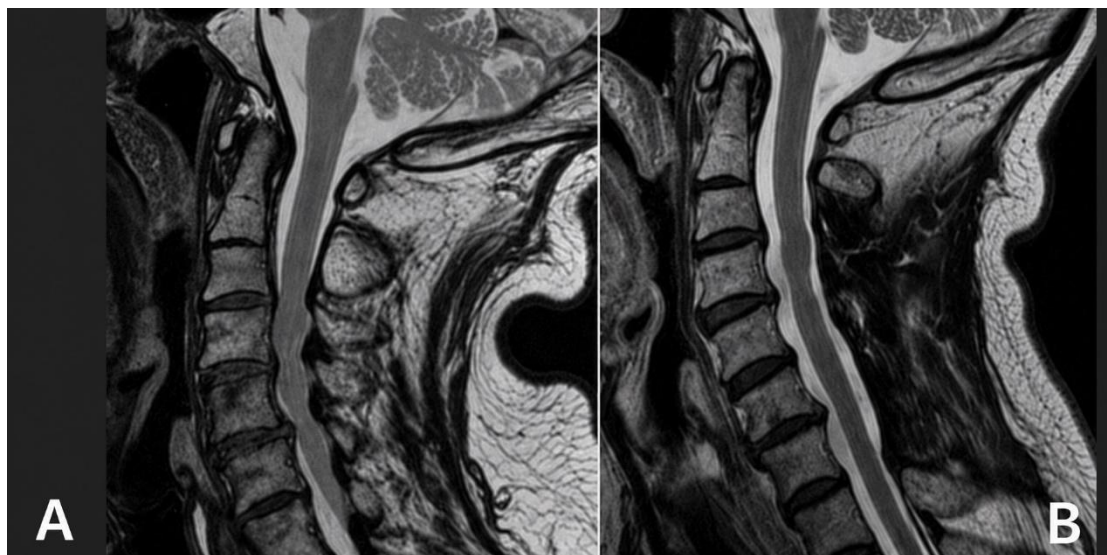


Рисунок-3. Дегенеративный стеноз позвоночного канала на уровне VC2-VC6: а) сагиттальная МРТ; б) состояние после ламинэктомии VC2-VC6 с целью декомпрессии спинного мозга.

After surgical treatment, an improvement in condition was observed in 73% of patients, no change in 18%, and a deterioration in 9%. The mean mJOA score increased from 12 to 15, and the VAS pain score decreased from 4 to 2.

The analysis results confirm that the nature of neurological disorders directly depends on the direction of compression and the level of involvement. With anterior compression, motor deficits predominate; with central compression, mixed deficits predominate; and with posterior compression, sensory deficits predominate. The obtained data are consistent with the results of foreign studies (Hussain et al., 2023; Smith et al., 2021; Watanabe et al., 2022), which indicates the universality of the identified patterns.

Neurophysiological parameters also reveal differences: in anteromedullary syndrome, there is a decrease in the amplitude of the M-wave and the conduction velocity of motor fibers, whereas in posteromedullary syndrome, there is a predominant impairment of sensory conduction.

Discussion

The results confirm the clinical heterogeneity of cervical spondylotic radiculomyelopathy and demonstrate a significant correlation between the nature of neurological deficits and the direction and morphological type of spinal cord compression. A differentiated analysis allowed us to identify three main variants of medullary syndromes—anterior, central, and posterior—each characterized by a specific clinical-neurological and neurophysiological pattern.

The predominance of the anteromedullary syndrome (53.2%) in the study group is consistent with the literature, which points to the leading role of ventral degenerative factors (osteophytes, protrusions, and herniated intervertebral discs) in the pathogenesis of cervical spondylotic myelopathy. The predominance of motor deficits in this type of compression is explained by the predominant involvement of the pyramidal tracts and the anterior horns of the spinal cord. The marked improvement in neurological status following surgical treatment in this group indicates the high efficacy of timely decompression in cases of ventral compression.

Centromedullary syndrome was characterized by combined motor and sensory deficits, with a predominance of segmental symptoms. This pattern of clinical manifestations is likely due to the involvement of the central gray matter and the crossed motor tracts. The relatively high percentage of favorable outcomes (84%) following surgical intervention indicates the potential for functional recovery provided there is early diagnosis and an appropriate choice of treatment strategy.

Posteromedullary syndrome was less common (14.3%), but was characterized by more pronounced disturbances in deep sensation and the development of ataxic syndrome. Involvement of the posterior columns of the spinal cord, confirmed by neurophysiological data, explains the predominance of sensory disorders and the less favorable prognosis for recovery compared with other groups. The deterioration in the condition of some patients after surgery may be associated with the duration of compression and irreversible degenerative changes in the conduction pathways.

Of particular interest are the results of neurophysiological studies, which have demonstrated differences in the nature of conduction abnormalities depending on the type of medullary syndrome. A reduction in M-wave amplitude and motor fiber conduction velocity in anteromedullary syndrome, as well as a predominant impairment of sensory conduction in the posteromedullary variant, confirm the diagnostic value of ENMG in the comprehensive evaluation of patients with cervical radiculomyelopathy.

Consequently, the comparison of clinical, radiological, and neurophysiological data allows not only for a more precise determination of the type of spinal cord lesion but also for predicting the outcomes of surgical treatment. The results obtained underscore the need for a differentiated approach to diagnosis and the selection of surgical strategies in patients with cervical spondylotic radiculomyelopathy.

Conclusions

1. Cervical spondylotic radiculomyelopathy is characterized by marked clinical heterogeneity, which is determined by the direction and morphological type of spinal cord compression.

2. The most common form of the condition is the anteromedullary syndrome, observed in 53.2% of patients, which confirms the leading role of ventral degenerative factors in the pathogenesis of the disease.

3. The type of medullary syndrome determines the predominant nature of neurological disorders:

- In anterior compression, motor deficits predominate;
- In central compression, combined motor and sensory deficits are present;
- In posterior compression, sensory deficits and ataxic syndrome are present.

4. Surgical decompression leads to a significant improvement in neurological status in most patients, with the most pronounced improvement observed in cases of anterior and central compression, as evidenced by an increase in mJOA scores and a reduction in the degree of disability on the Nurick scale.

5. Neurophysiological methods (EMG) have high diagnostic value and allow for the objective assessment of the degree of motor and sensory pathway involvement depending on the clinical type of syndrome.

The integration of clinical, neuroimaging, and neurophysiological data improves diagnostic accuracy, aids in predicting outcomes, and supports the rationale for a differentiated choice of surgical strategy in patients with cervical spondylotic radiculomyelopathy.

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