The Double, Triple, or Quadruple Crush Phenomenon in the Cervical Spine: Increasing Number of Levels of Cord Compression Predicts Myelopathy Severity

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INTRODUCTION:

The modified Japanese Orthopedic Association (mJOA) score has been used as a validated metric for assessing the severity of myelopathy caused by cervical spondylotic myelopathy (CSM). Prior studies have debated an association between mJOA score and the severity of spinal cord compression at a single level but have not assessed its relationship with the number of distinct, intervertebral levels of compression. While peripheral nerves are subject to the "double crush syndrome" whereby multiple sites of compression lead to more pronounced radicular symptoms, this hypothesis has not been analyzed with respect to the severity of myelopathy in the cervical spine. The purpose of this study is to determine whether the number of distinct, intervertebral levels of cervical spinal cord compression can predict the severity of myelopathy via mJOA score.

METHODS:

A retrospective cohort study at a single urban academic hospital was performed using a maintained surgical registry to obtain patients diagnosed with cervical myelopathy who underwent surgical treatment with at least one level of cervical spinal cord compression on MRI. T2-weighted axial and sagittal MRI cuts at the time of diagnosis were used to assess the number of levels of severe cervical spinal cord compression (NCL) caused by a herniated disc, disc-osteophyte-complex, and/or ligamentum flavum hypertrophy. Additional variables including age, sex, Charleston Comorbidity Index (CCI), BMI, smoking history and 12 item short form physical component scale (SF-12 PCS) scores were collected and used to predict mJOA score via a univariate regression model. Significant variables were then used to perform multivariate regression analysis. Significance was defined as $p < 0.05$.

RESULTS:

126 patients were included. In the univariate analysis, all variables except gender and smoking status were significantly associated with mJOA score (Table 1). NCL had the strongest (negative) correlation with the mJOA score ($B = -1.28$, $p < 0.001$). Upon multivariate analysis, only NCL ($p < 0.001$) and SF-12 PCS ($p < 0.001$) significantly correlated with mJOA score (Table 2).

DISCUSSION AND CONCLUSION:

In our series of patients with cervical myelopathy, the number of severely compressed levels on MRI correlated with the severity of disability, as measured by mJOA score. This suggests that multilevel central cord compression in the cervical spine may be subject to a "multiple-crush phenomenon." For patients presenting with mild myelopathy symptoms and multilevel, severe cervical central cord compression, prompt surgical treatment incorporating all severely compressed levels should be considered to prevent further neurologic deterioration.

Variable	B	95% CI for B		*p* - value
		Lower	Upper	
NCL	-1.28	-1.64	-0.93	**< 0.001**
Age	-0.05	-0.08	-0.02	**0.002**
Gender (male)	-0.03	-0.88	0.82	0.80
Smoking	-0.60	-1.48	0.27	0.17
BMI	-0.11	-0.1	-0.02	**0.014**
Preop SF-12 PCS	0.11	0.0	0.15	**< 0.001**
CCI	-0.58	-1.01	-0/15	**0.009**

Table 1. Univariate Regression Results. B, unstandardized regression coefficient; CI, confidence interval; NCL, number of compressed levels; BMI, body mass index; SF-12 PCS, Short Form 12 item survey, physical component scale; CCI, Charleston comorbidity index (without age). Significance was determined at $p < 0.05$.

Variable	B	95% CI for B		*p* - value
		Lower	Upper	
(Constant)	15.70	12.67	18.73	**< 0.001**
NCL	-1.12	-1.47	-0.76	**< 0.001**
Age	0.00	-0.03	0.03	0.93
Sex (male)	-0.09	-0.77	0.60	0.80
BMI	-0.04	-0.11	0.03	0.29
Preop SF-12 PCS	0.09	0.06	0.13	**< 0.001**
CCI	-0.08	-0.45	0.28	0.66

Table 2. Multivariate Regression Results. B, unstandardized regression coefficient; CI, confidence interval; NCL, number of compressed levels; BMI, body mass index; SF-12 PCS, Short Form 12 item survey, physical component scale; CCI, Charleston comorbidity index (without age). Significance was determined at $p < 0.05$.