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Factors predicting outcome after surgeries for cervical spondylotic myelopathy: A prospective study in Egypt

Factors predicting outcome of cervical decompression surgery

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Abstract

Aim: In this study, we aimed to study factors affecting the outcome after surgeries for cervical spondylotic myelopathy (CSM).

Material and Methods: A prospective study was conducted on 25 patients who had CSM surgeries at our institution. The assessment was done before the operation, at 1, 3, and 12 months after surgery using the Modified Japanese Orthopedic Association score (MJOA).

Results: Patients with age ≥ 65 years had significantly lower MJOA scores than younger patients at 1, 3, and 12 months (P=0.007*), (P=0.007*), and (P=0.035*) respectively. Patients with diabetes had significant lower scores at 3 months (p=0.021*), and 12 months (p=0.017*). The duration of symptoms was significantly correlated with the MJOA score at 3 and 12 months (P=0.035*), (P<0.001*), respectively. There was significant positive correlation between preoperative and postoperative MJOA scores at 1, 3, and 12 months (P<0.001*), (P=0.013*), and (P=0.009*), respectively. The number of operated segments during surgery correlated with the MJOA score at 1 month (p=0.001*), and 3 months (p=0.003*). Hospital admission days after surgery were significantly correlated with MOJAs at 1, 3, and 12 months (P<0.001*), (P=0.001*), and (P=0.004*), respectively. Preoperative somatosensory evoked potential, MRI, and mean arterial pressure at the beginning of surgery had no significant association with outcome.

Discussion: Age, diabetes mellitus, duration of symptoms, severity of myelopathy, number of operated segments and duration of hospital stay after surgery are considered predictors of outcome after CSM surgeries. MRI, somatosensory evoked potentials tests, and mean arterial blood pressure at the start of surgery had no significant association with outcomes.

Keywords

Cervical spondylotic myelopathy; MJOA score; Outcome

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Introduction

Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord impairment worldwide [1]. It causes sensory and motor dysfunction of the upper and lower limbs, also it causes gait and sphincter dysfunctions. Surgical decompression is the main treatment, especially in moderate to severe disease, which has been proved to be effective in relieving these symptoms [1,2]. However, the majority of the patients improved after surgery [2]. Some showed variability in the degree of improvement. The Modified Japanese Orthopedic Association score (MJOA), is one of the commonly used outcome measures in patients with CSM that improve after surgery.[3] The aim of our study was to investigate the clinical, radiological, neurophysiological and surgical factors affecting neurological recovery and functional outcome after surgical decompression for patients with cervical spondylotic myelopathy.

Material and Methods

Patients and methods

This prospective study was conducted on 25 patients with CSM who required surgical decompression at our institution. Patients included in the study had symptomatic cervical myelopathy with at least one clinical sign (e.g. gait abnormality, hyperreflexia of upper limbs and/or lower limbs, Hoffman's reflex and Babinski sign), and evidence of cervical spinal cord compression on magnetic resonance imaging (MRI) [4]. Patients with traumatic compression, pathologic fractures, spinal cord tumors, inflammatory disorders of the spinal cord, and infections myelitis were excluded from the study.

Preoperative assessment

All patients underwent history taking, neurological examination, and magnetic response imaging study to assess the cervical spinal cord compression level. The MJOA was performed to evaluate the upper and lower limbs and sphincter functions, as well as the severity of CSM for each patient [3]. The score is an 18-point scale that contains upper limb motor function (5 points) and lower extremity motor function (7 points), sensory function (3 points) and sphincter function (3 points) [3]. A score of 18 reflects no neurological deficits, whereas a lower score indicates a greater degree of disability and functional impairment. Mild myelopathy is A score of ≥15 MJOA indicates mild myelopathy; a score between12-14 indicates moderate myelopathy, and severe myelopathy is indicated by an MJOA score of <12.[3]

Some patients already had Somatosensory evoked potentials (SSEPs) before surgery to assess tract affection, and we just analyzed the results of SSEPs. Abnormality of SSEP latency or amplitude due to cervical spinal cord lesion was defined as follows: SSEP median nerve abnormality: absent N20, P22 and/or abnormal right-left amplitude ratio of N20 wave. SSEP tibial nerve abnormality: absent P40 wave and/or abnormal N22-P40 inter-peak latency and/or abnormal right- left amplitude ratio of P40 wave [5].

Surgical technique and Anesthesia

All surgeries were performed by an experienced senior spine surgeon using an intraoperative neuro-monitoring modality. The techniques used were either anterior cervical discectomy and fusion (ACDF) or posterior laminectomy with fusion. Total Intravenous anesthesia (TIVA protocol) using propofol and fentanyl was used in all the patients with short-acting muscle relaxants used only during intubation.

Postoperative Outcome

The outcome was assessed using the MJOA score and neurological examination at 1 month, 3 months, and 12 months after surgery.

Statistical analysis

Descriptive data were described as mean ±SD or n (%), and the statistical analyses were performed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). The Mann-Whitney test and the Kruskal-Wallis test were used to test the significant difference between different parameters in the studied group regarding the MJOA score. The correlation was calculated using the Spearman coefficient.

Ethical considerations

Before enrollment in the study, consent was obtained from all recruited patients for the use of their anonymous data and for the surgical process. The Ethical Committee (EC) at Alexandria University Faculty of Medicine approved the study. The EC has had FWA since 2010 and operates according to the ICH GCP guidelines and applicable local and institutional regulations and guidelines.

Results

Twenty-five patients with CSM had cervical decompression surgeries using IONM. These were 19 males and six females with a mean age of 54.24 ± 11.96 years. A detailed description of the preoperative clinical, radiological, SSEP and surgical findings of patients is depicted in Table 1. An example of one case is shown in Fgure 1. The association between these findings and outcome (MJOA score) was analyzed as follows:

1. Age and outcome: Patients aged ≥ 65 years had significantly lower MJOA score than patients with age <65 years at 1 month, 3 months, and 12 months follow up (P = 0.007*), (P = 0.007*), and (P = 0.035*), respectively. (Table 2).
2. Diabetes mellitus comorbidity: It was found that the group of patients with diabetes had significantly lower scores at 3 months (p = 0.021*), and 12 months (p = 0.017*). (Table 2).
3. Duration of symptoms: It was significantly correlated with postoperative MJOA score at 3 and 12 months follow- up (P = 0.035*), (P <0.001*), respectively (Table 3).
4. CSM severity (preoperative MJOA score): There was significant positive correlation between preoperative and postoperative MJOA score at 1 month, 3 months, and 12 months (P < 0.001*), (P = 0.013*), and (P = 0.009*), respectively (Table 3).
5. Number of compressed cord segments on MRI: There was no correlation between the number of compressed cord segments and postoperative MJOA score (Table 3).
6. Preoperative SSEP and outcome: Patients who had preoperative normal median nerve SSEP and posterior tibial nerve SSEP had a higher MJOA score than patients with abnormal median nerve SSEP at upper limbs and abnormal posterior tibial nerve SSEP, with no statistically significant difference (Table 2).
7. Other factors related to surgery: The number of operated decompressed segments during surgery correlated with the postoperative MJOA score at 1 month (p 0.001*), and 3 months

Table 1. Preoperative clinical, surgical, radiological, electro-diagnostic characteristics of the studied group (n=25)

Studied group (n =25)	No. (%) Mean ± SD (Range)
Sex	
Male	19 (76%)
Female	6 (24)
Age (years)	54.24 ± 11.96 (33–78)
Duration of symptoms (months)	8.84 ± 5.53 (1-18)
Diabetes Mellitus	7(28%)
Mean MJOA score (18 points)	11.84 ± 2.12 (7– 16)
Severity of myelopathy according to MJOA	
Mild (≥ 15 points)	2 (8)
Moderate (12-14)	11 (44)
Sever (<12)	12 (48)
MRI Hyper intense signal T2	25 (100)
Number of compressed cord segment on MRI	
<3 levels	9(36%)
≥3 levels	16 (64%)
SSEP Median nerve (n = 21)[1]	
Normal	5 (23%)
Abnormal	16(76.2)
SSEP posterior tibial nerve (n = 21)	
Normal	4(19%)
Abnormal	17(81%)
Surgical approach	
Anterior cervical discectomy and fusion	13 (52)
Posterior laminectomy with fusion	12 (48)
Numbers of operated levels	
<4 levels	8(32%)
≥ 4 levels	17(68%)
Baseline mean arterial pressure (mmHg)	84.56 ± 15.95 (57-125)
mean duration of hospital stay (days)	4.92 ± 2.52 (2-13)

[1]Only 21 patients had SSEPs from the total 25 patients
MJOA: Modified Japanese orthopedic association score; CSM; cervical spondylotic myelopathy; SSEP: somatosensory evoked potentials; MAP: mean arterial blood pressure

Table 2. Difference between (mean MJOAOJS score) and characteristic of the studied group

	Mean MJOAs 1 month	Mean MJOAs 3 months	Mean MJOAs 12 months
Age (years)			
< 65	14.40 ± 2.09	15.90 ± 1.74	16.60 ± 1.47
≥65	11.0 ± 2.0	13.20 ± 2.05	14.20 ± 2.68
Test of sig.	U=12.50*	U=12.0*	U=19.0*
(p value)	(0.007*)	(0.007*)	(0.035*)
Diabetes mellitus			
No	14.22 ± 2.26	16.0 ± 1.64	16.78 ± 1.26
Yes	12.43 ± 2.64	13.71 ± 2.29	14.43 ± 2.51
Test of sig.	U=38.0	U=25.50*	U=24.0*
(p value)	(0.141)	(0.021*)	(0.017*)
SSEP Median nerve			
Abnormal	13.63 ± 2.73	15.31 ± 2.36	16.06 ± 2.11
Normal	14.40 ± 2.41	15.60 ± 1.67	16.0 ± 2.0
Test of sig.	U=34.0	U=39.0	U=39.0
(p-value)	(0.660)	(0.968)	(0.968)
SSEP Tibial nerve			
Abnormal	13.71 ± 2.66	15.35 ± 2.29	16.12 ± 2.06
Normal	14.25 ± 2.75	15.50 ± 1.91	15.75 ± 2.22
Test of sig.	U= 30.0	U= 34.0	U= 30.50
(p value)	(0.763)	(1.000)	(0.763)
Mean MAP changes			
No drop MAP	13.84 ± 2.09	15.63 ± 1.34	16.47 ± 1.31
MAP drop <70	13.33 ± 3.61	14.50 ± 3.62	15.00 ± 3.22
Test of sig.	U= 54.50	U= 54.0	U= 48.50
(p value)	(0.877)	(0.877)	(0.598)

MJOAs: modified Japanese association score; SSEP: somatosensory evoked potential; MAP: mean arterial blood pressure
U: Mann-Whitney test
H: H for Kruskal-Wallis test
p: p -value for association between different categories

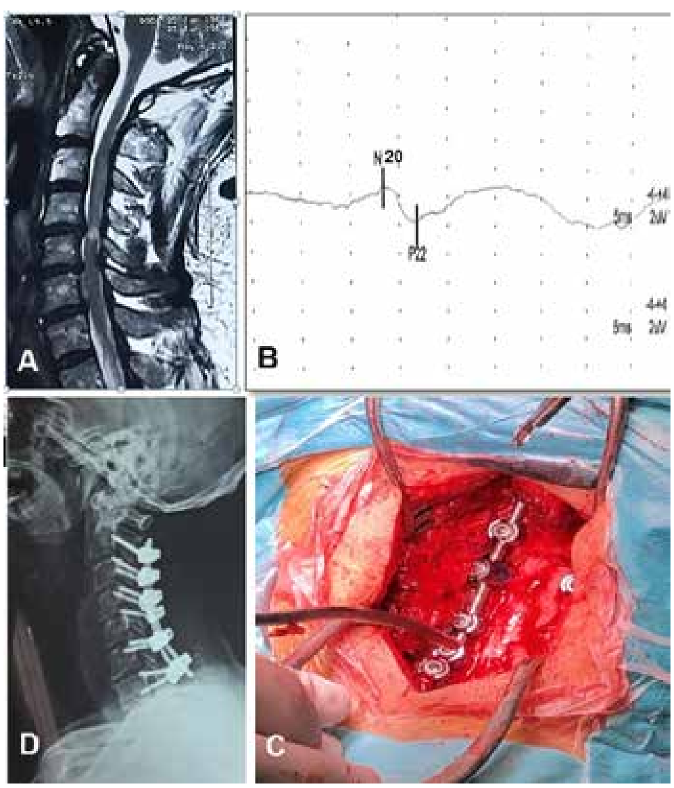

Figure 1. The 51-year-old man diagnosed as CSM who had C3-C7 posterior cervical decompression surgery, preoperatively had gait instability, severe left brachialgia with very mild weakness left hand

A) Preoperative T2 sagittal MRI cervical spine showed compressive posterior disc herniation at C4-C5, C5-C6 associated with the subtle area of T2 hyper- intense signal of the cord.

B) Right median SSEPs, rate 3 Hz, intensity 5.3 mA, duration 0.3 ms. Latency N20= 24 ms, P22= 21.7, and amplitude 2.63 (abnormal right-left amplitude ratio of N20 wave)

C) Intraoperative field showed fixation of the levels by two rods bilaterally with the application of screws caps

D) Postoperative plain x-ray sagittal showed Posterior laminectomy with fusion (C3-C6).

Table 3. Correlation between Mean postoperative MJOA score and different parameters

	1 month		3 months		12 months	
	r_s	P	r_s	p	r_s	P
	Mean postoperative MOJS					
Duration of symptoms	-0.256	0.217	-0.424	0.035*	-0.673	<0.001*
Mean pre-operative MJOA	0.693	<0.001*	0.488	0.013*	0.510	0.009*
Number of compressed segments MRI	-0.105	0.618	-0.112	0.595	-0.018	0.932
Number of operated segments in surgery	-0.604	0.001*	-0.570	0.003*	-0.394	0.051
MAP	0.117	0.579	0.236	0.256	0.185	0.377
Hospital admission days	-0.768	<0.001*	-0.632	0.001*	-0.551	0.004*

MJOAs: modified Japanese association score; MRI: magnetic resonance imaging; MAP: mean arterial blood pressure
r_s: Spearman coefficient *: Statistically significant at p ≤ 0.05

(p 0.003*) (Table 3). Baseline Mean arterial pressure (MAP) at the beginning of surgery did not correlate significantly with postoperative MJOA score (Table.3). However, patients with MAP drop < 70 mmHg during surgery had lower MJOA scores than group without, but there was no significant difference. (Table 2). Hospital admission days after surgery correlated significantly with the mean MOJAs at 1, 3, and 12 months follow- up (P< 0.001*), (P 0.001*), and (P = 0.004*), respectively (Table 3).

Discussion

The extent of outcome improvements can be predicted using a number of preoperative variables in our study group. The MJOA score was used as the outcome parameters to evaluate the recovery outcome.

1. Age and outcome

In the presenting study, it has been found that patients aged ≥ 65 years had significantly lower MJOA scores than patients aged <65 years at 1 month, 3 months, and 12 months follow up. This indicates that age is one of the main predictors of the outcome after surgeries of cervical myelopathy. The explanations for this difference between age groups is that the elderly have age-related degenerative changes in motor neurons, synapses and corticospinal tract and posterior column in the spinal cord that are less tolerant to the stress of surgery [6], they may have other comorbidities that may affect tasks of the MJOA scale, such as hip and knee osteoarthritis, diabetic neuropathy or urinary incontinence [7], and may have sever degenerative pathology that may require more complex surgery [6]. Two studies use a similar cut-off value for age and reported that “elderly” patients (≥65 years) exhibited worse outcomes on the MJOA score compared with “younger” patients (<65 years) [8]. Other studies found that age was a significant predictor of postoperative MJOA [8,9]. In contrast, some studies reported an insignificant association between age and surgical outcome [10].

2. Diabetes Mellitus and outcome

Our results revealed that patients with diabetes had significantly lower MJOA scores at 3 months and 12 months. This indicates that DM is one of the predictors of surgical outcomes, especially long-term outcomes. This explained by the fact that diabetic patients may have abnormalities in their spinal cord, such as infarcts, demyelination, or atrophy of the posterior columns [11]. Furthermore, diabetes may induce a state of chronic inflammation and amplify the hypoxic conditions due to associated microvascular and macrovascular disease [12]. Complications associated with diabetes, especially peripheral neuropathy, may impair a patient’s postoperative neurologic recovery and functional improvement. This was supported by many reports, which showed a significant relationship between diabetes and outcomes [13]. Others failed to identify a relationship between diabetes and outcomes.[14]

3. Duration of symptoms and outcome

Duration of symptoms was significantly correlated with postoperative MJOA score. This means that the longer duration of symptoms before surgery, the less recovery after surgery. The rationale behind this finding is that patients with longer disease duration may experience irreversible damage of the spinal cord due to chronic compression, which results in ischemia, inflammation, and apoptosis of the neurons of the corticospinal tracts [15]. Furthermore, a longer duration of compression may amplify the ischemia-reperfusion injury that results from the restoration of tissue blood flow after long periods of ischemia [16]. Other studies reported the association between postoperative MJOA scores and duration of symptoms [17,18], while others reported that duration of symptoms was an insignificant predictor of outcome [10]. This discrepancy between studies was due to the variability and non-specificity of symptoms at the onset and the concomitant carpal tunnel syndrome or other peripheral neuropathy that confuses patients about the onset of myelopathy symptoms.

4. CSM severity and outcome

There was a significant positive correlation between preoperative and postoperative MJOA scores at 1 month, 3 months, and 12 months. This indicates that the less severe the myelopathy, the better the recovery after surgery. Similar to our results, many studies have reported a significant association between preoperative myelopathy severity and surgical outcomes [9,10]. This is also explained by the fact that the more severe myelopathy, the more ischemia of the cord and the more necrosis and apoptosis [15,16].

5. Preoperative SSEP and outcome

In the present study, patients with abnormal preoperative SSEP had lower postoperative MJOA scores than patients with normal SSEP, however, this was no statistically significant differences. This means that SSEP was not sensitive in detecting myelopathy and was not related to outcome in patients with CSM, similar findings supported by Kellar et al. [19]. That is because CSM with motor dysfunction is usually more frequent than CSM with isolated sensory dysfunction, and SSEP has no role in the diagnosis of motor fibers of corticospinal tracts [19]. On the other hand, Lyu et al [20] reported that SSEP abnormalities commonly reflect severe cord dysfunction and have been correlated with low surgical response.

6. MRI features and outcome

In the present study, all (100%) our patients had increased signal intensities on T2-weighted MRI, thus we tried to find a correlation between numbers of compressed cord segments and the postoperative MJOA score, however, we did not find any correlation between them. This was supported by a systematic review by Tetreault et al. [21], who found low-level evidence that MRI factors related to cord properties are predictors of outcome. It was concluded that MRI features of the spinal cord before CSM surgery cannot accurately predict functional outcome after surgery and, hence further studies and alternative imaging approaches may be required.

7. Surgical factors and outcome

With regard to blood pressure during surgery, we use MAP <70 mmHg as the threshold below which blood pressure is needed to be increased [22] because cord hypoperfusion due to hypotension increases the risk of neurologic deficits in spinal surgeries, and unfortunately, is common in patients with spinal cord injury [23]. In the presenting study, patients with MAP drop <70 mmHg during surgery had less MOJA scores at 1, 3, 12 months follow-up than in the group without MAP drop, however, the difference was not statistically significant. Also, it has been found that baseline MAP at the beginning of surgery was not significantly correlated with the outcome score. This may be due to the optimal ranges of MAP monitored during surgery remain unknown or controversial, also in the present study, blood pressure was immediately therapeutically raised above 70 mmHg, and it has been found that not only the average of MAP, but also the duration of hypotension be more important in spinal cord injury recovery [22].

The number of surgically decompressed segments was significantly correlated with the MJOA score, which means that multilevel decompression surgery had less recovery after surgery. This was explained by the fact that the number of operated segments represents more compressed cord, more severe myelopathy, more complex surgery, and more postoperative complication like dysphagia, wound infection rates, neck pain, postoperative narcotic usage [24]. Also, multilevel decompression surgery had increased soft tissue dissection and retraction needed for exposure, as well as the increased time and manipulation, which may be a direct causes of increased morbidity [24].

The number of days of hospital stay after surgery correlated significantly with the postoperative MJOA scale and recovery rate at 1, 3, and 12 months follow-up. This means that the longer hospital stay after surgery, the lesser improvement in outcome, as it is a reflection of the extra time needed to control postoperative pain or infection [25].

Conclusion

Age, diabetes mellitus, duration of symptoms, severity of myelopathy, number of operated segments and duration of hospital stay after surgery are considered predictors of functional outcome and have a significant association with outcome. With respect to the number of compressed cord segments on MRI, somatosensory evoked potentials tests, we have failed to identify a significant association with outcomes. Finally, patients with MAP <70 mmHg during surgery had less functional improvements than patients without, however, that was not statistically significant.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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References

1. Nouri A, Tetreault L, Singh A, Karadimas SK, Fehlings MG. Degenerative cervical myelopathy: epidemiology, genetics, and pathogenesis. Spine. 2015;40(12):E675-93

2. Cheung WY, Arvinte D, Wong YW, Luk KD, Cheung KM. Neurological recovery after surgical decompression in patients with cervical spondylotic myelopathy-a prospective study. Int Orthop. 2008;32(2):273-8.

3. Kopjar B, Tetreault L, Kalsi-Ryan S, Fehlings M. Psychometric properties of the modified Japanese Orthopaedic Association scale in patients with cervical spondylotic myelopathy. Spine. 2015;40(1):E23-8

4. Harrop JS, Naroji S, Maltenfort M, Anderson DG, Albert T, Ratliff JK, et al. Cervical myelopathy: a clinical and radiographic evaluation and correlation to cervical spondylotic myelopathy. Spine. 2010;35(6):620-4

5. American Clinical Neurophysiology Society ACN. Guideline 9D: guidelines on short-latency somatosensory evoked potentials. J Clin Neurophysiol Off Publ Am Electroencephalogr Soc. 2006;23(2):168–79.

6. Terao SI, Sobue G, Hashizume Y, Li M, Inagaki T, Mitsuma T. Age-related changes in human spinal ventral horn cells with special reference to the loss of small neurons in the intermediate zone: a quantitative analysis. Acta Neuropathol. 1996;92(2):109-14.

7. Machino M, Yukawa Y, Hida T, Ito K, Nakashima H, Kanbara S, et al. Can elderly patients recover adequately after laminoplasty? A comparative study of 520 patients with cervical spondylotic myelopathy. Spine. 2012;37(8):667-71.

8. Nakashima H, Tetreault LA, Nagoshi N, Nouri A, Kopjar B, Arnold PM, et al. Does age affect surgical outcomes in patients with degenerative cervical myelopathy? Results from the prospective multicenter AOSpine International study on 479 patients. J Neurol Neurosurg Psychiatry. 2016;87(7):734-40.

9. Tetreault L, Wilson JR, Kotter MR, Nouri A, Cote P, Kopjar B, et al. Predicting the minimum clinically important difference in patients undergoing surgery for the treatment of degenerative cervical myelopathy. Neurosurg Focus. 2016;40(6):E14.

10. Karpova A, Arun R, Davis AM, Kulkarni AV, Massicotte EM, Mikulis DJ, et al. Predictors of surgical outcome in cervical spondylotic myelopathy. Spine. 2013;38(5):392-400.

11. Machino M, Yukawa Y, Ito K, Inoue T, Kobayakawa A, Matsumoto T, et al. Impact of diabetes on the outcomes of cervical laminoplasty: a prospective cohort study of more than 500 patients with cervical spondylotic myelopathy. Spine. 2014;39(3):220-7.

12. Arinzon Z, Adunsky A, Fidelman Z, Gepstein R. Outcomes of decompression surgery for lumbar spinal stenosis in elderly diabetic patients. Eur Spine J. 2004;13(1):32-7.

13. Kusin DJ, Ahn UM, Ahn NU. The influence of diabetes on surgical outcomes in cervical myelopathy. Spine. 2016;41(18):1436-40.

14. Oichi T, Oshima Y, Taniguchi Y, Matsubayashi Y, Chikuda H, Takeshita K, et al. Cervical anterolisthesis: a predictor of poor neurological outcomes in cervical spondylotic myelopathy patients after cervical laminoplasty. Spine. 2016;41(8):E467-73

15. Karadimas SK, Gatzounis G, Fehlings MG. Pathobiology of cervical spondylotic myelopathy. Eur Spine J. 2015;24(2):132-8.

16. Karadimas SK, Laliberte AM, Tetreault L, Chung YS, Arnold P, Foltz WD, et al. Riluzole blocks perioperative ischemia-reperfusion injury and enhances postdecompression outcomes in cervical spondylotic myelopathy. Sci Transl Med. 2015;7(316):316ra194.

17. Zhang P, Shen Y, Zhang YZ, Ding WY. Prognosis significance of focal signal intensity change on MRI after anterior decompression for single-level cervical spondylotic myelopathy. Eur J Orthop Surg Traumatol. 2012;22(4):269-73.

18. Morio Y, Teshima R, Nagashima H, Nawata K, Yamasaki D, Nanjo Y. Correlation between operative outcomes of cervical compression myelopathy and MRI of the spinal cord. Spine. 2001;26(11):1238-45.

19. Kelkar P, Ross MA, Yamada T. Isolated posterior column dysfunction: an unusual presentation of spondylotic myelopathy. J Spinal Disord. 2000;13(4):356-9.

20. Lyu RK, Tang LM, Chen CJ, Chen CM, Chang HS, Wu YR. The use of evoked potentials for clinical correlation and surgical outcome in cervical spondylotic myelopathy with intramedullary high signal intensity on MRI. J Neurol Neurosurg Psychiatry. 2004;75(2):256-61

21. Tetreault LA, Dettori JR, Wilson JR, Singh A, Nouri A, Fehlings MG, et al. Systematic review of magnetic resonance imaging characteristics that affect treatment decision making and predict clinical outcome in patients with cervical spondylotic myelopathy. Spine. 2013;38(22S):S89-110.

22. Hawryluk G, Whetstone W, Saigal R, Ferguson A, Talbott J, Bresnahan J, et al.

Mean arterial blood pressure correlates with neurological recovery after human spinal cord injury: analysis of high frequency physiologic data. J Neurotrauma. 2015;32(24):1958–67.
23. Hagen EM, Faerestrand S, Hoff JM, Rekand T, Gronning M. Cardiovascular and urological dysfunction in spinal cord injury. Acta Neurol Scand. 2011;124:71-8.
24. De la Garza-Ramos R, Xu R, Ramhmdani S, Kosztowski T, Bydon M, Sciubba DM, et al. Long-term clinical outcomes following 3-and 4-level anterior cervical discectomy and fusion. J Neurosurg Spine. Spine. 2016;24(6):885-91.
25. Jacobs W, Willems PC, van Limbeek J, Bartels R, Pavlov P, Anderson PG, et al. Single or double-level anterior interbody fusion techniques for cervical degenerative disc disease. Cochrane Database Syst Rev. 2011(1). DOI: 10.1002/14651858.CD004958.pub2.

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