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Intraoperative neuromonitoring loss in abnormal magnetic resonance imaging signal intensity from patients with cervical compressive myelopathy

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ABSTRACT

Purpose: Our objective of this study was to evaluate if cervical compressive myelopathy (CCM) patients with preoperative abnormal magnetic resonance imaging (MRI) might easily lead to intraoperative neuromonitoring (IONM) loss.

Method: A consecutive series of 152 CCM patients who underwent cervical cord decompression were enrolled in this study between December 2013 and February 2017. All patients with abnormal MRI signal intensity were divided into 2 groups (group 1: T2-WIs hyperintensity; group 2: both T2-WIs hyperintensity and T1-WIs hypointensity). Relevant IONM changes were identified as significant transcranial motor evoked potentials (MEP) loss associated with surgical decompression of cervical cord.

Results: There were 121 patients in group 1, and then 6 cases showed IONM degeneration; 31 patients in group 2, and then 13 cases showed IONM degeneration (6/121 versus 13/31, $p = 0.000$). Moreover, one case presented transient new spinal deficits after surgery, no permanent spinal deficit in group 1; 5 cases presented transient new spinal deficits, 2 cases showed permanent spinal deficit in group 2. And in group 2 the MEP amplitude before and after decompression had significant difference (134 μV ± 30.2 versus 65 μV ± 26.2, $^*p < 0.05$).

Conclusion: Our results suggest that the IONM degenerations or postoperative spinal deficits are more likely to appear on patients with abnormal T2-WIs and T1-WIs. Appropriate and timely interventions are probably useful for IONM recovery.

1. Introduction

Cervical compressive myelopathy (CCM) is one of the most common causes of spinal cord dysfunction in the elderly, and surgery is usually the treatment of choice for these patients. The role of magnetic resonance imaging (MRI) in confirming the clinical diagnosis of cervical compressive myelopathy (CCM) and directing surgical management is well established. In addition, and some previous studies thought that the preoperative MRI in CCM could reflect pathological changes in spinal cord and then probably became a reliable indicator of surgical outcome [1,2].

Intraoperative neuromonitoring (IONM) is becoming an essential method for preventing postoperative spinal deficits during CCM patients [3–6] [7,8]. Recently, according to our experience, the patients with preoperative abnormal MRI probably lead to the intraoperative neuromonitoring (IONM) change during surgery. So in order to test this hypothesis and help surgeons accurately predict the impending risk of IONM changes in CCM patients, our objective is to assess the relationship between the abnormal MRI and the intraoperative IONM loss.

2. Patients and methods

2.1. Clinical data

A total of 152 patients with cervical compression myelopathy (CCM) and preoperative abnormal MRI signal intensity were retrospectively analyzed from between December 2013 and February 2017. All patients underwent posterior decompressive surgery and neurological status was assessed immediately after surgery. General anesthesia protocol in CCM patient was according to previous well-documented protocol [6,7]. Intraoperative interventions in this study were as following: stop stimulating the cord, stabilization of the spinal column, further decompression, pulse methylprednisolone, increase blood pressure and temperature.

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2.2. IONM & MRI

In this study, intraoperative motor evoked potential (MEP) testing (Axon Systems Inc., Hauppauge, NY) was mainly performed and recorded among the important surgical points during surgery. And the mean amplitude was used for the statistical analysis. Abnormal MRI signal intensity included preoperative hyperintensity on T2-WIs or both hyperintensity on T2-WIs & hypointensity on T1-WIs.

2.3. Statistical analysis

MEP amplitude was described as means ± SEM, and the statistical analyses were performed by Microsoft Excel 2007 (Microsoft, Redmond, WA, USA), SPSS 19.0 (SPSS, Inc., Chicago, IL, USA) and Origin 8.5 (OriginLab, USA) software. Statistical comparisons were made by χ^2 test (Fisher's Exact Test) and One-way ANOVA analysis, and $p < 0.05$ was considered statistically significant.

3. Results

The major clinical characteristics and diagnosis of the population with abnormal MRI signal were showed in Table 1. A total of 152 patients with abnormal MRI signal intensity included 121 patients showing T2-WIs hyperintensity (group 1) and 31 patients showing both T1-WIs hypointensity and T2-WIs hyperintensity (group 2). Significant statistic difference in MEP degeneration were found between the two groups (6/121 versus 13/31, $p = 0.000$). Timely and appropriate interventions were used for significant IONM loss. The MEP amplitude of the baseline, pre-decompression, decompression and post-decompression in cervical cord was showed in Fig. 1. The MEP amplitude had significant difference before and after decompression (134 μV ± 30.2 versus 65 μV ± 26.2, *$p < 0.05$).

Moreover, the postoperative neurologic outcomes after IONM loss showed that 1 case presented transient new spinal deficits and no permanent spinal deficit in group 1; 5 cases presented transient new spinal deficits and 2 patients showed permanent spinal deficit in group 2 (Table 2).

The following 3 sample cases are presented to display intraoperative MEP changes in different MRI signal intensity abnormality. Fig. 2 showed a sample of no significant intraoperative MEP changes from a patient of group 1. Figs. 3 & 4 showed representative cases of intraoperative MEP degenerations from group 2 and then recovery after timely surgical interventions.

Table 1
The general data and the clinical diagnoses in all patients with abnormal MRI signal.

General data and diagnosis	Mean ± SD (Range)/N (%)
General data	
Age	59.7 ± 13.6 (42-69 yrs.)
Sex (male/female)	1.89 (34/18)
Height	166.4 ± 10.2 (145–180 cm)
Weight	71.6 ± 15.6 (44–98 kg)
BMI	24.9 ± 6.2 (15–33)
Operation time	154.3 ± 68.5 (100–300 min)
Bleeding volume	219.2 ± 168.9 (150–800 ml)
Diagnosis	
Cervical spondylotic myelopathy	117 (77.0%)
OPLL	23 (15.1%)
Others	12 (7.9%)
Abnormal MRI signal	**Number**
T2-WIs hyperintensity (group 1)	121
Both T2-WIs hyperintensity & T1-WIs hypointensity (group 2)	31

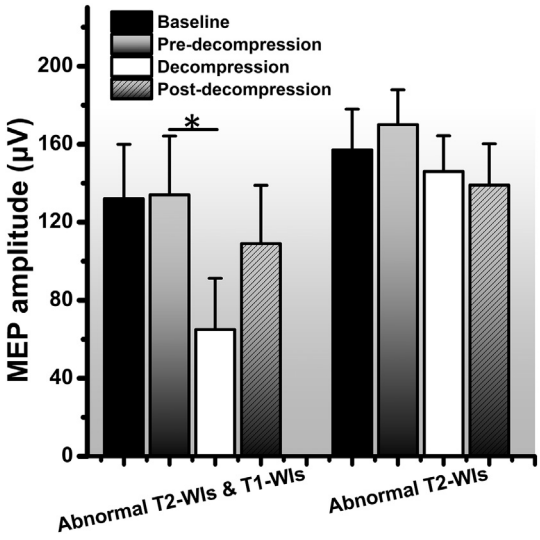

Fig. 1. The summary of MEP amplitude between the abnormal T2-WIs & T1-WIs (n = 31) and abnormal T2-WIs (n = 121) among different surgical points. The statistic difference was found between the maneuvers of pre-decompression and decompression in T2-WIs & T1-WIs group (134 μV ± 30.2 versus 65 μV ± 26.2, *$p < 0.05$).

Table 2
The patients with intraoperative IONM alerts and postoperative neurologic status.

	IONM alerts	Postoperative transient spinal deficits	Postoperative permanent spinal deficits
Group 1 (n = 121)	6	1	0
Group 2 (n = 31)	13	5	2

4. Discussion

The present study had focused on evaluating if preoperative abnormal MRI might easily lead to intraoperative neuromonitoring (IONM) changes in patients with cervical compressive myelopathy (CCM). The results suggest that the patients with both T1-WIs hypointensity and T2-WIs hyperintensity are probably related to intraoperative IONM loss. Timely and appropriate interventions are probably effective for IONM recovery.

Numerous investigators have assessed the association between various preoperative MRI parameters and postsurgical outcome in patients with CCM. However, their collective results have provided an unclear picture in terms of predictive value and practical application [9–11]. Despite this, international spine care professionals agree that MRI is an important prognostic tool [12]. In the current study, we first investigate the prognostic value of abnormal MRI in assessing intraoperative IONM changes for CCM patients.

Our results suggest that T2-WIs hyperintensity is not sufficient to lead to significant IONM loss compared to both abnormal T2-WIs and T1-WIs. Fig. 2 shows a typical case of intraoperative MEP monitoring in a patient with T2-WIs hyperintensity but no T1-WIs hypointensity. We can see that the MEP parameters do not show obvious changes during the whole surgery. And the patient did not show permanent postoperative neurologic deficit either. On the other side, several studies have reported that patients with T2-WIs hyperintensity would show a poor prognosis after surgery, [13–16] whereas others are not in agreement on that [17,18]. Despite some controversies still exist until now in the prognosis of T2-WIs hyperintensity, according to the current study, the T2-WIs hyperintensity is probably not correlated to the significant intraoperative IONM degenerations.