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Median nerve somatosensory evoked potentials and their high-frequency oscillations in amyotrophic lateral sclerosis ☆

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Abstract

Objective: To investigate sensory cortical changes in amyotrophic lateral sclerosis (ALS), we studied somatosensory evoked potentials (SEPs) and their high-frequency oscillation potentials.
Methods: Subjects were 15 healthy volunteers and 26 ALS patients. Median nerve SEPs were recorded and several peaks of oscillations were obtained by digitally filtering raw SEPs. The patients were sorted into three groups according to the level of weakness of abductor pollicis brevis muscle (APB): mild, moderate and severe. The latencies and amplitudes of main and oscillation components of SEP were compared among normal subjects and the three patient groups.
Results: The early cortical response was enlarged in the moderate weakness group, while it was attenuated in the severe weakness group. No differences were noted in the size ratios of oscillations to the main SEP component between the patients and normal subjects. The central sensory conduction time (CCT) and N20 duration were prolonged in spite of normal other latencies.
Conclusions: The median nerve SEP amplitude changes are associated with motor disturbances in ALS. The cortical potential enhancement of SEPs with moderate weakness in ALS may reflect some compensatory function of the sensory cortex for motor disturbances.
Significance: The sensory cortical compensation for motor disturbances is shown in ALS, which must be important information for rehabilitation.

Keywords: Somatosensory evoked potential; High-frequency oscillation; Amyotrophic lateral sclerosis

1. Introduction

Somatosensory evoked potentials (SEPs) have been studied in amyotrophic lateral sclerosis (ALS): some reports revealed no SEP abnormalities (Cascino et al., 1988; Chiappa, 1983; Oh et al., 1985), while others showed abnormalities in upper limb SEPs (Bosch et al., 1985; Cosi et al., 1984; Dasheiff et al., 1985; Radtke et al., 1986; Subramaniam and Yiannikas, 1990; Theys et al., 1999; Zanette et al., 1990) and lower limb SEPs (Georgesco et al., 1997; Matheson et al., 1986; Radtke et al., 1986; Subramaniam and Yiannikas, 1990; Zanette et al., 1996). They are still controversial.

The high-frequency oscillation (HFO), one newly developed SEP analysis, is considered to reflect some sensory cortical information processing. The N20 potential is considered to reflect an initial excitation of neurons in area 3b (Allison et al., 1991; Tiihonen et al., 1989). In contrast, the generators of HFOs remain to be determined, even though several candidates have been proposed; such as brainstem, thalamus, thalamocortical presynaptic action potentials and somatosensory cortex (Curio et al., 1997; Eisen et al., 1984; Gobbelé et al., 1998, 2004; Hashimoto et al., 1996, 1999; Klostermann et al., 2002; Shimazu et al., 2000). We

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previously reported changes in HFOs in movement disorders (Mochizuki et al., 1999). However, the high-frequency oscillations (HFOs) of median nerve SEP have not been studied in ALS.

In addition, several studies using transcranial magnetic stimulation (TMS) showed that pure sensory input facilitated the primary motor cortex (M1) (Hamdy et al., 1998; Kaelin-Lang et al., 2002; Ridding et al., 2000; Rosenkranz and Rothwell, 2003; Rosenkranz and Rothwell, 2004; Terao et al., 1995, 1999) and a number of gating studies confirmed an attenuation of the early cortical responses to median nerve stimulation by motor interferences (Gobbelé et al., 2003; Kakigi et al., 1995; Mochizuki et al., 2004; Rossini et al., 1999; Tanosaki et al., 2002; Valeriani et al., 1999). These reports indicate there are several kinds of interactions between the motor and sensory systems in humans. Those integrations of the sensorimotor information must be necessary for precise and purposeful movements.

One functional magnetic resonance imaging study revealed cortical reorganization in ALS (Konrad et al., 2002). They concluded that a partial compensation between motor areas was a strategy to optimize motor performances in ALS. We hypothesize that similar compensation for motor dysfunction might occur in the somatosensory system in ALS.

To solve the above-mentioned three issues; (1) the inconsistency of SEP results, (2) the lack of HFO studies, (3) sensory compensation for weakness, in the present communication, we studied median nerve SEPs in patients with ALS.

2. Subjects and methods

2.1. Subjects

We studied 26 patients with ALS. The diagnosis was based on the revised El Escorial criteria (Brooks et al., 2000): 15 had definite, five probable, and six probable-laboratory-supported ALS at the time of the examination. Their clinical features are summarized in Table 1. The age ranged from 33 to 78 years (mean ± SD; 62.1 ± 10.2 years). The duration of the illness at the time of our experiment ranged from 3 to 48 months (16.7 ± 15.9 months).

Table 1
Clinical characteristics of the patients F, female: M, male

Case No.	Age (year)	Sex	Disease duration (months)	El Escorial criteria	Clinical onset	Recorded side	Severity
1	33	M	7	Probable-laboratory-supported	Limb	Right	Mild
2	43	M	6	Probable-laboratory-supported	Limb	Right	Mild
3	45	M	14	Probable-laboratory-supported	Limb	Left	Mild
4	52	M	26	Probable	Limb	Right	Severe
5	57	M	14	Definite	Bulbar	Right	Mild
						Left	Mild
6	57	M	13	Definite	Limb	Left	Severe
7	58	M	12	Probable	Limb	Left	Mild
8	59	F	6	Probable	Limb	Right	Moderate
9	59	F	3	Definite	Limb	Right	Mild
						Left	Mild
10	60	F	9	Probable	Bulbar	Right	Mild
						Left	Mild
11	62	M	11	Probable	Limb	Left	Mild
						Right	Mild
12	63	F	20	Definite	Limb	Left	Mild
13	64	M	35	Definite	Bulbar	Right	Mild
14	64	M	36	Definite	Limb	Right	Severe
15	64	F	6	Definite	Bulbar	Right	Mild
						Left	Moderate
16	64	F	3	Definite	Limb	Right	Mild
17	66	M	48	Probable-laboratory-supported	Limb	Left	Mild
18	68	M	24	Definite	Limb	Right	Mild
						Left	Moderate
19	68	F	72	Definite	Limb	Right	Mild
						Left	Mild
20	69	M	10	Definite	Limb	Right	Severe
						Left	Severe
21	70	F	10	Definite	Bulbar	Right	Moderate
22	71	F	10	Probable-laboratory-supported	Limb	Right	Mild
						Left	Severe
23	72	F	11	Definite	Bulbar	Right	Mild
						Left	Mild
24	73	M	8	Definite	Limb	Right	Moderate
25	74	M	4	Definite	Limb	Left	Moderate
26	79	M	24	Probable-laboratory-supported	Limb	Left	Mild