Somatosensory evoked potentials reflect the upper limb motor performance in multiple sclerosis

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ABSTRACT

Objective: The aim of this multicentric study was to multidimensionally evaluate the relationship among somatosensory evoked potentials (SEPs) parameters, patient's perspective and clinical measures of the upper limb impairment in patients with multiple sclerosis (MS).

Methods: We consecutively enrolled 39 MS patients. For median nerve SEPs we acquired the N9, P14, N20 responses and the N9–P14 and P14–N20 interpeak latencies on the dominant side. We also used a validated patient-oriented questionnaire (Disabilities of the Arm, Shoulder and Hand — DASH) and a test of dexterity quantification as the 9-Hole Peg Test (9-HPT).

Results: A significant longer time to complete the 9-HPT ($p<0.00006$) was observed in patients with abnormal SEPs. Patients with undetectable N20 or P14 responses performed the 9-HPT in a significant longer time than patients with detectable responses ($p<0.0006$ and $p<0.001$ respectively). Concerning the perspective of patient (evaluated with the DASH questionnaire) significant differences in patients with undetectable P14 response ($p<0.01$) were observed.

Conclusions: Our data provide further information useful for interpretation of SEPs results, being the median nerve SEPs related to the upper limb performance in MS patients.

Significance: These data increase the significance of SEPs both in clinical practice and in experimental studies in MS.

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1. Introduction

Multiple sclerosis (MS) is a chronic inflammatory disease of the central nervous system especially affecting young people, determining disability and thus interfering with their life and work ability. There is a considerable heterogeneity in the clinical manifestations and functional impairment from one patient to another depending on the site and severity of the demyeliniting lesions.

Recently there is an increasing interest in measuring disability score and quality of life (QoL) in MS patients, but only two studies [1,2] focused on upper limb impairment assessing function, symptoms and performance in a multiperspective way. Up to date no study evaluated the relationship between neurophysiologic measures and upper limb impairment studied in a multiperspective way in MS patients.

The aim of our multicentric study was to evaluate the relationship among somatosensory evoked potentials (SEPs) parameters, patient's perspective and clinical measures of the upper limb impairment in patients with MS.

2. Materials and methods

2.1. Patients

From June to September 2006 we consecutively enrolled 39 MS patients fulfilling McDonald's diagnostic criteria [3] from 4 Italian MS centres (Catania, Catanzaro, Roma and Siena).

Patients with upper limb dysfunction due to muscle weakness primarily related to their MS, no ongoing relapse, ability to use the test materials and preserved cognitive function were included into the study.

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Table 1
Demographic and clinical characteristics of the study sample

	MS patients $n=39$
Age (mean±SD) (years)	37.5±10.1
Gender (M/F)	10/29
Disease corse (RRMS/SPMS)	32/7
Disease duration (mean±SD) (years)	9.3±8.2
Dominant hand (R/L)	39/0
EDSS score (mean±SD)	2.4±1.8
Ashworth scale score(R/L) (mean±SD)	0.08±0.27/0.05±0.22
MMSE score (mean±SD)	29.3±1
9-HPT right hand (mean±SD) (sec)	23.5±8.1
DASH F/S (mean±SD)	23.4±19.7
DASH W (mean±SD)	17±25.5
SEPs (A/N)	15/39

MS = multiple sclerosis; SD = standard deviation; M/F = male/female; RRMS/SPMS = relapsing–remitting multiple sclerosis/secondary progressive multiple sclerosis; R/L = right/left hand; MMSE = Mini Mental State Examination; 9-HPT = nine hole peg test; DASH F/S = DASH score on symptoms and functional status; DASH W = DASH score on the use of upper limb at work; SEPs = somatosensory evoked potentials; A/N = abnormal/normal.

All patients with age younger than 18 years and older than 50 years of age, recent worsening of their MS, cognitive impairment, upper limbs impairment not related to MS, and co morbidity with severe systemic disease were excluded.

All patients had been exhaustively informed on the study and all gave informed consent.

2.2. Measurements

On admission, each of the 39 MS patients was examined and assessed with Expanded Disability Status Scale (EDSS) [4] and the Ashworth scale (MAS) [5] by an experienced neurologist. The evaluation procedure started with the Mini Mental State Examination (MMSE) [6], in order to exclude those patients with cognitive impairment unable to correctly use the test materials. Then, the nine hole peg test (9-HPT) [7] was used to quantify dexterity followed by the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH) [8,9] to acquire patient-oriented data focused on symptoms and functions of the upper limb. Finally, SEPs on the dominant side (the right side being all patients right-handed) were performed. The quantitative measurements and SEPs were performed at the same day by an experienced neurologist and neurophysiologist, respectively. The measurements were as follows.

2.3. Ashworth scale (MAS)

The modified MAS [5] is the most widely used method for assessing muscle spasticity in clinical practice and research. The scale measures the degree of muscle hypertonia on a six point scale, ranging from 0 to 4 (0,

normal muscle tone; 4, fixed muscle contracture). All tests were carried out by one investigator in order to eliminate inter-rater variability.

2.4. Mini Mental State Examination (MMSE)

The MMSE [6] is the most widely used test to screen for the presence of cognitive impairment over a number of areas. Based on a series of questions and tests, points are achieved on the MMSE when they are answered correctly.

A maximum 30 points is possible. Any score over 24 (out of 30) is effectively normal. Therefore, the patients with MMSE score ≤24 were excluded.

2.5. Nine hole peg test (9-HPT)

The 9-HPT [7] was used to quantify dexterity. It is a simple, timed test of fine motor coordination. Its reliability and validity have been assessed. The test requires the subject to place 9 dowels in 9 holes and to remove them. Subjects are scored on the amount of time it takes to place and remove all 9 pegs.

Two trials for the dominant hand were performed. The score was obtained by the average of the times required to perform the 2 trials. The mean time (in seconds) was used.

2.6. Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire

To acquire patient-oriented data focused on symptoms and functions of the upper limb we used the Italian validated version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire [8,9]. It provides two specific scores: one on symptoms and functional status (DASH F/S) and another on the use of upper limb at work (DASH W). High scores for the DASH questionnaire indicate impairment. According to the patient perspective, functional deficit has been arbitrarily defined as a reduction of DASH score >20% in comparison with the maximum score.

2.7. SEP recording procedure

For SEPs recording, patients laid upon a couch in a warm and semidarkened room. Stimulations (0.3 ms duration, 5 Hz) were delivered by skin electrodes at the wrist for the median nerve; stimulus intensity was adjusted slightly above the motor threshold. The filter bandpass was 30–3000 Hz (−3 dB at cut-off point, 6 dB per octave). Responses were averaged with a bin width of 98 μs on a total analysis time of 50 ms including 2.5 ms of preanalysis for median nerve SEPs. Samples with excessive interference were automatically edited out of the average. Two averages of 2000 trials each were obtained and printed out by the computer on a desk-jet printer.

Electrodes were placed in the supraclavicular fossa (Erb's point), over the sixth cervical vertebra, and in parietal scalp regions contralateral and ipsilateral to the stimulated side. The Erb's point

Table 2
Comparison of upper limb performance multidimensionally evaluated and SEPs

	Patients with detectable N20	Patients with undetectable of N20	p	Patients with detectable P14	Patients with undetectable of P14	p	Patients with Normal SEPs	Patients with Abnormal SEPs	p
	$n=33$	$n=6$		$n=31$	$n=8$		$n=30$	$n=9$	
9-HPT dominant hand (mean±SD) (sec)	21.5±6.4	34.4±8.2	0.00*	21.3±4.8	32±12.4	0.00*	21±4 sec	31.8±11.7	0.00**
DASH F/S (mean±SD)	21.6±19.5	33.5±18.9	0.17	19.2±17.7	39.2±19.8	0.01*	19.8±17.7	35.2±22.1	0.21
DASH W (mean±SD)	17.7±26.7	13.7±19.5	0.95	14.4±20.6	27.4±39.6	0..90	14.3±20.9	26.4±37.1	0.50

SEPs = somatosensory evoked potentials; 9-HPT = 9-Hole Peg Test; DASH = the Disabilities of the Arm, Shoulder and Hand questionnaire; DASH F/S = DASH score on symptoms and functional status; DASH W = DASH score on the use of upper limb at work; SD = standard deviation; sec = seconds; n = number of patients; *the statistical significance is set at $p<0.05$; **the statistical significance is set at $p<0.001$.