

Somatosensory Evoked Potentials in Predicting Motor Deficit after Ischemic or Hemorrhagic Stroke

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ABSTRACT: 25 patients with stroke and hemiparesis in antecedents were recruited for the study. Objective: Recording Short Latency Somato-Sensory Evoked Potentials (SSEP) in dynamics and clinical assessment of th motor impairments. Results: The latency of the N20 wave from SSEP calculated from the dynamic recordings is increased at the level of the injured hemisphere. Medium latency of the recorded N20 wave at the level of the injured hemisphere and the recording at the level of the uninjured hemisphere have a statistically significant difference ($p < 0.05$). Conclusion: The absence or minimal modification of the SSEP post-stroke is correlated with an improved motor performance, while increased latencies of the N 20 wave are associated with a low rate of motor rehabilitation after the stroke(in this case, SSEP modifications can appear for long periods).

KEYWORDS: motor deficit after stroke, somatosensory evoked potentials, N20 wave.

Introduction

Stroke is an acute, serious condition which results after the blood flow is blocked from a cerebral territory.

In the world, stroke represents one of the primary causes of mortality and morbidity, because it causes 5 million deaths every year and another 5 million people remain every year with severe disabilities after stroke.

According to World Health Organization, in 2001 5.5 million people died because of a stroke, and annually 15 million people survive a stroke. There are significant differences between Eastern and Western Europe in the incidence, prevalence and mortality after a stroke. This difference is explained because in Eastern Europe, high blood pressure is more frequent than in Western Europe, with the consequences being more severe strokes.

In the future, demographic changes will cause an increase in the incidence and prevalence of stroke.

Stroke is also the second cause of Alzheimer's dementia by frequency, the most frequent cause of epilepsy in elderly people and a frequent cause of depression.

The lethality level of the stroke is 11% for women and 8.4% for men. [1]

Thrombosis, embolism, vasoconstriction, hypercoagulation are the primary causes for an ischaemic stroke, while high blood pressure is the primary cause for hemorrhagic stroke(2/3 of cases) followed by arterio-venous malformation, sanguine discrasia.

The clinical symptoms of stroke can vary. Some cases can be asymptomatic or with

minimal symptoms, and some patients can rapidly entry a comatose state with fulminating symptoms and die.

The major part of patients with stroke evolve sensory or motor injuries, the debilitating consequences of stroke is a serious problem, the injuries that remain after the acute event are a significant public health problem, and generates high social costs.

Imagistic investigation of the brain and blood vessels are of paramount importance in the evaluation of patients with stroke and TIA.

CT scan or MRI scan can differentiate ischaemic stroke from intracranial hemorrhage or from diseases with similar symptoms with stroke, also can identify the type of stroke and sometimes its etiology, it is particularly useful in making the difference between brain tissue affected irreversibly by the stroke from the brain matter that can recover after the infarction by so guiding the emergency treatment and can determine the evolution.

Vascular imagistic can help identify the location and cause of the blood flow obstruction and can help identify the patients with high risk of a recurrent stroke.

Even with optimal care in stroke dedicated units with thrombolysis, only 1/3 of the patients completely recover after a stroke. One of the most important consequences of the stroke is motor impairment, which affects the quality of life and social integration.

In the evaluation of stroke, evoked potentials have the advantage of being objective and often more accurate than the detailed neurological examination, evaluating the consequences of lesions. Short latency somatosensory evoked

potentials (also called somatosensory evoked potentials, or SSEP) elicited from the upper and lower limbs of percutaneous electrical stimulation are considered to be the result of action potentials and synaptic potentials from successive anatomic neural generators within the dorsal-lemniscus thalamo-cortical sensory system[2].

Material and Methods

This study was part of a research start-up grant that targeted evoked potentials in diagnostic and management of some neurological diseases.

Although in the present CT and MRI scan of the brain are the most used methods, evoked potentials can bring valuable information about the consequences of lesions: latency anomalies, amplitude and morphology of the evoked potentials, or the disappearance of waves are highly significant(2,3,4)

The study of Short Latency Somato-Sensory Evoked Potentials(SSEP) can be useful in complement with the imagistic investigations in stroke and can be an indicator of the recovery potential of the patient(5,6)

The proposed method follows the contribution of evoked potentials in predicting the presence of a motor injury after an ischaemic or hemorrhagic stroke:

- Selecting a group of patients with post-stroke hemiparesis and recovery treatment

- Making a database with information from the patients which includes clinical, paraclinical (including CT scan) and treatment data.

- Dynamic recording of SSEP in patients with motor injury post-stroke

- Analysis of the SSEP alterations in correlation with the evolution of the motor deficiency.

Patient Population:

25 patients were selected for the study (12 women and 13 men) with post-stroke hemiparesis and with recovery treatment. 24 patients had an ischaemic stroke in antecedents, and 1 patient had a hemorrhagic stroke in antecedents.

15 patients had the deficiency on the left-hand side and 10 patients had the deficiency on the right-hand side.

Comorbidities: 9 patients have also diabetes, 2 patients have high blood pressure and 1 has polycythemia vera. Dyslipidemia is present in all patients.

SSEP are recorded in dynamic and are evaluated in the same time with the clinical

neurological examination of the motor impairment.

The evoked potentials recordings were compared with those obtained from a group(9 volunteers) without neurological impairments.

The informed consent was obtained from each patient at the screening visit.

Patient assessment:

Recording of the evoked potentials was made using a Nihon Kohden Neuropack EMG/EP Measuring System.

SSEP are obtained by applying an electric stimulus in a selected area. The stimulator can apply a stimulus up to 100 mA.

The electric stimulus consists in applying an electric current on the skin for a very short period.

Stimulating the median nerve:

The stimulator is placed at the wrist, the cathode is proximally oriented, then the intensity of the stimulation is increased until we obtain a rhythmical movement of the pollices which is maintained through the entire period of stimulation.

SSEP of median nerve have duration of 30 ms. The recordings of SSEP on stroke patients were done bilaterally by stimulating the median nerve.

Electrode placement:

- Grounding electrode is placed on the forearm

- Channel 1: 1- at Epi 1+ at Epc

- Channel 2: 2- at Epc 2+ at Fpz

Number of stimulations: 500

The impedance of the electrodes must be below 5000 Ohms.

Epi = Erb point ipsilateral with the stimulation of the median nerve

Epc = Erb point contralateral with the stimulation of the median nerve

Fpz = Center of the medio-frontal region

The recording electrodes are placed in the bilateral Erb point(Epi - ipsilateral with the stimulation, Epc – contralateral with the stimulation). The Erb point is located in the angle formed by the collar-bone head of the sternocleidomastoidian muscle and the collarbone, at 2-3 cm above the collarbone.

The parietal electrodes are placed at 5 cm posterior of C8 and 7 cm lateral of the median line and the frontal electrode is placed at the Fpz point.

Settings:

Number of stimulations: 500

Analysis/division: 3 ms

Amplitude/division: 1 uV

Sensitivity: 20 uV

Hi-Cut: 2 KHz

Lo-Cut: 2 Hz

When the stimulus is applied at the level of the median nerve, the passing of the stimulus through the afferent pathways to the brachial plexus is recorded in the form of a field potential in the proximity of the Erb point (the N9 wave). The response is most-often tri-phasic and of high amplitude (1-10 uV) [3,4,5].

The N20 wave signifies the activation of the parietal primary sensitive cortex (area 3B Brodmann).

The significantly prolonged latency of the N20 wave, low peak amplitude and a low amplitude generally was found in patients with stroke in antecedents, in contrast with the subjects of the control group. It is also possible that SSEP will be absent in some cases and in other patients SSEP can be close to normal [5,6].

The rehabilitation success of a patient with stroke in antecedents can be estimated using SSEP. Clear benefits can be obtained by using a combination of rigorous clinical examination and neurophysiological measurements, with improved precision. The most important clinical aspects followed:

- motor performance
- muscle tonus
- global level of deficiency

The absence of SSEP implies little or no recovery after the stroke, and contrary, the preservation of close to normal SSEP values is a strong indication of a successful recovery. SSEP can be an important tool for assessing the rehabilitation results on long term [7,8].

Follow-up: SSEP are recorded in dynamic after the stroke (roughly after a month) and then we made another 3 recordings at an interval of 3 months each.

Results

SSEP recordings obtained by stimulating the left and right median nerve were stored and analyzed with specifically designed software.

The waves N9 and N20 were analyzed and had they're latencies measured. The values of the latency of the N20 wave were statistically analyzed and measured because the wave N20 translates the activation of the parietal primary sensitive cortex, in relation with the evolution the level of motor injury post-stroke.

In the test group, we performed SSEP recordings on subjects without neurological impairment and of similar age with the patients from the stroke ad hemiparesis group.

The medium value of the latency and the standard deviation of the N20 wave was calculated in the test group:

-medium value of latency (N20 wave) = 19.96 ms

-medium standard deviation (N20 wave) = 0.33

From the SSEP recorded in dynamic from the patients with post-stroke hemiparesis the following values of the latencies were calculated:

-medium value of the latency of the N20 wave recorded at the level of the injured hemisphere = 22.40 ms

-standard deviation of the N20 wave at the level of the injured hemisphere = 1.38

- medium value of the latency of the N20 wave recorded at the level of the uninjured hemisphere = 20.83 ms

- standard deviation of the N20 wave at the level of the uninjured hemisphere = 0.88

- medium value of the latency of the N20 wave recorded at the level of the injured hemisphere at the first recording (after the stroke) = 22.66 ms

-standard deviation of the N20 wave at the level of the injured hemisphere at the first recording (after the stroke) = 1.48

Table 1 presents the medium values of the N20 wave latency of the SSEP recordings from patients with motor impairment post-stroke and in the test group of healthy subjects. For exemplification, we present latencies evolution in some patients, in Fig.1.

Table 1. N20 SSEP latencies

SSEP	Normal	Injured Hemisphere Recent Stroke	Injured Hemisphere After Stroke	Uninjured Hemisphere After Stroke
Medium value of N20 wave	19.96 ms	22.66 ms	22.40 ms	20.83 ms
Std. deviation	0.33	1.48	1.38	0.88

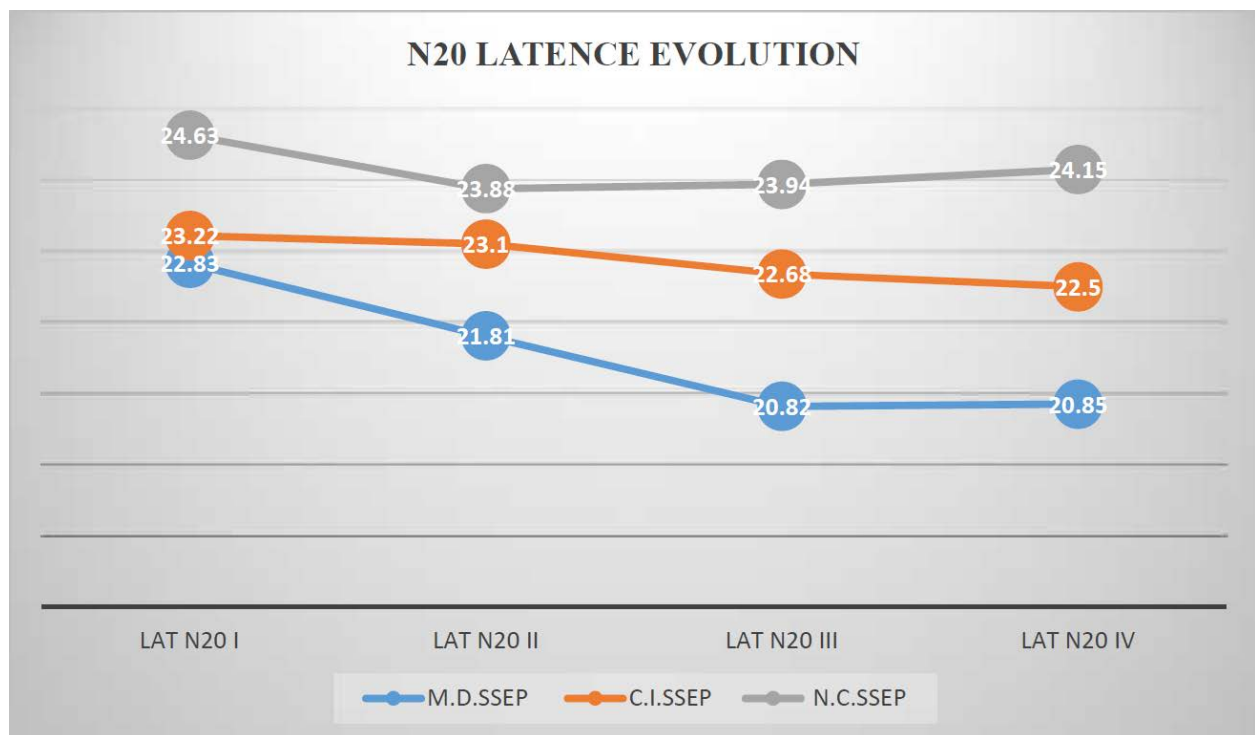


Fig.1. N20 SSEP latencies evolution in 3 patients after stroke

Discussions

The latency of the N20 wave in SSEP, calculated from the dynamic recordings is increased at the level of the affected hemisphere with a medium value of 22.40 ms. The increase in latency is greater after the acute event, with a medium value of 22.40 ms. The increased values of the latency are consistent with the values calculated in the test group and with those calculated at the level of the uninjured hemisphere [6,7].

With the statistical functions ANOVA and t-test the latencies of the N20 waves recorded in the injured and uninjured hemisphere in the study group with stroke patients were tested. The ANOVA test rejects the 0 hypothesis, highly significant differences between the group averages exists (p has an extremely low value).

By using the t-Test we compared the average latency of the N20 waves in the group of patients with stroke and the test group without neurological impairment. The p values are very small (towards 0), highly significant differences exists between the 2 average values.

We also used the t-Test to compare the medium values of the N20 wave recorded in the patient group with stroke, at the levels of the injured and uninjured hemisphere, the very small values of p indicates that there are highly significant differences between the 2 average values.

In conclusion, the prolonged latency of the N20 wave in SSEP recordings at the level of the injured hemisphere is a well-defined pathological aspect. In the group of patients with stroke there were no cases of absence of the N20 wave.

Increased latency of the N20 wave at the level of the injured hemisphere has the highest value after the acute event. In time, the latency of the N20 wave has a tendency to decrease towards normal values, but not in all cases.

For the evaluation of SSEP as a test of the success of the rehabilitation process, the following clinical variables were monitored:

- motor performance
- muscular tonus
- global level of impairment of the upper limb

We observed that those patients with minimal alterations or without modifications of the N20 latency after the stroke had the best rates of recovery, and these patients maintained SSEP values close to normal ones.

In other cases, when the latency of N20 wave after the stroke was significantly increased, the rehabilitation process had modest results, especially with the patients with N20 values above 24 ms [6,7,8].

In those patients, the abnormal aspect of SSEP is found through the whole monitoring period, with little or no tendency to recover.

Conclusions

-The latency of the SSEP N20 wave, calculated from the dynamic recordings is increased at the level of the injured hemisphere with a medium value of 22.40 ms

-The medium latencies of the N20 wave at the level of the injured hemisphere and at the level of the uninjured hemisphere and those of the healthy subjects are significantly statistical different ($p < 0.05$)

-The increased latency of the N20 wave in the injured hemisphere recorded from the patients with motor impairments after stroke is a well-defined aspect, and the latency of the N20 wave has the highest delay after the acute event.

-For the evaluation of SSEP as a test of the success of the rehabilitation process, the following clinical variables were monitored:

motor performance, muscular tonus, global level of impairment of the upper limbs

-We observed that those patients with minimal alterations or without modifications of the N20 latency after the stroke had the best rates of recovery, and these patients maintained SSEP values close to normal ones.

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-In those patients, the abnormal aspect of SSEP is found through the whole monitoring period, with little or no tendency to recover.

-In conclusion, SSEP is a very useful instrument for estimating the success of the rehabilitation proces after stroke

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Abbreviations list

EP = evoked potentials

SSEP = short-latency somatosensory evoked potentials

EMG = electromiography

Epi = Erb point ipsilateral to the stimulation of the median nerve

Epc = contralateral Erb point contralateral to the stimulation of the median nerve

Fpz = Medio-Frontal region center

EPc = Parietal Contralateral region

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