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Predilection Values of Early SEPs For Recovery of Function and Guidance of Proper Rehabilitation Program for Stroke Patients

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Abstract:

Stroke assessment and prediction of recovery uses clinical evaluation and functional quantified outcome measures. These scales mainly depend on performing physical and cognitive tasks, direct quantitative sensory measures were rarely concerned. A quantified reliable and objective tool to investigate and monitor functional recovery of neurological cortical lesion must u used. Therefore, huge literature on Somatosensory evoked potentials (SEPs) indicate the possible use to elucidate differences in cortical activity associated with a stroke cases. The aim of this study is to investigate the possible prediction of recovery of stroke patients and possible early guidance of the rehabilitation program at an early stage.

Methods: 24 healthy control and 30 patients who had had a stroke and had a sensory-motor impairment in the arm were examined, and their SEPs were recorded upon study entry (onset to 5 weeks after the stroke), and at approximately 3 and 6 months after the stroke.

Results: The result showed 30% of the patients had N20 absent or severely affected at 1st visit. It was minimally affected on 35%, this 65% showed correlation of sensory motor impairment. At the 2nd visit N20 improved in amplitude correlated with improvement in sensory motor function in 70%. at the 3rd visit almost more than half of the population (65%) showed amplitude improvement which correlate with marked functional improvement. P25 was absent in 55% of the patients at initial visit, with sever or moderate impairment of some sensory modalities. N30 was absent or severely attenuated in almost 60% of the population at initial visit and weak in 10%. all have severe or moderate functional impairment. Statistical calculation of functional outcome shows statistically significant increase when 1st and 2nd visits were compared similarly the 2nd and 3rd and 1st and 3rd, p value less than 0.05.

Conclusion: the improvement of somatosensory waves amplitude correlate with the recovery of function in most cases. The limited amplitude improvement is crucial for functional recovery. Cases with no amplitude improvement has no functional recovery. The technique may be a useful tool to predict recovery and guide the inclusion criterion for rehab program.

Keywords: Prediction; Recovery; SEPs; Stroke; Rehabilitation

Introduction

Impairment of specific cerebral areas following stroke is usually evaluated clinically and using CT scan and MRI. There is a variation in assessment of sensory motor functional outcomes across the world. Many indexes were developed in the 2nd half of the last century, e.g.: National Institutes of Health Stroke Scale (NIHSS), Scandinavian Stroke Scale (SSS)-1985, Canadian Neurological Scale (CNS)-1986, European Stroke Scale (ESS)-1994, and Functional and outcome Assessment Scale (FOAS). Barthel index first published 1965 [1]. This scale mainly depends on performing physical and cognitive tasks, direct quantitative sensory measures were rarely concerned. It is well known

that motor functions are dependent on sensory that in turn are provided in the parietal lobe. For example, if not for the sensory feedback of the muscles and joints (information which transmitted to the parietal lobe and then relayed to the motor areas) movement would become clumsy and lack integration: I.e., a person would not know where their limbs were in space and in relation to one another [2].

A somatosensory evoked potential (SEP) is the electrical activity response measured at the skin's surface following controlled peripheral nerve stimulation. Electrical activity from peripheral stimulation measured over the scalp reflects cerebral action potentials and are best recorded contralateral to peripheral nerve stimulation. The recorded electrical potential of this afferent volley bombardment generates a complex waveform [2].

Neurologically this pathway consists of peripheral receptors and afferent neurons that enter the dorsal root ganglion prior to ascending the spinal cord to the medulla where they synapse with the ipsilateral dorsal column nuclei. Once in the medulla they cross to the contralateral side of the brain (decussate) and the pathway continues to the contralateral ventral posterior lateral nucleus of the thalamus prior arrival at the primary somatosensory cortex for processing [3]. This pathway consists of the dorsal column-medial lemniscal, and thalamo-cortical sensory systems [4].

Dawson 1947 was the 1st to describe this technique and published the details. There have been many publications afterwards to explain the use of this techniques in evaluating and predicting sensory functions after stroke [5]. The pioneering study of Alajouanine who found the cortical SEPs in patient with thalamic and parietal syndrome cannot be detected [6]. Liberson was the 1st to report the possible prognostic values of SEPs [7]. Myoshi, Noel & Desmedt, and Karnaze have studied the SEPs on varieties of patients with cortical and subcortical lesions [8-10]. Alison pointed out that the recording of median nerve SEPs before and after surgical removal of motor cortex abolished the three early components (N20, P25, and N30) though they had been presented before surgery [11]. Desmedt and Cheron and Muaguere confirmed the abolished N20 on patient with central and post central cortex lesions, concluding that N20 indeed indexes the cortical response in that areas [12-13].

In a comprehensive review by Aymee Hernandez, stated that this may be a very useful in diagnosis of complication, prediction of evolution and disabilities of the stroke [14].

The above-mentioned studies to some extent highlighted the impotence of early SEPs to monitor improvement post stroke. The aim of this study is to investigate the possible prediction of recovery of stroke patients and guide the rehabilitation program at an early stage. they are very useful in diagnosis of complication, prediction of evolution and disabilities of the stroke [14].

Methods

A 24 healthy control and 30 patients who had had a stroke and had a sensory-motor impairment in the arm were examined, and their SEPs were recorded upon study entry (onset to 5 weeks after the stroke), and at approximately 3 and 6 months after the stroke, functional condition was assessed using the conventional clinical assessment and Barthel index. A regular rehabilitation program was performed Independently. SEPs were performed by stimulating the left and right median nerves at the wrist using NeuroScan software. Activities were recorded using the conventional 10-20 electrode placement on the scalp with modified positions of 32 channels montage with electrode on the Erb's point and reference electrode on the Mastoid bone ipsilateral to the stimulated side (Figure 1 and 2).

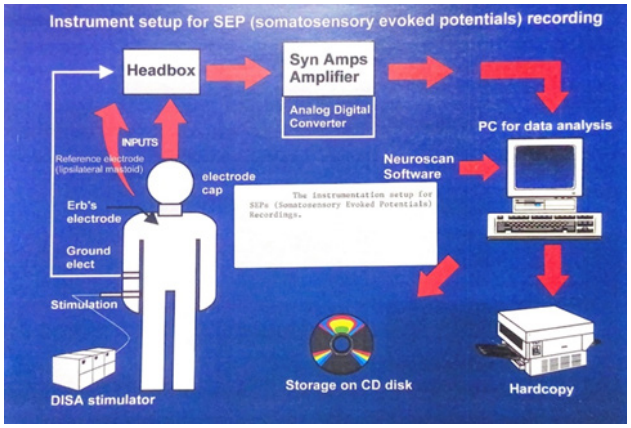


Figure 1: Recording instrument for SEPs.

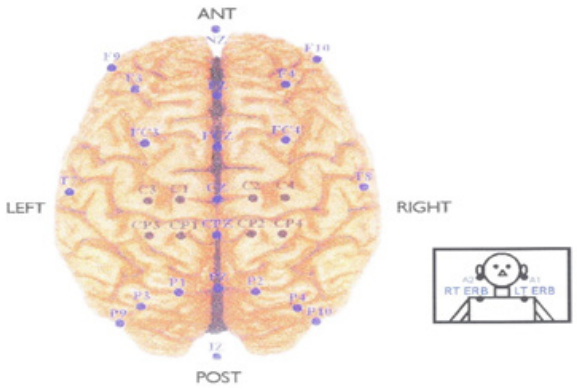


Figure 2: Electrode montage on 1020 system and drived positions.

The SEPs stimulation used DISA 15E07 stimulator to the median nerve at wrist, three time the sensory threshold to produce clear twitch of the muscle. Stimulation duration is 0.3 mesc. Square

pulses applied at 3/Sec with Cathode proximal. The volley monitored at the Erb's point. The recording conducted in a on a supine position in reclining comfortable chair in a semi-darkened room with a suitable temperature. To ensure relaxation patients and subjects were instructed to close their eyes during the recording. The SEPs recorded in two runs of 500 sweeps on each side then the two runs were superimposed then averaged to produce a reliable smooth trace. All control and patients were analyzed using the SPSS and Excel for the waves of N20, P25 and N30, these waves may present a little earlier within normal limit (WNL). Mean and standard deviation were computed for amplitude and latency using descriptive procedures in SPSS. Correlation and regression analysis (simple liner correlation r and regression equation were used to express the relationship between the amplitude and functional recovery as indicated by Barthel index score, r = the measure of (goodness of fit) of the regression line.

The SEPs analysis include morphology amplitude and latency, side to side comparison and with normal. Peak amplitudes measured from the base line to the maximum point of the positive P or negative N. latencies were measure from the onset of stimulus artifact at the zero time to the peak or trough of the cortical waves. The channels overlying the central and parietal cortex were selected for the statistical analysis. since the amplitude data do not show normal distribution, nonparametric tests were for the comparison of data, using the Wilcoxon pair signed rank test. Data were expressed in Mean and SD in the descriptive procedures in SPSS. Amplitude percentage for both the affected side and the nonaffected side as well as the normal subjects were used for the different visits. Also, data of both sides of the patients were plotted with that of normal to show fair comparison. The overall aim of this study is correlate the SEPs outcome with the functional recovery in light of Barthel index outcome.

Result

Normal: Twenty-four normal subjects aged (20-59) with mean of age 43.04 ys SD (± 13.19) had their median nerve SEPs recorded and analyzed successfully. The potentials peaks are reliable in polarity and latency in all normal variation within normal limits. N20 was seen highly repeatable in all normal. P25 was seen sharp and prominent. N20 mean amplitude was 2.27 μV, with SD ±.73, latency of N20 was 20.08 mesc ± .91. P25 seen at 25.74mesc ± 2.51, with mean amplitude 2.18 μV, ± 1.4SD. Subsequently to this was the negative wave N30, recorded at 31.37mesc±3.04 with amplitude mean 1.81 μV, ± 1.26. this wave exhibited son=me degree of variability in 20.8 % of the total normal. The overall pattern of SEPs wave was similar and perfect showed W shape.

Patients: Thirty patients were seen all have received conventional rehabilitation program except one who was placed at nursing home. Appropriate inferences were thought more likely to be produced by assessing the amplitude of the early cortical SEPs of both hemispheres of each individual and then compare with that of the normal to highlight any changes over the three occasions. A careful review of the medical report and the MRI or CT scan.

The result showed 30% of the patients had N20 absent or severely affected at 1st visit. It was minimally affected on 35%, this 65% showed correlation of sensory motor impairment. At the 2nd visit N20 improved in amplitude correlated with improvement in sensory motor function in 70%. at the 3rd visit almost more than half of the population (65%) showed amplitude improvement which correlate with marked functional improvement. P25 was absent in 55% of the patients at initial visit, with sever or moderate impairment of some sensory modalities. The obtained results in the following visit showed a trend towards normality in the amplitude and a little inconsistence of latency, this was correlated with good functional recovery. 35% showed deterioration or no improvement at the 2nd visit. Result in the 3rd visit showed further improvement in the amplitude of P25 of 40% of the patients correlated with marked clinical recovery. 55% showed no improvement in potential neither in clinic compared of that at the initial visit. N30 was absent or severely attenuated in almost 60% of the population at initial visit and weak in 10%. all have severe or moderate functional impairment. However, improvement in this peak at the 2nd visit were noticed in almost 80% majority of this percentage had correlated recovery of function. At the 3rd visit 40% had considerable improvement in the N30 amplitude that match marked functional recovery. The remaining percentage ether have very late recovery or inconsistence performance.

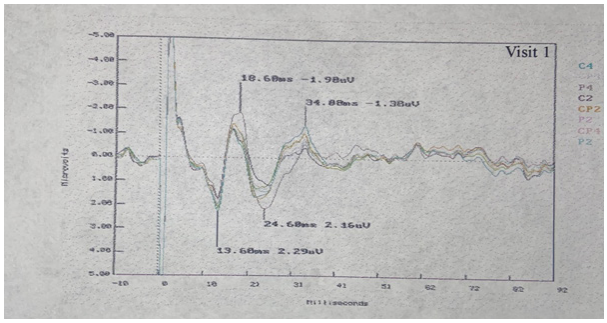
It is concluded that most of the improvement was likely to occur in the period between the onset and the 2nd visit and less at later time. It is a consistent finding that the N30 is likely to be affected more than the other peaks. It is seen that there a difference between normal and patients in N20 at 1st visit. This difference was seen reduced in the following visits. P25 was seen markedly reduced in all visits compared to that of the normal and showed no marked improve relatively to normal throughout. N30 seen sometimes higher than that of the normal. Abnormalities occurred more frequently in patients with sensory deficits. Patients who showed improvement in at least two of these waves were considered to have improved SEPs.

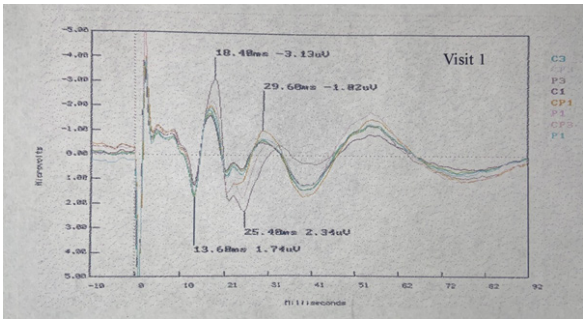
Then correlation was made with recovery of function. On this reference, it is concluded that the improvement on the SEPs peaks

amplitude were correlated with recovery of function in 60% [Table 1 and 2] [Figure 3, 4, 5 and 6].

Table 1: The overall correlation of function (left) amplitude specific correlation with function (right).			
%	**SEPs**	**Function**	**Specific Amplitude Correlation With Function**
60	+	+	N20 y=0.0104x +1.3588 R2= 0.0410 r=0.202
20	-	-	P25 y=0.0449x +25964 R2= 0.3836 r=0.619
10	+	-	N30 y=0.0425x +20276 R2=0.3886 r= 0.623
10	+	-	

Table 2: The overall amplitude means and standard deviation of the N20, P25 and N30 of the three visits of affected and nonaffected compared with the normal																	
Affected			**Non-Affected**		**Affected**			**Non-Affected**		**Affected**			**Non-Affected**		**Normal**		
Function	Mean	SD	Mean	SD	Function	Mean	SD	Mean	SD	Function	Mean	SD	Mean	SD	Function	Mean	SD
1st N20	-2	1	-2.17	0.9	P25	1.52	0.8	2.74	185	N30	-1.8	1.4	-1.9	1	N20	-2.3	0.82
2nd N20	-2	1	-2.32	1	P25	1.59	0.9	3.4	1.9	N30	-1.4	0.9	-2.3	2	P25	1.98	0.89
3rd N20	-2	1	-2.16	1	P25	1.94	1	2.4	1.3	N30	-2.1	1.3	-1.9	1	N30	-1.8	1.12





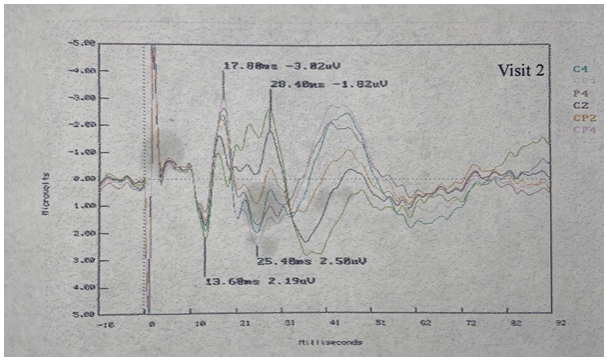
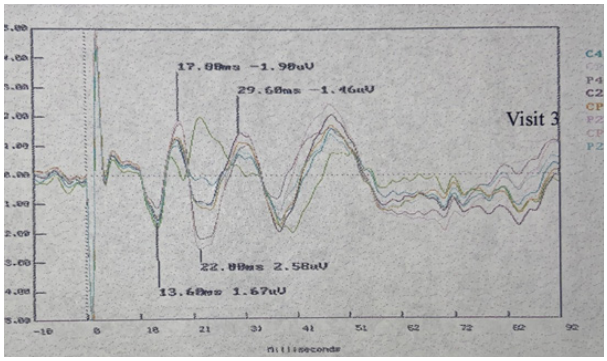
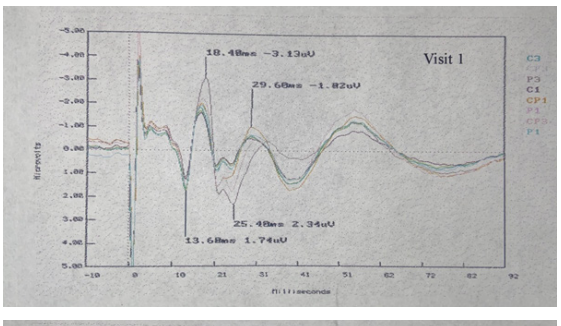
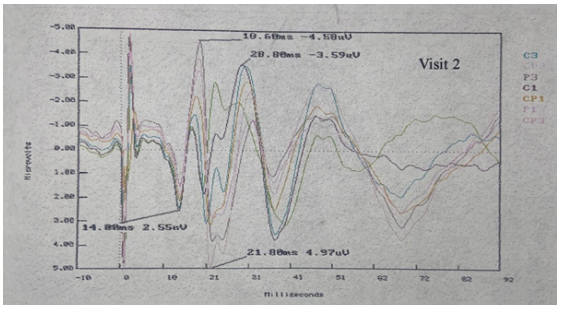


Figure 3: Shows superimposed waveforms of the contralateral centroparietal scalp(affected side). The waveform represent the one patient in three visits.







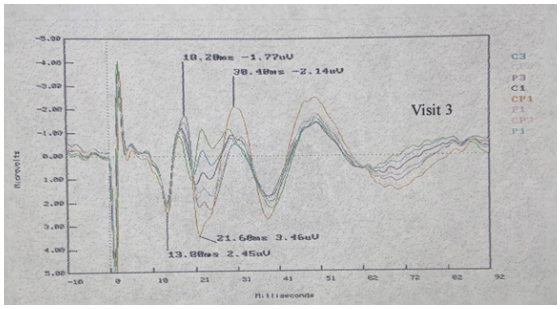


Figure 4: Shows superimposed waveforms of the contralateral centroparietal scalp (nonaffected side). The wave form represent the patient in fig3. It is clear that the nonaffected side has a massive alteration in the morphology.

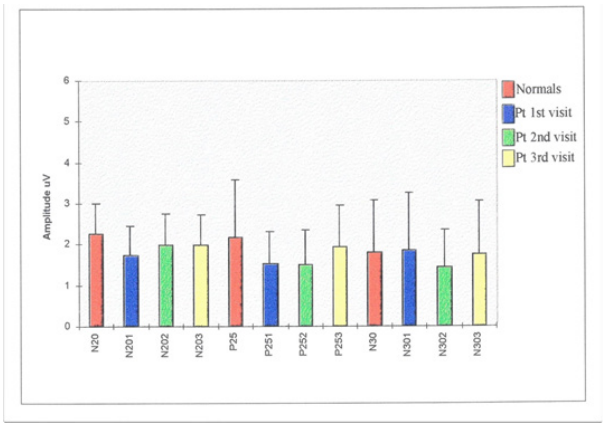


Figure 5: Amplitude mean (±SD of N20, P25.and N30 on healthy and patients over the three vists. (affected side).

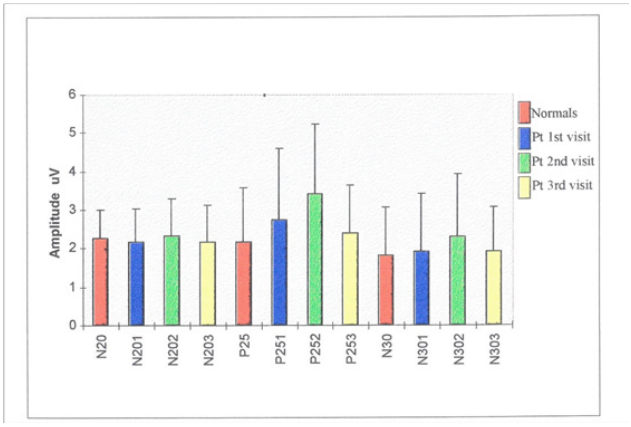


Figure 6: Amplitude mean (±SD of N20, P25.and N30 on healthy and patients over the three vists. (non-affected side).

SEPs recovery seen little proceeded the functional recovery. In few cases (almost 10%) the SEPs recovery do not consistence with functional recovery which may indicate a biological recovery only.

The patient with poor recovery on SEPs and function had lesions confined to more than on level (cortical and subcortical). This finding suggests that the relationship of SEPs abnormality to the outcome measure may be dependent on the site of the lesion.

It was expected to see a statistical significant difference in the amplitude measurement between patient's 1st visit compared to normal. in fact, there were a remarkable difference but none of them was significantly decreased. Since the normal side also showed disturbed potentials of all component throughout the study, comparison is on both sides is not applicable. A major factor of non-significant result is the small sample of the study, approximate number to draw significance is 50 cases.

Statistical calculation of functional outcome shows statistically significant increase when 1st and 2nd visits were compared similarly the 2nd and 3rd and 1st and 3rd, p value less than 0.05.

Discussion

Following a stroke insult within the sensory motor cortex of one or more body parts contralateral to the infarcted side result impaired or paretic. The impairment degree depends on several factors, such as the size, depth and severity of the infarct, the location of the damaged region(s) and the efficiency of the immediate medical care. Substantial functional recovery can occur in the first weeks after stroke, mainly due to spontaneous mechanisms Kwakke, Cramer, Darling, Ward, Grefkes [15-19].

. Around 26% of survivors are able to carry on ADL (Activity of Daily Living) without any support, but another 26% is forced to stay in a nursing facility Carmichael [20]. Impairments of upper and lower limbs are particularly disabling as they impact on the degree of the whole independence and ADLs. Overall a significant percentage of the patients exhibit persistent disability following ischemic attacks. It is therefore critical to promote an objective knowledge of post-stroke neuroplastic changes to enable implementing novel rehabilitative program.

Impairment of specific cerebral areas following stroke is usually evaluated clinically and using CT scan and MRI. There is a variation in assessment of sensory motor functional out comes across the world. Many indexes were developed in the second half of the last century among them is the Barthel index first published 1965. This scale mainly depends on performing physical and cognitive tasks, direct quantitative sensory measures were rarely concerned. It is well known that motor functions are dependent on sensory which in turn are provided in the parietal lobe. For example, if not for the sensory feedback of the muscles and joints (information which transmitted to the parietal lobe and then relayed to the motor areas) movement would become clumsy and lack integration: I.e., a person would not know where their limbs were in space and in relation to one another. Since the parietal and frontal lobes areas are richly interconnected, they serve in many ways as a single Neuro-cortical unit, i.e., sensorimotor cortex, [21]

In 1947 Dawson [5] described the SEPs and determined that there is a cerebral potential arising in the post-central sulcus cortex. There have been many publications afterwards to explain the use of this techniques in evaluating and predicting sensory functions after stroke. The pioneering study of Alajouanine who found the cortical SEPs in patient with thalamic and parietal syndrome cannot be detected [22]. Liberson [7] was the 1st to report the possible prognostic values of SEPs. Liberson [7], Myoshi [8], Noel & Dismedt [9] , and Karnaze [10] have studied the SEPs on varieties of patients with cortical and subcortical lesions. The promotion of technology made the comparison and the analysis much more beneficial. The result of this study is almost in line with the previous studies with more additional details. More than 65% of the study population were improved on SEPs (N20, P25 and N30) throughout, and this improvement was correlated with clinical functional recovery. Even though the amplitude improvement is not significant but found to be crucial to functional recovery. However, there are changes in the location and orientation of these waves which means that there is substantial alteration and reorganization of cortical functions. The irregularities of the wave morphology and distribution was noted at the 1st and 2nd recording. The SEPs waveforms showed alteration over both sides of the brain this may indicate a loss of inhibition particularly during the first few months poststroke. Similarly dipole and cartoon mapping confirm the massive alteration on both hemispheres which may addressed both the redundancy and vicariation concepts [23]. The significance of functional recovery as shown by the Barthel index that matches the improvement in at least two or more early cortical SEPs wave which found relocated in most of the cases indicate the strength of prediction values of SEPs to recovery of function. The limited improvement in SEPs is very crucial for the functional recovery. This however could be used to reinforce the criterion of accepting patients to rehabilitation programs at early stages. Moreover, this also can guide the rehabilitation process throughout.

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