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A COMPARATIVE STUDY OF MEDIAN NERVE SOMATOSENSORY EVOKED POTENTIAL IN THE TOTALLY BLIND AND NORMAL SUBJECTS

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Abstract : The totally blind individuals are often considered to be compensated for their visual loss by augmentation in the auditory and tactile perceptions as against the normal sighted individuals. The objective of the present work was to study the Somatosensory Evoked Potentials (SEPs) after median nerve stimulation in the wrist of totally blind and normal sighted individuals. SEPs were recorded after median nerve stimulation in the wrist of 15 Braille reading totally blind females and compared with 15 age matched normal sighted females. Latency and amplitudes of SEPs (N9, N13, and N20) were measured and analyzed statistically. Amplitude of N20 SEP was significantly larger in the totally blind than in normal sighted individuals ($P<0.05$). The amplitudes of N9 and N13 SEPs and the latencies of all SEPs showed no significant differences. The congenitally blind individuals have larger N20 amplitude, suggestive of greater somatosensory cortical representation than normal sighted individuals.

Key words : somatosensory evoked potentials totally blind normal sighted braille cortical representation

INTRODUCTION

Totally blind individuals require to compensate for the lack of visual information by other sensory inputs and develop supra normal abilities in their remaining sensory systems. In particular, the somatosensory and auditory inputs are crucial to such totally blind individuals. Specific electrophysiological recordings in the totally blind individuals have reported plasticity – brain reorganization changes in the involved neural tracts and the higher central nervous system following visual deprivation and dependence on non-visual sensory modalities (1, 2, 3, 4, 5). Like other tissue plasticities, the adaptive advantage of neural plasticity probably links to fine tuning development. Example following Braille reading or auditory stimuli. These changes are beneficial and the brain continually responds to changes in stimuli by reorganizing itself. Studies have shown

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augmentation of auditory evoked potential changes in totally blind in comparison with normally sighted (2, 3, 4, 5). But not much is documented on the augmentation of Somatosensory Evoked Potential (SEP) changes in the blind. Therefore, the present work was undertaken to study the SEPs and the probable plasticity of the somatosensory system in response to congenital (total) blindness. We studied Median Nerve SEPs elicited by stimulation at the wrist in totally blind individuals and compared them with those of the normally sighted.

METHODS

Fifteen congenitally blind females were recruited from blind schools and from those attending outpatient departments at M.S. Ramaiah Medical and Teaching Hospital, Bangalore. 15 Subjects with congenital blindness (Category-5) (6) and 15 age matched normal sighted healthy females from the general population were studied as controls. Subjects were in the age group 18–40 years were included for the study. Subjects with history of decreased/loss of sensory perception, other neurological disorders, using any drugs – narcotics, stimulants and neurotrophic drugs were excluded from the study. Individuals' details like menstrual history, last date of previous menstrual cycle and handedness was procured through history from all subjects. Subjects were screened for general physical health to rule out any clinical disorder, touch threshold and two point discrimination to rule out any peripheral sensory disorders likely to interfere with the study findings. Tactile sensations were tested for by clinical examination. All the subjects studied were right handed and in the early phase (the first week) of menstrual cycle. Informed written consent was obtained from all subjects. The study was approved by the institute's ethics committee.

Procedures

SEPs (Somatosensory Evoked Potentials) were recorded with the subjects awake, comfortably lying down in the bed in a semi-darkened room and were requested to remain calm keeping their eyes closed. SEPs were recorded using NIHON KOHDEN-Neuropack (MEB 2200 Version 03.02) instrument. Electrode placing, nomenclature and methodology of SEP recordings were according to Chiappa (1990) (7). The electrodes were arranged over the Erb's point, C5 spine on the back of neck, contra lateral parietal-occipital scalp over the sensorimotor cortical areas (C3' or C4') and referenced to F_Z. The 3 channel montage (7) used consisted of :

Channel I : Erb's point response, referred contralaterally to record N9

Channel II : Neck (C5S) referred to Fz to record N13

Channel III : Scalp (C3' or C4') referred to F_Z to record N20

Recordings were obtained with silver cup electrodes filled with contact gel. The skin surface was prepared with abrasive gel, electrodes fixed and secured with adhesive plasters. At all recording sites, electrode impedance was kept below 5Ω. All subjects were delivered with a short duration electrical stimulus (200–300 μs) using a bipolar electrode to stimulate the wrist. The repetition rate of the stimulus was 2 Hz. A total of 500 evoked responses were recorded and averaged for two trials each (to assess reproducibility) from the right and left wrist. Broadband pass filters at 10 to 2500 Hz, restrictive filtering of 150 and 300 to 3000 Hz and amplification at 3,00,000. All channels were recorded and averaged simultaneously with a dwell period of 5 μs. Samples contaminated with artifacts were auto discarded.

Absolute latency and peak amplitude of SEP waveforms, (N9, N13, N20) and interpeak latencies of SEP waveforms (N9 – N20, N13–N20) were measured.

Statistical analysis :

Two tailed independent student t test has been used to find the significance of basic characteristics between the congenitally blind and the normally sighted and also the significance of Latency and Amplitude of all parameters between the 2 groups. Paired Student t test has been used to find the significance of latency and amplitude of various parameters within each group and between Right and. Left Wrist.

Statistical software :

The Statistical software namely SPSS 11.0 and Systat 8.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate tables.

RESULTS

This Comparative study consisted of 15 congenitally blind (Group A) and 15 normal sighted individuals (Group B). Somatosensory evoked potential parameters of the two groups were compared.

The basic characteristics did not show significant difference between the two groups (P>0.05) (Table I).

The mean pattern of absolute latencies of SEPs (N9, N13, N20), inter-peak latencies (N9-N20, N13-N20) after wrist stimulation did not show significant difference between the two groups (P>0.05) (Table II).

TABLE I : Basic characteristics of the study.

Basic characteristics Mean ± S.D.	*Group A (n–15)*	*Group B (n–15)*	P value
Age in years	27.50±3.28	24.95±1.67	0.654
Height in cm	151.71±8.78	154.47±3.62	0.273
Weight in kg	48.71±10.01	52.13±2.64	0.212
Head circumference in cm	52.79±1.05	53.40±1.06	0.128
Arm length in cm	65.07±2.73	66.27±1.53	0.154

TABLE II : Comparison of Mean Pattern of Latency on Wrist stimulation between the two groups.

Latency Mean± S.D.	*Wrist*	*Group A*	*Group B*	*P value*
N9	Right	9.15±0.63[a]	9.12±0.59[a]	0.907
	Left	9.17±0.69[a]	8.89±0.64[a]	0.270
N13	Right	11.91±0.66[a]	12.26±0.52[a]	0.120
	Left	12.01±0.82[a]	12.09±0.68[a]	0.767
N20	Right	17.22±0.78[a]	17.59±0.63[a]	0.165
	Left	17.20±0.79[a]	17.59±0.48[a]	0.121
N9-N20	Right	8.07±0.22[a]	8.20±0.19[a]	0.105
	Left	8.03±0.23[a]	8.22±0.36[a]	0.100
N13-N20	Right	5.31±0.52[a]	5.33±0.39[a]	0.894
	Left	5.19±0.25[a]	5.28±0.34[a]	0.406

Superscripts – Comparison with in each group - Right vs Left
Non-Identical Superscripts (a vs b) are significant at 5% level of significance
Identical Superscripts (a vs a) are non-signficant.

The absolute latencies, inter-peak latencies of SEPs (after wrist stimulation) between right and left in the same groups did not show significant difference (P>0.05) (Table III). The mean pattern of amplitude (base-peak) of SEP – N20 after wrist stimulation showed significant difference between the two groups (P<0.0001 for right wrist and P<0.005 for left wrist). N9, N13 amplitudes (base-peak) did not show significant difference (P>0.05) (Table III).

The mean pattern of amplitude (peak-peak) of SEP–N20 after wrist stimulation showed significant difference between the two groups (P<0.0001 for right wrist and P<0.001 for left wrist). N9, N13 amplitudes (peak-peak) did not show significant difference (0.05) (Table IV).

TABLE III : Comparison of Mean Pattern of Amplitude (B-P) on Wrist stimulation between the two groups.

Amplitude (B-P) Mean± S.D.	*Wrist*	*Group A*	*Group B*	*P value*
N9	Right	5.91±2.54[a]	6.86±2.73[a]	0.341
	Left	6.87±2.45[a]	7.42±3.81[a]	0.648
N13	Right	3.15±0.75[a]	2.94±0.31[a]	0.347
	Left	3.87±0.72[a]	3.46±0.83[a]	0.168
N20	Right	4.82±1.36[a]	2.74±0.95[a]	0.000**
	Left	4.20±1.57[a]	2.76±0.83[a]	0.004**

*Significant at 5%; **Significant at 1%.

Superscripts – Comparison with in each group - Right vs Left

Non-Identical Superscripts (a vs b) are significant at 5% level of significance

Identical Superscripts (a vs a) are non-signficant.

TABLE IV : Comparison of Mean Pattern of Amplitude (P-P) on Wrist stimulation between the two groups.

Amplitude (P-P) Mean± S.D.	*Wrist*	*Group A*	*Group B*	*P value*
N9	Right	8.77±3.09[a]	9.09±3.77[a]	0.803
	Left	9.42±3.29[a]	9.49±3.94[a]	0.958
N13	Right	4.89±1.22[a]	4.43±1.03[a]	0.277
	Left	5.59±0.92[a]	4.93±1.03[a]	0.077
N20	Right	9.49±2.83[a]	4.37±1.85[a]	0.000**
	Left	8.77±2.60[a]	4.95±2.71[a]	0.001**

*Significant at 5%; **Significant at 1%.

Superscripts – Comparison with in each group - Right vs Left

Non-Identical Superscripts (a vs b) are significant at 5% level of significance

Identical Superscripts (a vs a) are non-signficant.

DISCUSSION

We studied Median Nerve SEPs elicited by stimulation at the wrist in totally blind individuals and compared them with those of the normally sighted. The totally blind individuals used more than one finger to read Braille, more of the index, middle and ring fingers. Hence the median nerve was stimulated in the wrist to get a cumulative record of reading fingers.

All SEPs–N9, N13 and N20 evoked from median nerve at the wrist in the congenitally blind and normal sighted individuals did not differ in their latencies and Inter-peak latencies. This suggests that the conduction (peripheral and central conduction) time of the stimulus did not vary in the two groups. These findings are in agreement with those of Alvaro Pascaul-Leone et al (10).

Contradictory findings have been reported with decreased SEP latencies in the totally blind individuals by recording Event related potentials (11). These findings are probably linked to increased attention and hence quicker processing during the discrimination tasks of the event related potentials.

We measured the base to peak and peak to peak of all SEPs–N9, N13, N20. Both of these two methods are commonly used. The amplitudes of N9 and N13 were comparable in the two groups after wrist stimulation. The N20 amplitudes both base to peak and peak to peak in the congenitally blind individuals were significantly larger as compared to normal sighted individuals. The increased amplitude of N20 evoked from median nerve in wrist in congenitally blind shows its large scalp distribution and can be interpreted as a true enlargement of the somatosensory cortical representation. These findings are in agreement with those of Alvaro Pascaul-Leone et al (10). Within the same group in the totally blind individuals, N20 amplitudes were more on right sided stimulation (dominant side) than the left.

Such an observation in our study suggests the way in which the brain reorganizes itself in response to blindness, possibly as a result of greater attention to and reliance on nonvisual sensory avenues to maintain interaction with the world around him. The absence of differences in the sensory function, including two-point discrimination tests between the congenitally blind and normal sighted individuals seems to indicate that the results drawn in these experiments are not related to the differences in the peripheral sensory system.

This plastic reorganization could result from an increase in the effectiveness of pre-existing pathways, suggesting that the representational plasticity is a consequence of the heavy differential sensory input-acquisition of the Braille reading skill. One plausible explanation of the expansion of sensory cortex in the blind individuals as found by Elbert et al (3) is the elaboration of the use-dependent cortical reorganization involving either an unmasking of previously silent connections and/or sprouting of new neural elements from those that previously existed. The reorganization of the somatosensory cortex in the blind (12, 13, 14) would appear to be an excellent composite example of the principle formulated by Merzenich et al 15 of the continual competition for cortical space.

Conclusions

The congenitally blind individuals have larger N20 amplitude, which is suggestive of greater somatosensory cortical activity than normal sighted individuals. Peripheral and central conduction times are not significantly different in the congenitally blind and normal sighted individuals. Effect of blindness and Braille reading skills is greater on SEPs recorded from the dominant and preferred hand.

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