

Central Conduction in Leprosy – A multidomain study

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Abstract—This paper reports the findings of a pioneering study of central conduction in 21 leprosy patients. Somatosensory evoked potentials (SEP) and compound nerve action potentials (CNAP) are recorded after electrical stimulation of median nerves of subjects. The data from both the SEPs and the CNAPs were subjected to time domain, frequency domain and discriminant analyses. The amplitudes and power spectra of the SEPs and the discriminating power of the central conduction time unambiguously prove that the central nervous system (CNS) is spared in leprosy. In contrast, the significant changes in the characteristics of CNAPs indicate a high degree of peripheral nerve abnormality. Thus, that the mycobacterium leprae do not infect the CNS is electrophysiologically established for the first time.

I. INTRODUCTION

The study of somatosensory evoked potentials (SEP) and compound nerve action potentials (CNAP) help in the diagnosis and assessment of various neuropathies. Hanseniasis has been described as a neuropathy [1]. The nerves may be involved at any level from the peripheral cutaneous nerve twigs to the dorsal root ganglia. Leprosy is thought not to affect the spinal cord or the brain, though there has not been any electrophysiological basis for this so far. Sequential recording of evoked potentials at multiple sites along the course of the stimulated nerves and from the scalp is needed to study and localise the level of the leprosy lesions. Clinical neurophysiological studies in leprosy have so far been limited mainly to EMG and motor nerve conduction. To the knowledge of the authors, the possible changes in central conduction in leprosy have not been reported so far. In the present work, parameters of nerve conduction obtained from the peripheral and central neural responses of subjects were subjected to detailed analyses.

II. METHODS

An evoked potential system, built by the authors around an IBM PC/XT compatible was used for this study [2]. Median nerves

were stimulated at the wrist on one of the arms of 25 normals and on both the arms of 21 patients and SEPs were recorded. Further, CNAPs were recorded from the digit, elbow and the ipsilateral Erb's point, before the nerve impulse enters the spinal cord at C7. Central Conduction Time (CCT) is computed as the difference between the latency of CNAP at the Erb's point (N9) and that of the SEP (N19) at the contralateral cortex [3]. Such a measurement of interwave latency (N19-N9) minimizes latency variability due to differing limb lengths and conduction velocities. The amplitudes of all the responses and the segmental nerve conduction velocities (NCV) for the palm, elbow and arm segments were obtained. The power spectra of the normal responses were compared with those of the patients' responses. Finally, average spectra obtained from the normal data were superimposed on those of patients to study the possible dissimilarities between them. The peripheral and central parameters were subjected to discriminant analysis and a successful classifier was obtained using only a subset of the data from both healthy and leprosy subjects. By multiplying the discriminant coefficient (E_i) of each variable x_i by the corresponding difference in means of the two groups of data, ($\bar{x}_{in} - \bar{x}_{ip}$), the distance d_i contributed by that variable is obtained. The discriminating power of each variable is expressed as a percentage of this distance to the Mahalanobis' generalised distance, D_2 between the two groups [4]. The latter is defined as

$$D_2 = \sum_{i=1}^p E_i d_i \quad (1)$$

where p is the total number of variables.

III. RESULTS AND DISCUSSION

Table I shows the sample statistics of the various parameters for the subjects studied. Whereas the reductions in the mean

amplitudes of the elbow and Erb's point responses (A_e and A_r) are significant, the reduction in the SEP amplitude (A_s) is not statistically significant. The marginal reduction in A_s of patients is attributable to less excitation reaching the Central Nervous System (CNS) from the brachial plexus where the CNAP amplitude is significantly ($p < .001$) reduced. It is seen that the mean value of the CCT of patients is almost the same as that for normals. The marginal reduction in the mean CCT of patients is due to the inclusion of very low values of a young patient. Table I also gives the mean values of forearm NCV (V_{fa}). Since it has been observed that the NCV in all the 3 peripheral segments is significantly reduced, the results show that conduction in the CNS is not altered due to leprosy.

The power spectra of the distal CNAPs for the healthy subjects are very smooth, whereas clear peaks were present at two different frequencies in the case of patients. Fig. 1 displays the average spectra of SEPs for normals and patients. The two spectra are practically indistinguishable.

The classifier obtained could correctly classify all the rest of the data from both groups not used for computing the discriminant coefficients. Table II gives the discriminating power for the central and some of the peripheral conduction variables. While the powers of A_e and V_{fa} are 31% and 14.7%, those of CCT and A_s are 0% and -1.2%, thus clearly illustrating that the values of CCT of a subject cannot be used to differentiate patients from normals.

IV. CONCLUSION

The mean values of CCT and amplitude of SEP of patients are the same as those of normal subjects. Further, the average frequency spectra of SEPs of normal subjects

TABLE I
AMPLITUDES, VELOCITIES AND CENTRAL CONDUCTION TIMES

Subject Group	A_e μV	A p4	A_s μV	V_{fa} m/sec	CCT msec
Mean (Normals) :	17.1	7.3	3.4	75.5	8.78
S.D.	5.1	2.6	1.1	4.7	0.49
Mean (Patients):	7.4	4.8	3.3	67.2	8.59
S.D.	5.5	2.6	1.6	6.3	0.90
Sig($p \leq$)	.001	.001	N/S	.001	N/S

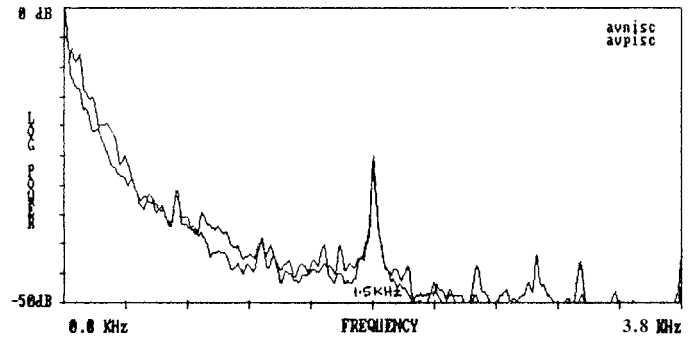


Fig. 1. Comparison of the average spectra of SEPs of normal subjects and patients.

TABLE II
DISCRIMINATING POWERS OF CONDUCTION PARAMETERS

Para Meter	Coeff. E_i	$-d_i = -x_{in} - x_{ip}$	D.Power % of D_2
A_e , μV	0.837	9.7	31.0
A_s , μV	-0.696	0.1	-1.2
V_{fa} , m/sec	0.802	8.3	14.7
CCT, msec	-0.272	0.19	0.0

and patients are indistinguishably identical. The discriminant analysis too has clearly shown that none of the characteristics of the SEPs are capable of discriminating between normal and abnormal population. There is however a highly significant reduction in the amplitudes of all the peripheral potentials and the segmental NCVs. Thus these electrophysiological studies conclusively prove that the CNS is spared in leprosy.

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