Extraction of Significant Nerve Conduction Predictors in Early Diagnosis of Leprosy

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***Abstract*-Compound nerve action potentials were obtained from 25 normal subjects and 21 leprosy patients after electrical stimulation of median nerves. Parameters such as sensory nerve conduction velocity, motor threshold of stimulation and peak to peak amplitudes were measured. Responses were recorded from two orthodromal locations and one antidromal site. Multivariate analysis was applied on the data to determine the discriminating power of each of the parameters. Results clearly indicate the suitability of amplitudes more than conduction velocities in correctly quantifying neural abnormalities. Clinical correlation studies confirm these results.**

I. Introduction

That the sensory nerves are the first to be affected in leprosy is well known [1]. Hence, if one is interested in early detec tion, which is so essential in leprosy, one must necessarily look for correlates in sensory nerve conduction parameters. However, most earlier electrophysiological studies in leprosy have concentrated on EMG and nerve conduction velocity in motor fibres only. In the present study, a comprehensive approach is made in observing all relevant variables including stimulus threshold and amplitude of the Compound Nerve Action Potentials (CNAP). Further, it is necessary to get an objective measure of effectiveness of each parameter in differentiating normal from abnormal potentials. This discriminating power of different parameters was obtained by a multivariate analysis and verified by means of correlation with clinical observations.

II. Methods

An IBM PC/XT compatible was converted into a dedicated system for acquisition, analysis and classification of evoked potentials by the addition of appropriate hardware and software [2]. Using this system, median nerves of subjects were stimulated percutaneously at the wrist. Responses were recorded from (i) the palmar side of third digit (ii) proximal to the elbow crease, medial to the brachial artery and (iii) the Erb's point. Twenty five normal subjects and 21 patients were studied. The stimulus intensity is maintained at a value to effect a minimal thumb twitch. Stimulus of 100 μS duration was applied at a repetition rate of two per second. Some of the patients were affected only unilaterally. However, responses were obtained from both the arms in order to electrophysiologically assess the clinically normal median nerves of patients.

The data from clinically normal and abnormal nerves were grouped separately. The stimulus threshold (S), absolute and relative latencies of the CNAPs, peak to peak amplitudes (A_i), nerve conduction times (NCT), and segmental nerve conduction velocities (NCV) were calculated and tabulated. Thirteen such parameters were fed as input for discriminant analysis [3]. Only part of the data from both the normal and the clinically affected patient groups were utilized in arriving at the discriminant function. This eliminates bias in the results and enables testing of the discriminant classifier on the rest of the normal and patient data.

Electrophysiological data was correlated to the clinical assessment of the patients. Patient files from the hospital had data regarding areas of partial or total loss of sensation, paresis, paralysis or anaesthekinesia, locations of active and healed patches, hand clawing, surgical decompression of the nerves, etc.

III. Results and Discussion

Table I lists the sample statistics and significance of deviation of each group of patient data from normal data. It is seen that while the reduction in amplitudes of CNAPs are significant (at $p<.001$) for all three responses from affected nerves, NCVs are significantly reduced only in two

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segments at the same level. Further, even in the case of clinically unaffected nerves, the two distal amplitudes (A_d and A_e) are significantly reduced (at $p<.001$) and the NCVs at $p<.005$, $p<.001$ and $p<.05$ level.

Discriminant analysis showed that only seven of the parameters are very effective in distinguishing normal from abnormal responses. The coefficients (E_i) of the discriminant function and the percentage discriminating power of only those 7 predictors are shown in Table II. The stimulus threshold and the NCVs of the palm and forearm segments (V_p and V_{fa}) have discriminating powers of 15% whereas the amplitudes of the digit and elbow potentials (A_d and A_e) have powers of 30%. Amplitude at Erb's point (A_b) and NCV of arm segment (V_a) discriminate less. The discriminant function was able to correctly classify the entire normal data both included and excluded for the analysis. Though the classifier was trained only on data from clinically abnormal arms of patients, it classified the clinically normal nerve parameters of most patients as abnormal. This result shows that clinically unaffected nerves have such significant changes as could be picked up by a classifier trained on data from clinically affected nerves. Clinical correlation confirmed that in all cases, amplitudes are well correlated whereas NCVs are not always correlated to clinical observations. Finally, another run of the discriminant analysis using only 3 parameters A_d, V_p and S clearly showed that these 3 are sufficient parameters for classifying the data. The discriminant function obtained was

$$D = -0.063\ S + 0.1817\ V_p + 0.2081\ A_d.$$

TABLE I.
TIME DOMAIN DATA FOR NORMALS AND PATIENTS

Subj. Group	S Volts	V_p m/sec	V_{fa} m/sec	V_a m/sec	A_d μV	A_e μV	A_b μV
Normal subjects :							
Mean	34	67.0	75.5	70.5	50.0	17.1	7.3
S.D.	9	7.3	4.7	6.9	20.6	5.1	2.6
Patients (Affected nerves) :							
Mean	59	52.0	68.1	62.2	4.2	4.2	4.0
S.D.	32	10.9	7.5	12.6	4.2	3.2	2.3
Sig(p<)	.005	.001	.001	.02	.001	.001	.001
Patients (Unaffected nerves) :							
Mean	50	57.7	66.4	65.7	13.6	10.3	6.4
S.D.	17	10.9	4.5	7.4	9.1	5.4	3.9
Sig(p<)	.001	.005	.001	.05	.001	.001	N/S

TABLE II.
SIGNIFICANCE OF THE PREDICTORS

PARAMETER	COEFF. E_i	D.POWER %
S,Volts	-0.282	19.7
V_p,m/sec	0.398	16.8
V_{fa},m/sec	0.802	14.7
V_a,m/sec	-0.267	-6.7
A_d,μV	0.220	30.1
A_e,μV	0.837	31.0
A_b,μV	-0.811	-7.8

IV. Conclusion

The amplitudes of the distal peripheral potentials are much better indicators of leprous neuropathy than the sensory nerve conduction velocities. This estimation of relative significance of the amplitudes of the CNAPs over the NCVs as also the confirmation by clinical correlation has not been reported so far. The reduction in amplitude of responses in clinically unaffected nerves may indicate an early stage of the nerve involvement, thus being of some predictive value. The study of distal conduction in the nerves of upper limbs may well be used to screen an exposed population to mycobacterium leprae, the score of the discriminant function being used as the deciding factor. Such a quantitative electrophysiological assessment of sensory nerves could become a tool for early diagnosis of leprosy.

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