

Nerve Conduction Studies In Paucibacillary And Multibacillary Leprosy: A Comparative Study.

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Abstract: Background: Leprosy is one of the principal causes of non-traumatic neuropathy. Functional derangement of nerves can be shown by nerve conduction studies before the appearance of clinical signs and symptoms of the disease. **Materials and Methods:** We conducted an electrophysiological study on 18 multibacillary and 7 paucibacillary patients with clinical manifestations of leprosy. This study was done to assess the nerve conduction velocity, amplitude and latency of ulnar and median nerves. **Results and Conclusion:** We found reduced conduction velocities, latency and amplitude in the affected nerves. Changes in nerve conduction were more pronounced in multibacillary compared to paucibacillary patients.

Keywords: Leprosy, electrophysiology, nerve conduction, neuropathy

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I. Introduction

Leprosy is a predominantly a disease of the skin and peripheral nerves. Nerve involvement in leprosy affects sensory, motor and autonomic function of peripheral nerves. The effect of the disease on nerves leads to disability and deformity. Nerve conduction studies (NCS) are very important for the study of peripheral neuropathy.

The World Health Organization classifies leprosy, on the basis of findings from skin smears, as paucibacillary and multibacillary leprosy; patients showing negative skin smears for acid-fast bacillus at all sites examined are grouped as paucibacillary leprosy whereas patients having positive skin smear for acid-fast bacillus from any site are grouped as multibacillary leprosy. NLEP, India (2009) Classification includes nerve involvement other than skin lesions and slit skin smear (SSS). Multibacillary leprosy includes more than one nerve irrespective of the number of skin lesions, SSS positive at any site and skin lesions more than 5 while paucibacillary leprosy includes no nerve/ only one nerve with or without 1-5 lesions, SSS negative at all sites or less than 6 skin lesions.¹

II. Material And Methods

The present study was conducted over a period of one year. Diagnosed (on treatment) cases of Hansen's disease fulfilling the WHO criteria and attending the Out Patient Department were included in the study. However, cases with associated diabetes mellitus, cervical trauma, neurological disease, cardiovascular disease, patients with pace makers, chronic alcoholics, patients of age less than 6 years and cases during the reaction episodes were excluded from the study.

In each case, informed written consent, detailed history and thorough examination with reference to clinical involvement in leprosy was done. In all cases slit skin smear examination was done. Sensory examination and voluntary motor testing was performed. Any deformities present were noted. We used a questionnaire, skin and electrophysiological examination for our study. Nerve conduction of ulnar and median (motor and sensory) nerves was done using machine – 4 channel EMG system of Sigma Neurowork from Germany.

The general principle of nerve conduction study is that the recording or active electrode is placed over muscle or nerve segment to be studied. While the reference electrode for motor response is positioned off and distal to the muscle being tested on a nearby bone or tendon, whereas the reference electrode for sensory response is placed distal to and on the nerve segment being studied. The ground electrode is usually placed on the body prominence between the stimulating and recording electrodes. Stimulating electrodes are usually two

metal electrodes or felt pad electrodes. The interpretation of electrophysiological functions of nerve trunks is usually based on the analysis of three basic criteria - velocity, latency and amplitude of the evoked response.²

In this comparative study, we evaluated the nerve conduction parameters in patients with paucibacillary and multibacillary leprosy. The various parameters studied in NCS were sensory nerve action potential (SNAP), onset latency and conduction velocity for sensory nerves. However in case of motor nerves distal motor latency, compound muscle action potential and conduction velocity was recorded (Figure-1). The normal values of different parameters studied are shown in Table-1.³

III. Results

Clinical disease profile

Out of 25 patients studied 18 patients (72%) were multibacillary and 7(28%) were paucibacillary. Skin smears were positive in 14 (56%) patients at diagnosis and they were treated as multibacillary cases. Smears were negative in 11 cases. Out of these, 4 were treated as multibacillary cases. However, 7(28%) cases with a negative skin smear were treated as paucibacillary.

Demographic profile

The study included 25 patients, 19 males and 6 females (male: female ratio of 3.2:1) with an age range of 17 to 52 years (33.5 ± 8.34 years). 88% of patients were in the age group 15 - 44 years. The rest of the age wise distribution of patients is shown in Figure-2.

68% patients were from the state of Himachal Pradesh while 32% were immigrants. Out of the 8 immigrant patients, 6(75%) were from Nepal and 2 (25%) were from other states. 17(68%) patients had occupations involving strenuous physical activities (manual labour/farming). History of contact was elicitable in 6 patients (24%). In all of these patients, the contact was within the household.

Disease spectrum

Incidentally, 60% patients were in the lower spectrum of the disease (BL/LL) as well as in borderline spectrum with some overlap. At the time of diagnosis, 3 patients were seen downgrading from BT to BL and 1 from BL to LL (Table -2).

Disease manifestations

On clinical examination skin lesions were present in all 25 patients. Other manifestations of the disease are shown in Figure-3.

Nerve thickening

Ulnar nerve thickening was seen in 18(72%) patients i.e. 34 nerves, with bilateral involvement in 16 (64%) patients and unilateral involvement in 2(8%) patients. Median nerve was not thickened in any patient.

Nerve function impairment

Nerve function impairment (ulnar and median) on nerve conduction studies was found in 10(40%) patients. All the patients with nerve function impairment were multibacillary type. Nerve function impairment was absent in paucibacillary patients. 8(80%) patients with nerve impairment were involved in strenuous physical activities. Based on the spectrum all the patients with nerve function impairment were of lower spectrum (BL/LL) (Figure-4).

It was found that the ulnar nerves (24%) were more commonly involved than the median nerves (22%). Out of 34 thickened ulnar nerves clinically; only 12 nerves (35.3%) had nerve function impairment. All the patients with nerve impairment had thickened ulnar nerve. Nerve function impairment was present in 11 (22%) median nerves.

Sensory nerves (22%) were more commonly involved than the motor nerves (13%). Ulnar sensory (24%) was more severely involved than the median sensory (20%) but median motor (14%) was involved more than the ulnar motor (12%) (Table 3).

Out of the 23 nerves with nerve function impairment, mixed type (47.8%) was the most common followed by axonal (26.1%) and demyelinating (26.1%) type in equal proportion.

Out of the 10(40%) patients with Nerve function impairment, 3 patients (12%) had bilateral involvement of ulnar and median nerves. One patient (4%) had 3 nerves involved while remaining 6 patients (24%) had either one or two nerve involvement. One patient (4%) had median motor involvement without sensory involvement.

4 patients (4 nerves i.e. 4%) had only sensory impairment clinically but on nerve conduction studies, both sensory and motor impairment was found in these patients. One patient (1 nerve i.e. 1%) had no sensory/motor

impairment clinically but nerve conduction study detected motor impairment. Thickened nerves may also have normal functions as in our study (22 nerves i.e. 64.7%). Thus, the Nerve Conduction Studies can help in detection of early nerve impairment which was otherwise not detected clinically, as in our study it was detected in 20% patients (5 % nerves).

IV. Discussion

Nerve conduction studies are helpful in assessment of degree of nerve dysfunction, the type of fibres involved and for detecting subclinical involvement in leprous neuropathy.

72% of our patients were multibacillary and rest 28% were paucibacillary. In Jindal *et al.*⁴ study also the majority of the patients were multibacillary (81.59%) and the rest (18.41%) were paucibacillary as in our study. Skin smears were positive in 14 (56%) patients at diagnosis and they were treated as multibacillary cases. Smears were negative in 11 cases. Out of these, 4 were treated as multibacillary cases. However, 7 cases with a negative skin smear were treated as paucibacillary. 46% were smear positive in Jindal *et al.*⁴ study which is less than in our study as most of the patients (60%) in our study were in the lower spectrum of the disease.

Leprosy affects both the sexes; however, males are affected more often as compared to females, generally in the proportion of 2:1.⁵ The male to female ratio of 3.2:1 was noted in our study. More number of male cases could be attributed to their greater mobility and increased opportunity for contact. Males are also more active in reporting to health facility for seeking treatment. Additionally, 32% of our patients were migrant workers, which predominantly consist of male population; also, in our state females cover most of their body parts which could lead to decreased detection of skin lesions. These could be the factors responsible for higher proportion of males in our study.

In another study from our state by Jindal *et al.*⁴ also reported male to female ratio of 3:1, similar to our study. Chhabra *et al.*⁶ also reported higher male to female ratio (2.3:1). 54.3% of patients were migrant workers in their study. The explanation given by them for the higher male to female ratio was similar to our study.

Leprosy can occur at any age but is more common in the age group of 20 - 30 years. Our study included 25 patients with the mean age of 33.5 ± 8.34 years. 88% of the patients were in the age group 15 - 44 years; all the patients in our study were above the age of 14 years. The percentage of childhood leprosy is low in our study which indicates absence of active transmission of the disease in the community. In our study 80% of the patients were in the middle age group (20-40 years) which is in accordance with the literature. In Jindal *et al.*⁴ study majority of patients (47.8%) were in the middle age group (20-40 years). In Chhabra *et al.*⁶ study the mean age of patients was 32.08 ± 15.46 years which was similar to our study.

A large number of migrant labour, mainly from Nepal, travel to Himachal Pradesh for employment. Himachal Pradesh, a low endemic area for leprosy, is too getting its share of migrant leprosy as is evident from the data from our study. In our study 68% patients were from the state of Himachal Pradesh while 32% were immigrants. In Jindal *et al.*⁴ study 71.78% patients were from Himachal Pradesh, 28.22% patients were immigrants which was similar to our study.

68% of our patients had occupations involving strenuous physical activities (manual labour/farming). 32% patients had occupations involving light physical activity. Alam *et al.*⁷ reported that a large majority of patients (78%) were involved in heavy manual work as farmers and labourers as in our study.

In our study 24% gave a history of contact with a leprosy patient. In all of these patients, the contact was within the household. Rate of household contact in our series was higher than that reported by Jindal *et al.*⁴ (9.2%). It has been shown that the probability of finding familial occurrence of leprosy is higher in families that include a lepromatous patient; than in those where it does not.⁸ Most of the other studies from India have included neighbourhood contacts also and therefore the data could not be compared. Van Beers *et al.*⁹ have shown that risk of a person developing leprosy is four times higher when there is a neighbourhood contact and up to nine times higher when the contact is intra-familial.

In the clinical disease spectrum, incidentally, 60% patients were in the lower spectrum as well as in borderline spectrum with LL (32%) and BT (32%) being the most common. In Jindal *et al.*⁶ study 53.98% patients were in the borderline spectrum followed by LL (33.12%) and polar tuberculoid leprosy (5.52%). Pure neuritic and indeterminate leprosy accounted for 3.06% each. The type of leprosy commonly present was LL followed by BT which is almost similar to our study. In Murthy *et al.*¹⁰ study of 100 patients, 55 were BT followed by LL (29), BL (8), TT (5), BB (2) and only one patient of indeterminate leprosy. Skin smear examination showed the presence of bacilli in 32% (4 cases of BL and 28 cases of LL). This is in contrast to other studies which show BT, followed by TT to be commonest spectrum (Mahajan *et al.* 2003, Singh *et al.* 2009).^{11,12} The reason given by Jindal *et al.* was that the Himachal Pradesh holds a better position as compared to overall trend in India except for invisible deformity and MB cases, the ratio of which is significantly higher in Himachal Pradesh; another reason given was large load by immigrant population.⁴

On clinical examination skin lesions were present in all the patients in our study. Jindal *et al.*⁴ reported skin lesions in 96.9% of the patients as 3.1% of the patients were of pure neuritic leprosy, compared to our study in which no patient had pure neuritic leprosy.

In our study ulnar nerve thickening was seen in 72% patients. In a study by Chaurasia *et al.*¹³ ulnar nerve thickening was seen in 65% cases. This difference may be due to difference in proportion of multibacillary (52.5%) and paucibacillary (47.5%) compared to our study in which 72% patients were multibacillary type and rest 28% of patients were paucibacillary. Sajid and Malaviya¹⁴ detected ulnar nerve thickening in 70.8% cases while Vashisht *et al.*¹⁵ observed ulnar nerve thickening in 72% patients which was almost similar to our study. The variation in different studies may be due to difference in different proportion of multibacillary and paucibacillary cases. This can be due to higher MB cases in Himachal Pradesh. A large number of places in Himachal Pradesh are far off and difficult to reach and people seek medical care only late in the disease process.⁴

In our study nerve function impairment on nerve conduction studies was found in 40% patients. All the patients with nerve function impairment were multibacillary type. Based on the spectrum all the patients with nerve function impairment were of lower spectrum (BL/LL). 80% patients with nerve impairment were involved in strenuous physical activities. Chaurasia *et al.*¹³ also reported that the patients with multibacillary leprosy had significantly more severe changes on NCS as compared to paucibacillary leprosy. In contrast to our study Sajid and Malaviya¹⁴ reported that the changes in multibacillary cases were less marked compared to paucibacillary. No explanation for the above finding was given in the above two studies.

In our study the patients with MB leprosy had significantly more severe changes on NCS as compared to PB leprosy since the number of patients of PB were also less (only 28%). Due to the study of only ulnar/median nerve and different spectrum of the disease in various studies, the results cannot be compared.

Patients with thickened ulnar nerves on palpation, only 35.3% patients had nerve function impairment on NCS but all the patients with nerve impairment had thickened ulnar nerves. Vashist *et al.*¹⁵ reported sensory deficit in the distribution of thickened ulnar nerve in 86% of thickened nerves. The lower percentage in our study may be attributed to uneven involvement of nerve fascicles.

In our study it was found that the ulnar nerves (24%) were more commonly involved than the median nerves (22%), while sensory nerves (22%) were more commonly involved than the motor (13%), which is in conformity with the literature. Ulnar sensory (24%) was more severely involved than the median sensory (20%) but median motor (14%) was involved more than the ulnar motor (12%). Ramadan *et al.*¹⁶ also detected involvement of median motor more than the ulnar motor, motor nerve conduction of median nerve was abnormal in 72.5%, while motor nerve conduction of ulnar nerve was abnormal in 70% and sensory nerve conduction of ulnar nerve was abnormal in 77.5% of the total. The involvement of median motor more than ulnar motor in our study and Ramadan *et al.* study may be attributed to uneven involvement of nerve fascicles or may be related to the chronological occurrence of nerve damage among different nerve fibres or fascicles in the same nerve, this point needs further studies on different grades of nerve damage in a sufficient number of leprosy patients before any conclusion can be made. Sajid and Malaviya¹⁴ and Vashisht *et al.*¹⁵ also found changes in NCS in the affected nerves. Changes in sensory nerve conduction were more pronounced than motor which is in accordance with the literature.

In our study only one patient had median motor impairment without sensory impairment on NCS. In another study by Gupta *et al.*¹⁷ motor nerve conduction velocity was found to be reduced in more number of patients when compared with sensory nerve. The sensory fibres are damaged early in leprosy and therefore show more quanta of changes in conduction velocities as compared to motor nerve fibres in the early stages of damage.¹⁴ However, the amplitude changes are much more marked for motor nerve fibres¹⁸ which may explain the median motor impairment without sensory impairment in one of our patients.

Based on the changes in velocity, amplitude, and latency of the evoked response, the nerve function impairment is divided into three types – axonal, demyelinating and mixed type. Mixed type has changes of both axonal and demyelinating types (Table-4). In our study mixed (47.8%) type of nerve function impairment was the most common followed by axonal (26.1%) and demyelinating (26.1%) type in equal proportion which is consistent with the previous studies. Chaurasia *et al.*¹³ also detected mixed type as the commonest type of nerve function impairment. In contrast Soysal *et al.*¹⁹ reported predominantly axonal neuropathy, 68.42% of the patients had axonal neuropathy; while demyelinating and mixed neuropathies were seen in 15.79% of subjects each, predominance of axonal type in their study could be due to higher percentage of patients with lower spectrum since the nerve damage in this spectrum is due to fibrosis of the nerves which results in axonal type of damage.

In our study 4% nerves had only sensory impairment clinically but on nerve conduction studies, both sensory and motor impairment was found in these patients. One patient (1%) had no sensory/motor impairment clinically but nerve conduction study detected motor impairment in one of his nerves. Thickened nerves may also have normal functions as in our study (22 nerves i.e. 64.7%). Thus, nerve conduction studies can help in

detection of early nerve impairment which was not detected clinically, as in our study it was detected in 5% nerves. Ghiglione *et al.*²⁰ detected nerve function impairment (NFI) in 43.6% in clinically asymptomatic nerves. This difference was due to more number of nerves studied in this study compared to our study. Sajid and Malaviya¹⁴ found that even though clinically normal, 16% among ulnar and 20% among median nerves were electrically abnormal in leprosy. They also observed that it is difficult to decide whether or not a clinically enlarged nerve in a patient is necessarily at risk. If the nerve is enlarged but has normal electrophysiological functions, a further period of observation is indicated. Several workers^{21, 22, 23} have noted that normal sensory-motor conduction velocities could be found in the diseased nerves which could be explained by involvement of certain fascicles of the affected nerve with little or insignificant involvement of others. Chaurasia *et al.*¹³, Sohi *et al.*²⁴ and Ramkrishnan and Srinivasan²⁵ also detected NFI before it was clinically evident.

V. Conclusion

Electrophysiological assessment suggested that in leprosy there was mixed involvement of axons as well as myelin sheath. NCS revealed involvement of nerves which were apparently normal on clinical examination.

In conclusion, it could be stated that nerve conduction studies help in demonstrating and detecting the integrity of nerve function in leprosy. They are useful not only in assessing nerve function at the time of diagnosis but also in the follow-up study of leprosy patients and complement clinical tests for nerve function assessment.

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Table- 1: Nerve conduction studies normal values ³

Nerve	Record	Amplitude (μV)	Conduction Velocity(m/s)	Latency (ms)
Median Motor	APB	≥ 4.0	≥ 48	≤ 4.2
Ulnar Motor	ADM	≥ 3.7	≥ 49	≤ 3.4
Median Sensory	Digit 2	≥ 17	≥ 44	≤ 3.5
Ulnar Sensory	Digit 5	≥ 17	≥ 44	≤ 3.1

APB: Abductor Pollicis Brevis; ADM: Abductor Digiti Minimi

Table 2: Disease spectrum

n	TT	BT	BB	BL	LL	Pure neuritic	Indeterminate
25	2(8%)	8(32%)	0	7(28%)	8(32%)	0	0

Table-3: Sensory/motor nerve function impairment.

NERVE	NERVES	PATIENTS
ULNAR SENSORY	12	8
ULNAR MOTOR	6	3
MEDIAN SENSORY	10	7
MEDIAN MOTOR	7	5

Table-4: Type of nerve function impairment.

TYPE	VELOCITY	LATENCY	AMPLITUDE
Axonal	N/Slight ↓	N/Slight ↓	↓↓↓
Demyelinating	↓↓↓	↑↑↑	N/Slight ↓
Mixed	↓↓↓	↑↑↑	↓↓↓

Figure-1: Compound muscle action potential (CMAP). ³

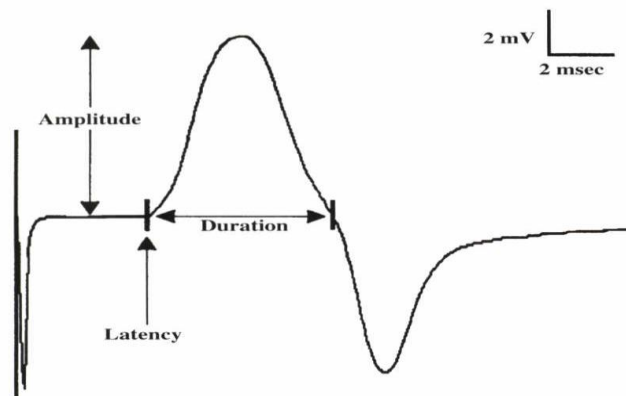


Figure-2: Age distribution

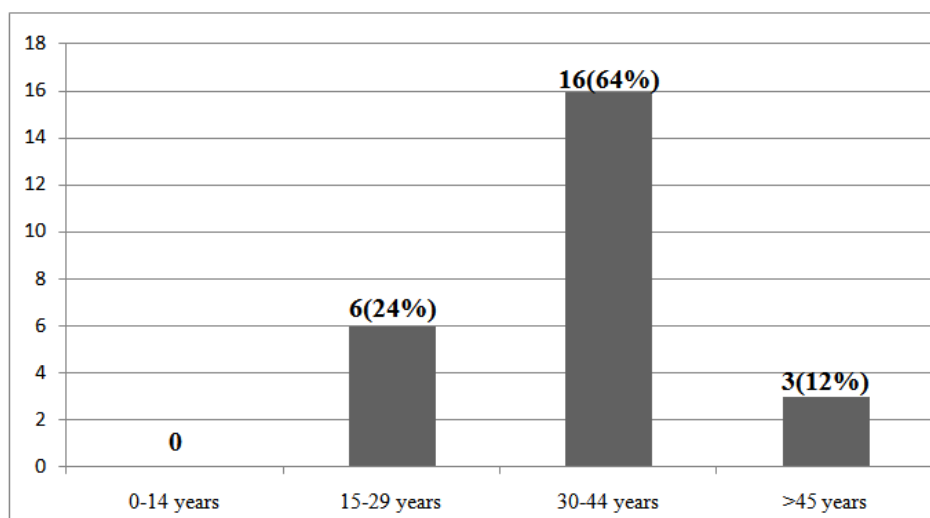


Figure-3: Disease manifestations

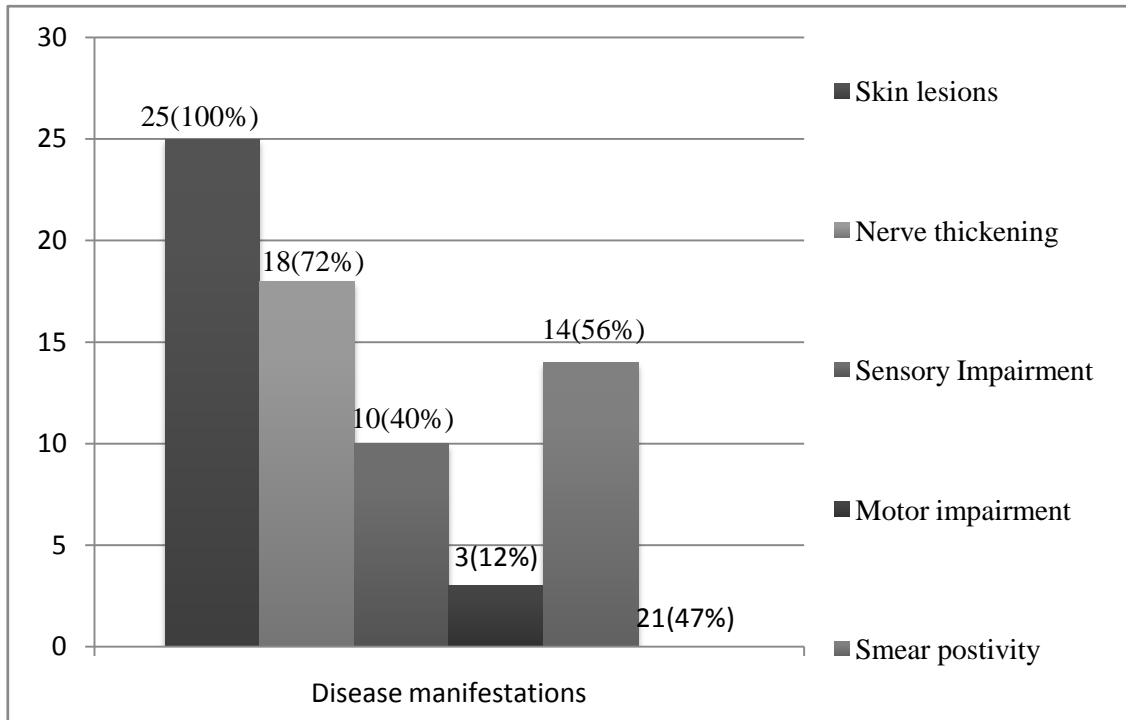
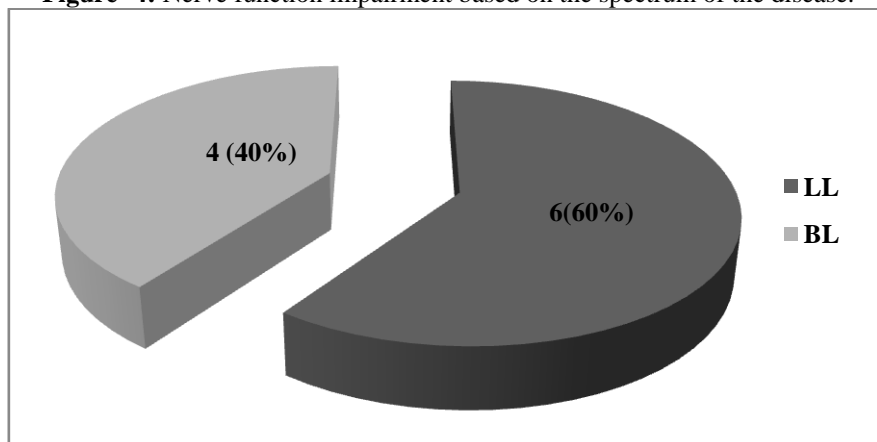


Figure- 4: Nerve function impairment based on the spectrum of the disease.



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