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Electrodiagnostic Referrals at a Tertiary Center

ABSTRACT

Introduction: Electrodiagnostic studies are used for the diagnosis of various lower motor neuron disorders. A set of necessary tests are performed for exact localization of disease. The aim of this study is to assess the frequency of the different lower motor neuron diseases and to see how many patients require follow up EDx studies for different conditions. **Material and methods:** This is a retrospective study and data of consecutive patients assessed in our EDx laboratory in the years 2021 and 2022 were included. Data was included as number of cases with a final EDx diagnosis. Total number of cases of each type were entered month wise with the total number of cases of each EDx diagnosis as inferred after the test. **Results:** In the year 2021, a total of 2732 patients were tested for EMG and EPs in the EDx laboratory. In the year 2022, 3425 patients were tested. The maximum number of patients (905) had normal EDx findings. The most common abnormal diagnosis included traumatic nerve/plexus injuries (668), closely followed by upper/lower limb radiculopathies (645). Somatosensory evoked potential studies for assessing posterior column conduction defects formed the next large referral (598). 478 patients underwent follow up studies followed by Carpal tunnel syndrome (357) and Diabetic peripheral neuropathies (347). Also, a special mention of 130 cases of EMG guided laryngeal botulinum toxin injections for patients with spasmodic dysphonia where the injection is given by Laryngologist/Voice surgeon. **Conclusion:** To conclude, in our study, the order of electrodiagnostic outcome is normal study followed by peripheral neuropathies, followed by traumatic neuropathies/plexopathies and somatosensory evoked potential studies over the course of 2 years in a total of 6157 patients. Our study reports the maximum percentage of normal EDx findings as consistent with other studies. Most other studies have reported polyneuropathy, entrapment neuropathy, and disorders of the motor nerve root and plexus as the most common reasons for electrodiagnostic requests (19,20). The large number of SSEP referrals as in our laboratory, have not been studied at other centres as reviewed. The strength of our study is (1) the large sample size even though the study has been done only at one centre, and, (2) the maintenance of accurate records.

Key words: EDx diagnosis, Consecutive, Total, Requests, Outcome, Records

INTRODUCTION

Electrodiagnostic examination is an extension of clinical examination. Electrodiagnostic studies include nerve conduction studies (NCS), needle electromyography (EMG), and evoked potential studies, which include somatosensory evoked potential (SSEP), visual evoked potential (VEP), and brainstem auditory evoked potential (BAEP) studies. Patients are referred to the laboratory for studies directed towards the diagnosis of various lower motor neuron disorders.[1] In the laboratory, a set of necessary tests is performed based on clinical symptoms and working diagnosis to help in the exact localization of disease, for example, nerve, root, plexus, muscle, neuromuscular junction, or anterior horn cell.[1] The studies help in knowing the severity of the disease and the temporal profile. Electrodiagnosis (EDx) studies help to classify the disease pathophysiology as axon loss or demyelination. Furthermore, follow-up studies are useful in various conditions for either knowing the response to treatment or for prognostication. At our tertiary center, patients are referred for EDx studies by neurologists as well as various other specialty physicians and surgeons. The aim of this study is to assess the frequency of the different lower motor neuron diseases and to see how many patients require follow-up EDx studies for different conditions.

Alika Sharma, Priyanka Chavan, Khushnuma A Mansukhani

Department of Clinical Neurophysiology (EMG and EP), Bombay Hospital and Medical Research Centre, New Marine Lines, Mumbai, Maharashtra, India

Corresponding Author:
Alika Sharma, Department of Clinical Neurophysiology (EMG and EP), Bombay Hospital and Medical Research Centre, New Marine Lines, Mumbai, Maharashtra, India.
E-mail: alika.sharma@gmail.com

MATERIALS AND METHODS

This is a retrospective study, and data from consecutive patients assessed in our EDx laboratory in the years 2021 and 2022 were included. Patients with the first study at our laboratory and follow-up studies were both included.

Tests done in the laboratory included sensory-motor NCS with needle EMG, repetitive nerve stimulation studies, and evoked potential studies.

A spread sheet was created, and month-wise data was entered. Data were entered as the number of cases with a final EDx diagnosis. The final EDx diagnosis used was:

1. Individual neuropathies-any cause except traumatic
2. Radiculopathies
3. Traumatic nerve or plexus involvement, including obstetric plexopathies
4. Anterior Horn cell involvement-motor neuron disease
5. Anterior Horn cell disease-SMA or old poliomyelitis
6. Hirayama disease
7. Myopathies
8. Facial neuropathies
9. Hyperexcitable peripheral nerve disorders
10. Acute inflammatory demyelinating polyneuropathy (AIDP) and variants
11. Chronic IDP (CIDP) and variants
12. Inherited neuropathies
13. Other peripheral neuropathies, except diabetes-related
14. Neuromuscular junction disorders, including postsynaptic, presynaptic, and congenital myasthenic syndromes
15. Upper motor neuron involvement
16. Neuralgic amyotrophy
17. Carpal tunnel syndrome
18. Diabetes mellitus-related neuropathy
19. Hansen's neuropathy
20. Covid-related LMN involvement
21. EMG-guided laryngeal botulinum toxin injections
22. EMG-guided botulinum toxin injections for dystonias
23. Follow-up studies
24. Interesting/rare cases
25. SSEP study
26. VEP study
27. BAEP study
28. Normal EDx study.

The total number of cases of each type was entered month-wise with the total number of cases of each of the above-mentioned EDx diagnosis as inferred after the test.

RESULTS

In the year 2021, a total of 2732 patients were tested for EMG and EPs in the EDx laboratory. In the year 2022, 3425 patients were tested. The total number of cases of each EDx diagnosis is calculated and summarized in Tables 1 and 2. The year-wise distribution of cases is depicted in Figures 1 and 2.

As seen, the maximum number of patients (905) had normal EDx findings. The most common abnormal diagnosis included traumatic nerve/plexus injuries (668), closely followed by upper/lower limb radiculopathies (645). Somatosensory-evoked potential studies for assessing posterior column conduction defects formed the next large referral (598). 478 patients underwent follow-up studies, followed by carpal tunnel syndrome (357), and diabetic peripheral neuropathies (347). Peripheral neuropathies (other than diabetic neuropathies) (277) and motor neuron disease (282) followed next. The least number of EDx diagnoses was hyperexcitable peripheral nerve disorders, in keeping with the rare nature of the disorder. 238 cases were classified as interesting cases, which included rare or unusual lower motor neuron diagnoses. Also, a special mention of 130 cases of EMG-guided laryngeal botulinum toxin injections for patients with spasmodic dysphonia, where the injection is given by a laryngologist or voice surgeon.

EDx test protocol used and criteria for EDx diagnosis/impression

All tests were conducted according to protocols based on clinical referrals, patient symptoms, and clinical examination.[2] Sensory-motor NCS were performed as per standard techniques, and standard normative data was used. Needle EMG studies were performed as per the disease protocol as derived after NCS. Evoked potential studies were performed as per standard criteria using the 10–20 system for placement of electrodes. The final EDx impression was made by correlating all findings with the clinical impression and using the EDx criteria for disease diagnosis wherever applicable (e.g., ALS, demyelinating peripheral neuropathies, CTS, etc.).

Table 1: Summary of all EDx cases in 2021 and 2022

EDx diagnosis	Individual nerve	Radiculopathy	Trauma	Normal	AHC	Myopathy	Facial	MG	Hyperexcitable PN	AIDP	CIDP	PN
2021	81	287	317	368	121	102	14	29	2	28	20	87
2022	97	358	351	537	161	110	19	33	2	36	18	190
Total	178	645	668	905	282	212	33	62	4	64	38	277

AIDP and CIDP: Acute inflammatory demyelinating polyneuropathy/chronic IDP

Table 2: Summary of all EDx cases in 2021 and 2022

EDx diagnosis	Inherited neuropathy	UMN	Neuritis	SMA	CTS	DM	FU	INT	LBTX	H	HD	COV	SSEP	VEP	BAEP
2021	39	29	43	48	164	148	235	100	62	19	5	9	253	95	25
2022	49	29	37	48	193	199	243	138	68	20	14	9	345	91	29
Total	88	59	80	96	357	347	478	238	130	39	19	18	598	186	54

SSEP: Somatosensory evoked potential, VEP: Visual evoked potential, BAEP: Brainstem Auditory evoked potential

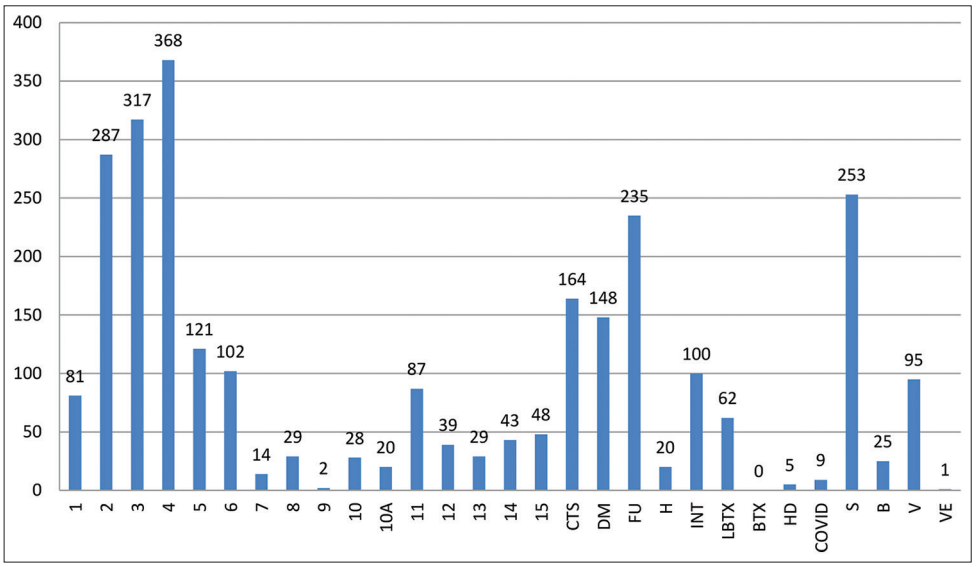

Figure 1: Bar diagram showing cases in 2021

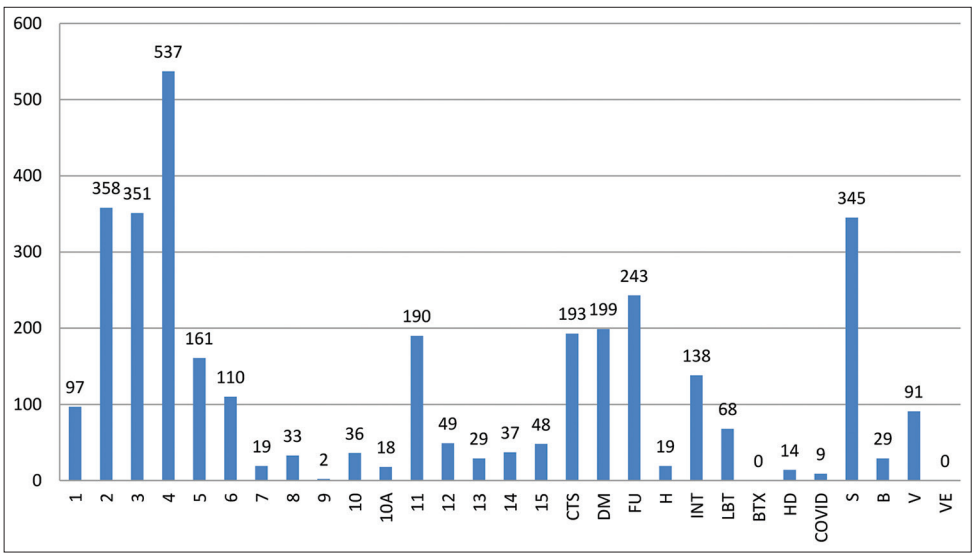

Figure 2: Bar diagram showing cases in 2022

DISCUSSION

EDx laboratories get referrals for a large spectrum of lower motor neuron disorders in individuals of all age groups. The patients tested in the laboratory ranged in age from as young as 1 month to elderly as old as over 90 years of age. In the present study, patients of all age groups have been included in the total number of cases, which have been divided into the above-mentioned list of final EDx diagnoses. The top 4 diagnosis in our laboratory are depicted in the pie chart in Figure 3. The maximum number of patients, almost 14% of the total, has had a normal EDx study. This does not imply unnecessary referrals, but a large number of patients are referred with paresthesia, pain, and fatigue, which may not be due to lower motor neuron disorders but need to be excluded.[3] Paraestheisae could also be central nervous system-induced or related to myofascial pain.[4]

In a study done by Simms and Goldenberg, it was found that 84% of patients with myofascial pain complained of tingling and numbness at the time of the initial evaluation.[5] Furthermore, pain is a cardinal feature in patients with fibromyalgia, and in a study by Devigili *et al*., it has been mentioned that nerve conductions and EMG findings are normal in these patients, except in a few studies that suggest associated large fiber peripheral neuropathy in these patients.[6] Furthermore, psychological factors may give rise to subjective symptoms,

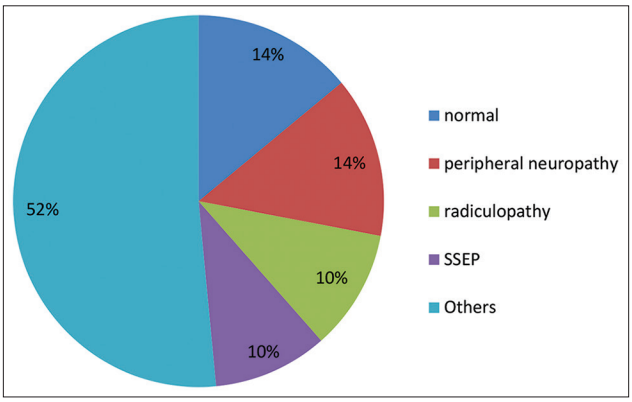

Figure 3: Pie chart showing the top 4 EDx based diagnosis in our laboratory

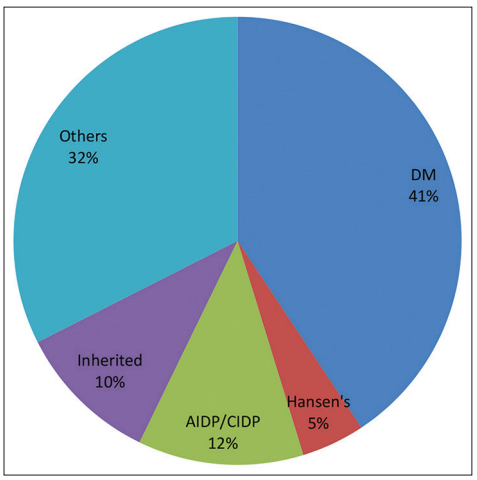

Figure 4: Pie chart showing the different etiologies of peripheral neuropathy in our electrodiagnosis laboratory

such as numbness and pain, mimicking neuromuscular disorders, and would have normal EDx findings.[7] The next large group of referrals is for peripheral neuropathies, with 853 patients, or almost 14% of the total referrals. These include diabetic peripheral neuropathies (347), acute and chronic peripheral neuropathies (102), Hansen's neuropathies (39), inherited neuropathies (88), and peripheral neuropathies other than diabetic neuropathies (277) [Figure 4]. Peripheral neuropathies are a very common neurological condition, and the prevalence of peripheral neuropathy in the general population ranges from 1% to 7%, with higher rates among those older than 50 years.[8,9] Of these, diabetic peripheral neuropathies are the most common, and that is consistent in our laboratory, with almost 40% of all peripheral neuropathies being related to diabetes mellitus.[10] The next largest group in our laboratory is traumatic neuropathies and plexopathies. This has not been reported in many studies but is possibly due to our center being a tertiary center with a large surgical facility with neurosurgeons, orthopedicians and plastic surgeons. Upper and lower limb radiculopathies are one of the most common referrals to the EDx laboratory, and consistent with the reviewed literature, our laboratory has about 10.5% cases of radiculopathies.[11] The somatosensory-evoked potential studies form the next large group, with almost 10% of all referrals. This has not been reviewed in earlier studies. However, it has been observed by Muzyka and Estephan that the utility of SSEPs has become more popular in recent years, despite the advance of imaging studies such as magnetic resonance imaging.[12] The utility of SSEP ranges from a wide variety of neurological conditions, ranging from peripheral neuropathies, including proximal sensory segment studies in AIDP and CIDP, to myelopathies and other central nervous system disorders like multiple sclerosis and the evaluation of ataxias.[13]

Electrodiagnosis is a powerful tool that, when used with the correct timing and for appropriate uses, provides useful information to help clinicians in planning further evaluation, treatment, and prognostication of patients.[14-16]

CONCLUSION

To conclude, in our study, the order of electrodiagnostic outcome is normal, followed by peripheral neuropathies, followed by traumatic neuropathies/plexopathies, and somatosensory-evoked potential studies over the course of 2 years in a total of 6157 patients. In a study done by Nikolic *et al*., 36.1% of patients had normal EDx findings out of 570 patients.[17] Furthermore in a study by Zewde *et al*., in a 3-year study with 313 patients, 26.5% of all patients had normal EDx findings.[18] This large percentage in both studies could be related to the relatively smaller total sample size as compared to our study. However, even our study reports the maximum percentage of normal EDx findings as consistent with other studies. Most other studies have reported polyneuropathy, entrapment neuropathy, and disorders of the motor nerve root and plexus as the most common reasons for electrodiagnostic requests.[19,20] The large number of SSEP referrals in our laboratory have not been studied at other centers, as reviewed.

The limitations of the study are (a) the retrospective nature of the study; (b) we have not studied the referral-outcome relationship; (c) we have not studied the demographic profile and effect on the EDx outcome; (d) which specialty physician or surgeon is sending referrals for the EDx study; and (e) the above study is being done at only one tertiary center. The above five could be looked at in the future as an extension of the present study. The strengths of our study are (1) the large sample size, even though the study has been done only at one center, and (2) the maintenance of accurate records.

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