Section: Physiology

Original Research Article

TO STUDY THE ELECTROPHYSIOLOGICAL PARAMETERS IN PATIENTS WITH UPPER LIMB WEAKNESS

Labdhi Sanghvi[1], Vinod Shende[2], Sachin Pawar[3], Prashanth A[4]

[1]Final MBBS Student, MGIMS Sevagram, India.
[2]Associate Professor, Department of Physiology, MGIMS Sevagram, India.
[3]Professor and Head, Department of Physiology, MGIMS Sevagram, India.
[4]Postgraduate Student, Department of Physiology, MGIMS Sevagram, India.

Received : 10/04/2024
Received in revised form : 30/05/2024
Accepted : 15/06/2024

Keywords:
Upper limb weakness, nerve, neuropathy, polyneuropathy, brachial plexopathy, nerve conduction studies, NCS, nerve conduction velocity, NCV.

Corresponding Author:
Dr. Vinod Shende,
Email: drvinodshende@gmail.com

DOI: 10.47009/jamp.2024.6.4.21

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 97-101

Abstract

Background: Upper limb weakness symptoms are often overlooked until they worsen significantly due to the high cost of available diagnostic tests. Chronic health conditions like diabetes, uremia, leprosy, and stroke can lead to this complication. Timely recognition of neuropathies is crucial to alleviate symptoms, prevent progression, and avoid permanent damage [8]. Consequently, there is an urgent need to develop cost-effective tests with high sensitivity and specificity. Nerve Conduction Studies (NCS) fulfill these requirements but require further studies to enhance reliability and usage. **Aim and Objectives:** To establish early and accurate diagnosis in patients with upper limb weakness by using NCS. **Settings and Design:** It was a cross-sectional study conducted at the Neurophysiology Laboratory of the Department of Physiology in rural medical college of central India. Sample Size: 30 clinically diagnosed patients with upper limb weakness referred from department of orthopedics and medicine. **Materials and Methods:** NCS were performed on RMS EMG EP - MARK II, assessing parameters such as compound muscle action potential (CMAP), distal motor latency (DML), nerve conduction velocity (NCV) for various motor nerves, as well as sensory nerve action potential (SNAP), NCV, and F-wave latency for sensory nerves. **Statistical Analysis**: Statistical Package for Social Sciences (SPSS) software after data entry in Microsoft Excel sheets. **Results:** The results provided diagnosis of mono or polyneuropathies, differentiated neural and muscular involvement, classified nerve damage based on pathophysiology, and determined the affected nerves. This information is valuable for planning therapeutic strategies. The study's findings were consistent with epidemiological data from other studies. **Conclusion:** NCS were ascertained to be simple, non-invasive, cost-effective, and sensitive tests for early neuropathy diagnosis. However, their usage should be further encouraged to improve patient outcomes.

INTRODUCTION

Upper limb weakness is a common cause of disability in middle-aged people. Causes of upper limb weakness include carpal tunnel syndrome, cervical radiculopathy, wrist drop, diabetes mellitus, and stroke. The most prevalent cause of upper limb weakness is reported to be stroke at 70%,[1] whereas diabetes and polio being other common causes with the prevalence of carpal tunnel syndrome being 10%–20%.[2,3,4,5] Although upper limb weakness has several underlying causes, it presents similar clinical signs and symptoms. Disorders such as mild carpal tunnel syndrome and severe brachial plexopathy need to be considered in patients presenting with pain, paraesthesia, or weakness involving the shoulder, arm, forearm, or hand,[6] in the absence of a known acute or insidious bone, soft tissue, or vascular injury on onset.[7] Moreover, these neuropathies may mimic other common musculoskeletal disorders,[7] therefore, it is important to differentiate and recognize the presence of entrapment neuropathies, as intervention can alleviate symptoms, prevent progression, and avoid permanent damage to the nerve.[8] The current diagnostic techniques include Electromyography which is very invasive and needle-related pain, electrical injury is common and may cause studies to be prematurely discontinued.[21,22] Some severe but rare complications also include bleeding, infection, nerve injury, pneumothorax, and other local traumas.[22,23] Magnetic resonance imaging is also widely used but

requires very high resolution for detecting anomalies, accurate knowledge of anatomy, very expensive and there is a lack of normative data.[13,25] Ultrasonography is a fairly good alternative however it has shown inconsistent changes and cannot show intrinsic signal abnormalities.[24,26] Others include computed tomography, nerve biopsy and laboratory testing which have not yielded very promising results.[10,14]

Nerve conduction studies (NCS) where nerves are electrically stimulated found to be very helpful in evaluating the functionality of the peripheral nerves involved and diagnoses of diseases. NCS help in depicting the extent and distribution of neural lesions; they distinguish two major types of peripheral nerve diseases, demyelination and axonal degeneration.[9,10,11,12] Steady development and standardization of methods have made NCS a reliable test in clinical settings.[10–12] Currently, they are widely used for the precise localization of lesions and accurate description of nerve functions.[10] A review done on distal symmetric polyneuropathy also concluded that NCS results change either diagnosis or treatment in more than 40% of patients.[28]

Symptoms of upper limb weakness are usually ignored until they become extremely severe because most diagnostic tests are very expensive. Furthermore, it is a major complication of chronic health conditions such as diabetes, uremia, leprosy, and stroke. Thus NCS being cost and noninvasive tests are useful in early diagnosis and extent of upper limb weakness and thus helps the clinicians for early and accurate treatment. Therefore, in this study, we aimed to establish early and accurate diagnosis of patients with upper limb weakness by using NCS.

MATERIALS AND METHODS

Study Design and Setting

It was a cross-sectional study was conducted on clinically diagnosed patients of upper limb weakness in Neurophysiology Laboratory of Department of Physiology at a rural medical college of central India. The duration of the study was 2 months. Institutional Ethics Committed was obtained and written informed consent was taken from all study participants.

Sample Size

On an average 15–20 patients get referred to the Neurophysiology department per month. Therefore, during the period of two months of our study, the subjects who arrived for NCS and met the inclusion criteria were selected. A total of 30 patients were included in the study.

Inclusion Criteria

- Prospective patients with upper limb weakness.
- Subjects willing to provide written informed consent for the study.
- Patients aged 20–60 years.

Exclusion Criteria

- Patients with a known cause of upper limb weakness, like fractures.
- Patients not willing to provide written informed consent for the study.
- Patients not aged 20–60 years.

Methods

Initially, a detailed history of the subjects was obtained, including general signs and symptoms related to upper limb weakness, alcohol intake, smoking, and history of any other drug usage along with socio-demographic variables like gender, age and profession. Blood pressure and anthropometric parameters were recorded for all subjects.

NCS were performed by using RMS EMG EP - MARK II available in the Clinical Neurophysiology Unit, Department of Physiology.

Motor and sensory NCS

Motor NCS involve stimulation of a motor nerve at two different sites with maximum stimulus; the distance was measured and automatically divided by conduction time between the two points (difference between proximal and distal motor latencies), which yielded the conduction velocity. The ground electrode was placed between the stimulating and recording electrodes. The following bilateral motor nerves were tested: median, ulnar, radial, axillary, musculocutaneous, and suprascapular. The surface disc electrode was placed on the corresponding muscles. A belly tendon montage was used with the cathode and anode 3 cm apart. Filters were set at 2 Hz to 5 kHz and the sweep speed was 5 ms per division for the motor study; DML, CMAP amplitude, NCV were evaluated for motor nerves.

Sensory conduction study (antidromic) involved proximal stimulation of sensory nerves and recording of SNAP with electrodes placed distally over the dermatome distribution. The distance between the active electrode and cathode of the stimulator was divided automatically by onset latency to yield sensory conduction velocity. The SNAP amplitude was recorded from the peak to the base. The following bilateral sensory nerves were tested: median, ulnar, and radial. Filters were set at 20 Hz to 3 kHz and sweep speed was 2 ms per division for the sensory study. The duration for both studies was 100 μs. SNAP amplitude and NCV were evaluated for sensory nerves 29).

F wave study (Late response)

F wave study involves the supramaximal stimulation of motor nerves. F wave recording electrode setting was maintained same as that for the motor NCS. Apart from F-min latency, other F-wave parameters such as M-latency, F-max. latency, F- Median latency, F-M latency, and F-velocity were evaluated.

Statistical Analysis

Data was maintained in Microsoft Excel sheets and analysed through appropriate statistical tests by using SPSS version 2.0, IBM Co. The results are presented in the form of percentages and proportions.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

RESULTS

Descriptive Statistics

The analysis of the demographic data of the patients shows that 70% of them were men and 43.33% were in the age group of 30-50 years. The values of NCS of 30 patients with upper limb weakness were compared with the normative data available,[29] for evaluating abnormality in nerve conduction. This was done to localize the nerves involved, classify the pathophysiology and differentiate neural involvement from muscular.

Table 1 displays the analysis of CMAP values of cases obtained by NCS. These were compared with NCV and DML values for deriving a final conclusion. It was concluded that 4 patients had significantly less MNS parameters showing nerve damage affecting motor function of the upper limb. Nerve damage was then categorized, according to pathophysiology corresponding to the values, as demyelinating, axonal or transection. [Table 1]

Sensory Nerve Conduction Studies (SNS)

Table 2 displays the analysis of SNAP values of cases obtained by NCS. It concluded that 7 patients had significantly less sensory nerve conduction parameters showing nerve damage affecting sensory function of the upper limb. Nerve damage was then categorized, according to pathophysiology corresponding to the values, as demyelinating, axonal or transection.

F Wave (Late Response) Study

Tables 3 displays the analysis of F-min values of cases obtained by NCS. This helps in assessing the severity and pathophysiology of nerve damage. It was concluded that 1 patient had an extremely severe nerve transection injury. [Table 3]

Table 4 and Fig 1 display that a total of 8 patients were diagnosed with having substantial loss of nerve conduction by NCS. These patients came with varying clinical presentation of injury; tingling sensation; numbness, weakness, suspected carpal tunnel syndrome and many more in construction workers, electricians or farmers. NCS diagnosed mononeuropathy, polyneuropathy and brachial plexopathy with mainly axonal or transectional pathophysiology affecting motor or sensory nerves or both. We were successfully able to localize the particular nerves involved and the stage of nerve damage which would help the clinician in providing the appropriate treatment- medicinal or surgical, to ensure complete recovery and a better lifestyle.

28.57% of these patients had diabetes who presented mainly with tingling sensation and weakness. They were all diagnosed with sensory axonal polyneuropathy. [Table 4]

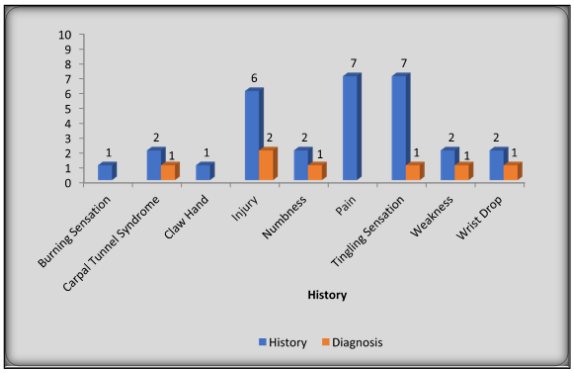

Figure 1: Distribution of patients according to their history

Table 1: Distribution of patients according to CMAP values of the major upper limb nerves

MNS	RA	LA	RR	LR		RU	LU	RM	LM
N(>5mV)	27(90%)	27(90%)	24(80%)	24(80%)	N(>8mV)	29(96.67%)	22(73.33%)	27(90%)	26(86.67%)
AbN(<5mV)	3(10%)	3(10%)	6(20%)	6(20%)	AbN(<8mV)	1(3.33%)	8(26.67%)	3(10%)	4(13.33%)
T	30(100%)	30(100%)	30(100%)	30(100%)	T	30(100%)	30(100%)	30(100%)	30(100%)
M	12.5	14.9	6.7	6.4	M	12	10.8	12.1	12.3
IQR	8.125	6.65	2.65	1.95	IQR	4.625	5.3	5.925	6.9

*** N- normal, † AbN- abnormal, ‡ T- total, § M- median, || IQR- interquartile range**

Table 2:

SNS	RM	LM	RR	LR	RU	LU
N(>8µV)	26 (86.67%)	27 (90%)	27 (90%)	27 (90%)	26 (86.67%)	26 (86.67%)
AbN (<8µV)	4 (13.33%)	3 (10%)	3 (10%)	3 (10%)	4 (13.33%)	4 (13.33%)
T	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)	30 (100%)
M	36.4	37.65	33.8	55.8	46.5	24.7
IQR	26	31.9	27.5	19.8	39.55	41.925

Table 3: Distribution of patients according to F-min values of the major upper limb nerves

	RM	LM	RU	LU
N (<30ms)	29 (96.67%)	29 (96.67%)	30 (100%)	29 (96.67%)
AbN (>30ms)	1 (3.33%)	1 (3.33%)	0 (0%)	1 (3.33%)
T	30 (100%)	30 (100%)	30 (100%)	30 (100%)
M	26	25.7	26.3	25.6
IQR	3.4	1.9	3.6	3.45

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 4: Distribution of patients according to their history and having abnormal NCS

Presenting signs and symptoms (History)	Number of patients	Abnormal NCS
Burning sensation	1 (3.33%)	
Carpal tunnel syndrome	2 (6.67%)	1 (20%)
Claw hand	1 (3.33%)	
Injury	6 (20%)	2 (33.33%)
Numbness	2 (6.67%)	1 (50%)
Pain	7 (23.33%)	
Tingling sensation	7 (23.33%)	1 (14.28%)
Weakness	2 (6.67%)	1 (50%)
Wrist drop	2 (6.67%)	1 (50%)
Total	30 (100%)	8 (26.67%)

DISCUSSION

This study provides an overview of all types of neuropathies and along with the prevalence with which they cause upper limb weakness. The different types of diagnostic modalities used are also presented. We successfully diagnosed focal or polyneuropathies, differentiated neural involvement from muscular, and classified nerve conduction abnormalities according to pathophysiology, which would help in determining treatment options for the patients. Upper limb weakness may have various underlying etiologies such as muscular, neural, or systemic disorders (polyneuropathies). Therefore, the differentiation of these causes through proper diagnostic tools is of extreme importance because prolonged ignorance can lead to irreversible damage.[17] Upper limb weakness can also have varied effects on mental and physical health because of pain and daily life limitations.[18–20]

According to best our knowledge there is no such study existing where mononeuropathies and polyneuropathies affecting upper limb weakness are considered together hence we aspire for future studies on this topic because of its impact on patient's quality of life.

The prevalence of neuropathy is higher among patients older than 50 years.[16] This is also seen in our study where 62.5% of patients with abnormal NCS were older than 50 years of age.

We successfully differentiated the type of nerve injury according to pathophysiology and localized the nerve involved. This would help planning therapeutic efforts to restore function. Most of the patients did not have substantial loss of nerve conduction; therefore, we suspected them of having muscular involvement. However, we completely ruled out any neural abnormalities in the upper limb. These findings are consistent with Mallik et al who found that NCS are an extension of the clinical history and examination, important in the management of peripheral neuromuscular disease, localizing lesions and determining the pathological processes responsible.[27]

The proportion of patients with diabetes having an abnormal NCS showing neuropathy in upper extremity were 28.5%, which is consistent with the findings of Young et al who showed the prevalence of peripheral neuropathy in patients with diabetes as 5%–50%.[15] Kender et al showed a clinically relevant sensory loss regarding mechanical and thermal detection of the hands in patients with diabetes,[18] which is coherent with our study, as the patients were identified to have sensory axonal polyneuropathy.

CONCLUSION

India has an enormous burden of patients with upper limb weakness caused by varied diseases. It mostly affects individuals older than 50 years, causing severe disability. Unfortunately, most cases remain undiagnosed and untreated, affecting work performance and economic productivity. NCS are simple, non-invasive, cost- effective, and sensitive tests to diagnose neuropathy at the earliest, which can help in the early diagnosis and proper management of these patients. Therefore, NCS should be included as routine tests for neuropathy diagnosis. However, despite their advantages, they remain underutilized. Therefore, future studies are required for utilization of NCS and to gather more data regarding their usefulness.

Limitations

The sample size was small and only cases were evaluated; therefore, future case-controlled studies with a larger sample size would be required to validate the current findings. We did not consider paediatric and elderly patients because of other variables affecting diagnosis hence separate detailed NCS should also be done concerning them. There should also have been follow-up done with clinical departments for the treatment strategies used by them for the patient and the contribution of NCS reports in making that decision, which was difficult in a hospital set-up.

Acknowledgement: The present study was ICMR STS project, we acknowledge the financial help from ICMR, New Delhi.

REFERENCES

1. Nakayama H, Jørgensen HS, Raaschou HO, Olsen TS. Recovery of upper extremity function in stroke patients: The Copenhagen Stroke Study. Arch Phys Med Rehab. 1994 Apr;75(4):394-8.
2. Ferry S, Pritchard T, Keenan J, Croft P, Silman AJ. Estimating the prevalence of delayed median nerve conduction in the general population. Br J Rheumatol. 1998 Jun 1;37(6):630-5.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

3. Atroshi I, Gummesson C, Johnsson R, Ornstein E, Ranstam J, Rosén I. Prevalence of carpal tunnel syndrome in a general population. JAMA. 1999 Jul;282(2):153-8.
4. Dyck PJ, Kratz KM, Karnes JL, Litchy WJ, Klein R, Pach JM, Wilson DM, O'brien PC, Melton L. The prevalence by staged severity of various types of diabetic neuropathy, retinopathy, and nephropathy in a population-based cohort: The Rochester Diabetic Neuropathy Study. Neurology.1993 Apr;43(4):817.
5. Brogårdh C, Flansbjer UB, Lexell J. Muscle weakness and perceived disability of upper limbs in persons with late effects of polio. PM&R. 2016 Sep;8(9):825-32.
6. Rutkove SB. Overview of upper extremity peripheral nerve syndromes. UpToDate. Access in. 2020;2019. 6/10/22
7. Neal SJ, Fields KB. Peripheral nerve entrapment and injury in the upper extremity. AFP. 2010 Jan;81(2):147-55.
8. Gilchrist JM, Dandapat S. Neuromuscular mimics of entrapment neuropathies of upper extremities. HAND (N Y). 2020 Sep;15(5):599-607.
9. Kimura J. Principles and pitfalls of nerve conduction studies. Ann Neurol.1984 Oct;16(4):415-29.
10. Garg R, Bansal N, Kaur H, Arora KS. Nerve conduction studies in the upper limb in the malwa region-normative data. JCDR. 2013 Feb;7(2):201.
11. Gassel MM. Sources of error in motor nerve conduction studies. Neurology. 1964 Sep;14(9):825.
12. Simpson JA. Fact and fallacy in measurement of conduction velocity in motor nerves. J Neurol Neurosurg Psychiatry.1964 Oct;27(5):381.
13. Dong Q, Jacobson JA, Jamadar DA, Gandikota G, Brandon C, Morag Y, Fessell DP, Kim SM. Entrapment neuropathies in the upper and lower limbs: anatomy and MRI features. RADI. 2012 Oct;2012.
14. Rutkove SB. Overview of polyneuropathy. UpToDate® Online. 2014;19. 8/10/22
15. Young MJ, Boulton AJ, MacLeod AF, Williams DR, Sonksen PH. A multicentre study of the prevalence of diabetic peripheral neuropathy in the United Kingdom hospital clinic population. Diabetologia. 1993; 36:150-154.
16. Castelli G, Desai KM, Cantone RE. Peripheral neuropathy: evaluation and differential diagnosis. AFP. 2020 Dec 15;102(12):732-9.
17. Thatte MR, Mansukhani KA. Compressive neuropathy in the upper limb. Indian J Plast Surg. 2011 May;44(2):283.
18. Kender Z, Groener JB, Jende JM, Kurz FT, Fleming T, Sulaj A, Schuh-Hofer S, Treede RD, Bendszus M, Szendroedi J, Nawroth PP. Diabetic neuropathy is a generalized phenomenon with impact on hand functional performance and quality of life. Eur J Neurol. 2022 Oct;29(10):3081-91.
19. Marinho FS, Moram CB, Rodrigues PC, Franzoi AC, Salles GF, Cardoso CR. Profile of disabilities and their associated factors in patients with type 2 diabetes evaluated by the Canadian occupational performance measure: The Rio De Janeiro type 2 diabetes cohort study. Disabil Rehabil. 2016; 38:2095-2101.
20. Lieshout EC, van de Port IG, Dijkhuizen RM, Visser-Meily JM. Does upper limb strength play a prominent role in health-related quality of life in stroke patients discharged from inpatient rehabilitation? Top Stroke Rehabil. 2020 Oct;27(7):525- 33.
21. London ZN. Safety and pain in electrodiagnostic studies. Muscle Nerve. 2017 Feb;55(2):149-59.
22. Al-Shekhlee A, Shapiro BE, Preston DC. Iatrogenic complications and risks of nerve conduction studies and needle electromyography. Muscle Nerve. 2003 May;27(5):517-26.
23. Preston DC, Shapiro BE. Electrical safety and iatrogenic complications. Electromyography and Neuromuscular Disorders: Clinical–Electrophysiologic Correlations, 3rd ed, Elsevier, New York. 2013:614.
24. Kim SJ, Hong SH, Jun WS, Choi JY, Myung JS, Jacobson JA, Lee JW, Choi JA, Kang HS. MR imaging mapping of skeletal muscle denervation in entrapment and compressive neuropathies. Radiographics. 2011 Mar;31(2):319-32.
25. Chen Y, Haacke EM, Li J. Peripheral nerve magnetic resonance imaging. F1000Res. 2019;8.
26. Walker FO. Diagnostic ultrasound in neuromuscular disease. UpToDate. Jan 2011;30. 12/10/22
27. Mallik A, Weir A. Nerve conduction studies: essentials and pitfalls in practice. J Neurol Neurosurg Psychiatry. 2005 Jun;76(suppl 2): ii23-31.
28. Bodofsky EB, Carter GT, England JD. Is electrodiagnosic testing for polyneuropathy overutilized?. Muscle Nerve. 2017 Mar;55(3):301-4.
29. Pawar SM, Taksande AB, Singh R. Normative data of upper limb nerve conduction in Central India. Indian J Physiol Pharmacol. 2011 Jul;55(3):241-5.

ISSN (O): 2687-5365; ISSN (P): 2753-6556