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# DIAGNOSTIC UTILITY OF ELECTRONEUROMYOGRAPHY AND LATE RESPONSES IN CERVICAL RADICULOPATHY

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**ABSTRACT** The incidence of cervical radiculopathy is increasing in the present scenario and the use of radiologic examination is time consuming. Thus, there is a definite need to establish a cost effective, reliable, and accurate means for establishing the diagnosis of cervical radiculopathy. A cross sectional study was conducted on 114 subjects of 40 years and above. Electrophysiological profile studied includes MNCS, SNCS, Late response study and Electromyography. Among various MNCS parameters CMAP was found to be more sensitive with high PPV. SNCS parameters have less sensitivity but higher specificity. Among late response study, f-minimum latency has highest sensitivity and PPV. EMG study in affected myotome was also found to have reliable sensitivity and specificity. Based upon our observations we are of the opinion that, MNCS, SNCS, late response study and EMG examination may be considered as useful supportive diagnostic tool for suspected cervical radiculopathy.

**KEYWORDS :** Cervical radiculopathy, Electromyography, Sensitivity, Specificity

## INTRODUCTION

Cervical radiculopathy (CR) is a clinical entity resulting from compression of cervical nerve roots [1]. Cervical nerve root compression may occur due to herniation of disk material or bony osteophytes that impinge on the cervical nerve root [2]. The bulk of cases of CR, nonetheless are not due to "soft" disc herniation, but rather due to cervical spondylosis. Cervical spondylosis refers to the degenerative changes that occur in the cervical spine with age [3]. Cervical radiculopathy has an annual incidence rate of 107.3 per 100,000 for men and 63.5 per 100,000 for women, with a peak at 50 to 54 years of age. The commonest cause of cervical radiculopathy (in 70 to 75 percent of cases) is cervical spondylosis. Herniation of the nucleus pulpous is responsible for 20 to 25 percent of cases. Other causes, including tumors of the spine and spinal infections, are infrequent. C7 is the most frequently affected root among all, followed by the C6 [4, 5].

Well defined diagnostic criteria for cervical radiculopathy are lacking, and no universally accepted criteria for its diagnosis have been established. Clinical examination, radiological imaging and electrophysiologic evaluation are the different methods available to diagnose CR. Studies have shown that the true diagnostic accuracy of clinical examination for cervical radiculopathy is arguable. Imaging with CT myelogram or MRI scans can usually identify the presence of a structural lesion entrapping the nerve roots [6, 7]. Seldom cervical radiculopathy may occur without a structural lesion seen on MRI or CT myelogram. Apart from that imaging studies are associated with high false-positive rates. In such cases further investigation is required, usually with nerve conduction studies and EMG. Often, the patient's history and physical examination are inadequate to differentiate cervical radiculopathy from other neurologic causes of neck and arm pain [8, 9]. In such situations electrodiagnostic tests are useful to rule out peripheral neuropathies. Electrodiagnostic methods assess the physiologic integrity of the nerve roots. Thus, EMG is useful in the electrodiagnosis of radiculopathy [10].

The frequency of Cervical Spondylosis and such conditions is increasing in the current scenario and the use of radiologic examination is time consuming and costly for the common Indian setup. Thus, there is a definite need to establish a cost effective, reliable, and accurate means for establishing the diagnosis of cervical radiculopathy (CR). Electro diagnostic tests are the closest to achieve these criteria and therefore, the present study is undertaken to evaluate diagnostic utility of various electrophysiological parameters in cervical radiculopathy.

## MATERIAL AND METHODS

The cross-sectional study included clinically diagnosed cervical radiculopathy subjects of both gender residing in rural area of central India aged 40 years and above. Total 114 subjects were recruited after obtaining their written informed consent. Study proposal was approved by the Institutional Ethics Committee.

## INCLUSION CRITERIA:

1) Patients with history consistent with radiculopathy.
2) Dermatomal sensory loss, myotomal weakness or segmental reflex loss was considered as supportive evidence.
3) Patients with spine MRI performed.

## EXCLUSION CRITERIA:

Subjects with
1) Diabetes mellitus
2) Clinical or electrophysiological evidence of polyneuropathy
3) Symptoms of less than 3 weeks duration
4) Spinal surgery within the preceding 15 years.

## PROCEDURE AND INSTRUMENT

The present study was performed on RMS EMG EP Mark-II machine in the Clinical Neurophysiology Unit, Department of Physiology. All tests were performed by the same investigator and under constant room temperature ($30^0$C) to reduce the errors. Electrophysiological profile includes Motor nerve conduction, sensory nerve conduction, F wave study and Electromyography study.

## MOTOR NERVE CONDUCTION STUDY

Motor nerve conduction study involves stimulation of motor nerve at two different sites with maximum stimulus and calculation of conduction velocity. Nerves tested were median, ulnar, radial, axillary, musculocutaneous and suprascapular nerves. Belly tendon montage was used with cathode and anode 3 cm apart. Setting was kept at sweep speed 5 ms/Division, filter between 2 Hz and 5 Hz and stimulus strength duration will be 100 µs [11].

## SENSORY NERVE CONDUCTION STUDY

Sensory NCS was done antidromically involving stimulation of sensory nerves proximally and recording sensory nerve action potentials with electrodes placed distally over the dermatomic distribution. Nerves tested were median, ulnar and radial nerves. Setting were kept at sweep speed 2 ms/Division, intensity 2 mV, frequency 2 Hz, filter between 20 Hz to 3 KHz and stimulus strength duration was 100 µs [11].

## LATE RESPONSE (F WAVE) STUDY

F wave study involved supramaximal stimulation of motor nerves. Setting was kept at sweep speed 10 ms/Division, intensity 2 mV, frequency 2 Hz, filter between 2 Hz and 10 KHz, and stimulus strength duration was 100 µs [11].

## EMG STUDY

Standard concentric needle EMG examination was performed on all the cases. For assessing spontaneous activity gain was 50 µV, sweep speed 10ms/D and filter setting was 10 Hz to 10 KHz. For assessing voluntary activity gain was 200- 500 mV, sweep speed 10ms/D and filter setting was 10 Hz to 10 KHz. Parameters studied were spontaneous activity, Single MUAP examination and Interference pattern analysis.

## STATISTICAL ANALYSIS

Statistical analysis was done by using statistical package for social science (SPSS) 16th version. The study observations and results were noted and analyzed to find the Specificity, Sensitivity, Positive Predictive Value and Negative Predictive Value.

## RESULTS

Out of 114 subjects, 75 were males (mean age 52.17±8.79) and 39 females (mean age 52.3± 9.49) in study group.

### TABLE 1: AGE AND GENDER WISE DISTRIBUTION OF PATIENTS

| Subjects | Males | Females | P value |
|---|---|---|---|
| Number(n) | 75 | 39 | NS(P > 0.05) |
| Age(years) | 52.17 ± 8.79 | 52.3 ± 9.49 | |

Data are mean ± SD. NS- non-significant

### TABLE 2: DIAGNOSTIC EFFICACY OF MOTOR NERVE CONDUCTION PARAMETERS.

| Nerve | Parameters | Sensitivity (%) | Specificity (%) | Positive Predictive Value (%) | Negative Predictive Value (%) |
|---|---|---|---|---|---|
| Median | DML | 21.21 | 81.81 | 77.77 | 25.71 |
| | CMAP | 60.60 | 63.63 | 83.33 | 35.00 |
| | CV | 36.36 | 63.63 | 75.00 | 25.00 |
| Ulnar | DML | 18.18 | 81.81 | 75.00 | 25.00 |
| | CMAP | 42.42 | 54.54 | 73.68 | 24.00 |
| | CV | 42.42 | 54.54 | 73.68 | 24.00 |
| Radial | DML | 39.39 | 45.45 | 68.42 | 20.00 |
| | CMAP | 100.00 | 09.09 | 76.62 | 100.00 |
| | CV | 63.63 | 45.45 | 77.77 | 29.41 |
| Musculocutaneous | CMAP | 51.51 | 54.54 | 77.27 | 27.27 |
| Axillary | CMAP | 48.48 | 54.54 | 76.19 | 26.08 |
| Suprascapular | CMAP | 66.66 | 54.54 | 81.48 | 35.29 |

DML- distal motor latency; CMAP – compound muscle action potential; CV- conduction velocity

Among various motor nerve conduction parameters CMAP was found to be more sensitive with high positive predicative value. CV was found to have greater specificity and DML had least negative predictive value. Among nerves proximal nerves were found to have somewhat greater sensitivity and specificity as compared to distal nerves.

### TABLE 3: DIAGNOSTIC EFFICACY OF SENSORY NERVE CONDUCTION PARAMETERS

| Nerve | Parameters | Sensitivity (%) | Specificity (%) | Positive Predictive Value (%) | Negative Predictive Value(%) |
|---|---|---|---|---|---|
| Median | SNAP | 0.00 | 100.00 | 0.00 | 25.00 |
| | CV | 21.21 | 90.90 | 87.50 | 27.77 |
| Ulnar | SNAP | 21.21 | 45.45 | 53.84 | 16.12 |
| | CV | 33.33 | 36.36 | 61.11 | 15.38 |
| Radial | SNAP | 3.03 | 90.90 | 50.00 | 23.80 |
| | CV | 6.06 | 81.81 | 50.00 | 22.50 |

SNAP- sensory nerve action potential; CV-conduction velocity

Sensory nerve conduction parameters were found to have less sensitivity but higher specificity as compared to motor parameters. Positive and negative predictive values were comparable to motor parameters.

### TABLE 4: DIAGNOSTIC EFFICACY OF LATE RESPONSE STUDY

| Nerve | Parameter | Sensitivity (%) | Specificity(%) | Positive Predictive Value(%) | Negative Predictive Value(%) |
|---|---|---|---|---|---|
| Median | f-minimum latency | 84.84 | 27.27 | 77.77 | 37.50 |
| Ulnar | f-minimum latency | 75.75 | 18.18 | 73.52 | 20.00 |

F-min latency was found to have highest sensitivity and positive predictive value among all nerve conduction parameters.

### TABLE 5: DIAGNOSTIC EFFICACY OF ELECTROMYOGRAPHY (EMG) STUDY

| Test | Specificity | Positive Pred. Value | Negative Pred. Value |
|---|---|---|---|
| EMG | 54.54 | 84.84 | 54.54 |

EMG study in affected myotome was found to have reliable sensitivity and specificity.

## DISCUSSION

The present study was conducted to study the diagnostic efficacy of MNCS, SNCS, late response and EMG parameters in cervical radiculopathy. Our study findings suggested that among different MNCS parameters CMAP was found to be more sensitive with high PPV. CV has greater specificity and DML has least NPV. Proximal nerves were found to have relatively greater sensitivity and specificity as compared to distal nerves. SNCS parameters were found to have less sensitivity but higher specificity as compared to MNCS parameters. PPV and NPV values were comparable to MNCS parameters. Among different late response parameters, f-minimum latency has highest sensitivity and PPV among entire nerve conduction parameters. EMG study was also found to have reliable sensitivity and specificity among different myotomes tested. All the observations were symmetrical on both right and left side.

Our study findings are comparable with that of Zahra Soltani et al. Authors reported their findings on 114 clinically diagnosed cervical radiculopathy patients. They evaluated the agreement of MRI and electro diagnostic studies by comparing their findings in patients with clinically suspected radiculopathy. They reported that these two methods are complementary in general and it is reasonable to add EDX when there is discrepancy between MRI and clinical findings or when MRI neurologic findings are not properly visible [12].

Our findings are concurrent with that of Nardin RA et al and [13]. They noted that EMG is a sensitive parameter for diagnosis of cervical radiculopathy; also EMG and MRI are two complimentary diagnostic modalities. Han JJ and colleagues proclaimed that needle EMG finding like abnormal insertional activity, including positive sharp-wave potentials and fibrillation potentials were present in the limb muscles of the affected myotome within three weeks of the onset of nerve compression in cervical radiculopathy [8].

Kerry H. Levin [14] observed that sensory radiculopathy can only rarely be accurately localized segmentally by electrodiagnostic (EDX) techniques for the following reasons: symptoms of pain and paresthesia are mainly mediated through C-type sensory fibers, which are too tiny to be studied by routine EDX techniques; the peripheral processes of sensory root fibers stay intact with intraspinal lesions, so SNAPs remain normal. They found EMG as the most sensitive and specific method for axon loss radiculopathy. Our observations also coincide with these findings.

Findings of clinical examination in cervical radiculopathy are usually dubious if the patient is in pain [15]. Plain radiographs can be helpful, but clinical symptoms usually correspond poorly with the radiological findings [16]. Imaging techniques mainly localize the abnormality, identify compression of the spinal cord, nerve roots, and exclude intraspinal lesions. Shafaie and colleagues [15] reported that correlation between MRI and surgical findings is usually unreliable. Also, abnormalities in MRI have been found in asymptomatic subjects. Thus neurophysiological investigations are recognized by many as helpful in the diagnosis of cervical radiculopathy and are also helpful in ruling out peripheral nerve lesions. Needle EMG appears to be the most widely accepted method among all electrodiagnostic procedures for the diagnosis of cervical radiculopathy [17] with sensitivity in cervical radiculopathy varying from 50 to 93%. Our results are comparable with these reports.

## CONCLUSION

As per above observations and discussion we assume that, motor nerve conduction studies, late response study and EMG examination are useful supportive diagnostic modalities for suspected cases of cervical radiculopathy as they are found to have reliable sensitivity and specificity.

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