Original Article

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The Study of Diagnostic Efficacy of Nerve Conduction Study Parameters in Cervical Radiculopathy

Physiology Section

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ABSTRACT

Background: Cervical Radiculopathy (CR) is a neurologic condition characterised by dysfunction of a cervical spinal nerve, the roots of the nerve, or both. Diagnostic criteria for CR are not well defined, and no universally accepted criteria for its diagnosis have been established. Clinical examination, radiological imaging and electrophysiologic evaluation are the different modalities to diagnose CR. The incidence of Cervical Spondylosis and related conditions is increasing in the present scenario and the use of radiologic examination is time consuming and uneconomical 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. Electrodiagnostic tests are the closest to fulfill these criteria.

Aim: To evaluate diagnostic utility of various motor and sensory nerve conduction study parameters in cervical radiculopathy.

Setting and Design: It was a cross-sectional study conducted on 100 subjects of age > 40 years.

Material and Methods: The consecutive patients clinically diagnosed to have cervical radiculopathy, referred from department of Orthopaedics were prospectively recruited for the motor and sensory nerve conduction study using RMS EMG EP Mark-II. Parameters studied were Compound Muscle Action Potential (CMAP), Distal Motor Latency (DML) and Conduction Velocity (CV) for motor nerves and Sensory Nerve Action Potential (SNAP) and CV for sensory nerves.

Statistical Analysis: Study observations and results were analysed to find the Specificity, Sensitivity, Positive Predictive Value and Negative Predictive Value using SPSS 16.0.

Results: 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. Sensory nerve conduction parameters were found to have less sensitivity but higher specificity as compared to motor parameters.

Conclusion: Nerve conduction studies are useful supportive diagnostic tool for suspected cervical radiculopathy as they are found to have reliable sensitivity and specificity.

Keywords: Conduction velocity, Sensitivity, Specificity

INTRODUCTION

Cervical Radiculopathy (CR) is a neurologic condition characterised by dysfunction of a cervical spinal nerve, the roots of the nerve, or both [1]. It is a clinical diagnosis based on a sclerotomal distribution of motor and/or sensory changes or complaints. Any process that causes impingement of exiting cervical nerve roots can lead to a radicular disorder. Impingement may be brought about by acute pathologic changes or by degenerative changes consistent with cervical spondylosis. Retropulsed disk material, zygoapophyseal joint hypertrophy, neurocentral joint hypertrophy, and other soft-tissue abnormalities all may cause compression of an exiting nerve root. The reported annual incidence rate of CR is 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 [2]. Cervical spondylosis is considered as the most common cause of cervical radiculopathy (in 70 to 75 percent of cases).

Diagnostic criteria for CR are not well defined, and no universally accepted criteria for its diagnosis have been established [3]. Clinical examination, radiological imaging and electrophysiologic evaluation are the different modalities to diagnose CR. Studies have shown that the true diagnostic accuracy of clinical examination for cervical radiculopathy is debatable [4]. Imaging with CT myelogram or MRI scans can usually identify the presence of a structural lesion entrapping the nerve roots. However, it is important to note that radiculopathy and polyradiculopathy may both 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 [5]. Often, the patient's history and physical examination are inadequate to distinguish cervical radiculopathy from other neurologic causes of neck and arm pain. [6]. In these circumstances electrodiagnostic tests are useful to rule out peripheral neuropathies [7].

The incidence of Cervical Spondylosis and related conditions is increasing in the present scenario and the use of radiologic examination is time consuming and uneconomical 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. Electrodiagnostic tests are the closest to fulfill these criteria and therefore, the present study was undertaken to evaluate diagnostic utility of various motor and sensory nerve conduction study parameters in cervical radiculopathy.

MATERIAL AND METHODS

It was a cross-sectional study conducted on 100 subjects aged 40 years and above after getting their informed written consent to participate. The consecutive patients clinically diagnosed to have cervical radiculopathy, referred from department of Orthopaedics were prospectively recruited for the study. Subject's detailed history and thorough clinical examination parameters were recorded. Subjects with Diabetes mellitus, with clinical or electrophysiological evidence of polyneuropathy as well as subjects with symptoms of less than 3 weeks duration and having spinal surgery done within the preceding 15 years were excluded. In all the subjects spine MRI was performed. Institutional Ethics Committee's approval was obtained and study was conducted at fixed room temperature of 30^{0}C.

ELECTROPHYSIOLOGICAL METHODS

In all the subjects, nerve conduction study was done using RMS EMG EP Mark-II. Motor nerves tested were Median, Ulnar, Radial, Axillary, Musculocutaneus and Suprascapular nerve. Surface disc electrode was placed on corresponding muscles. Ground electrode was placed between stimulating and recording electrodes. Belly tendon montage was used with cathode and anode 3 cm apart. Filters were set at 2 Hz to 5 kHz and sweep speed was 5 ms per division for motor study and for sensory study, filters were at 20 Hz to 3 kHz and sweep speed was 2 ms per division. Duration for both motor and sensory study was at 100 µs. Parameters like Distal Motor Latency (DML), Compound muscle action potential (CMAP) amplitude, Conduction Velocity (CV) were evaluated for motor nerves. Sensory conduction study (antidromic) involved stimulation of sensory nerves proximally and recording Sensory Nerve Action Potential (SNAP) with electrodes placed distally over the dermatomic distribution. Distance between active electrode and cathode of stimulator was divided automatically by onset latency to give sensory conduction velocity. SNAP amplitude was taken from peak to base. Sensory nerves tested were Median, Ulnar and Radial nerves. Parameters like SNAP amplitude and conduction velocity were evaluated for sensory nerves.

STATISTICAL ANALYSIS

Statistical analysis was done by using Statistical Package for Social Science (SPSS) version16. The study observations and results were noted and analysed to find the specificity, sensitivity, positive predictive value and negative predictive value.

RESULTS

Age and gender wise distribution of all the study subjects is depicted in [Table/Fig–1]. Age groups were not statistically different between male and females in study subjects. The sensitivity, specificity, positive and negative predictive values of motor and sensory nerve conduction study is shown in [Table/Fig–2 and 3]. 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 various nerves proximal nerves were found to have somewhat greater sensitivity and specificity as compared to distal nerves. 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/Fig–2 and 3].

Subjects	Males	Females	p–value
Number(n)	67	33	NS(p> 0.05)
Age(years)	52.13 ± 8.99	52.5± 9.89	

[Table/Fig-1]: Gender and age wise distribution of total study subjects
Data are mean± SD. NS- non-significant

Nerve	Parameters	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Median	DML	53.85	52.63	70.00	35.71
	CMAP	64.10	57.89	75.76	44.00
	CV	41.38	63.16	63.16	41.38
Ulnar	DML	23.08	68.18	56.25	33.33
	CMAP	46.15	57.89	69.23	34.38
	CV	38.46	63.16	68.18	33.33
Radial	DML	46.15	36.84	60.00	25.00
	CMAP	97.44	10.53	69.09	66.67
	CV	58.97	47.37	69.70	36.00
Musculocutaneous	CMAP	46.15	57.89	69.23	34.38
Axillary	CMAP	43.59	63.16	70.83	35.29
Suprascapular	CMAP	58.97	57.89	74.19	40.74

[Table/Fig-2]: Diagnostic efficacy of motor nerve conduction parameters
DML- Distal Motor Latency ; CMAP – Compound Muscle Action Potential; CV- Conduction Velocity

Nerve	Parameters	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Median	SNAP	10.26	84.21	57.14	31.37
	CV	17.95	89.47	77.78	34.69
Ulnar	SNAP	20.51	63.16	53.33	27.91
	CV	28.21	57.89	57.89	28.21
Radial	SNAP	5.13	89.47	50.00	31.48
	CV	5.13	84.21	40.00	30.19

[Table/Fig-3]: Diagnostic efficacy of sensory nerve conduction parameters
SNAP- Sensory Nerve Action Potential; CV-Conduction Velocity

DISCUSSION

Any process that causes impingement of exiting cervical nerve roots can lead to a radicular disorder like cervical radiculopathy. This impingement may be brought about by pathological or degenerative changes. Though MRI is considered as the gold standard for diagnosis of cervical radiculopathy, sometimes this disease may present itself even without any evident structural lesion seen on MRI. In such circumstances role of Electrophysiologic tests in the diagnosis is crucial. Therefore it is reasonable to evaluate diagnostic efficacy of nerve conduction studies and also there is a definite need to establish a cost effective, reliable, and accurate means for establishing the diagnosis of cervical radiculopathy.

Clinical examination is not always straight forward if the patient is in pain [8]. Plain radiographs in various projections may be helpful, but clinical symptoms often correlate poorly with the radiological findings [9]. Imaging techniques are mainly directed to localise the abnormality, identify compression of the spinal cord, nerve roots, and to exclude intraspinal lesions. Shafaie et al., [8] have reported that correlation between MRI and surgical findings is frequently unreliable. Furthermore abnormalities in MRI have been found in asymptomatic subjects. In this scenario, neurophysiological investigations are perceived by many as being helpful in the diagnosis of cervical radiculopathy and are also useful in excluding peripheral nerve lesions.

In present study, we documented that among various motor nerve conduction parameters Compound Muscle Action Potential (CMAP) was found to be more sensitive with high positive predicative value in diagnosing cervical radiculopathy. Conduction Velocity (CV) was found to have greater specificity and Distal Motor Latency (DML) had least negative predictive value. Among nerves, proximal nerves were found to have some what greater sensitivity and specificity as compared to distal nerves. Sensory nerve conduction parameters were found to have less sensitivity but higher specificity as compared to motor parameters. Positive and negative predictive values of sensory nerve conduction studies were comparable to motor parameters.

Nerve compression in CR may lead to motor, sensory, and/or autonomic changes. The usefulness of nerve conduction studies is dependent on their ability to detect motor changes occurring as a result of nerve compression. In radiculopathy, abnormalities in sensory-nerve action potentials (SNAPs) are uncommon. Typically, compression that leads to cervical radiculopathy occurs proximal to the dorsal root (sensory) ganglion. Unless the dorsal root ganglion at the distal most aspect of the neural foramen is involved, the SNAPs will remain normal. Compound muscle action potentials show a decrease in amplitude proportional to muscle atrophy. Significant alterations may be seen in polyradiculopathies with multiple muscle involvement. Nerve-conduction velocity and latency changes are not typically found in cervical radiculopathies

unless there is extreme demyelination of axons [10]. We recorded the comparable results as these findings. Sensory radiculopathy can only rarely be reliably localized segmentally by electrodiagnostic (EDX) techniques for the following reasons: symptoms of pain and paraesthesia are primarily mediated through C-type sensory fibers, which are too small to be studied by routine EDX techniques; the peripheral processes of sensory root fibers remain intact with intraspinal lesions, so SNAPs remain normal [5]. Our results go hand in hand with these observations.

Ashkan et al., [11] reported that sensitivity of both MRI and neurophysiologic studies (NPS) for the diagnosis of cervical radiculopathy was 93 and 42% respectively, whilst the positive predictive values for MRI and NPS were similar 91 and 86%. MRI had a higher negative predictive value (25% vs 7%). However, agreement between MRI and NPS was highest in patients with clear radicular symptoms and abnormal clinical signs (60%), suggesting that MRI and NPS remain complementary modalities in the evaluation of cervical radiculopathy. This is co-existent with our findings.

CONCLUSION

Therefore, based upon above observations and discussion we are of the opinion that, nerve conduction studies are useful supportive diagnostic tool for suspected cervical radiculopathy as they are found to have reliable sensitivity and specificity. We further conclude that among motor nerve conduction parameters compound muscle action potential is more sensitive as compared to distal motor latency and conduction velocity and sensory nerve conduction parameters are less sensitive in diagnosing cervical radiculopathy.

LIMITATIONS AND RECOMMENDATIONS

It was cross-sectional study with quite lesser sample size, therefore future studies with larger sample size are recommended.

REFERENCES

[1] Bogduk N. The anatomy and pathophysiology of neck pain. *Phys Med Rehabil Clin N Am.* 2003; 14(3):455-72.
[2] Radhakrishan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy: a population-based study from Rochester, Minnesota, 1976 through 1990. *Brain.* 1994 Apr; 117(Pt 2):325-35.
[3] Dillin W, Booth R, Cuckler J et al .Cervical radiculopathy: *A review. Spine.* 1986; 11:988-91.
[4] Fisher MA. Electrophysiology of radiculopathies. *Clin Neurophysiol.* 2002; 113(3):317–335 (Review).
[5] Levin KH. Electrodiagnostic approach to the patient with suspected radiculopathy. *Neurol Clin.* 2002; 20(2): 397–421.
[6] Han JJ, Kraft GH. Electrodiagnosis of neck pain. *Phys Med Rehabil Clin N Am.* 2003; 14:549-67.
[7] Marc J. Levine, Todd J. Albert, Michael D. Smith. Cervical Radiculopathy: Diagnosis and Nonoperative Management. *J Am Acad Orthop Surg.* 1996; 4:305-16.
[8] Shafaie FF, Wippold FJ 2nd, Gado M, Pilgram TK, Riew KD. Comparison of computed tomography myelography and magnetic resonance imaging in the evaluation of cervical spondylotic myelopathy and radiculopathy. *Spine*. 1999; 124(17):1781–85.
[9] Khan MR, McInnes A, Hughes SP. Electrophysiological studies in cervical spondylosis. *J Spinal Disord*. 1989; 2(3):163–69.
[10] Gnatz SM, Simpson JM: Non-surgical evaluation, treatment and rehabilitation of cervical spine disorders, in An HS, Simpson JM (eds): *Surgery of the Cervical Spine. London: Martin Dunitz*, 1994, pp 147-65.
[11] Ashkan K, Johnston P, Moore AJ. A comparison of magnetic resonance imaging and neurophysiological studies in the assessment of cervical radiculopathy. *Br J Neurosurg*. 2002; 16(2):146–48.

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