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Research Article

Electrophysiological Diagnostic Certainty in Spinal Nerve Root Entrapment

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ABSTRACT

Objective: Evaluation of sensitivity of different electrophysiological parameters among Egyptians with clinically spinal nerve entrapment.

Methods: 100 spinal nerve entrapment patients and 41 healthy control. Exclusion; diabetes mellitus, renal, hepatic, endocrine disorder, other nerve involvements.

Patients subjected to: Demographic data, detailed neurological history, examination. EDX; NCS, H-reflex, F-wave, Dermatomal Sensory Evoked Potential (DSEP), EMG. Normal cervical DSEP latency and same side Inter-root latency difference was calculated. Values more than 1.57 were considered abnormal.

Results: Mean age 49.6 ± 10.6. sensory pattern 87%, motor pattern 9%, sensorimotor patterns 4%. Single nerve root (56%), highest C7 root (25%) (.44%. Multiple nerve root; highest C6,C7 (20.5%). No significant pattern difference among single versus multiple roots.

Among single root: 91.9% sensory, 6.9% motor, 1.7% sensorimotor. Within multiple roots; sensory (81.8%), motor (11.4%), sensorimotor 6.8%. Positive DSEP; 98.2% sensory and all motor/sensoriomotor, all cervical and 93.8% lumbosacral patients. Cervical Latency normal/pathological: C5 l 18.68 ± 3.5/27.84 ± 4.02. C6: 22.18 ± 1.6)/26.38 ± 2.8. C7; 21.01 ± 1.8./25.6 ± 2.04. C8: 21.93 ± 1.7/5.93 ± 2.5. Significant difference between normal vs pathological latency. Positive F-wave; 57.5% sensory, 80%motor, 83.3%, sensorimotor. Abnormal H-reflex in patients with S1 root manifestations. Abnormal EMG: motor, sensorimotor and 54.2% sensory patterns.

Conclusion: Commonest presentation is sensory. H-reflex is highly sensitive among S1 patients. DSEP is highly sensitive among sensory patterns. Sensitivity of F-wave is low among sensory, higher with motor/sensorimotor, with two segments accuracy. EMG is highly sensitive in motor but less with sensory pattern.

Keywords: Spinal nerve root entrapment; Electrophysiology; Dermatomal Somatosensory Evoked Potential (DSEP); Sensorimotor presentation patterns

INTRODUCTION

The clinical presentations of spinal nerve roots entrapment are mostly sensory, motor manifestations occur less frequently [1-3]. Regarding the diagnosis of the spinal nerve root entrapment; two diagnostic challenges; namely the relevance and the localization [4]. The combination between imaging and electrophysiological techniques is needed for proper localization [5-7]. Correlation between clinical, imaging and electrophysiological variables is mandatory for accurate diagnosis [1-4].

Literature review, revealed that the correlation between the patterns of clinical presentation and the pathophysiological mechanisms of spinal nerve root entrapment were not adequately considered. The exact correlation between the presentation patterns of spinal nerve root entrapment and exact match and yield of different electrophysiological techniques are not fully studied in the literature.

Objective

Evaluation of the sensitivity of different electro-physiological parameters among Egyptian patients presented with clinical picture suggestive of spinal nerve root entrapment.

MATERIALS AND METHODS

A hundred patients (54 males and 46 females) with symptoms suggestive of spinal nerve root compression were selected randomly and included in the study after signing informed consent. Exclusion Criteria: central or peripheral nerve involvement, chronic medical conditions that can influence

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the nerves as diabetes mellitus, hepatic, renal insufficiency and endocrinal disorders.

Each studied patient was subjected to the following: Detailed history, neurological examination this is followed by electro-physiological testing. Namely: Motor conduction velocity [8], sensory conduction velocity [8]. H-reflex, [8] Dermatomal Somatosensory Evoked Potential (DSEP) [9,10], F-wave [8], Axillary F-central root latency [8], Needle EMG for segment pointing muscle [11].

A control group of 41 healthy subjects were also included for the determination of the normal values of the cervical Dermatomal Somatosensory Evoked Potential (DSEP) latency. The normative values of the short latencies of the cervical dermatomal somatosensory evoked potentials were determined and the mean and SD were calculated, (Table 1). Inter-root latency difference at the same side was calculated for C6, C7, C8 (Table 2). Values more than 1.57 (mean ± 3 SD) were considered abnormal.

Table 1: Latency values of cervical DSEP in control subjects.

Root	Mean (ms)	SD (ms)	Min (ms)	Max (ms)	Critical value
C5	17.3	0.66	16.4	18	19.1
C6	22.8	1	21.2	24.8	25.7
C7	23.4	0.83	21.5	25.4	25.8
C8	23.3	0.88	21.9	25.6	25.7

Table 2: Inter-root latency difference (C6, C7, C8).

	Mean (ms)	SD (ms)	Min (ms)	Max (ms)	Critical value (ms)
C7-C6	0.57	0.34	0.0	1.2	1.57
C7-C8	0.3	0.15	0.1	0.7	0.75
C8-C6	0.47	0.34	0.0	1.2	1.49

RESULTS

Mean patient age 49.6 ± 10.6 (20 -77 years). The age group of 50-59 years had the largest number of patients, while the age group 70-77 years had the lowest. Pattern of presentations; 87% sensory, 9% motor and 4% sensorimotor patterns. Single spinal nerve root entrapment was encountered in 56%, with the highest frequency of C7 spinal root (25%) and the lowest frequency of C5 spinal root (1.8%), (Table 3).

Table 3: Frequency of single spinal nerve root entrapment.

Nerve roots	N	%
C5	1	1.8
C6	12	19.6
C7	13	25.0
C8	6	10.7
L4	2	3.6
L5	11	19.6
S1	11	19.6
Total	56	100

Table 4 demonstrates multiple spinal nerve root entrapment combinations. Highest frequency within combination of nerve roots C6, C7 (20.5 %), while the lowest frequency (2.3%) was encountered in combination of C5, C6, C7, L2-L3 and L3,4,5, S1. The frequencies of clinical patterns of presentation among cases with single spinal nerve root entrapment and cases with multiple spinal nerve root were found to be statistically insignificant ($p>0.05$), (Table 5).

Table 4: Frequency of multiple spinal nerve root entrapment combination.

Nerve roots	N	%
C5,C6	8	18.2
C7,C8	6	13.6
C 6, C7	9	20. 5
C5,C6,C7	1	2. 3
C6,C7,C8	3	6.8
C5,C6,C7,C8	3	6.8
L2,L3	1	2.3
L4,L5	2	4.5
L5,S1	6	13.6
L4, L5,S1	4	9.1
L3,L4,L5,S1	1	2. 3
Total	44	100

Table 5: Frequency of clinical presentation patterns among patients with single and multiple spinal nerve root entrapment.

Clinical presentation	Single	Multiple	Total
Sensory	51	36	87
Motor	4	5	9
Sensorimotor	1	3	4
Total	56	44	100

Dermatomal Somatosensory Evoked Potential (DSEP) was studied in 91 patients and 41 control subjects. The majority of the patients (98.2%) yielded positive results. Abnormalities of DSEP were detected in all patients with motor and sensorimotor presentations (9,4 patients respectively). Abnormal DSEP was detected in 100% of cervical root lesion and 93.8% with lumbar and/or sacral root lesion.

F-wave abnormalities were detected in 57.5% of sensory pattern patients, 80% of motor patterns and 83.3% of sensorimotor pattern patients.

In twenty-one patients with suspected involvement of first sacral spinal root, irrespective of the clinical presentation, H-reflex latency was prolonged.

Concentric needle EMG study was performed randomly only in 30 patients with lumbar and/or sacral root involvement. Abnormal EMG patterns were encountered in 100% of motor or sensorimotor pattern patients and 54.2% of sensory pattern patients.

DISCUSSION

Electrophysiological techniques are useful in the evaluation of spinal nerve root entrapment, complementing neuro-radiologic imaging. Electrophysiologic data possess both diagnostic and prognostic yields. The validity of the diagnostic yield of these techniques was a major concern by many authors [7,12,13]. However, they did not relate explicitly the employed electrophysiological techniques to the given clinical presentation such strategy might have been responsible for inconsistency of the reported electrophysiologic findings by different authors [7,12-14].

The results of this study are going to be analyzed and discussed with reference to the presenting clinical patterns.

A. Electrophysiological findings in sensory clinical presentation patterns

In this study, the sensory presentation pattern was the commonest presentation whether with single or multiple spinal nerve root entrapment. This can be attributed to the fact that the sensory neurons are more susceptible to compression than motor neurons [15].

The yield of DSEP in the present study was 98.2%, while those of F-wave and EMG were 57.5% and 54.2% respectively. These results suggest that DSEP is a sensitive technique in evaluating root entrapment with sensory pattern, as it assesses clinically relevant sensory path [16].

Abnormalities of DSEP latencies were encountered in 100% and 93.8% of cervical and lumbosacral root entrapment respectively. Such variability might be attributed to the relatively shorter length of the sensory path along which the applied electric stimuli to upper limb neurons had to propagate compared to that of lower limbs. Mild delay at the lumbar root might be masked. Other studies did not detect discrepancy between cervical and lumbosacral root lesion.

Aminoff et al. [7] in their study contradict our results of high yield of DSEP among lumbosacral root entrapment. And reporting low diagnostic accuracy among lumbosacral root entrapment (25%), within whom 96.4% presented with sensory manifestation. They pointed out that the use of maximal normal inter side latency difference based on 3 SD from the mean of their normal subjects might be a cause of low yield [7].

Leblhuber et al. [14] investigated different electrophysiological techniques among 26 patients with radiologically documented cervical disc prolapse with variable clinical patterns, they found DSEP in 85%, EMG in 67%, F-wave 38%. They concluded that DSEP is more sensitive than EMG in detecting cervical root lesion [14].

Molitor [16] studied the diagnostic significance of different somatosensory evoked potential techniques and parameters in evaluating lumbar and cervical root lesion and concluded SEP following segmental stimulation may serve as an additional diagnostic tool to nerve root lesions [16].

Saal et al. [17] demonstrated significant correlation of SEP findings with anatomic abnormalities revealed by MRI and CT scan.

Hussein N, et al. reported that DSEP is highly sensitive than needle EMG in diagnosing and localizing chronic sensory lumbosacral radiculpathies, even if MRI findings are inconclusive [18].

Tans et al. [13] concluded that cutaneous SEP in lumbosacral radiculopathy is better or at least as reliable as EMG.

Walk et al. [12] concluded that SEP serves as useful adjunct to EMG in absence of muscle denervation in lumbosacral radiculopathy.

In the present study, EMG yielded positive results in 54.2% of sensory patterns lumbosacral patients which indicate some compromise of the motor axons in association with sensory axons. Aminoff et al. [7] reported EMG abnormalities in 75% of patients, 10 patients of them had pure sensory manifestations and two had only pain. They concluded that EMG could detect abnormalities even in the absence of clinical motor deficit because of difficulty to determine the exact site of pathology by clinical exam with disagreement between dermatomal territory of each root and multi-segmental supply of the limbs [7].

Tans et al. [13] found EMG abnormalities in 31.5% of patients with lumbosacral root lesions. They could not explain the relationship between EMG abnormalities and clinical sensory deficits.

Walk D et al. [12] detected EMG abnormalities in 28.9% of lumbosacral radiculopathy patients and they criticize the use of EMG in cases with predominant sensory manifestations [12].

F-wave abnormalities encountered in 57.5% of the studied patients with sensory presentation pattern.

Eisen et al. [19] and De weerd [20] found delayed F wave in 65% of patients with L5 radiculopathy confirmed by myelography. On the other hand, Tonzola et al. [21] detected in only 26% lumbosacral root compression patients. Aminoff et al. [7] observed delayed F -wave in 18% of patients with L5 radiculopathy.

Aiello et al. [22] detected F- wave abnormalities in 37.7% of patients with L5 radiculopathies. None of the aforementioned authors reported about the pattern of clinical presentation.

H-reflex was abnormal in 100% of patients with suspected S1 root involvement presented with sensory pattern. This documents its sensitivity in S1 root compromise.

Literature review revealed the incidence of H-reflex abnormalities in S1 root lesion varied from 41-100% [7,23,24]. This is may be due to defining abnormal parameters and case selection.

B. Electrophysiological findings in motor and sensorimotor presentation patterns

These two presentations patterns are discussed together as their frequencies among the studied cases are rather few (9% and 4% respectively) and their electrophysiological findings are almost alike.

An abnormal DSEP was present in all patients of both patterns. No Previous reports of such yield in motor pattern was encountered. Such high yield is mainly related to the fact that the occurrence of high degree of nerve root compression manifested by motor deficits will be inevitably associated with compromise of sensory fibers.

EMG revealed positive results in all studied patients with motor and sensorimotor patterns, compared to 54.2% of sensory pattern patients. This is related to patient with sensorimotor pattern are most likely having motor axon compromise leading to positive EMG yield.

Johnson et al. [25] reported EMG abnormalities in 35% of patients with lumbar radiculopathy and concluded that it is accurate in determining the level and degree of lumbar root involvement, however they did not relate EMG yield to the presenting clinical manifestations.

Khatri et al. [26] reported positive correlation between EMG and CT scan in 52.5% of low back pain patients.

Partanen et al. [27] concluded that EMG could determine root level with 1-2 accuracy segments in 57% of patients with cervical radiculopathy contradicting to the result of this study.

Leblhuber et al. [14] found EMG abnormalities in 67% of patients with radiologically verified cervical disc prolapse and recommended combination of EMG and DSEP in the evaluation of cervical root lesion.

From this study and previous studies, EMG exam is the test of choice for motor pattern patients with localizing accuracy of 1-2 segments.

In this study, F-wave yield in patients with motor and sensorimotor patterns presented were 80%, 83.3% respectively. This yield was higher than that of sensory pattern patients (57.5%). This is attributed to the fact that the presence of motor manifestations reflect advanced degree of motor axon involvement with affection of the fastest conducting fibers along which F-wave is propagated.

F-wave yield is lower than EMG in motor pattern patients as F-wave may not be affected in mild motor nerve lesions as each muscle has two roots and F-wave might be traveling along the uninvolved root. Johnson [28] emphasizes that denervation potentials detected by EMG is earlier to be detected compared with F-wave yield.

Leblhuber et al. [14] reported low yield of F-wave (38%) compared to other electrophysiological parameters in cervical disc patients. They used minimal F-wave and suggested including dispersion measurement and different stimulation rate could provide additional data regarding the site of the lesion.

Aiello et al. [22] found F-wave abnormalities in 29% of patients with L5 root lesion and concluded that it is not a sensitive technique. Mebrahtu et al. [29] found that F-wave dispersion has no substantial value in evaluating lumbosacral radiculopathy over that minimal latency of F-wave.

CONCLUSION

In conclusion, Sensory pattern is the commonest among spinal nerve root entrapment whether cervical or lumbosacral. H-reflex is highly sensitive among S1 patients. DSEP is highly sensitive among sensory patterns. Sensitivity of F-wave is low among sensory, higher with motor/sensorimotor, with two segments accuracy. EMG is highly sensitive in motor but less with sensory pattern.

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