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Correlation between Dermatomal Somatosensory Evoked Potential, Needle Electromyography and Magnetic Resonance Imaging in Chronic Sensory Lumbosacral Radiculopathies

Naglaa A Hussein[1*], **Alaa Abdelraouff Bayiomy**[2] **and Mohamed Sami Barakat**[3]

[1]*Faculty of Medicine, Alexandria University, Resident of Physical medicine and rehabilitation, Albert Einstein College of medicine, NY, USA*

[2]*Department of Neurosurgery, Faculty of Medicine, Alexandria University, Egypt*

[3]*Department of Radiodiagnosis, Faculty of Medicine, Alexandria University, Egypt*

[*]**Corresponding Author:** Naglaa A Hussein, Alexandria University, Resident of Physical medicine & rehabilitation, Albert Einstein College of medicine, NY, USA, Tel: 20103714793; E-mail: nagla_kashif@hotmail.com

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Abstract

Objective: To correlate between dermatomal somatosensory evoked potential (DSEP), needle electro myography (EMG) and magnetic resonance imaging (MRI) in patients with clinical picture suggestive of chronic sensory lumbosacral radiculopathy.

Design: cross sectional study.

Setting: outpatient setting.

Participants: 50 patients (29 Males, 21 Females) with chronic sensory lumbosacral radiculopathy. 20 healthy subjects were included as control for DSEP values.

Main outcome measures: Medical history, detailed neurological examination, Lumbosacral MRI, lumbosacral DSEP and needle EMG for segment pointing muscles were done for all patients. DSEP were done for lumbosacral roots for control subjects.

Results: Mean age of patients 56.36 ± 10.26. Mean disease duration 17.48 ± 6.85 months.Spondylosis constituted 74%, followed by spinal stenosis 14%, lumbar disc prolapse 8%, lastly spondylolithesis 4% In relation to sensory symptoms, DSEP is significantly higher than EMG in detecting lumbosacral radiculopathies (p=0.0001). DSEP sensitivity and accuracy is higher than needle EMG at L4, L5 and S1 In relation to MRI, sensitivity of DSEP at L4 was 93.3%, at L5 and S1 100%. Sensitivity of needle EMG at L4 was 20%, at L5 24.3%, at S1 47.1% .

Conclusion: DSEP is highly sensitive than needle EMG in diagnosing and localizing chronic sensory lumbosacral radiculpathies, even if MRI findings are inconclusive.

Keywords: Needle electromyography; Radiculopathy; Magnetic resonance imaging

Introduction

The clinical presentation of radiculopathy is mostly sensory. Motor manifestations occur less frequently [1]. It is mandatory for the diagnosis of radiculopathy to consider collectively the clinical, imaging, and electrophysiological variables, Magnetic resonance imaging is now considered the most accurate imaging technique in detecting compressing pathology resulting in radiculopathy but the results of magnetic resonance is technique-dependent and needs an expert neuroradiologist [2,4]. In addition, the results of the imaging techniques should be meticulously correlated with the clinical picture in diagnosing radiculopathies [3,4].

Electrophysiologic techniques are important aids in evaluation of lumbosacral radiculopathies. They identify the physiologic abnormality in the nerve root, verify the relevance of the radiological findings to the presenting clinical manifestation, as well as determine the prognosis [3,5] (Figure 1).

Needle electromyography [needle EMG] is the earliest electrophysiological technique known to have a significant role in the diagnosis of radiculopathies [6]. Investigators have concluded that needle EMG is the single most effective method in acute lumbosacral radiculopathy [7]. Needle EMG may be also of additional value in patient with clinical suspicion of lumbosacral radicular syndrome without nerve root involvement on MRI [8].

Dermatomal Somatosensory Evoked Potential (DSEP) is a sensitive electrophysiological method that not only used to evaluate single nerve root function but also is helpful in the localization of the lesion [9]. However, some investigator doubted the utility of DSEP in lumbosacral radiculopathies and recommended further investigation [10].

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Aim of the study

To correlate between dermatomal somatosensory evoked potential,needle EMG and magnetic resonance imaging in patients with clinical picture suggestive of chronic sensory lumbosacral radiculopathy.

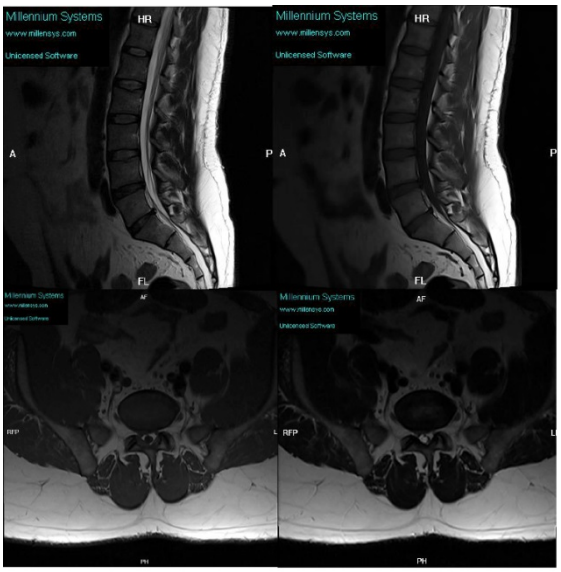

Figure 1: T1 and T2 sagittal and axial images showed LV5-SV1 right postero-lateral disc protrusion compromising the right exiting and traversing nerve roots. Also noted, LV4-LV5 mild posterior disc bulge with no significant neural compromise.

Methods

Study design

This was cross sectional study. Ethics approval was obtained before initiation of the study from research ethics committee at Alexandria University.

Participants

Fifty patients (29 Males 58%, 21 Females 42%) from those attending the outpatient clinic of Physical medicine, Rheuamtology and Rehabilitation department at Alexandria University were asked if they would voluntarily participate in this study provided that they meet the inclusion criteria. Their age ranged 28-68 years (mean ± SD 56.36 ± 10.26)

Inclusion criteria

Clinical picture suggestive of chronic sensory lumbosacral radiculopathy. Patients were selected based on the confinement of their findings to one or more dermatomal territory. Exclusion criteria were motor findings to one or more myotomal territory suggestive of motor radiculopathy. Patients with overt manifestations suggestive of central and/or peripheral nerve involvement or internal medical conditions that are known to induce changes in the central and peripheral nervous system as diabetes mellitus, hepatic, renal insufficiency and endocrinal disorders were also excluded (Figure 2).

Twenty ages matched healthy adults were also included in the study for determination of the normal reference values for the dermatomal somatosensory evoked potential for lumbosacral roots.

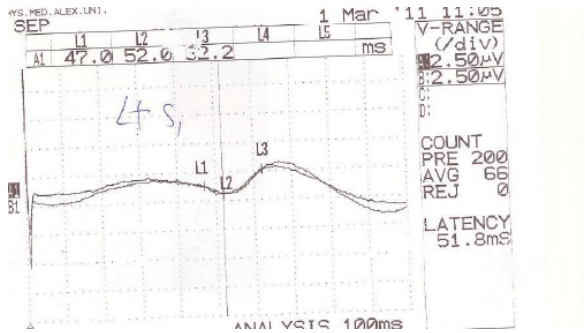

Figure 2: DSEP of the above patient showed delayed peak latency of S1.

Procedures

Each patient signed an informed consent for participation in the study after being informed about the details of the procedure. Medical history, including sensory complaints and general physical examination were conducted for all patients. Detailed neurological examination was conducted for all patients by the principal investigator 3: This included objective sensory data, motor data (wasting, weakness and fasciculation). Deep tendon jerks (knee and ankle).

Electrophysiological procedures

The currently employed techniques were conducted for all patients. The tests were carried out by the principal investigator: Motor conduction study for posterior tibial and deep peroneal nerves. Sensory conduction studies for sural to exclude peripheral neuropathy. Bilateral dermatomal somatosensory evoked potential (DSEP) [11] was registered after stimulation of dermatomal sites considered after the modified dermatomal map of Slimp et al. [11]. The stimuli had duration of 200 microseconds; an intensity 2.5-3 times sensory perception threshold and they are delivered at frequency of 4 Hz -7 Hz, with averaging 100-200 times for recoding of the evoked potential, at filter setting 1-2000. The recording electrodes were the the ordinary surface electrode used for nerve stimulation. The active electrode was placed 2 cm behind Cz and the reference electrode was placed halfway between Fz and Fpz (International 10-20 system). The criteria for abnormalities were absent response or when the peak latency was exceeding the normal values of the control subjects done at our laboratory (Figure 3).

Needle EMG for segment pointing muscle [12]. The gastrocnemius and soleus were considered to be related to S1 root. The extensor hallucis and tibialis anterior to L5. The quadriceps femoris to L4. Criteria for root lesion in the needle EMG were presence of fibrillation potentials and or positive sharp waves in at least two muscles supplied by the same root. And /or the presence of polyphasic motor units indicating chronicity.

Magnetic resonance imaging

T1 and T2 sagittal and axial images were carried out to all patients by a radiologist who did not know the results of the electro diagnostic tests using Avanto Siemens (Germany) machine [13]. MRI abnormalities were classified as being either 2:1) indicative of root injury because they showed clear distortion or displacement of a visualized nerve root by an identifiable anatomic abnormality or (2) consistent with root dysfunction on the basis of (a) compromise of neural foramina (b) evidence of arachnoiditis or c) indentation of the thecal sac by hypertrophic bone or ligament, extruded or herniated disk material or a large disc bulge.

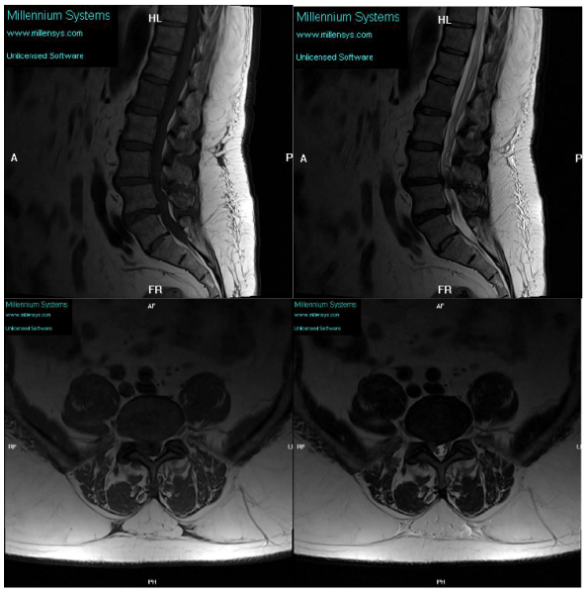

Figure 3: T1 and T2 sagittal and axial images showed LV4-LV5 right postero-lateral disc protrusion compromising the right exiting and traversing nerve roots; augmented by facet osteoarthropathy at the same level. Also noted, LV3-LV4 posterior central disc protrusion.

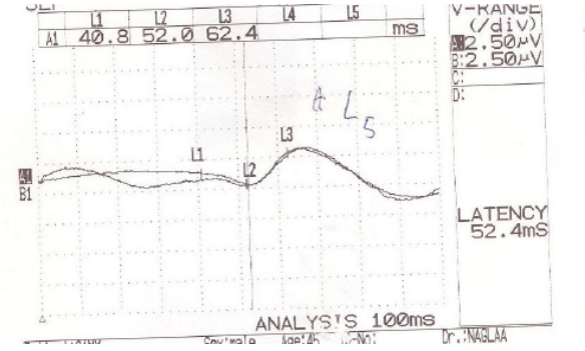

Figure 4: DSEP of the above patient showed delayed peak latency of L5 root.

Electrodiagnostic and radiographic studies were performed and interpreted independently, without prior knowledge of the results of other studies Control group of 20 normal adults were included for determination of the normal values of DSEP for L4, L5 and S1 nerve roots only.

Statistical analysis

The Data was collected and entered into the personal computer. Statistical analysis was done using Statistical Package for Social Sciences (SPSS/version 15) software. The statistical test used as follow: Arithmetic mean, standard deviation, number and percent were calculated, for categorized parameters Chi square test was used. The level of significant was 0.05.

The prognostic value of the tests determined by

1. Sensitivity of the test: the percent of the positives by the test and the true positives.
2. Specificity of the test: the percent of the negatives by the test and the true negatives.
3. Accuracy: the percent of agreement between the two tests.

Results

Mean disease duration 17.48 ± 6.85 months. Spondylosis constituted 74% (37 patients), followed by spinal stenosis 14% (7 patients), lumbar disc prolapse 8% (4 patients), lastly spondylolithesis 4% (2 patients). Only 23 patients (46%) had clinical sensory signs in addition to the sensory symptoms.

The normal value of DSEP of the control group was: L4root peak latency mean ± SD 38.93 ± 0.35 (38.5-40), L5 root peak latency 39.89 ± 0.28 (39.4 - 40.3), S1 root peak latency 39.92 ± 0.20 (39.4-40.2), Multiple root involvement affecting L4, 5, S1 and L5 S1 were the most frequent as revealed by DSEP (Table 1).

	DSEP		Needle	
	No.	Percentage (%)	No.	Percentage (%)
Single L4	3	6	5	10
Single L5	5	10	3	6
Single S1	4	8	1	2
Bilateral L4	2	4	0	0
Bilateral L5	4	8	1	2
Bilateral S1	1	2	1	2
Combination				
L4-L5	1	2	0	0
L4-S1	1	2	1	2
L5-S1	14	28	3	6
L4-L5-S1	15	30	1	2

Table 1: Distribution of affected nerve roots as obtained by DSEP and needle EMG.

In relation to sensory symptoms, DSEP is significantly higher than EMG (p=0.0001) in detecting lumbosacral radiculopathies (Table 2).

DSEP sensitivity and accuracy is higher than needle EMG at L4, L5 and S1 (Table 3).

	DSEP		Needle EMG	
	No.	Percentage (%)	No.	Percentage (%)
Positive	50	100	17	34
Negative	0	0	33	66
X^2	20.48			
p	0.0001*			

Table 2: Comparison between DSEP and needle EMG in relation to subjective sensory symptoms; *p is significant if ≤ 0.05.

In relation to MRI as a gold standard tool for detecting lumbosacral radiculopathy, the electrophysiolgical abnormality from dermatome L4 was detected mainly in patients with L3-4 lumbar disc prolapse, the electrophysiologic abnormality from L5 dermatome was detected mainly in patients with L4-5 lumbar disc prolapse. The abnormality from dermatome S1 was detected mainly in patients with L5 S1 lumbar disc prolapse. DSEP was highly sensitive and accurate in comparison to needle EMG at L4, 5 and S1 (Tables 4-6). Sensitivity of DSEP at L4 was 93.3%, at L5 and S1 100%. Sensitivity of needle EMG at L4 was 20%, at L5 24.3%, at S1 47.1%. Whereas, needle EMG had higher specificity in comparison to DSEP at L4, 5 and S1 (Tables 4-6).

	DSEP				Needle EMG			
	No.	Percentage (%)	Sensitivity	Accuracy	No.	Percentage (%)	Sensitivity	Accuracy
L4								
Negative	28	56	44	60	46	92	8	34.3
Positive	22	44			4	8		
L5								
Negative	11	22	78	84.3	41	82	18	41.4
Positive	39	78			9	18		
S1								
Negative	15	30	70	78.5	40	80	20	42.8
Positive	35	70			10	20		

Table 3: Sensitivity and accuracy of DSEP and needle in different position in relation to subjective sensory symptoms.

	MRI				Sensitivity	Specificity	Accuracy
	Negative		Positive				
	No.	Percentage (%)	No.	Percentage (%)			
DSEP							
Negative	27	77.1	1	6.7	93.3	77.1	82.0
Positive	8	22.9	14	93.3			
Needle							
Negative	34	97.1	12	80.0	20.0	97.1	74.0
Positive	1	2.9	3	20.0			
Total	35		15				

Table 4: Sensitivity, specificity and accuracy of DSEP and Needle EMG in L4 in relation to the MRI as a gold standard method.

DSEP was correlated to MRI results in all positive cases. Moreover it was; able to detect root lesion in absence of MRI findings. This was in 8 patients at L4, 2 patients at L5 and 18 patients at S1.

	MRI				Sensitivity	Specificity	Accuracy
	Negative		Positive				
	No.	Percentage (%)	No.	Percentage (%)			
DSEP							
Negative	11	84.6	0	0.0	100.0	84.6	96.0
Positive	2	15.4	37	100.0			
Needle							
Negative	13	100.0	28	75.5	24.3	100.0	44.0
Positive	0	0.0	9	24.3			
Total	13		37				

Table 5: Sensitivity, specificity and accuracy of DSEP and Needle EMG in L5 in relation to the MRI as a gold standard method.

Discussion

The sensory pattern of clinical presentation of lumbo-sacral radiculopathy is by far the commonest presentation pattern. Such high frequency is attributed to the fact that the sensory neurons are more susceptible to compression than motor neurons [14]. That is why the target of this study was patients suffering from chronic sesnsory lumbo-sacral radiculopathy.

This also could explain the finding that DSEP yielded very high sensitivity and accuracy in detecting nerve root lesion as it assesses the clinically relevant sensory path. In addition, DSEP in the present study could uncover abnormalities of single root lesion as well as multiple root lesions. Owen et al reported that DSEP can be used to determine the presence of single or multiple levels of nerve root compromise in both diagnostic and intra-operative setting [15]. Other investigators also concluded that DSEP is a sensitive method to evaluate single nerve root function and to localize the lesion [9,16]. Walk et al. concluded that cutaneous SEP serves as useful adjunct to EMG in the absence of extremity muscle denervation [2]. On the other hand, Dumitru and Drefyuss questioned the accuracy of DSEP. They related the limitation of their study to several factors including, the small sample size (20 patients), the high degree of biologic variation of the reference values, the degree of nerve root compromise and the type of nerve fibers pathology that influence SEP yield [17]. Others also doubted the diagnostic utility of DSEP and suggested the need of further investigation [10].

	MRI				Sensitivity	Specificity	Accuracy
	Negative		Positive				
	No.	Percentage (%)	No.	Percentage (%)			
DSEP							
Negative	15	45.5	0	0.0	100.0	45.5	64.0
Positive	18	54.5	17	100.0			
Needle							
Negative	31	93.9	9	52.9	47.1	93.9	78.0
Positive	2	6.1	8	47.1			
Total	33		17				

Table 6: Sensitivity, specificity and accuracy of DSEP and Needle EMG in S1 in relation to the MRI as a gold standard method.

In this study, DSEP results correlated with the positive results of MRI at all the examined lumbosacral roots. Moreover, it could detect nerve root pathology in absence of MRI finding. This could suggest the high diagnostic utility of DSEP in chronic sensory lumbosacral radiculopathy. In the previous literature, DSEP was not tested specifically for chronic sensory lumbosacral radiculopathy but rather for all types of lumbosacral radiculopathy whether sensory, motor, mixed, acute or chronic. This could explain the variability of our results. Saal et al. used DSEP for upper lumbar radiculopathy. They demonstrated significant correlation for SEP findings with the anatomic abnormalities revealed by computerized tomography, MRI and discogram [18].

The presence of abnormal DSEP in the absence of MRI finding needs further discussion. Nerve injury is not solely caused by compressive phenomena. Chemical mediators can create neural injury and neurophysiologic abnormalities [19]. This kind of inflammatory process is not easily detected on an imaging study. In some cases disc disruption can cause chemical radiculitis. Some of those patients who had positive DSEP and normal MRI could have had a chemically mediated radicular syndrome [19].

In the present study, needle EMG examination yielded very low sensitivity and high specificity in detecting chronic sensory lumbosacral radiculopathy. This indicates some degree motor axon compromise in association with sensory axons. Although the high specificity of needle EMG, it could not be used as a sole diagnostic tool for chronic lumbosacral radiculopathy. Walk D et al. criticized the use of EMG due to low sensitivity in lumbosacral radiculopathy especially in the presence of dominant sensory manifestation [2]. The high specificity of needle EMG agreed with the results of Tong Hc et al. who concluded that needle EMG has excellent specificity for lumbosacral radiculopathy [20].

On contradiction, Amin off et al. concluded that EMG examination is the single most useful electrophysiological examination in patients with L5 S1 radiculopathy. However, their patients were not only patients with chronic sensory presentation but rather motor, sensory and mixed pattern of presentation [21].

In the present study, due to low sensitivity yield of EMG examination. It was also not highly correlated with MRI findings.

Conclusion

DSEP is highly sensitive non-invasive technique in diagnosing and localizing chronic sensory lumbosacral radiculopathy even if MRI findings are inconclusive. Needle EMG examination has low sensitivity yield although highly specific among patients with chronic sensory lumbosacral radiculopathy. Further studies are recommended to document the sensitivity of DSEP for sensory lumbosacral radiculopathy.

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