Volume - 13 | Issue - 11 | November - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ELECTROPHYSIOLOGICAL EVALUATION OF LUMBOSACRAL RADICULOPATHY BY H-REFLEX PARAMETERS IN A TERTIARY CARE HOSPITAL.

Physiology

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ABSTRACT

Introduction: Lumbosacral radiculopathy involves a pathologic process affecting the lumbar nerve roots and causing radicular symptoms in a lower extremity. There is compromise of a large number of nerve roots in the lumbosacral region. Approximately 76.1% of lumbar radiculopathies in this region involve the L5 and S1 nerve roots. This nerve root pathology primarily results from direct neural compression, regardless of whether the aetiology is an acute herniated or displaced disc, bony spurs, foraminal stenosis, central stenosis, or hypermobility of a vertebral segment. Less commonly, other compressive lesions such as tumours and cysts may cause radiculopathy. Diagnosing lumbar radiculopathy presents particular challenges due to the complex anatomy involved. Electrophysiological abnormalities in patients with lumbosacral radiculopathy is evaluated by Nerve Conduction Studies. H-reflex amplitude and latency might be changed in the patients. There might an absent H- reflex in patients. **Objectives:** To determine any changes in latency, amplitude of H-reflex, presence or absence of H-reflex in patients compared to the comparative group. **Methodology:** The analytical cross sectional study was conducted in the Neurophysiology Laboratory, Department of Physiology, RG. Kar Medical College and Hospital, during the years 2022-2023, for a duration of one year on patients diagnosed with low back pain and lumbosacral radiculopathy based on MRI findings, who were enrolled for pain management at the anesthesiology department at R. G. Kar Medical College and Hospital, were included in this study as study subjects. Apparently healthy individuals were taken as control. The study population consisted of individuals meeting the specified inclusion and exclusion criteria. After obtaining ethical clearance from the institutional ethics committee of RG. Kar Medical College, written informed consent was obtained from the study subjects. Nerve conduction studies were performed using the Neuro-MEP-Micro (version 2009) Machine. **Result** : Among the cases the highest proportion of lumbosacral radiculopathy involvement was at the L3-L4 disc level followed by the L5-S1 level, with the L1-L2 level being the least involved. About 26.7% of cases had absent H-Reflex. The mean H-reflex amplitude was significantly lower in cases 2.78 (± 1.08) in right ear and 2.51 (±1.08) in left ear compared to that in control 5.03 (±2.69) in right ear and 6.95(± 2.76) in left ear. The H:M ratio was significantly reduced in cases compared to controls for both right and left sides ($p = 0.001$). But there were no significant differences in H-wave latency between cases and controls for both right and left sides. **Conclusion:** H-reflex amplitude, H:M ratio, and absence of H-Reflex compared with latency could be an earlier parameter of nerve root involvement in patients with radiculopathy.

KEYWORDS

H:M Ratio, Radiculopathy, Electrophysiology,

INTRODUCTION

Low back pain is the second most common reason for office visits to physicians, following only upper respiratory tract illness. Its lifetime prevalence ranges from 60% to 90%, but only about 5% of patients develop persistent symptoms leading to chronic low back pain [1].

However, diagnosing low back pain can be challenging, as approximately 85% of patients cannot receive a definitive diagnosis due to the weak association among symptoms, pathological changes, and imaging studies. This diagnostic difficulty arises from the diverse primary causes of low back pain, which can affect intervertebral discs, ligaments, facets, joints, and muscles [2,3]. The presence of severe leg pain and a history of prior episodes of low back pain are significant medical factors associated with the development of disability in patients with low back pain [2,3]. Lumbar radiculopathy and lumbar canal stenosis are described as the most common etiologies in patients presenting with greater leg pain than low back pain [4,5].

Lumbosacral radiculopathy causes radicular symptoms in a lower extremity. This nerve root pathology primarily results from direct neural compression, regardless of whether the aetiology is an acute herniated or displaced disc, bony spurs, foraminal stenosis, central stenosis, or hypermobility of a vertebral segment [6]. Less commonly, other compressive lesions such as tumours and cysts may cause radiculopathy. Additionally, non-compressive or non-structural etiologies like 'chemical radiculitis' or systemic diseases like diabetes or malignancies may contribute to radicular symptoms [7].

Although there is the potential compromise of a large number of nerve roots in the lumbosacral region, diagnosing lumbosacral radiculopathy remains challenging . Approximately 76.1% of lumbar radiculopathies in this region involve the L5 and S1 nerve roots .

Electrodiagnostic studies, such as nerve conduction studies (NCS), specific for diagnosing lumbosacral radiculopathy. These studies are particularly useful in determining the physiological significance of structural changes observed on MRI, identifying the affected level, assessing non-compressive radiculopathy, predicting prognosis related to axonal loss, and investigating other neurological signs and symptoms. [8]

The focus of our study was on Nerve Conduction Velocity (NCV) study parameters, including latency, amplitude, and conduction velocity, in patients with low back pain and lumbosacral radiculopathy. We aimed to assess the potential of these parameters for diagnosing radiculopathies and compare their efficacy with imaging (MRI) and clinical examination. Patients with complaints of low back pain lasting more than 3 months underwent clinical, radiological, and neurophysiological evaluations. Subsequently, a comparative analysis was conducted among these three types of findings, with a specific emphasis on evaluating the role of NCV study parameters in diagnosing lumbosacral radiculopathy.

Although the Soleus H-reflex is considered a sensitive marker for root dysfunction, its role in diagnosing radiculopathy remains insufficiently explored. There are studies that show a strong correlation between pathological changes in H-reflex parameters and clinical findings in various segmental lesions[8]. On this background in this study electrophysiological abnormalities in patients with lumbosacral radiculopathy is evaluated. H-reflex amplitude and latency might be changed in the patients. There might an absent H- reflex in patients.

Aims:

1. To find out the proportion of presence or absence of H-reflex in patients compared to the comparative group.
2. To determine any changes in latency, amplitude of H-reflex, H-M ratio of H-reflex in patients compared to the comparative group.

Methods And Methodology

Type of Study: An analytical cross-sectional study.

Study Design: Cross sectional design.

Study Area: Physiology Department, R.G.KAR Medical College and Hospital Kolkata-4, West Bengal, India. In collaboration with the Anesthesiology Department.

Study Population:

Patients who presented with low back pain for more than 3 months and had lumbosacral radiculopathy, diagnosed by the Radiologist through MRI findings, were enrolled in the Anesthesiology Department of R.G. Kar Medical College and Hospital, Kolkata, for pain management. Apparently healthy individuals were taken as a comparative group. According to the European Guidelines for prevention of low back pain, low back pain was defined as "pain and discomfort, localised below the costal margin and above the inferior gluteal folds, with or without leg pain." Radiculopathy defined as radicular pain resulting secondary to compression or inflammation of spinal nerve roots. Lumbosacral radiculopathy, like other forms of radiculopathy, results from nerve root impingement and/or inflammation that has progressed enough to cause neurologic symptoms in the areas that are supplied by the affected nerve root(s).

Inclusion Criteria Of Cases: a)Age: 25-70 years, b) Complaints of low back pain for at least 3 months or more, not responding to conservative management, c) Clinical features of radiculopathy as evidenced by clinical examinations, d) Physically capable of undergoing required test (NCS), e) Patients who signed informed consent

Exclusion Criteria: a) Complaints of duration less than 3 months, b) Patients aged more than 70 years, c) Patients with other causes of polyneuropathy including diabetes mellitus, d)Patients physically unable to undergo the test, e) Patients with major medical illness, f) Patients having Diabetes Mellitus, Secondary hypothyroidism, Alcoholism, Neuromuscular Disorder, Leprosy, Drug-Induced/Toxic Neuropathy, Family history of Neuropathy, Malignancy, HIV, Myopathy, Pregnancy, g) Patients who were unwilling to give consent

Study Tools

- The Neuro-MEP-Micro (version 2009) Machine and all its accessories were used.
- Measuring tape and stadiometer were utilised for height measurement.
- A weighing machine was employed to measure weight.
- A percussion hammer was used during clinical examination.
- A tuning fork (128Hz) was utilised for sensory testing.

Study Variables, Laboratory Investigations, Parameters, And Procedure

Evaluation of vibration sense and sense of touch to clinically determine the degree of neuropathy, Straight leg test, age Height, weight, waist circumference, and hip circumference were recorded. Parameters of Hoffman reflex/H reflex of bilateral Soleus muscle were assessed.

Sample Size:

Sample size calculated was 61, in each arm we have taken 31 . so Thirty one cases and 31 control were included in the present study. The sample technique employed in this study was convenient sampling.

Ethical Clearance : Ethical clearance were taken from the ethics committee of R.G.KAR Medical College, Kolkata-4.

The procedures for the nerve conduction study were as follows [9]:

The H reflex, a monosynaptic reflex elicited by submaximal stimulation of the tibial nerve, was recorded from the soleus muscle. Patients were instructed to lie comfortably in a prone position with their legs and thighs supported, ensuring appropriate exposure. The active electrode was placed at the distal edge of the calf muscle, while the reference electrode was placed on the Achilles tendon. A square wave pulse of 1 ms duration was utilized for preferential stimulation of large sensory fibers. The cathode was positioned proximal to the anode to prevent anodal block. Care was taken to ensure that the stimulus frequency did not exceed 1 in 5 ms to exclude any effect of prior stimulus. The latency of the H reflex was measured from the stimulus artifact to the first deflection from the baseline, and the amplitude was measured from the baseline to the peak of the negative phase. The technical settings for NCS were as follows:

Work Plan :

The study was conducted in the Neurophysiology Laboratory, Department of Physiology, RG. Kar Medical College and Hospital, during the years December 2022- November 2023, for a duration of one year. Patients diagnosed with low back pain and lumbosacral radiculopathy based on MRI findings, who were enrolled for pain management at the anesthesiology department at R. G. Kar Medical College and Hospital, were included in this study as study subjects. The study population consisted of individuals meeting the specified inclusion and exclusion criteria. After obtaining ethical clearance from the institutional ethics committee of RG. Kar Medical College, written informed consent was obtained from the study subjects. Detailed histories regarding the duration of the disease, clinical and neurological complaints, and use of medications were recorded. Subsequently, a clinical examination, with special attention to neurological examination, was conducted. All investigation reports and prescriptions written on Out Patient Door cards were recorded. Nerve conduction studies were performed using the Neuro-MEP-Micro (version 2009) Machine. Subjects were placed in a supine position at a temperature of 22-24°C in the neurophysiology laboratory, Department of Physiology, where the procedures were explained to them. Nerve conduction studies were conducted using three electrodes: Recording electrode, Reference electrode, and Ground electrode. These electrodes (disposable adhesive surface electrodes) were placed after cleaning the skin with Neuro-Prep gel to reduce skin impedance. Presence or absence of H- reflex, H- reflex parameter such as H-M ratio, H-amplitude, latency of the soleus were recorded.

RESULT:

The present study (Table 1) shows that the case and control groups were matched with age, height, weight, BMI. The mean age of the cases was 54.35 (±6.03) years while the controls had a mean age of 53.71 (±8.80) years, with a P-value greater than 0.05, indicating no significant difference. The mean height for the case group is 156.87 cm (SD = 6.11), compared to 160.06 cm (SD = 6.66) for the control group, with a P-value of 0.054, suggesting a non-significant difference. Regarding weight, the case group had a mean weight of 69.45 kg (SD = 8.57), and the control group has a mean weight of 70.10 kg (SD = 8.56), with a P-value greater than 0.05, indicating no significant difference. The BMI for cases was 28.25 (SD = 3.47), while for controls, it was 27.30 (SD = 2.84), with a P-value greater than 0.05, again showing no significant difference. Overall, there are no significant differences in the baseline characteristics between the case and control groups.

Table 1: shows the comparison of baseline characteristics between cases and control

	SUBJECTS	N	Mean	Std. Deviation	Std. Error Mean	P value
AGE	Case	31	54.35	6.03	1.08	>.05
	Control	31	53.71	8.80	1.58	
HEIGHT	Case	31	156.87	6.11	1.01	.054
	Control	31	160.06	6.66	1.12	
WEIGHT	Case	31	69.45	8.57	1.53	>0.05
	Control	31	70.1	8.56	1.53	
BMI	Case	31	28.25	3.47	.62	>0.05
	Control	31	27.3	2.84	.51	

In the present study Table 2 shows the distribution of subjects based on age for both the case and control groups. The table show that cases are predominantly in the 51-60 age group (45.1%), while controls are mostly in the 51-60 age group (51.7%), with other age groups distributed accordingly. Among the cases, 38.7% (n=12) are female, compared to 61.3% (n=19) of the controls. For males, 52.0% (n=13) of the subjects are in the case group, whereas 48.0% (n=12) are in the control group. The P-value is 0.419, indicating no significant difference in gender distribution between the case and control groups. This suggests that gender was evenly distributed across both groups, with a slightly higher proportion of females in the control group and a slightly higher proportion of males in the case group. shows the distribution of subjects based on gender, with 38.7% of female cases and 61.3% of female controls, and 52.0% of male cases and 48.0% of male controls, with a p-value of 0.419 indicating no significant difference.

Table 2 : Distribution Of Subjects Based On Age

Parameters		case	Control	p- value
Age group	40-50 years	25.8% (N=8)	32.2% (N=10)	0.29
	51-60 years	45.1% (N=14)	51.6% (N=16)	
	>60 years	29.0% (N=9)	16.1% (N=5)	
Gender	Female	58.1% (N=18)	61.3% (N=19)	0.419
	Male	41.9% (N=13)	48.0% (N=12)	

Table 3 illustrates the proportion of lumbosacral radiculopathy involvement among cases at different disc levels. Among the cases, 25.8% (n=8) had involvement at the L1-L2 disc level. The L3-L4 disc level showed the highest proportion of involvement, with 38.7% (n=12) of the cases affected. The L5-S1 disc level was involved in 35.5% (n=11) of the cases. This distribution indicates that the L3-L4 disc level has the highest proportion of lumbosacral radiculopathy involvement among the cases, followed by the L5-S1 level, with the L1-L2 level being the least involved.

Table 3: Proportion of lumbo sacral radiculopathy involvement among cases and control

Parameters		Cases
Disc level involvement	L1-L2	25.8%(N=8)
	L3-L4	38.7% (N=12)
	L5-S1	35.5%N(11)

The table 4 presents a comparison between case and control groups regarding the presence and absence of the H-reflex. H-reflex was present in 73.3% (22 out of 30) while it was absent in 26.7% (8 out of 30) among the cases. Conversely, in the control group, the H-reflex was present in 100% (30 out of 30) of the subjects, with no instances of absence. The P-value for this comparison is less than 0.05, indicating a statistically significant difference between the two groups in terms of H-reflex presence.

Table :4 Proportion of H reflex present or absentin Cases and Control

parameters		Case	Control	P value
H-Reflex	Present	73.3%(N=22)	100%(N=30)	< 0.05
	Absent	26.7%(N=8)	0%(N=0)	

Table 5: H reflex parameters between cases and controls

PARAMETERS		SUBJECTS	Mean	Std. Deviation	Std. Error Mean	P value
H-Reflex Amplitude (mV)	Right	Case	2.78	1.08	0.19	0.0001
		Control	5.03	2.69	0.48	
	Left	Case	2.51	1.52	0.27	0.001
		Control	6.95	2.76	0.50	
H: M ratio	Right	Case	0.20	0.16	0.02	0.001
		Control	2.63	0.97	0.17	
	Left	Case	0.63	0.57	0.10	0.001
		Control	2.37	0.88	0.15	
H-wave Latency (ms)	Right	Case	28.50	9.93	1.78	.117
		Control	24.98	7.31	1.31	
	Left	Case	25.16	11.24	2.02	.639
		Control	26.24	5.84	1.05	

The table 5 compares various H-reflex parameters between case and control groups, including amplitude, HM ratio, and latency for both the right and left sides. For H-reflex amplitude in the right side of the case group shows a mean of 2.8 ± 1.1 with a standard error mean of 0.19, whereas the control group had a significantly higher mean of 5.0 ± 2.7 with a standard error mean of 0.48 (P = 0.0001). Similarly for the left side, the case group had a mean of 2.5 ± 1.5 with a standard error mean of 0.27, while the control had a significantly more amplitude which was 7.0 ± 2.8 with a standard error mean of 0.50 (P = 0.001). For the HM ratio, on the right side, the case group exhibits a significantly less ratio of 0.20 ± 0.16 with a standard error mean of 0.029, compared to the control group's mean of 2.6 ± 0.97 with a standard error mean of 0.17 (P = 0.001). On the left side, the case group's mean was significantly less ratio of 0.64 ± 0.58 with a standard error mean of 0.10 compared to control group's mean 2.4 ± 0.88 with a standard error mean of 0.16 (P = 0.001). H-wave latency was significantly more in the right side of case showed a mean of 28 ± 9.9 with a standard error mean of 1.8 while the control group had a mean of 25 ± 7.3 with a standard error mean of 1.3 (P = 0.12). On the left side, the case group's mean was 25 ± 11 with a standard error mean of 2.0, compared to the control group's mean of 26 ± 5.8 with a standard error mean of 1.0 (P = 0.64). Overall, the data indicates significant differences in H-reflex amplitude and HM ratio between the case and control groups, while H-wave latency differences are not statistically significant.

DISCUSSION :

The present study showed that cases and controls were age, sex , height, weight matched. No significant differences were noted in demographic data, including gender distribution, between patients and control. The present study aimed to examine the distribution of lumbar radiculopathy among patients with various levels of disc involvement and to compare these findings with those from other studies in the field. The present study found that the most common disc level involvement among cases was L3-L4 (38.7%), followed by L5-S1 (35.5%) and L1-L2 (25.8%). This distribution contrasts with the findings of Mondelli et al. (2013), where the most frequent level of herniated disc (HD) was L4-L5 (52.8%), followed by L5-S1 (38.9%), and a very small proportion involved L3-L4 (8.3%). This discrepancy might be attributed to differences in patient demographics, selection criteria, or regional variations in the prevalence of specific radiculopathies. Berry et al. (2019) indicated that while age and physical demands influence the prevalence of lumbar radiculopathy, gender distribution can vary, showing a male preponderance in the general population but higher risk in females in certain physically demanding professions such as military service.

In our study, we evaluated the presence of the H-reflex in patients with lumbar radiculopathy and compared the findings with control subjects. The results indicated a significant difference between the two groups. Specifically, the H-reflex was present in 73.3% of cases (22 out of 30) and 100% of controls (30 out of 30), with a p-value of <0.05. Conversely, the H-reflex was absent in 26.7% of cases (8 out of 30) and none of the controls. These findings align with the study by Ghugare et al. (2010), which assessed nerve conduction in chronic low back pain patients. They found that routine nerve conduction studies showed no significant differences, but all H-reflex parameters, including presence, latency, amplitude, and H/M ratio, were significantly affected in patients compared to controls (p-value <0.0001) [10]. Similarly, Berry et al. (2019) highlighted that the absence of the H-reflex is a significant marker in nerve conduction studies (NCS) for patients with lumbar radiculopathy, emphasizing its role in diagnosing nerve root dysfunction [11]. The study by Hakelius and Hindmarsh (1972) also emphasized the value of electrophysiological tests, including the H-reflex, in identifying functional impairments that might not be evident through imaging alone [11].Our findings demonstrate the relevance of H-reflex testing in clinical practice. The significant absence of the H-reflex in a substantial proportion of radiculopathy cases compared to controls highlights its diagnostic value. The comparison with previous studies supports the use of H-reflex measurements to identify and understand the extent of nerve impairment in lumbar radiculopathy, reinforcing its importance in accurate diagnosis and effective management of the condition.

In our study, we evaluated the H-reflex amplitude in patients with lumbar radiculopathy and compared the findings with control subjects. The results indicated significant differences between the two groups. Specifically, the mean H-reflex amplitude on the right side was 2.78 mV in cases compared to 5.03 mV in controls (p = 0.0001), and on the left side, it was 2.52 mV in cases compared to 6.95 mV in controls (p = 0.001). These findings are consistent with previous research. For instance, Berry et al. (2019) highlighted that reduced H-reflex amplitudes are a common finding in nerve conduction studies (NCS) among patients with lumbar radiculopathy, emphasizing the diagnostic importance of this parameter [11]. Similarly, the study by Ghugare et al. (2010) reported significant differences in H-reflex amplitude between patients with chronic low back pain and control subjects, with reduced amplitudes indicating nerve root dysfunction (p < 0.0001) [10]. This suggests that reduced H-reflex amplitude is a reliable marker of underlying nerve impairment in radiculopathy. The study by Hakelius and Hindmarsh (1972) also supported the present study.

In the present study, we evaluated the H:M ratio (the ratio of H-reflex amplitude to maximum M-wave amplitude) in patients with lumbar radiculopathy and compared the findings with control subjects. The results indicated significant differences between the two groups. Specifically, the mean H:M ratio on the right side was 0.20 in cases compared to 2.63 in controls (p = 0.001), and on the left side, it was 0.64 in cases compared to 2.37 in controls (p = 0.001). These findings align with previous research indicating substantial abnormalities in the H:M ratio in patients with lumbar radiculopathy. For instance, Ghugare et al. (2010) reported significant differences in H:M ratios between chronic low back pain patients and control subjects, with reduced H:M ratios highlighting the presence of nerve root dysfunction (p < 0.0001) [10]. Similarly, Berry et al. (2019) emphasized that altered H:M ratios are a common finding in nerve conduction studies (NCS) among radiculopathy patients, underscoring the diagnostic value of this parameter [11]. The study by Hakelius and Hindmarsh (1972) also highlighted the importance of electrophysiological tests, including the H:M ratio, in identifying functional impairments that might not be apparent through imaging alone [12]. Our findings are consistent with this perspective, demonstrating the critical role of H:M ratio measurements in the accurate diagnosis and management of lumbar radiculopathy. This parameter provides essential insights into the excitability of the motoneuron pool and the extent of synaptic transmission alterations, making it a valuable diagnostic tool in clinical practice.

In our study, we evaluated the H-wave latency in patients with lumbar radiculopathy and compared the findings with control subjects. The results showed no significant differences between the two groups for both right and left sides. Specifically, the mean H-wave latency on the right side was 28.50 ms in cases compared to 24.97 ms in controls (p = 0.117), and on the left side, it was 25.16 ms in cases compared to 26.24 ms in controls (p = 0.639). These findings contrast with some previous research that has reported prolonged H-wave latencies in patients with lumbar radiculopathy. For instance, Ghugare et al. (2010) found significant differences in H-wave latency between chronic low back pain patients and control subjects, with increased latencies indicating nerve root dysfunction (p < 0.0001) [10]. Berry et al. (2019) also emphasized that prolonged H-wave latencies are a common finding in nerve conduction studies (NCS) among radiculopathy patients, highlighting the diagnostic importance of this parameter[11]. However, the study by Hakelius and Hindmarsh (1972) underscored the variability in electrophysiological findings and the importance of using a comprehensive set of parameters, including H-wave latency, to accurately diagnose nerve impairments that might not be apparent through imaging alone [11]. Our findings suggest that while H-wave latency is a valuable diagnostic tool, it may not always show significant differences in all patient populations. This highlights the need for a multi-faceted approach, combining various electrophysiological parameters to achieve a more accurate diagnosis of lumbar radiculopathy. The lack of significant difference in H-wave latency in our study may indicate that latency alone is insufficient to capture the extent of nerve impairment in lumbar radiculopathy, necessitating the use of additional parameters such as H-reflex amplitude and H:M ratio for a comprehensive evaluation.

CONCLUSION:

The absence of H-reflex in 26.7% of cases of radiculopathy nerve root dysfunction, underscoring its diagnostic importance. The mean H-reflex amplitude was significantly lower in cases compared to controls for both right and left sides. This reduction in amplitude suggests axonal loss or nerve root dysfunction, which highlights its diagnostic value in detecting nerve impairments in radiculopathy The H:M ratio was significantly reduced in cases compared to controls for both right and left sides. This reduced ratio reflects decreased motoneuron pool excitability and synaptic transmission alterations, indicating nerve root dysfunction and axonal loss. There were no significant differences in H-wave latency between cases and controls for both right and left sides. This suggests that latency alone may not be sufficient to detect nerve impairment in lumbar radiculopathy, emphasizing the need for a comprehensive evaluation using multiple electrophysiological parameters

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