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Prevalence of Electrodiagnostic Lumbosacral Nerve Root Involvement in Patients Presenting with Radicular Low Back Pain Referred to Physical Medicine and Rehabilitation Clinic

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Abstract

Background: Low back pain is one of the most common causes of clinic referrals. In most patients, radicular pain results from the compression or injury of the proximal nerve root or dorsal root ganglion.
Objectives: This study aimed to investigate the electrodiagnostic involvement of lumbar nerve roots in patients with lumbar radicular pain undergoing electromyography (EMG) and nerve conduction study.
Methods: The sample population was selected from 18-70-year-old patients who had files in the clinic, complaining of lumbar pain radiating to the lower extremities for at least 2 months. Patient data were extracted from the available data and recorded in a separate anonymous information sheet.
Results: This study was carried out on 352 patients with lumbar radicular pain. In addition to radicular pain, paresthesia was present in 86 patients (24.4%). Out of 352 patients with radicular pain, 294 cases (83.52%) showed unilateral or bilateral involvement in EMG. Among those who had paresthesia, 74 patients (86%) showed nerve root involvement in EMG.
Conclusions: This study indicated the compatibility between lumbar radicular pain symptoms and the features observed in EMG, particularly in areas of paresthesia or the side of pain. Therefore, the patient's symptoms can help predict nerve root involvement in the electrodiagnostic study before conducting this test.

Keywords: Prevalence, Electrodiagnosis, Lumbosacral, Nerve Roots, Low Back Pain with Radiation

1. Background

In most countries around the globe, 65 - 80% of individuals experience low back pain during their lifetime. The most common cause of low back pain in various communities is disc herniation, accounting for more than 90% of low back pain causes. In most patients, radicular pain results from the compression of the proximal nerve root or dorsal root ganglion. Other causes include inflammation and spinal canal stenosis due to a combination of degenerative spondylolisthesis, ligament hypertrophy, and spondylolisthesis (1). Radiculopathy is a common disease constituting 2% of all causes of admission to health centers (2, 3). Radiculopathies are often painful and unilateral (4). In addition to taking a detailed clinical history and performing a thorough physical examination, various diagnostic procedures, such as lumbar radiography (X-ray), lumbar magnetic resonance imaging (MRI), and electrical diagnostic measures, such as electromyography (EMG), nerve conduction study (NCS), and somatosensory evoked potentials, are also used to diagnose low back pain and characterize the involved nerve roots (lumbar radiculopathies) (5).

Electrophysiological studies play an important role in screening patients with neuromuscular disorders. It is essential to use EMG, particularly in combination with spinal cord imaging, to appropriately evaluate lumbar radiculopathies. The EMG is helpful in detecting complicated radiculopathies, identifying the affected myotome, and excluding diagnoses, such as plexopathy (1). The studies performed to date show that needle EMG has been the most

commonly used test to confirm radiculopathy. This test is performed on a sufficient number of muscles and at least one motor and one sensory NCS in the involved limb. Mondelli et al. evaluated clinical findings and electrodiagnostic test results in 108 patients with lumbosacral radiculopathy due to disc herniation. They reported that only several electrodiagnostic parameters had diagnostic validity for lumbosacral radiculopathy (2).

However, there is no specific diagnostic standard for these patients, and more importantly, for selecting patients with radiculopathy who might need surgical interventions. In addition to their role in early diagnosis, the results of electrodiagnostic tests are important to decide if the patient needs surgery. Furthermore, electrodiagnostic findings can avoid undergoing unnecessary EMG analysis, saving the patient's money and time and help detect underlying causes earlier.

2. Objectives

This study investigated the electrodiagnostic features and the prevalence of electrodiagnostic involvement of lumbar nerve roots in patients complaining of lumbar radicular pain.

3. Methods

This was a cross-sectional descriptive-analytical study. The study population was selected based on the files of the patients referred to the Physical Medicine and Rehabilitation Clinic of Imam Khomeini hospital in Tehran, Iran, within February 2017 to February 2020. The sample population was selected from patients within an age range of 18 - 70 years and complaining of lumbar radicular pain (extended to the lower extremities, either unilateral or bilateral) for at least 2 months.

Patient information was extracted from patients' files and recorded. Patients with a history of previous surgery on the back and a diagnosis of diabetic neuropathy, according to EMG-NCS findings, were excluded from the study. In this study, radicular pain was defined as the pain spreading through a specific myotome in the lower extremities from the back toward the lower parts. The NCS examination of the lower extremities was conducted using the sensory nerve action potential (SNAP) wave (bilateral sural nerves) and the compound motor action potential (CMAP) wave (bilateral tibial [abductor hallucis brevis muscles] and deep peroneal nerves extensor digitorum brevis muscles).

For each patient, needle EMG was performed on six to eight lower limb muscles (including quadriceps, gastrocnemius, tibialis anterior, and peroneus longus), along with at least one lumbar paraspinal muscle that was suspected to be the most involved. In the present study, mild radiculopathy was considered when the CMAP amplitude was normal, and a slight decrease was observed in motor unit action potential (MUAP) recruitment in EMG. It is notable that SNAP amplitude remains unchanged in radiculopathy. Moderate radiculopathy was considered when the CMAP amplitude was reduced, accompanied by a moderate reduction in MUAP recruitment in EMG. Severe radiculopathy was considered when the CMAP wave disappeared, accompanied by a sharp decrease in MUAP recruitment in EMG.

4. Results

This study was performed on 352 patients (62.2% male and 37.8% female) complaining of radicular pain. The mean age of the patients was 48.54 ± 11.47 years. Regarding the frequency of paresthesia, 24.4% (n = 86) of the patients manifested this condition in association with radicular pain. Regarding the limbs involved in radicular pain based on patient complaints, 38.9%, 35.8%, and 25.3% complained of right limb pain, left limb pain, and bilateral pain, respectively. Out of 352 patients complaining of radicular pain, 294 cases (83.52%) showed either unilateral or bilateral involvement in EMG. The results showed that the correlation between clinical symptoms and EMG findings was 36%. In this regard, bilateral involvement in EMG was observed in 68.1% of the patients; however, only 27.1% of the subjects complained of bilateral pain.

In addition, right- and left-sided involvements in EMG were observed in 18% and 13.9% of the patients, respectively; nevertheless, pain in the right and left limbs was declared by 39.3% and 33.6% of patients, respectively. In other words, in the patients complaining of right-limb pain, EMG revealed bilateral involvement and unilateral right-sided involvement in 56% and 43.1% of the cases, respectively; however, left-sided involvement in EMG was rare in these patients (0.9%). In the patients who complained of left-limb pain, EMG revealed bilateral and left-sided involvements in 60.6% and 37.4% of cases, respectively. Finally, rare cases (2%) complained of left-limb pain while showing right-sided involvement in EMG (Table 1).

Regarding the severity of involvement based on EMG findings, out of 294 patients who showed nerve root involvement in EMG, the intensity of involvement was mild, moderate, and severe in 50.7%, 39.5%, and 9.8% of the cases, respectively. Regarding the presence of paresthesia in the patients revealing nerve root involvement in EMG, 86 patients (24.4%) showed signs of this condition. Among those with paresthesia (n = 86), 74 patients (86%) showed nerve root involvement in EMG. In other words, the presence

Table 1. Prevalence of Limb Involvement Based on Patient Complaints and Electromyography Findings [a]

Involvement in EMG	Involvement Based on Patient Complaints			Total	P-Value
	Right-sided	Left-sided	Bilateral		
Right	50 (43.1)	2 (2)	1 (3.8)	53 (18)	< 0.001
Left	1 (0.9)	37 (37.4)	3 (1.3)	41 (13.9)	
Bilateral	64 (56)	60 (60.6)	76 (95)	201 (68.1)	
Total	115 (39.3)	99 (33.6)	80 (27.1)	294 (100)	

Abbreviation: EMG, electromyography.
[a] Values are expressed as No. (%).

of paresthesia predicted a probability of 86% for nerve involvement in EMG (Table 2). The results showed that out of 294 patients with nerve involvement in EMG, active denervation was observed in 35.1% of the cases; nonetheless, 64.9% of the patients had inactive radiculopathy. Among those who demonstrated either bilateral or unilateral (right or left) nerve root involvement, the most common nerve root involved was L5, followed by S1 (Table 3).

5. Discussion

In the present study, all the participants suffered from the symptoms of lumbar radicular pain. Accordingly, electrodiagnostic findings showed nerve root involvement in EMG in about 84% of the patients, indicating a high correlation between the presence of EMG involvement and lumbar radicular pain, which has also been noted in various studies. In a study by Hosseinzadeh et al., the frequency of electrodiagnostic root involvement in patients with radicular pain was 76.8% (6), which is consistent with the observation in the present study. Additionally, another study by Eskandaroghli et al., who investigated the diagnostic value of EMG in patients with radicular pain, showed that EMG involvement was highly frequent in patients with radicular lumbar pain, reflecting its excellent diagnostic sensitivity and validity (7).

In a study by Nardin et al. on 47 patients with suspected cervical or lumbosacral radiculopathy, a 60% agreement was reported between EMG and MRI findings (8). In contrast, in a statement by the American Association of Neuromuscular & Electrodiagnostic Medicine, EMG was reported to have a moderate sensitivity (50 - 71%) and a high specificity (65 - 85%) for the diagnosis of radiculopathy. The EMG can be particularly helpful in symptomatic patients for whom negative or unclear images have been obtained. The predictive ability of EMG for successful surgical outcomes further confirms its diagnostic validity. A study conducted on 20 patients suspected of cervical radiculopathy undergoing neck surgery showed that presurgery EMG abnormalities (observed in eight patients) predicted significantly superior postoperative outcomes (9).

In the present study, it was noticed that more than half of the patients had mild electrodiagnostic nerve root involvement. Moreover, 39.5% and 9.8% of the patients had moderate and severe involvements, respectively. The aforementioned results are in line with those reported by Graberski-Matasović et al. (10). In addition, in a study conducted by Fish et al. (11), the researchers used electrodiagnostic tests to predict the severity of lumbar radiculopathy and reported results similar to those of the current study. Accordingly, Hosseininezhad et al. reported that most of their participants had mild radiculopathy, which was highly consistent with MRI findings (6), confirming the observation in the present study. In the current study, 35% of the patients with nerve root involvement in EMG also revealed active denervation.

Another important finding of the present study was that the most frequently involved root was L5 on the right side, and the least frequent involvement was related to L2, L3, and L4. Additionally, the most frequently involved root on the left side was S1, followed by L5, and the least frequently involved roots were L2, L3, and L4. In patients with bilateral EMG involvement, nearly half of the involved roots were in the L5 and S1 territories, and the least frequent involvement was related to L4. Overall, the highest rate of nerve root involvement in EMG was related to L5, followed by S1 roots, which is consistent with the results of Nafissi et al.'s study (12). Other studies have reported that the most frequently involved roots in patients with lumbar pain were related to the L4, L5, and S1 territories (13).

In this study, most of the patients were male. Therefore, it can be said that lumbar radicular pain is more common in male patients. In this regard, Radhakrishnan et al. studied the epidemiology of cervical radicular pain and reported that most patients with this type of pain were male (14). Because the recent study was conducted on patients with cervical radicular pain, its results might not be comparable to the results of the current study; nevertheless, it can be argued that male cases constitute the majority of pa-

Table 2. Nerve Root Involvement in Electromyography According to the Presence or Absence of Paresthesia [a]

Involvement in EMG	Paresthesia		Total	P-Value
	Yes	No		
Yes	74 (86)	221 (83.5)	294 (84.1)	0.568
No	12 (14)	44 (16.5)	56 (15.96)	
Total	86 (100)	266 (100)	352 (100)	

Abbreviation: EMG, electromyography.
[a] Values are expressed as No. (%).

Table 3. Frequency of the Roots Involved in Electromyography [a]

Involvement in EMG	Left-sided Involvement in EMG	Right-sided Involvement in EMG	Bilateral Involvement in EMG
L4	0 (0)	6 (11.5)	2 (1)
L5	6 (14.6)	13 (25)	27 (13.4)
L4, L5	12 (29.3)	12 (23.1)	44 (21.9)
S1	7 (17.1)	2 (3.8)	8 (4)
L5, S1	14 (34.1)	17 (32.7)	95 - 98 (48.8)
L2, L3, L4	0 (0)	1 (1.9)	6.5 (4.5)
L3, L4	2 (4.9)	1 (1.9)	13 (9)
Total	41 (100)	52 (100)	201 (100)

Abbreviation: EMG, electromyography.
[a] Values are expressed as No. (%).

tients presenting with radicular pain. On the other hand, Wu et al. assessed the global prevalence of lumbar pain within 1990 - 2017 and reported that almost all patients in these years were female, which also revealed a higher rate of disability (15). In another study, Suri et al. evaluated the recurrence rate of radicular pain or lumbar pain after undergoing nonsurgical treatment for symptomatic lumbar disc herniation, in which female subjects constituted only 26.7% of patients, which is in line with the results of the present study (16).

The mean age of the patients in the present study was 48.5 years, which is consistent with the results of a study by Radhakrishnan et al., reporting a mean age of 48.2 years for men and 47.5 years for women (14). However, the mean age of patients was slightly higher (i.e., 54.5 years) in the study of Suri et al. Overall, it can be noted that lumbar radicular pain is most commonly observed within the age range of 45 - 55 years (16).

Another objective of the present study was to determine the frequency of underlying diseases. In this regard, the results of the current study showed that a small percentage of the studied population suffered from underlying conditions, including hypothyroidism and diabetes. A relationship has been noted between diabetes and lumbar radicular pain attributed to diabetic neuropathy (17). It is notable that Liu et al. scrutinized the potential role of diabetes in the development of lumbar disc herniation and lumbar pain and found that prolonged diabetes for more than 10 years can be a risk factor for low back pain (18). In the present study, the frequency of diabetes was low among the patients, and it was impossible to further evaluate the potential link between this disease and lumbar radicular pain.

In addition, as mentioned in the methods section, patients with diabetic neuropathy were excluded from the study. Therefore, one reason for the higher prevalence of diabetes in other studies can be the presence of diabetic neuropathy in their patients. In addition, a study stated that the results of EMG-NCS can be influenced by various factors, including patient cooperation, pain intensity, room temperature, electrolyte, and fluid balance, and the presence of concomitant diseases, such as hypothyroidism and diabetes (19). Due to the low prevalence of hypothyroidism and diabetes in the current study's patients, it was not applicable to investigate such associations.

This study also showed that 24.5% of the patients had paresthesia (i.e., the tingling or numbness of limbs). Paresthesia is a sign of some neurological diseases, such as multiple sclerosis, and systemic diseases, such as anemia and diabetes. In a study by Nafissi et al., it was reported that 22.8% of patients with radicular pain in the L5 region had paresthesia (12), which is consistent with the results of the present study.

In this study, it was also observed that there was no noticeable difference in the prevalence of paresthesia between patients with (25%) and without (12%) EMG nerve root involvement. Studies have noted that paresthesia is one of the main and important findings of radicular pain (20). On the other hand, another clinical finding in the present study was that the left-side and right-side limbs were almost equally involved, both showing a higher frequency than bilateral limb involvement. In the study of Nafissi et al., the frequencies of left-sided, right-sided, and bilateral limb involvement were 38%, 30%, and 32%, respectively (12), which are close to the proportions observed in the present

study. In the study of Hassankhani and Omidi-Kashani, 67, 46, and 39 out of 152 patients had radicular pain in the left-side lower limbs, right-side lower limbs, and the limbs of both sides, respectively (21), which somehow supported the findings of the present study.

In general, the accuracy of electrodiagnostic tests seems to be dependent on the operator's experience and skills, varying based on different methods and in different laboratories. Additionally, some variations in muscular innervation of the lumbosacral nerve roots in individual patients might lead to misdiagnosis of radicular pathologies (22). The accuracy of these tests is often low in patients with intermittent prolonged (more than a year) symptoms, whose main complaint is fatigue-free pain. These tests do not evaluate sensory fibers and are not sensitive to demyelinating lesions. They are more sensitive to motor radiculopathies. Nevertheless, nerve root damage can produce similar electrical findings independent of the causative agent (e.g., disc herniation, tumor invasion, and ulcer). In addition, electrodiagnostic examinations need to be promptly performed in order to be beneficial. Moreover, needle EMG examination entails patient cooperation. On the other hand, the structural abnormalities observed in MRI do not necessarily disclose the main cause of clinical symptoms.

This study assessed EMG-NCS features in patients complaining of lumbar radicular pain. It was observed that there was a high correlation (i.e., 84%) between lumbar radicular pain symptoms and EMG characteristics, including the side of pain, which particularly showed a high correlation with EMG findings. Therefore, it can be concluded that the clinical history of patients with lumbar radicular pain can be helpful in predicting nerve root involvement with high accuracy, even prior to EMG-NCS analysis. Finally, regarding its high correlation with patients' clinical symptoms, EMG-NCS can be regarded as a helpful method in screening patients with lumbar radicular pain.

It should be mentioned that the results of this study are limited to the population referred to one center, and due to the cross-sectional and retrospective nature of the study, the results should be interpreted with caution when generalizing to the entire population of the country. Therefore, it is required to carry out future multicenter and prospective studies with larger sample sizes.

5.1. Conclusions

Since the results of electrodiagnostic study play an important role in patients with radicular low back pain to reach a precise diagnosis and choose the best treatment strategy, the current study investigated the characteristics of electrodiagnosis in patients who presented with lumbosacral radiculopathy. In this investigation, it was determined that there was a strong relationship between the symptoms of lower limb radicular pain and EMG results, especially in the area of the side of the patient's pain and paresthesia. Therefore, correct and accurate history-taking and physical examination can help predict nerve root involvement before conducting an electrodiagnostic test. However, EMG-NCS is a helpful method in screening patients with radicular low back pain.

Footnotes

Authors' Contribution: MH and SZER conceptualized, designed, and managed the entire study. MH and SZER also edited and critically reviewed the manuscript. MA and SMMM collaborated in data collection. SMMM performed the statistical analysis. SMMM and MH wrote the manuscript.

Conflict of Interests: What is the role of the author (reviewer, associate editor, or editor-in-chief)? ZR and MH are the reviewers of the journal. Has this author with conflicts of interest (CoI) an active role in the editorial board (if yes, since when)? As reviewers since 2018. Was this author involved in the review process of the current manuscript? Please, clearly state that: None of them. The authors declared that two of the authors (Seyyede Zahra Emami Razavi and Maryam Hosseini, as reviewers of the journal) are members of the editorial board. The journal confirmed that the aforementioned authors with CoI were completely excluded from all review processes. The authors also introduced these authors with CoI during the submission as opposed to reviewers.

Ethical Approval: This study was approved by the Ethics Committee of the Education Development Center, Tehran University of Medical Sciences, Tehran, Iran (IR.TUMS.IKHC.REC.1398.254).

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