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Original Research Article

Assessing Role of the Electrophysiological Studies in Patients with Lumbar Disc Disease: An Observational Study

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Abstract

Aim: The aim of the present study was to assess the role of the electrophysiological studies in patients with lumbar disc disease.

Methods: This study was conducted in the Department of Neurosurgery. study was conducted for the period of 3 years on 200 patients with lumbar disc prolapse, and all these patients were subjected to surgery.

Results: A total of 200 patients were 72% male and 28% female. Low back pain was the most prevalent symptom in 96% of patients, followed by leg pain in 75%, lower limb numbness in 26%, and bowel and bladder control lessness in 6%. According to EMG abnormalities, L4–L5 and L5–S1 were the most common levels of intervertebral disc prolapse, accounting for 32% and 31% of cases, respectively. L5–S1 was seen in 27% of patients with L2–L3, L3–L4, and L4–L5 PIVDs and 4% of L3–L4, L4–L5 PIVDs. The EMG results of 140 (70%) of the 200 patients coincided with surgical findings, whereas 60 (30%) did not. Post-surgery, 40 patients had normal H-reflex latency, whereas 40 had extended latency. Overall, 80 patients exhibited improvement. After surgery, NCV values improve significantly.

Conclusion: The EMG approach is very accurate in both detecting and precisely locating compressive nerve root lesions caused by disc prolapse. EMG is precise when it is connected with the surgical results.

Keywords: lumbar disc disease, electrophysiological

Introduction

Lumbar spinal stenosis (LSS) is a degenerative condition characterized as a narrowing of the spinal canal, resulting in lower extremity impairment and neurogenic intermittent claudication caused by entrapment and compression of cauda equina and/or nerve roots. Patients with LSS commonly exhibit a forward stoop while walking as a result of experiencing leg pain, numbness, and weakness. Low back pain (LBP) is a prevalent symptom in almost all patients with lumbar spinal stenosis (LSS), frequently occurring in the initial phases of the condition. [1] Leg symptoms are more diagnostically significant for diagnosing LSS than the presence of LBP. Degenerative lumbar spinal stenosis (LSS) is characterized by a clinical syndrome involving pain and/or fatigue in the buttocks and/or lower limbs, which can occur with or without pain in the back. [2]

Lumbar spine degenerative disease is a common neurosurgical condition. Degenerative processes primarily impact the lumbar spine, affecting its various vertebral structures, including bones, ligaments, muscles, and particularly the intervertebral disc. The disc is prone to losing its structural and functional characteristics due to degenerative factors, increased body weight, a predisposition to degeneration, climatic changes, and work activities that cause disc damage. [3,4] Compression and desiccation events result in the protrusion and herniation of discs. [3] Clinically, a herniated disc presents predominantly with low back pain or sciatica, paresthesias, over postural and walking alterations.

The lumbosacral plexus is a cluster of nerves that come together and separate, ultimately combining into terminal nerves that provide nerve supply to the pelvis and lower extremities. Lumbosacral plexopathy is a clinical disease characterized by motor and sensory abnormalities that can result from damage of the lumbosacral plexus by different types of insults. [5] Radiculopathy caused by nerve roots compression or inflammation manifests with pain, weakness, and paresthesia anywhere along the nerve supply. Electrophysiological studies such as electromyography (EMG) and nerve conduction studies (NCSs) are used to demonstrate the presence of radiculopathy with a high specificity and low sensitivity. [6] The purpose of the current investigation was to analyse the role of the electrophysiological tests in individuals with lumbar disc disease.

Materials and Methods

This study was conducted in the Department of Neurosurgery, Institute of Medical Sciences, Banaras Hindu University [IMS-BHU], Varanasi, India and study was conducted for the period of 3 years on 200 patients with lumbar disc prolapse, and all these patients were subjected to surgery.

Both pre- and post-operative (from 1 to 6 month after surgery) electrophysiological studies were conducted and compared. A detailed history, complete physical and neurological examinations were carried in all patients. Magnetic resonance imaging scan of the lumbosacral region was used to confirm the diagnosis, and it showed prolapsed disc, theca, nerve root etc., very clearly. Electrophysiological studies including EMG and nerve conduction study (NCS) were carried out both preoperatively and 1–6 months after surgery. NCS was performed on common peroneal, tibialis, and sural nerves, and H-reflexes were obtained from soleus muscles bilaterally. EMG study was performed by recording active and resting potentials in five muscle groups comprised iliopsoas, quadriceps femoris, gastrocnemius, anterior tibialis, and extensor hallucis longus muscles. In addition, lumbar paraspinal muscles were evaluated in all patients. Other muscles were also tested if clinically or electro physiologically indicated.

The basis of the EMG localization of a single nerve root lesions is the finding of denervation fibrillation in those muscle supplied specifically by the nerve root involved and is no other muscles.

In performing postoperative EMG, the level and length of the operation scar were noted, and the skin was marked 3 cm lateral to the scar. The locations of the spinous processes were determined, and at each spinous process, the EMG electrode was inserted to a depth of 4–5 cm at both locations lateral to scar. Each lumbar root level was explored bilaterally in this fashion. Clinical NCSs were performed with the EMG apparatus that incorporates built in nerve conduction equipment. NCSs require the addition of a nerve stimulator to standard EMG apparatus. The nerve stimulator delivers stimuli of various durations from a minimum of 0.1 ms to at least 1 ms and the frequency stimulation from 0.5 to 50 Hz.

Both motor and sensory NCSs were carried out. Motor NCS required stimulation of a peripheral nerve while recording from a muscle innervated by that nerve. Sensory NCSs were performed by stimulating a mixed nerve while recording from a cutaneous nerve or by stimulating a cutaneous nerve while recording from a mixed or cutaneous nerve. Studies were conducted on common peroneal, tibial, and sural nerves. Following parameters were measured latency, compound muscle action potentials: conduction velocity, and amplitude H-reflex: Hoffman’s reflex. it is considered to be a monosynaptic reflex. H-reflex can most easily and consistently elicited in the muscles innervated by the S1 roots and the tibial nerve.

The amplitude of H-wave and H-latency is determined. The active electrode was placed over the median gastrocnemius half way between the popliteal crease and the proximal medial malleolus. The reference electrode is placed over the Achilles tendon with the ground electrode being lateral to the active electrode. The tibial nerve is stimulated at the popliteal crease with the cathode proximal.

H-latency value can be predicted from the following formula:

H-latency (ms) = 9.14 + 0.46 leg length (cm) + 0.1 age (years) + 5.5

When the study was performed, stimulus of short duration (0.05 ms) was given at a frequency no greater than once every 2 s. The H-reflex appeared and became maximal with a stimulus that is submaximal; the amplitude decreased as the strength increases to supramaximal. The measurement of latency was to the first deflection from the baseline when a maximal response was noted. H-reflex latency was used as objective evidence of S1 radiculopathy. As little as 1.5 ms difference in the H-reflex latency of both legs of the same patients was found to be objective evidence of S1 radiculopathy. There is either prolongation or absence of H-reflex on the affected side in patients with unilateral S1 radiculopathy. In normal participants, the difference between two sides is <1.2 ms.

F-wave: The F-wave was most easily elicited by placing the recording electrode over an intrinsic muscle of foot and supramaxillary stimulating the appropriate motor nerve. Stimulation frequency of 1/s was recommended. F-wave has a latency that is approximately the same as the H-reflex over the same segment.

Results

Table 1: Demographic data and clinical presentation with electromyographic abnormalities

Gender	N (%)
Male	144 (72)
Female	56 (28)
Clinical symptoms	
Low back ache	192 (96)
Leg pain/radiculopathy	150 (75)
Numbness	52 (26)
Loss of bowel and bladder control	12 (6)
Level of PIVD as per electromyographic abnormalities	
L2-L3, L3-L4, L4-L5	12 (6)
L3-L4, L4-L5	8 (4)
L4-L5	62 (31)
L4-L5, L5-S1	64 (32)
L5-S1	54 (27)

Of the 200 patients, 72% were males and 28% were females. Low back pain was the most common symptoms seen in 96% of patients, followed by the leg pain seen in 75% in patients, numbness of lower limbs in 26% of patients, and loss bowel and bladder control was least and was present in 6% of patients. As per the EMG abnormalities, most common levels of intervertebral disc prolapse were L4–L5 and L5–S1 accounting for 32% and 31% of cases each followed by L5–S1 level which was seen in 27% of patients with L2–L3, L3–L4, and L4–L5 prolapsed intervertebral disc (PIVD), and 4% of patients with L3–L4, L4–L5 PIVDs.

Table 2: Comparison of electromyographic and operative findings

Herniated or PIVD found at surgery	N	EMG	
		Correlated	Not correlated
L5-S1	90	64	26
L4-L5	50	34	16
L4-L5, L5-S1	30	24	6
L2-L3, L4-L5	10	6	4
L3-L4, L4-L5	20	12	8
Total	200	140 (70)	60 (30)

Of the 200 patients, EMG findings correlated with operative findings in 140 (70%) patients, however operative findings did not correlate with EMG findings in 60 (30%) patients.

Table 3: Comparison of preoperative nerve conduction velocity parameters with the postoperative changes

NCV parameters	Preoperative	Post-operative	
		Improved	Not improved
Prolonged H reflex latency	120	80	40
Delayed tibial NCV	80	48	32
Delayed peroneal conduction velocity	40	24	16
Delayed F-wave latency	80	48	32

Table 4: Comparison between pre- and post-operative electrodiagnostic studies

	Preoperative EMG		Postoperative EMG	
Test	Normal	Abnormal	Normal	Abnormal
Number of patients (%)	Nil	200 (100)	130	70
	Preoperative H-reflex latency		**Postoperative H-reflex latency**	
Test	Normal	Abnormal	Normal	Abnormal
Number of patients (%)	Nil	120 (60)	80	40
	Preoperative tibial nerve velocity		**Postoperative tibial nerve velocity**	
Test	Normal	Abnormal	Normal	Abnormal
Number of patients	120 (60)	80 (40)	48	32
	Preoperative peroneal nerve velocity		**Postoperative peroneal nerve velocity**	
Test	Normal	Abnormal	Normal	Abnormal
Number of patients (%)	160 (80)	40 (20)	24	16
	Preoperative sural nerve velocity.		**Postoperative sural nerve velocity**	
Test	Normal	Delayed	Normal	Delayed

Number of patients (%)	168 (84)	32 (16)	12	20
Preoperative F-wave latency			Postoperative F-wave latency	
Test	Normal	Delayed	Normal	Delayed
Number of patients (%)	120 (60)	80 (40)	48	32
EMG – Electromyography				

After surgery, 40 patients showed normal H-reflex latency, while 40 continued with prolonged H-reflex, so improvement was noted in 80 patients after surgery. A total of 80 patients (40%) were having delayed tibial nerve velocity after surgery. After surgery, tibial nerve velocity was delayed in 32 patients and improvement was noted in 48 patients. 40 patients (20%) had delayed preoperative peroneal nerve conduction velocity. A total of 80 (40%) patients had delayed F-wave in the preoperative period. After surgery, improvement was noted in 48 patients, while 32 patients continued with delayed F-wave latency. Significant improvement in NCV parameters after surgery can be observed. (Table 3 and Table 4)

Discussion

Electrophysiological investigations are effective approaches for diagnosing and predicting the prognosis of radiculopathies. An electrical anomaly manifests as fibrillation potentials and neurogenic motor unit action potentials (MUAPs) in a specific segment or myotome, indicating the affected nerve root. These investigations are suitable for distinguishing the diagnosis of lumbosacral radiculopathy from similar conditions such as plexopathies and polyneuropathies. [7] Several studies have shown that posterior decompression surgery for lower extremities symptoms in Lumbar spinal stenosis may lead to considerable relief in lower back pain. [8,9] Jolles et al [9] hypothesized that the elongated lumbar spine resulting from decompression surgery would alleviate lower back discomfort. Nevertheless, the impact of decompression on lower back pain remains unknown, and a more severe level of back pain is linked to a notably worse result after decompression. [10]

Out of the total of 200 patients, 72% were male and 28% were female. The predominant symptom seen in 96% of patients was low back pain, followed by leg pain in 75% of patients, numbness in the lower limbs in 26% of patients, and the least prevalent symptom was loss of bowel and bladder control, occurring in 6% of patients. The most frequently observed levels of intervertebral disc prolapse, based on EMG abnormalities, were L4–L5 and L5–S1, which accounted for 32% and 31% of cases, respectively. The L5–S1 level was seen in 27% of patients with L2–L3, L3–L4, and L4–L5 prolapsed intervertebral discs (PIVD), and in 4% of patients with L3–L4 and L4–L5 PIVDs. Upon comparing the findings of our research with the existing literature, we discovered a congruence between our results and the information already published. Our research found that electromyography (EMG) accurately predicted the proper diagnosis in 74% of patients and showed a strong correlation with the results from surgical procedures. In 1950, Shea et al [11] demonstrated that electromyography (EMG) accurately diagnosed 90% of patients and was consistent with surgical results. Marinacci [12] documented a total of 71 instances of lumbosacral herniation of the intervertebral disc. In 94.3% of these cases, the electromyography (EMG) results were consistent with the abnormalities seen after surgery. Research conducted by Knutsson [13] shown that electromyography (EMG) accurately coincided with surgical results in 55 out of 60 patients, resulting in a success rate of 91.6%.

Following the surgical procedure, 40 patients exhibited normal H-reflex latency, but 40 patients still had extended H-reflex. Therefore, a total of 80 patients shown improvement following the operation. After surgery, 40% of the patients had delayed tibial nerve velocity, totaling 80 individuals. Following the surgical procedure, 32 patients saw a delay in the velocity of their tibial nerve, whereas 48 patients showed signs of recovery. Out of the total of 40 patients, which accounts for 20% of the sample, had delayed preoperative peroneal nerve conduction velocity. During the preoperative period, 80 patients, which accounted for 40% of the total, had delayed F-wave. Following the surgical procedure, 48 patients exhibited improvement, however 32 patients still had delayed F-wave latency. Noticeable enhancement in NCV parameters is shown after the surgical procedure. Aiello et al [14] assessed the precision of electromyography (EMG) in identifying and pinpointing nerve root impairment in patients who had undergone surgery for a single lumbar disc at the L3-L4 level. They discovered a 100% true positive rate for detecting disc herniation at L4-L5 (with a 96% true positive rate) and at L5-SI (with a 71% true positive rate). Out of the 50 patients who had preoperative electromyography (EMG) indicating fibrillation potentials that suggested nerve or root damage (disc prolapse), 32 patients (64%) had normal EMG results after surgery (laminectomy). Electromyography (EMG) was conducted during a period of 1 to 6 months after the surgical procedure. Eighteen patients, accounting for 36% of the total, nevertheless had electromyography (EMG) abnormalities. Upon comparing our findings with those reported in western literature, we see that

EMG anomalies continue to exist in around one-third of post laminectomy patients, namely 33%, which aligns with the outcomes of our research.

Braddom and Johnson [15] assessed the H-reflex tests in a group of 25 individuals who were clinically suspected of having SI radiculopathy. Each of the 25 patients had H-reflex latencies that exceeded 2 standard deviations above the mean of the control group. Out of the fifty patients, F-wave delay was extended in twenty individuals, which accounts for 40% of the total. After the surgery, there was an improvement in F-wave delay in 12 out of 20 cases (60%). Western literature [16] indicates that the diagnostic yield with F-wave ranges from 18% to 65%. Out of the fifty patients, twenty (40%) had slowed tribal nerve conduction velocity. Postoperative tribal nerve conduction was conducted 1 to 6 months after the operation. neural conduction improved in 12 individuals, accounting for 60% of the total, while 8 patients maintained tribal neural conductivity. Similarly, the velocity of peroneal nerve conduction was delayed in 10 patients before to surgery. Following surgery, six patients (60%) showed improvement, whereas four patients (40%) still had delayed peroneal nerve conduction. Similarly, the velocity of sural nerve conduction was delayed in twenty patients (40%) before to surgery. Following surgery, 12 patients (60%) showed improvement in sural nerve conduction velocity, whereas 8 patients (40%) still had delayed sural nerve conduction velocity.

Conclusion

The EMG approach is very accurate in both detecting and precisely locating compressive lesions of nerve roots caused by disc protrusion. EMG is precise when it is connected with the surgical results

References

1. Verbiest H. Lumbar spine stenosis. 3d ed. Philadelphia: Saunders, 1990: 2805-55.
2. North American Spine Society Evidence-Based Clinical Guidelines for Multidisciplinary Spine Care: Diagnosis and treatment of degenerative lumbar spinal stenosis. NASS Evidence-Based Clinical Guidelines Committee. 2011.
3. Falck B, Nykvist F, Hurme M, Alaranta H. Prognostic value of EMG in patients with lumbar disc herniation--a five year follow up. Electromyography and clinical neurophysiology. 1993 Jan 1;33(1):19-26.
4. Lee JH, Lee SH. Clinical and radiological characteristics of lumbosacral lateral disc herniation in comparison with those of medial disc herniation. Medicine. 2016 Feb;95(7).
5. Soldatos T, Andreisek G, Thawait GK, Guggenberger R, Williams EH, Carrino JA, Chhabra A. High-resolution 3-T MR neurography of the lumbosacral plexus. Radiographics. 2013 Jul;33(4):967-87.
6. Barr K. Electrodiagnosis of lumbar radiculopathy. Physical Medicine and Rehabilitation Clinics. 2013 Feb 1;24(1):79-91.
7. Ropper AH, Brown RJ. Adams and Victors Principles of Neurology. 8th ed. New York: McGraw Hill Professional; 2005.
8. McGregor AH, Hughes SP. The evaluation of the surgical management of nerve root compression in patients with low back pain: Part 1: The assessment of outcome. Spine 2002 ; 27(13): 1465-70.
9. Jolles BM, Porchet F, Theumann PN. Surgical treatment of lumbar spinal stenosis. Five-year follow-up. J Bone Joint Surg Br 2001; 83(7): 949-53.
10. Kleinstück FS, Grob D, Lattig F, et al. The influence of preoperative back pain on the outcome of lumbar decompression surgery. Spine 2009; 34(11): 1198-203.
11. Shea PA, Woods WW, WERDEN DH. Electromyography in diagnosis of nerve root compression syndrome. Archives of Neurology & Psychiatry. 1950 Jul 1;64(1):93-104.
12. Marinacci AA. Applied Electromyography. Philadelphia: Lea and Febiger; 1968.
13. Knutsson B. Comparative value of electromyographic, myelographic and clinical-neurological examinations in diagnosis of lumbar root compression syndrome. Acta Orthopaedica Scandinavica. 1961 Mar 1;32 (sup49):3-135.
14. Aiello I, Serra G, Migliore A, Tugnoli V, Roccella P, MC C. Diagnostic use of H-reflex from vastus medialis muscle.
15. Braddom RI, Johnson EW. Standardization of H reflex and diagnostic use in Sl radiculopathy. Archives of physical medicine and rehabilitation. 1974 Apr 1;55(4):161-6.
16. Aminoff MJ, Goodin DS, Parry GJ, Barbaro NM, Weinstein PR, Rosenblum ML. Electrophysiologic evaluation of lumbosacral radiculopathies: electromyography, late responses, and somatosensory evoked potentials. Neurology. 1985 Oct;35(10):1514-.