ORIGINAL RESEARCH

A hospital-based study to assess the role of the electrophysiological studies in patients with lumbar disc disease

[1]Dr. Narsimha Katta, [2]Dr. Sujay Kumar Parasa, [3]Dr. Hari Krishna Reddy Mogili

[1]Associate Professor of Neurosurgery, Government Medical College and Hospital, Ramagundam, Telangana, India
[2]Assistant Professor, Department of Anaesthesia, Government Medical College, Nizamabad, Telangana, India
[3]Assistant professor, Department of General Medicine, Nizamabad Medical College, Nizamabad, Telangana, India

Corresponding Author
Dr. Narsimha Katta
Associate Professor of Neurosurgery, Government Medical College and Hospital, Ramagundam, Telangana, India

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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 and study was conducted for the period of 2 years on 100 patients with lumbar disc prolapse, and all these patients were subjected to surgery.**Results:** Of the 100 patients, 70% were males and 30% were females. Low back pain was the most common symptoms seen in 95% 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 5% 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-L4and L4-L5 prolapsed intervertebral disc (PIVD)and L3-L4 and L4-L5 PIVDs were seen in 5% of cases each. Of the 100 patients, EMG findings correlated with operative findings in 70 (70%) patients, however operative findings did not correlate with EMG findings in 30 (30%) patients. Significant improvement in NCV parameters after surgery can be observed.**Conclusion:** In compressive lesions of nerve roots (due to disc prolapsed), the EMG method has a high degree of accuracy in determining not only the presence of such lesions but also their exact location. EMG is accurate when correlated with the operative findings.
Key words: Lumbar disc disease, electrophysiological

INTRODUCTION

Lumbar spine degenerative degeneration is a common disorder that often requires neurosurgical intervention. Degenerative processes primarily impact the lumbar spine, affecting its different vertebral systems, including bones, ligaments, muscles, and particularly the intervertebral disc. The disc is prone to losing its morphological and functional properties owing to degenerative causes, increasing body weight, tendency to degeneration, climatic changes, and work-related disc injury.[1,2] Compression and desiccation events result in the protrusion and herniation of discs.[1] A herniated disc often manifests with primary symptoms of low back pain or sciatica, accompanied by paresthesias and noticeable changes in posture and gait.

Diagnostic exams, such as radiographic imaging, neuroradiological tests like spine CT and MRI, and neurophysiologicalassessments like electromyography, are conducted.[3,4] The combination of these tests, together with clinical observation, is essential for pre-surgical assessment, since each of them contributes in its own way to the diagnosis. However, it is common for there to be a disparity between these tests. This raises concerns regarding the appropriate diagnostic protocols to be used. The possible combinations are as follows:

Lumbar pain-CT/MRI reveals a disc herniation, whereas electromyography (EMG) indicates symptoms of radiculopathy at the specific intervertebral area affected.

The patient is experiencing lumbar discomfort, as shown by the CT/MRI scan revealing a disc protrusionand the EMG indicating symptoms of radiculopathy.

The patient is experiencing lumbar pain, as indicated by the CT/MRI scan revealing a disc herniation. However, the electromyography (EMG) test did not show any signs of radiculopathy.

The lumbosacral plexus is a network 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, resulting from the compression or inflammation of nerve roots, manifests as pain, weaknessand abnormal sensations occurring anywhere along the affected nerve's distribution. Electrophysiological investigations, such as electromyography (EMG) and nerve conduction studies (NCSs), are employed to confirm the existence of radiculopathy with a high level of specificity and a low level of sensitivity.[6]

The objective of this study was to evaluate the significance of electrophysiological studies in patients diagnosed with lumbar disc disease.

MATERIALS AND METHODS

This study was conducted in the Department of Neurosurgery and study was conducted for the period of 2 years on 100 patients (after taking a proper informed consent from the patient and approval from the Institutional Ethics Committee) with lumbar disc prolapseand all these patients were subjected to surgery.

Electrophysiological studies were conducted both before and after surgery, ranging from 1 to 6 months post-operation, and then compared. A thorough investigation was conducted, including a comprehensive medical evaluation and examination of the nervous system in all patients. An MRI scan of the lumbosacral region was performed to confirm the diagnosis. The scan clearly revealed a prolapsed disc, theca, and nerve root. Electrophysiological studies, such as EMG and nerve conduction study (NCS), were conducted before and after the surgery, with a follow-up period of 1-6 months. Electrophysiological tests were conducted on the nerves in the lower leg, and reflexes were measured in the muscles of the calves on both sides. An EMG study was conducted to record the active and resting potentials in five different muscle groups. These muscle groups include the iliopsoas, quadriceps femoris, gastrocnemius, anterior tibialis, and extensor hallucis longus muscles. Furthermore, the lumbar paraspinal muscles were assessed in all patients. Additional muscles were examined if there was a clinical or electrophysiological indication.

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.

During the postoperative EMG procedure, the medical team made observations regarding the level and length of the operation scar. They also marked the skin 3 cm away from the scar. The locations of the spinous processes were identified, and an EMG electrode was inserted at each location lateral to the scar, to a depth of 4-5 cm. We explored each lumbar root level bilaterally using this method. Clinical NCSs were conducted using the EMG apparatus that includes integrated nerve conduction equipment. Nerve conduction studies (NCSs) necessitate the inclusion of a nerve stimulator to the typical EMG equipment. The nerve stimulator is capable of delivering stimuli of different durations, ranging from a minimum of 0.1ms to at least 1ms. It also allows for frequency stimulation within the range of 0.5 to 50 Hz.

Both motor and sensory nerve conduction studies were conducted. Motor NCS involves stimulating a peripheral nerve and recording from a muscle that is connected to that nerve. Tests were conducted to measure nerve responses by stimulating different types of nerves and recording the results. Research was carried out on the common peroneal, tibial, and sural nerves. The measurements included latency, conduction velocityand amplitude of compound muscle action potentials. H-reflex: Hoffman's reflex. It is regarded as a monosynaptic reflex. The H-reflex is 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 2s. 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	70 (70)
Female	30 (30)
Clinical symptoms	
Low back ache	95 (95)
Leg pain/radiculopathy	75 (75)
Numbness	26 (26)
Loss of bowel and bladder control	5 (5)
Level of PIVD as per electromyographic abnormalities	
L2-L3, L3-L4, L4-L5	5 (5)
L3-L4, L4-L5	5 (5)
L4-L5	31 (31)
L4-L5, L5-S1	32 (32)
L5-S1	27 (27)

Out of the total of 100 patients, 70% were men and the remaining 30% were girls. The predominant symptom seen in 95% of patients was low back pain, followed by leg pain in 75% of patients, numbness in the lower limbs in 26% of patients, and loss of bowel and bladder control, which was the least prevalent and present in 5% of patients. The most frequently observed levels of intervertebral disc prolapse, based on EMG abnormalities, were L4-L5 and L5-S1, accounting for 32% and 31% of cases respectively. The L5-S1 level was also observed in 27% of patients, along with L2-L3, L3-L4, and L4-L5 prolapsed intervertebral discs (PIVD). L3-L4 and L4-L5 PIVDs were observed in 5% of cases each.

Table 2: Comparison of electromyographic and operative findings

Herniated or PIVD foundat surgery	N	EMG	
		Correlated	Not correlated
L5-S1	45	32	13
L4-L5	25	17	8
L4-L5, L5-S1	15	12	3
L2-L3, L4-L5	5	3	2
L3-L4, L4-L5	10	6	4
Total	100	70 (70)	30 (30)

Of the 100 patients, EMG findings correlated with operative findings in 70 (70%) patients, however operative findings did not correlate with EMG findings in 30 (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	60	40	20
Delayed tibial NCV	40	24	16
Delayed peronealconduction velocity	20	12	8
Delayed F-wave latency	40	24	16

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

Preoperative EMG	Postoperative EMG			
Test	**Normal**	**Abnormal**	**Normal**	**Abnormal**
Number of patients (%)	Nil	100 (100)	65	35
Preoperative H-reflex latency	**Postoperative H-reflex latency**			
Test	**Normal**	**Abnormal**	**Normal**	**Abnormal**

Number of patients (%)	Nil	60 (60)	40	20
Preoperative tibial nerve velocity Postoperative tibial nerve velocity				
Test	**Normal**	**Abnormal**	**Normal**	**Abnormal**
Number of patients	60 (60)	40 (40)	24	16
Preoperative peroneal nerve velocity Postoperative peroneal nerve velocity				
Test	**Normal**	**Abnormal**	**Normal**	**Abnormal**
Number of patients (%)	80 (80)	20 (20)	12	8
Preoperative sural nerve velocity Postoperative sural nerve velocity				
Test	**Normal**	**Delayed**	**Normal**	**Delayed**
Number of patients (%)	84 (84)	16 (16)	6	10
Preoperative F-wave latency Postoperative F-wave latency				
Test	**Normal**	**Delayed**	**Normal**	**Delayed**
Number of patients (%)	60 (60)	40 (40)	24	16
EMG – Electromyography				

After surgery, twenty patients exhibited normal H-reflex latency, whereas 20 persisted with extended H-reflex, hence improvement was found in 40 patients after surgery. After the procedure, 40% of the patients had delayed tibial nerve velocity. Following the surgical procedure, 16 patients saw a delay in the velocity of their tibial nerve, whereas 24 patients showed signs of recovery. Out of the total number of patients, 20% had delayed preoperative peroneal nerve conduction velocity. Forty percent of the patients had delayed F-wave in the preoperative stage. Following the surgical procedure, 24 patients exhibited improvement, however 16 patients still had delayed F-wave latency. Noticeable increase in nerve conduction velocity (NCV) measures might be detected after the surgical procedure. Tables 3 and 4

DISCUSSION

Electrophysiological studies are effective methods for diagnosing and predicting the prognosis of radiculopathies. An electrical abnormality indicates the affected root through the presence of fibrillation potentials and neurogenic motor unit action potentials (MUAPs) in a specific segment or myotome. These studies are useful for distinguishing the diagnosis of lumbosacral radiculopathy from similar conditions like plexopathies and polyneuropathies.[7] On the other hand, multiple studies have shown notable enhancements in lower back pain following posterior decompression surgery for lower extremity symptoms in Lumbar spinal stenosis.[8,9] Jolles *et al*.[9]hypothesised that the elongated lumbar spine following decompression surgery may alleviate lower back pain. Nevertheless, the impact of decompression on lower back pain remains unclear, and experiencing more severe back pain is linked to a notably poorer outcome following decompression.[10]

Out of the 100 patients, the majority were males, accounting for 70% of the total, while the remaining 30% were females. Low back pain was the most common symptoms seen in 95% of patients, followed by the leg pain seen in 75% in patients, numbness of lower limbs in 26% of patientsand loss bowel and bladder control were least and was present in 5% 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 L3-L4 and L4-L5 PIVDs were seen in 5% of cases each. Upon comparing the findings of our study with the existing literature, we discovered a strong alignment between our results and the information already published. In our study, EMG was accurate in 74% of patients and showed a strong correlation with operative findings. In 1950, Shea et al11 demonstrated the accuracy of EMG in a majority of patients, which aligned with the findings from surgery. Marinacci[12] reported 71 cases with lumbosacral herniation of the intervertebral disc in which the EMG findings agreed with the operative findings in 94.3%. A study by Knutsson[13] revealed that EMG correlated correctly with operative findings in 55 out of 60 patients, i.e., 91.6%.

Of the 100 patients, EMG findings correlated with operative findings in 70 (70%) patients, however operative findings did not correlate with EMG findings in 30 (30%) patients. After surgery, twenty patients showed normal H-reflex latency, while 20 continued with prolonged H-reflex, so improvement was noted in 40 patients after surgery. A total of 40 patients (40%) were having delayed tibial nerve velocity after surgery. After surgery, tibial nerve velocity was delayed in 16 patients and improvement was noted in 24 patients. 20 patients (20%) had delayed preoperative peroneal nerve conduction velocity. A total of 40 (40%) patients had delayed F-wave in the preoperative period. After surgery, improvement was noted in 24 patients, while 16 patients continued with delayed F-wave latency. Significant improvement in NCV parameters after surgery can be observed. Aiello *et al*. [14] evaluated the accuracy of EMG for detecting and localizing nerve root compromise in patients with surgical findings of a single lumbar disc at L3-L4 level and found 100% true positive rate with disc herniation at L4-L5 (96% true positive rate) and with disc herniation L5-SI (71% true positive rate). Of the 50 patients with preoperative EMG evidence of fibrillation potentials suggestive of nerve of root lesions (disc prolapse), 32

(64%) patients showed normal EMG after surgery (laminectomy). Postoperative EMG was done 1-6 months after surgery. Eighteen patients, which accounted for 36% of the total, still exhibited EMG abnormalities. When we compare our findings with those published in western literature, it is interesting to note that EMG abnormalities in post laminectomy patients continue to persist in approximately one-third of the patients, specifically 33%, which aligns with the results of our study.

Braddom and Johnson[15] examined H-reflex tests in 25 patients who showed signs of SI radiculopathy. All 25 patients exhibited H-reflex latencies that were significantly higher than the average for the control group. Out of the fifty patients, twenty (40%) patients had prolonged F-wave latency.After the operation, there was a noticeable improvement in F-wave latency for 12 individuals, which accounted for 60% of the cases. Studies in Western literature[16] have shown that the diagnostic yield of F-waves can range from 18% to 65%. Out of the fifty patients, twenty (40%) patients showed a delay in nerve conduction velocity. Postoperative nerve conduction tests were conducted 1 to 6 months after surgery. 12 patients (60%) experienced improved nerve conduction, while 8 patients still had ongoing issues with their nerve conduction. Similarly, the conduction velocity of the peroneal nerve was found to be delayed in ten patients prior to surgery. Following the surgical procedure, six patients (60%) showed improvement, while four patients (40%) still experienced delayed peroneal nerve conduction. Similarly, the conduction velocity of the sural nerve was found to be delayed in twenty (40%) patients prior to surgery. However, after surgery, there was a noticeable improvement in the sural nerve conduction velocity for 12 (60%) patients, while 8 (40%) patients still experienced delayed conduction velocity.

CONCLUSION

When it comes to nerve root compressive lesions caused by disc prolapse, the EMG method is highly accurate in not only detecting the presence of these lesions but also pinpointing their precise location. EMG is highly reliable when compared to the results of the surgery.

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