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Original Research Article

A Study Assessing the Association between Clinical Findings and Electrophysiological Changes in Patients with Lumbar Disc Disease: Analytical Study

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Abstract:

Aim: The aim of the present study was to assess the role of the electrophysiologic studies in prolapsed lumbar/lumbosacral intervertebral discs for finding the association between clinical findings and electrophysiological changes and to compare the electrophysiologic studies pre‐ and post‐operatively.

Methods: This study was conducted in the department of Neurosurgery . It was conducted prospectively with the aim of evaluating patients with lumbar disc prolapse by means of electrophysiological studies, electromyography (EMG), and nerve conduction velocity. The study was conducted for the period of 2 years on 100 patients (after taking a proper informed consent from the patient with lumbar disc prolapse, and all these patients were subjected to surgery.

Results: Of the 100 patients, 75% were males and 25% 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 30% 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, accounting for 34% of cases followed by L5–S1 32%, L5–S1 level which was seen in 24% 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. 60 patients had L5–S1 lesion, after surgery, 38 patients showed normal H‐reflex latency, while ten continued with prolonged H‐reflex, so improvement was noted in 63.34% of 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 (40%) patients and improvement was noted in 60% (24 patients). 20 patients (20%) had delayed preoperative peroneal nerve conduction velocity. 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.

Keywords: Disc, electromyography, lumbar, prolaps.

Introduction

Back pain in the third and fourth decade of life is frequently caused by lumbar disc herniation. [Most people relate their back and leg pain to a traumatic incident as the pain is usually brought on by repetitive twisting, bending, or heavy lifting. [1] 95% of the lumbar disc herniation involves L4/5 and L5/S1 level, the latter being the commonest. [2] Radiculopathy due to lumbar disc herniation is defined by North American Spine Society as localized displacement of disc material beyond the normal margins of the intervertebral disc space resulting in pain, weakness, or numbness in a myotomal or dermatomal distribution. [3] Lumbar disc herniation is suspected from the history and clinical examination. Plain radiographs can be used to exclude infection, tumors, or other anomalies but are limited in diagnosing lumbar disc herniation or other intraspinal lesions. Magnetic resonance imaging (MRI) is the most useful tool for identifying structural abnormalities in the intervertebral disc area.1

Nerve conduction studies (NCS) are electrodiagnostic tests (EDX) that assess peripheral nerve functions and can be used to evaluate patients with neuromuscular complaints. Radiculopathy is a pathological process that affects the nerves at the root level. Patients usually present with sensory symptoms but motor symptoms also can exist either mixed with sensory symptoms or alone. Because the nerve affected is proximal to the dorsal root ganglia, sensory nerve conduction study is usually normal. For assessing patients with lumbosacral radiculopathy, motor studies of the common peroneal nerve and posterior tibial nerve can be performed. Late responses (F-wave and H-reflex) provide information about the proximal nerve segment (nerve root). [4]

Studies evaluating the use of nerve conduction studies in the diagnosis and assessment of patients with lumbosacral radiculopathy vary widely. [5-10] Nerve conduction studies have the advantage of being a noninvasive, objective, and reproducible tool to assess the physiologic integrity of the nerve root. NCS are not widely used in assessing patients with lumbosacral radiculopathy. NCS might provide a useful aid in patients' management with regard to options of treatment, postoperative evaluation of recovery, and detection of recurrence. There is a need for more studies to be conducted to correlate the findings of the NCS in patients with lumbosacral radiculopathy with the clinical manifestations of the disease, provided that there is limited number of published researches addressing this issue.

The aim of the present study was to assess the role of the electrophysiologic studies in prolapsed lumbar/lumbosacral intervertebral discs for finding the association between clinical findings and electrophysiological changes and to compare the electrophysiologic studies pre‐ and post‐operatively.

Materials and Methods

This study was conducted in the department of neurosurgery, Govt. T.D. Medical College & Hospital, Alappuzha, Kerala, India. It was conducted prospectively with the aim of evaluating patients with lumbar disc prolapse by means of electrophysiological studies, electromyography (EMG), and nerve conduction velocity. The study was conducted for the period of 2 years on 100 patients with lumbar disc prolapse, and all these patients were subjected to surgery.

Both pre‐ and post‐operative (from 1 to 6 months 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 an 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 and Clinical presentation with electromyographic abnormalities

Gender	**N%**
Male	75 (75)
Female	25 (25)
Clinical presentation	
Low back ache	95 (95)
Leg pain/radiculopathy	75 (75)
Numbness	30 (30)
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	32 (32)
L4‑L5, L5‑S1	34 (34)
L5‑S1	24 (24)

Of the 100 patients, 75% were males and 25% 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 30% of patients, and loss bowel and bladder control was least and was present in 5% of patients. All the patients in our study presented with more than one symptoms. As per the EMG abnormalities, most common levels of intervertebral disc prolapse were L4–L5, accounting for 34% of cases followed by L5–S1 32%, L5–S1 level which was seen in 24% 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.

Table 2: Comparison of electromyographic and operative findings

Herniated or PIVD found at surgery	**N**	**EMG**	
		Correlated %	**Not correlated %**
L5‑S1	45	35 (77.77)	10 (22.23)
L4‑L5	25	19 (76)	6 (24)
L4‑L5, L5‑S1	15	11 (73.33)	4 (26.67)
L2‑L3, L4‑L5	5	3 (60)	2 (40)
L3‑L4, L4‑L5	10	7 (70)	3 (30)
Total	100	75 (75)	25 (25)

Of the 100 patients, EMG findings correlated with operative findings in 75 (75%) patients, however operative findings did not correlate with EMG findings in 25 (25%) patients.

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

NCV	Preoperative (%)	Postoperative parameters	
		Improved %	Not improved %
Prolonged H‑reflex latency	60	38 (63.34)	22 (36.66)
Delayed tibial NCV	40	24 (60)	16 (40)
Delayed peroneal conduction velocity	20	12 (60)	8 (40)
Delayed F‑wave latency	40	24 (60)	16 (40)

60 patients had L5–S1 lesion, after surgery, 38 patients showed normal H‑reflex latency, while ten continued with prolonged H‑reflex, so improvement was noted in 63.34% of 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 (40%) patients and improvement was noted in 60% (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 (60%) patients, while 16 patients, i.e., (40%) continued with delayed F‑wave latency. Significant improvement in NCV parameters after surgery can be observed.

Discussion

Electrophysiological studies are efficacious methods in the diagnosis and predicting the prognosis of radiculopathies. An electrical abnormality represents the involved root in the form of fibrillation potentials and neurogenic motor unit action potentials (MUAPs) in a segment or a myotome. These studies are proper for differentiating the diagnosis of the lumbosacral radiculopathy from mimics such as plexopathies, polyneuropathies. [11] Nerve conduction studies are considered part of the clinical evaluation of patients with neuromuscular complaints.

Of the 100 patients, 75% were males and 25% 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 30% of patients, and loss bowel and bladder control was least and was present in 5% of patients. All the patients in our study presented with more than one symptom. As per the EMG abnormalities, most common levels of intervertebral disc prolapse were L4–L5, accounting for 34% of cases followed by L5–S1 32%, L5–S1 level which was seen in 24% 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. Of the 100 patients, EMG findings correlated with operative findings in 75 (75%) patients, however operative findings did not correlate with EMG findings in 25 (25%) patients. Shea et al [12] showed that EMG was correct in 90% of patients and correlated with operative findings. Marinacci [13] 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 [14] revealed that EMG correlated correctly with operative findings in 55 out of 60 patients, i.e., 91.6%. Toyokura et al [15] carried out study in 2002; they studied F-minimum and F-duration of tibial nerve in mild S1 radiculopathy. They concluded that F-minimum and F-duration corrected by the subject's height (F-min/H) were both significantly longer on the affected side than on the unaffected side and longer than the normal group. However, the incidence of abnormality was very low for both parameters.

60 patients had L5–S1 lesion, after surgery, 38 patients showed normal H‑reflex latency, while ten continued with prolonged H‑reflex, so improvement was noted in 63.34% of 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 (40%) patients and improvement was noted in 60% (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 (60%) patients, while 16 patients, i.e., (40%) continued with delayed F‑wave latency. Significant improvement in NCV parameters after surgery can be observed. Aiello et al [16] 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). Braddom and Johnson [17] evaluated H‑reflex tests in 25 patients with clinically suspected SI radiculopathy. All 25 patients had H‑reflex latencies greater than 2 standard deviations above the mean for the control group. Of the fifty patients, F‑wave latency was prolonged in twenty (40%) patients. Postoperatively, F‑wave latency improved in 12 (60%). Western literature [18] reveals diagnostic yield with F‑wave between 18% and 65%. Of the fifty patients, twenty (40%) patients demonstrated delayed tribal nerve conduction velocity.

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.

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