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Electrodiagnostic Parameters of Peroneal Nerve in Lumbar Spinal Canal Stenosis

Dr. Manjinder Kaur[1], Dr. Harpreet Singh[2], Dr. Ishaan Kalavatia[3*]
Miss Muskan Singh[4]

1. Prof. & Head, Dept. of Physiology, Geetanjali Medical College & Hospital, Udaipur.
2. Prof. & Head, Dept. of Orthopedics, Geetanjali Medical College & Hospital, Udaipur.
3. Senior Demonstrator, Dept. of Physiology, Govt. Medical College & Hospital, Dungarpur.
4. Muskan Singh, MBBS Student, Geetanjali Medical College & Hospital, Udaipur.
** Corresponding Author – Dr. Ishaan Kalavatia*

Abstract:
Background:
Lumbar spinal canal stenosis (LSCS) is described as a condition in which there is diminished space available for the neural and vascular elements present in the lumbar spine which results in compression of nerve roots.
Objective: *To determine the electrodiagnostic parameters of peroneal nerve in relation to severity of lumbar spinal canal stenosis.*
Method: *A cross-sectional study was carried out on 51 patients of confirmed lumbar spinal stenosis at Geetanjali Medical College & Hospital, Udaipur. Nerve conduction study was conducted on peroneal nerve among all above mentioned patients. Based on their MRI findings, stenosis was categorized as evident (12 – 15 mm), severe (10 – 12 mm) and absolute stenosis (< 10 mm). All relevant information of the nerve conduction study was recorded in predesigned questionnaire.*
Results: *Out of 51 patients of lumbar spinal stenosis, 26 (50.98%) were males and 25 (49.02%) were females. Mean age of the patients was 49.0 ± 16.77 years. Evident, severe and absolute stenosis was present in 13 (25.49%), 09 (17.65%) and 29 (56.86%) patients respectively. The study was directed towards the lumbosacral region of the spinal cord. The level of lesion in the patients was found to be variable. But, the most common site of lesion (94.12%) was observed to be at L4 – L5. The electrodiagnostic parameters measured for motor nerve conduction in peroneal nerve show significant (p=0.001) bilateral reduction in conduction velocity, which is in proportion to the severity of stenosis.*
Conclusion: *Patients with spinal stenosis show significant abnormalities in NCS findings. Hence, NCS is a valuable tool in evaluating subjects with LSCS.*
Key words: *Lumbar spinal canal stenosis, nerve conduction study, peroneal nerve.*

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I. Introduction:

Lumbar spinal canal stenosis (LSCS) is described as condition in which there is diminished space available for the neural and vascular elements present in the lumbar spine which is caused due to bulging of intervertebral discs, decreased disc height and/or hypertrophy of the ligamentum flavum and facet joints which cause decrease in the space of spinal canal, resulting in compression of the nerve roots.[1-3] This is an anatomical definition, used when the patient is symptomatic and has characteristic clinical features such as neurogenic claudication, pain, fatigue, heaviness and weakness in lower limb. Rarely, sphincter dysfunction is also seen.[4-6] Symptomatic LSCS affects approximately 27% of the general population and represents one of the leading causes of attendance in the pain clinics. Yet, a number of patients remain asymptomatic till the stage of advanced stenosis.[7,8]

LSCS should be confirmed by diagnostic tests or examinations. The diagnostic tests used must be sensitive and specific enough to diagnose LSCS in early the stage. Unfortunately, a single test cannot define LSCS diagnosis. It is done through a combination of history, physical examination, neurophysiology and imaging. Magnetic resonance imaging (MRI) is the preferred imaging test for assessing the presence stenosis. But it is not used as a screening tool as it does not evaluate nerve function.[9,10] Despite advances in the clinical understanding of LSCS along with improvements in imaging techniques, it occasionally still remains difficult to diagnose this disorder.[11,12] MRI does not define properly which part of the nervous system is being affected by the stenosis. For determining the location of stenosis nerve conduction studies (NCS) are a preferable. NCS is

done for functional assessment of electrical conduction in the motor and sensory nerves of the human body. This enables the clinician to recognize signs which could not have been be affirmed by neurological examination alone, and hence facilitate diagnosis and treatment.[13] Therefore, the present study is planned to find association between electrodiagnostic parameters and severity of lumbar spinal canal stenosis.

Objective: To determine the electrodiagnostic parameters of peroneal nerve in relation to severity of lumbar spinal canal stenosis.

II. Material And Methods:

Study design and study setting- A cross-sectional study was performed at the department of Physiology of Geetanjali Medical College & Hospital, Udaipur.

Study participants- Patients presenting signs and symptoms of lumbar spinal stenosis at the Orthopedic department at our institute which are them confirmed by MRI. They were evaluated for NCS profile by the department of Physiology.

Inclusion criteria- Symptomatic patients with MRI findings, suggestive of spinal canal stenosis in the lumbar region.

Exclusion criteria-

1. Unknown peripheral axonal and demyelinating polyneuropathy.
2. Definite motor weakness of the lower extremities.
3. History of previous spinal surgery.
4. Non-consenting patients.

Data collection- Based on inclusion and exclusion criteria, 51 confirmed patients of lumbar spinal stenosis were enrolled in study. Written consent was taken from the patients after detailed explanation of the purpose and procedure of study. Information related to the patients was collected by using pre-designed structured questionnaire which includes socio-demographic details, history of disease, clinical examination, investigations (including MRI findings) and results of NCS. All information was recorded in individual case sheet.

Recording of Electrodiagnostic parameters:

After recruitment in the study, the subjects were graded according to severity of lumbar spinal canal stenosis (Based on the diameter)[14]:

a. Evident Stenosis (AP Diameter 12 mm to 15 mm)
b. Severe stenosis (AP Diameter 10 mm to 12 mm)
c. Absolute stenosis (AP Diameter less than 10 mm)

However patients having canal diameter >15mm were labeled as no stenosis. The nerve conduction studies were done on Peroneal nerve of these patients. EMG Octopus, manufactured by Clarity Medical Pvt. Ltd. was used to carry out the study in the Dept. of Physiology (Table1). The case record performa was filled up and the test, were conducted on the patients.

Table 1: Settings done on NCS machine for recording the motor and sensory nerve conduction[15].

	MNCV (Peroneal nerve)	**SNCV (Peroneal nerve)**
Low filter	10 Hz	2- 10 Hz
High filter	10 kHz	2 kHz
Noise	≤ 0.4 µ	≤ 0.4 µ
Sensitivity	5 mv	20 mv
Sweep	2-3 ms/D	1-2 ms/D
Placement of recording electrode (G1)	Tibialis anterior muscle (Proximal to mid-anterior lateral calf)	Between the tibialis anterior tendon & lateral Malleoli
Placement of reference electrode (G2)	Distally over the anterior ankle	Placed 3-4 cm distally
Placement of ground electrode	In between stimulating and recording electrode	In between stimulating and Recording electrode

Various parameters like threshold stimulus, proximal & distal latencies (for MNCV) and onset latency (for SNCV), amplitude and nerve conduction velocities were tested and recorded for MNCV & SNCV.

The subject was examined in a calm setting, after being thoroughly briefed about the procedure and resting for 30 min before beginning the procedure. The MNCV and SNCV were recorded after doing the appropriate settings and placement of electrodes, as given in Table1.

Statistical analysis: Statistical analysis was performed using SPSS version 22.0. Mean and standard deviation were calculated to describe the continuous variables and frequencies were calculated to describe the categorical

variables. Association between clinical findings and NCS studies abnormalities was established by Chi-Square/Fisher's Exact test. P values less than 0.05 was considered statistically significant.

Ethical Approval: Enrollment of patients was begun only after taking ethical clearance from institutional ethics committee. Written consent was then taken upon enrollment from all the participants.

Results: During study period, total of 51 confirmed patients of lumbar spinal stenosis who fulfilled inclusion and exclusion criteria, were recruited in our study. Out of these 51 patients, 26 (50.98%) were males and 25 (49.02%) were females. Age of participants varied from 22 years to 85 years with mean age of 49.0 ± 16.77 years (Male- 50.04 ± 18.99, Female- 47.92 ± 14.43). (Table 2)

Table 2: Distribution of study participants according to socio-demographic variables.

Variables	Numbers (n=51)	Percentage (%)
Age (years)		
Mean age	49.0 ± 16.77	
20 – 40	20	39.22
41 – 60	17	33.33
> 60	14	27.45
Gender		
Male	26	50.98
Female	25	49.02

Table 3: Distribution of study participants according to Lumbar spine stenosis.

Variables	Numbers (n=51)	Percentage (%)
Lumbar spine stenosis		
Evident Stenosis (AP diameter 12-15 mm)	13	25.49
Severe Stenosis (AP diameter 10-12 mm)	09	17.65
Absolute Stenosis (AP diameter < 10 mm)	29	56.86
Compression		
Central	05	9.80
Lateral	41	80.40
Left Lateral	36	70.58
Right Lateral	39	76.47
Both	05	9.80
Level of lesion*		
L2-L3	22	43.14
L3-L4	36	70.59
L4-L5	48	94.12
L5-S1	32	62.75

***Lesions in spinal cord were at multiple levels.**

According to MRI findings, 13 (25.49%) subjects had evident stenosis, while 09 (17.65%) subjects had severe stenosis and remaining 29 (56.86%) subjects had absolute stenosis in lumbar spine. Compression was present centrally among 05 (9.80%) subjects, laterally among 41 (80.40%) subjects while the remaining 05 (9.80%) subjects had central as well as lateral compression. Left lateral compression was found among 36 (70.58%) subjects and right lateral compression was found among 39 (76.47%) subjects. Level of lesion on spinal cord was found to be variable with most common level being L4-L5 (94.12%). (Table 3)

Table 4: Association of Nerve conduction study results of Peroneal nerve (Motor Nerve) and severity of Lumbar spine stenosis.

Lumbar spine stenosis	Proximal Latency (ms)		Distal Latency (ms)		Amplitude (mV)		NCV (m/s)	
	Right	Left	Right	Left	Right	Left	Right	Left
Evident Stenosis (n = 13)	17.57±1.9	16.59±1.4	5.30±0.6	5.38±0.4	2.82±0.7	2.83±0.6	62.33±4.3	62.18±3.5
Severe Stenosis (n = 09)	16.40±1.4	16.77±0.8	5.13±0.5	5.47±0.4	2.61±0.6	2.65±0.6	60.95±3.1	62.38±2.7
Absolute Stenosis (n = 29)	15.88±1.9	16.39±1.2	5.33±0.5	5.51±0.3	2.45±0.7	2.13±0.7	47.51±8.1	49.87±8.0
P value	0.034*	0.70	0.66	0.60	0.35	0.009*	0.001*	0.001*

The electrodiagnostic parameters for motor nerve conduction of peroneal nerve, viz., proximal and distal latencies and mean amplitude are shown in table 4. Significant change was found in proximal latency of right limb (p=0.034) in relation to canal diameter while on the left side, it was insignificant (p=0.70). A non-significant difference with the reducing canal diameter was found in distal latency for both limbs (p>0.05).

Amplitude showed no significant changes with change canal diameter in right side (p=0.35) while it was significant on the left side (p=0.009). The conduction velocity reduced significantly (p=0.001) on both sides with increasing severity of stenosis (Figure2).

Table 4: Association of Nerve conduction study results of Peroneal nerve (Sensory Nerve) and severity of Lumbar spine stenosis.

Lumbar spine stenosis	Latency (ms)		Amplitude (mV)		NCV (m/s)	
	Right	Left	Right	Left	Right	Left
Evident Stenosis (n = 13)	3.86±0.5	3.81±0.6	3.63±0.4	3.48±0.3	48.09±3.2	48.05±5.7
Severe Stenosis (n = 09)	3.98±0.7	3.83±0.7	3.37±0.4	3.51±0.4	47.34±2.7	48.48±1.7
Absolute Stenosis (n = 29)	3.92±0.7	4.08±0.6	3.75±0.4	3.33±0.7	47.24±4.6	48.26±2.9
P value	0.94	0.46	0.10	0.70	0.85	0.97

The electrodiagnostic parameters for sensory nerve conduction of peroneal nerve, viz., onset latency, mean amplitude and conduction velocity shows a non significant difference with the reducing canal diameter (p>0.05).

III. Discussion:

LSCS is defined as a condition in which there is diminished space available for the neural and vascular elements present in the lumbar spine as a result of degenerative changes in the spinal canal. Nerve conduction studies are considered an essential part of clinical evaluation of the patients with neuromuscular complaints.[16] There are very few studies dedicated to evaluating the utility of standard electrodiagnostic studies in LSCS. North American Spine Society guidelines published in 2011, suggest that electrodiagnostic studies are helpful for the evaluation of patients in whom stenosis, alone, may not account for the neurologic symptoms.[17,18]

In present study, LSCS was found among 39.22% participants, who were below 40 years of age, 33.33% participants were between 41 to 60 years of age whereas 27.45% participants were above 60 years. Ratio of males to females was nearly equal to 50.98% males and 49.02% females. Marcus Sofia Ziegler et al[19] analysed 31 patients. Among them 29% were males and 71% were females. Age of participants varied from 60 to 84 years, with a mean of 71 ± 8.2 years. Min Cheol Chang et al[20] studied 32 patients with mean age of 66.9 ± 7.4; years and male to female ratio of 8:24.

In our study, evident stenosis was found among 25.49% subjects, severe stenosis and absolute stenosis was found among 17.65% and 56.86% subjects respectively. Among most of patients lateral compression (80.40%) was found, while central compression was found in 9.80% patients. 09.80% patients had central as well as lateral compression. Although lesion on spinal cord was present at variable levels but the most common site of lesion was found to be at L4-L5 (94.12%). Min Cheol Chang also found L4-L5 as the most common site of stenosis. Severe and moderate stenosis was found in 43.75% and 56.25% patients respectively.

In present study, the electrodiagnostic parameters for motor nerve conduction in peroneal nerve show significant changes in proximal latency of right limb (p=0.034) along with amplitude on the left side (p=0.009). Conduction velocity was reduced significantly (p=0.001) on both sides in proportion to severity of stenosis. The electrodiagnostic parameters for sensory nerve conduction of peroneal nerve, viz., onset latency, mean amplitude and conduction velocity showed a non significant difference in relation to the reducing canal diameter (p>0.05). In concern to the relationship between the grade of stenosis and electrodiagnostic findings, a recent study conducted by Haig A J et al[21], including 115 patients, found no corelation between the severity of LCSS and the results of NCS on the lower extremity. Meanwhile Min Cheol Chang found that patients with moderate or severe LCSS showed significantly lower distal amplitudes in peroneal NCSs, as compared to subjects without LCSS.

Seung Wha Jang et al[22] also found no relationship between grade of stenosis and mean amplitudes of the motor nerves in the multivariate regression analysis for peroneal nerve. Safa Yousif found no significant difference in the NCS parameters of both common peroneal and tibial nerves between patients and the control group.

IV. Conclusion:

Currently there is no specific test which gives an accurate diagnosis of LSCS along with involvement of nerves. Patients with spinal stenosis show significant abnormalities in NCS findings. Hence, NCS is a valuable tool in evaluating subjects with LSCS.

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