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Original Research Paper

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ELECTRODIAGNOSTIC PARAMETERS OF TIBIAL & SURAL NERVE IN LUMBAR SPINAL CANAL STENOSIS.

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ABSTRACT

Background: Lumbar spinal canal stenosis (LSCS) is defined as the narrowing of the lumbar spinal canal due to bulging intervertebral discs and/or hypertrophy of the ligamentum flavum and facet joints that results in the compression of nerve root that might affect the nerve conduction studies. **Objective:** To determine the electrodiagnostic parameters of tibial and sural nerve with and severity of lumbar spinal canal stenosis. **Methods:** A comparative study was conducted on 51 patients of LSCS diagnosed clinically and canal diameter measured on MRI. All patients were subjected to nerve conduction study by EMG Octopus manufactured by Clarity Medical Pvt. Ltd. **Results:** The mean age of participants was 49.0±16.77 years (22-85 years), out of which 26 (50.98%) were males and 25 (49.02%) were females. They were divided into 3 groups based on antero-posterior lumbar canal diameter for severity of stenosis. LSCS was found at multiple levels in spinal cord with most common site is LSCS in L4-L5. There was a significant decrease in motor nerve conduction (p=0.01(Rt. & Lt. tibial)) and sensory nerve conduction (p= 0.007(Rt. sural), 0.008 (Lt. sural)) velocities. However, significant differences in motor and sensory latencies and amplitude were not observed. **Conclusion:** The significantly reduced motor and sensory nerve conduction velocities are suggestive of functional impairement of the tibial and sural nerve with the severity of LSC; however, the non significant changes in latencies and amplitude suggests no evidence of peripheral demyelination or axonal loss.

KEYWORDS : nerve conduction studies, lumbar radiculopathy, neurophysiological studies, neurogenic claudication.

INTRODUCTION:

The syndrome of lumbar spinal canal stenosis (LSCS) was not widely diagnosed until Verbiest's clinical description in 1954.[1] Lumbar spinal canal stenosis is defined as the narrowing of the lumbar spinal canal due to bulging intervertebral discs and/or hypertrophy of the ligamentum flavum and facet joints that results in the compression of nerve roots[2]. It is often combined with instability in one or several segments of the lumbar spine. Being a degenerative process associated with age, it predominantly affects individuals older than 50 years[3]. It can be classified based on the anatomical location of the narrowing of the spinal cord (central spinal stenosis, lateral spinal stenosis, foraminal stenosis), or based on the etiology (primary or acquired).[4]

Some patients may be asymptomatic,[5] while others may show the cardinal symptoms of LSCS that is neurogenic claudication, which refers to leg pain, fatigue, heaviness, and/or weakness that typically worsens with lumbar extension and relieved when sitting and forward bending.[5-8] Rarely in some cases, sphincter dysfunction is also observed[9]. Neurogenic claudication results in the limited mobility in the patients hence making them seek the medical assistance to improve their quality of life.[4]

Despite advances in the clinical understanding of LSCS and improvements in imaging techniques, it occasionally remains difficult to diagnose.[10,11] The diagnosis is straightforward in cases with typical neurogenic claudication symptoms and unequivocal imaging findings. However, not all patients present with typical symptoms.[4] Diagnosis of LSCS is made through a complete assessment that combines history, physical examination, neurophysiological studies and imaging. Magnetic resonance imaging (MRI) is used as the most useful tool for identifying structural abnormalities in the intervertebral disc area.[8,12,13] However, there is no definite correlation between the severity of lumbar spinal canal stenosis seen on imaging studies and the associated pain.[14,15] Additionally, nerve conduction studies (NCS) are the part of electro-diagnostic tests (EDX) for assessing peripheral nerve functions, that are often used to identify the specific site to be treated when equivocal findings and/or multiple-level lesions are detected via CT or MRI.[6,16]

NCS are done for functional assessment of electrical conduction of the motor and sensory nerve of the human body,[17] which empowers the clinician to recognize signs that cannot be affirmed by neurological examination alone and can manage diagnosis and treatment.[18] A normal healthy nerve shows the normal conduction studies whereas compression, demyelination and other diseases affect the conduction. Nerve conduction studies also helps in surveying complexities of treatment and in addition distinguishing the course of disease.[19]

Hence, the present study was planned to determine the relationship between nerve conduction velocity and lumbar canal diameter measured on MRI.

MATERIAL AND METHOD:

The present study was conducted on 51 clinically symptomatic patients of lumbar canal stenosis, who presented themselves in the Dept. of Orthopedics of our institution, during the study period. The study was designed as cross-sectional observational study and conducted in the Department of Physiology.

This study started recruiting the patients after obtaining the approval from the HREC. Before recruitment of participants, a written informed consent was obtained from them. The consecutive sampling was done and only the patients fulfilling the inclusion criteria like clinically symptomatic cases confirmed on magnetic resonance imaging were recruited in the study. However, the patients with other causes of demyelinating disorders, peripheral axonal polyn europathy, previous spinal surgeries, motor weakness of lower limbs were excluded from the study. Even the patients who did not consent for the participation in study were excluded.

METHODOLOGY

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[20]:

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 the canal diameter >15mm was labeled as no stenosis. The nerve conduction studies were done on tibial & sural nerve of these patients using EMG Octopus manufactured by Clarity Medical Pvt. Ltd. in the Dept. of Physiology (Table1). The case record proforma was filled up and the test was conducted on the patients.

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

	MNCV (Tibial nerve)	SNCV (Sural nerve)
Low filter	2 Hz	2 Hz
High filter	5 KHz	5 KHz
Noise	≤ 0.4 μ	≤ 0.4 μ
Sensitivity	5 mv	5 mv
Sweep	5 ms/D	5 ms/D
Placement of recording electrode (G1)	On Abductor Hallusis	Between lateral Malleoli & Tendo Achilles
Placement of reference electrode (G2)	Over metatarsal-phalangeal joint of the great toe	3 cm distal to Active Electrode
Placement of ground electrode	In between stimulating and recording electrode	In between stimulating and recording electrode

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

The participant was examined in a calm setting and then he was thoroughly briefed about the procedure and allowed to rest 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 was performed using SPSS version 22.0. Mean and standard deviation were calculated to describe continuous variables and frequencies were calculated to describe categorical variables Association between clinical findings and NCS studies abnormalities was carried out by Chi-Square/Fisher's Exact test. P value less than 0.05 was considered statistically significant.

RESULTS:

In this study, we had recruited 51 patients of lumbar canal stenosis diagnosed clinically and confirmed on the MRI, who fulfilled all the inclusion and exclusion criteria. Out of 51 patients of lumbar spinal stenosis, 26 (50.98%) were male and 25 (49.02%) were females. The mean age of the study participants was 49.0±16.77 years (range 22-85 years). The distribution of participants according to age is shown in Table 2 and lumbar canal stenosis according to severity, type and level of lesion is shown in table 3.

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

Table 3: Distribution of study participants according to parameters of Lumbar spinal canal stenosis.

Variables	Total number of subjects (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**
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

The electrodiagnostic parameters for motor nerve conduction of tibial nerve, viz., proximal and distal latencies and mean amplitude showed a non significant difference with the reducing canal diameter (Figure 1) whereas the conduction velocity was reduced significantly (p=0.01) on both sides with the severity of stenosis (Figure2).

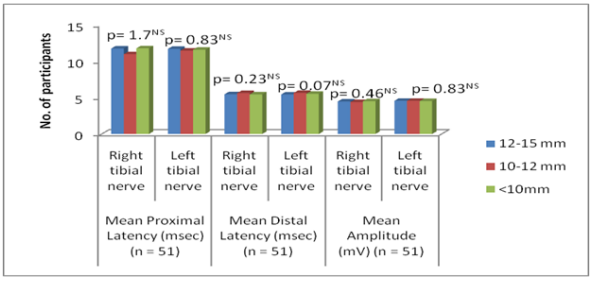


Figure 1: Proximal and distal Latencies, Amplitude with anteroposterior lumbar canal diameter.

NS: p- value is Non significant

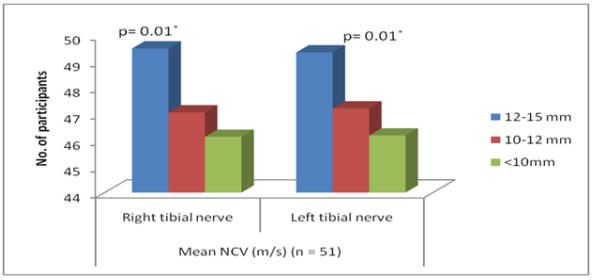
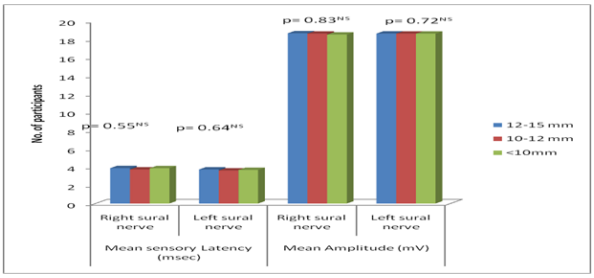


Figure 2: Motor Nerve conduction velocities with antero posterior lumbar canal diameter

- ***p value is highly significant**

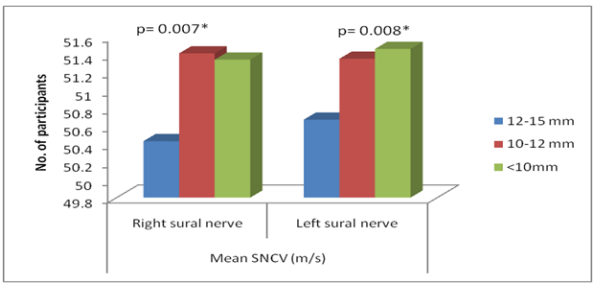
The electrodiagnostic parameters for sensory nerve conduction of sural nerve, viz., onset latency and mean amplitude showed a non significant difference with the reducing canal diameter .

(Figure 3) whereas the conduction velocity was reduced significantly (p=0.007 & 0.008) on right and left side respectively with the severity of stenosis (Figure 4).



NS: p- value is Non significant

Figure 3 : Onset Latency, Amplitude with antero-posterior lumbar canal diameter



***p value is highly significant**

Figure 4 : Sensory nerve conduction velocity with antero-posterior lumbar canal diameter

DISCUSSION:

In LSCS patients, exacerbation of symptoms on walking and relief of symptoms in flexion or sitting are common findings. Severity and functional impairment in such patients are usually quantified by measuring maximal walking distance at which the patients can no longer continue walking, due to increasing leg symptoms (absolute claudication distance). In lumbar stenosis, the narrowing of the spinal canal can result in direct or indirect mechanical compression of nerve roots. Additionally, the rise in intrathecal pressure can compromise venous and arterial blood flow, leading to ischemic injury of lumbosacral nerve roots and further compromising impulse conduction. L5 is the most frequently affected nerve root in LSCS. Peroneal and tibial nerves receive a significant contribution of fibers from this root and thus constitute a suitable target for NCS. Among such patients nerve conduction studies are considered part of the clinical evaluation of patients with neuromuscular complaints. So, a cross-sectional study was performed to identify the role of neurophysiological study in LSCS and to find any association between nerve conduction velocity and severity of stenosis. Study was perform on 51 confirm patient of LSCS.

In present study, age of study participants was varied from 22 years to 85 years with mean age of 49.0 ± 16.77 years. Most of participants belong to age group of 20 to 40 years. Male to female ratios were nearly equal. Study done by Kumar A et al[21] found mean age of 80 male 35.4 ± 12.7 years and 38 female 33.8 ± 13.7 years with the age range of 20 to 60 years. Min Cheol Chang et al[22] planned a retrospective study on 32 patients of LSS and found mean age 66.9 ± 7.4 years with male female ratio 1:3. Hence, our study finds that the prevalence of lumbar canal stenosis is mostly seen in young adults and distributes equally among both the genders.

Out of 51 patients of LSCS, 25.49% were had minimal stenosis, 17.65% had moderate and 56.86% had severe stenosis at lumbar spine in this study. Multiple level lesions at spinal cord were present and 94.12% patients had lesion at L4-L5 (94.12%). L5 was also found as most common site of lesion by Park S.H et al.[23] Jang SW et al[24] also found distribution of the lumbar stenosis at L1-2 (5%), L2-3 (16%), L3-4 (30%), L4-5 (43%), and L5-S1 (6%) levels. Our study reports the high (56.86%) prevalence of absolute stenosis and most of these patients had involvement of multiple levels of discs with most common site being L4-L5.

In the present study, we find a significant decrease in motor nerve conduction (p=0.01(Rt. & Lt. tibial)) and sensory nerve conduction (p= 0.007(Rt. Sural), 0.008 (Lt. Sural)) velocities. However, significant difference in motor and sensory latencies and amplitude were not observed in the present study. Looking back to find the literary support for our findings, Min Cheol Chang et al[22] foumd that distal amplitudes in both the peroneal and tibial nerves were significantly smaller in the severe and moderate LSCS groups compared to the normal group although no significant difference was observed within the LSCS groups. However, Haig A.J et al[25] found no relation between the severity of LSCS and the results of NCS on the lower extremity. Similarly, Jang SW et al[24] also observed a significant difference in NCS with severity of spinal stenosis during univariate analysis although in the multiple regression analysis, the severity of spinal stenosis did not show a significant association with abnormalities in the NCS findings of the nerves of the lower extremities.

Hence, we conclude that the significantly reduced motor and sensory nerve conduction velocities are suggestive of functional impairement of the tibial nerve. The non significant changes in latencies rule out any peripheral demyelination/ nerve involvement and non significant change in amplitude rules out the axonal loss. The delay in conduction could however be attributed to the proximal root compression, which could be better understood by the study of the late responses of the tibial nerve (F wave) and sural nerve (H reflex).

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Conflicts of Interest: Authors report no conflicts of interest.

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