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Electromyography and Nerve Conduction Studies in Patients with Lumbar Spinal Stenosis: Is Neurophysiological Examination an Important Tool?

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Abstract

Background: There is no single test that defines properly lumbar spinal stenosis (LSS) diagnosis, and diagnosis of the syndrome continues to rely on clinical judgment. LSS symptoms may be broad and may be seen in multiple disorders in elderly.

Hypothesis: To identify the role of electromyography and nerve-conduction studies on LSS diagnosis.

Materials and Methods: A cross-sectional study with prospective data collection was conducted. 31 symptomatic patients with LSS confirmed by MRI were evaluated with neurophysiology tests. We compared symptoms and neurophysiologic findings.

Results: All patients reported pain, 83.9% of patients reported it to be moderate or severe and 90% of patients took pain medication. LSS did not affect NCS or SSR. Electromyography confirmed high frequency of radiculopathy, particularly multiradiculopathy. L5 and S1 roots were the most susceptible to injuries. We also found a higher prevalence of L4 radiculopathy.

Discussion: Correlating electromyography with clinical findings, we found that the clinical presentation, the most important starting point of an evaluation, is poor in terms of identifying radiculopathy, a frequent consequence of LSS. For this reason, we suggest that electromyography may play an important role as a diagnostic tool, being useful in determining when symptoms are neurogenic in nature. In addition, it may serve to focus treatment only in the area where it is really necessary.

Keywords: Lumbar spinal stenosis; Electromyography; Sympathetic skin response; Nerve conduction studies; Radiculopathy

Introduction

Lumbar spinal stenosis (LSS) refers to a spinal canal narrowing compressing the spinal cord and its nerves at the level of the lumbar vertebra [1,2]. Symptoms include leg weakness, back pain, and rarely sphincter dysfunction [3-6]. Some patients are asymptomatic [7]. This constellation of symptoms may also be identified in elderly with different conditions rather than LSS. Consequently clinical suspected LSS should be confirmed by a diagnostic exam. Unfortunately there is no single test that strongly defines LSS diagnosis. LSS diagnosis is made through a complete assessment that combines history, physical exam, neurophysiology and imaging. Magnetic resonance imaging (MRI) is used as the preferred imaging test for assessing the stenosis [1,3], but it is not used as a screening tool and it does not evaluate nerve function. Despite advances in the clinical understanding of LSS and improvements in imaging techniques, it occasionally remains difficult to diagnose this disorder [7-11]. MRI does not define properly which part of the nervous system is being affected by the stenosis (spine, nerves or both). For this reason the aim of this study is to identify the role of neurophysiology study on LSS.

Methods

A cross-sectional study with prospective data collection was performed at Hospital São Lucas Pontifícia Universidade Católica do Rio Grande do Sul (HSL-PUCRS) during 8 months. Inclusion criteria was symptomatic patients that filled the MRI diagnostic criteria for LSS [7,12]. Exclusion criteria were people younger than 60 years of age, previous history of diabetes mellitus, alcoholism and other confirmed neurologic disorders. The project was approved by local Research and Ethics Committee and informed consent was obtained.

Neurophysiology evaluation (Viasys Synergy equipment)included bilateral (i) antidromic sensory nerve conduction study (SNCS) of the superficial peroneal and sural nerves, (ii) motor nerve conduction study of the common peroneal nerve and tibial nerve, (iii) concentric needle electromyography (EMG) of the iliacus (L2-L3), vastusmedialis and adductor magnus (L4), tibialis anterior and gluteus medius (L5)

and medial gastrocnemius and biceps femoris (short head) muscles (S1); (iv) sympathetic skin response (SSR) recorded in the region of the right plantar and stimulation in the left tibial nerve [13,14]. SNCS of the superficial peroneal and sural nerves, and motor conduction studies of the deep peroneal and tibial nerves were compared with 4 control groups (one for each nerve) composed of 45 men and 105 women, balanced by age group, randomly taken from the HSL-PUCRS database. Radiculopathy was defined as the presence of the following in at least 2-limb muscles innervated by the same nerve root: huge MUAPs, fibrillation potentials, positive sharp waves and reduced recruitment.

Data was analyzed using SPSS version 17.0.The means for age and neurophysiological parameters established through neurophysiological study were compared between participants and control groups using an independent samples t-test taking into account the similarity between variances verified by Levene's test. The frequencies of imaging and clinical variables (categorical) were compared between participants with and without an electromyography diagnosis of radiculopathy using Pearson's chi-squared test. P values less than or equal to 5% were considered to be significant.

Results

We analysed 31 patients: 9 (29%) men and 22 (71%) women. Age varied from 60 to 84 years with a mean and standard deviation of 71 ± 8.2. All patients reported pain (90% complained of back pain and 81% complained of sciatic pain). Bilateral sciatic pain was seen in 56%. Almost 40% of patients were unable to walk 100 meters because of the pain. Use of pain relief drugs was seen in 90% of elderly, 25% of those used non-steroidal anti-inflammatory drugs, 32% narcotics and 43% corticosteroids.

Regarding MRI findings, compression was by the vertebra in 29% of patients, by the intervertebral space in 61% and by both in 10%. Only one patient had compression by the vertebral body (anterior). The remaining vertebral compressions were by the arch, with 5 (16%) at only one level and 6 (19%) at two or more levels. Sixteen patients (52%) had stable compression of the intervertebral space, mostly of lateral (23%) or centrolateral (26%) location. Unstable intervertebral involvement was seen in 16% of patients with most being centrolateral in location. The area of stenosis was 16% in the entrance zone, 52% in the mid-zone, and 32% in the exit zone.

Regarding nerve conduction studies (NCS), Table 1 compares latency, amplitude and conductive velocity between participants and controls. The sural nerve latency was smaller in LSS patients comparing to normal controls (P<0.01). Superficial peroneal nerve conductive velocity was slightly greater in LSS patients comparing to normal controls. Both findings had no clinical significance. Noneparticipant had absent SSR and only 4 participants had amplitude of less than 300μV, with 3 of these having multiradicular lesions. The latency ranged from 1.3 to 3.5ms, with a mean of 2.2ms and standard deviation of 0.5ms.The amplitude ranged from 60 to 4129 μV, with a mean of 1056 μV and standard deviation of 952 μV. No difference of the mean amplitude was seen between participants and the control group (P>0.05).

Neurophysiologic Parameters	Patients			Controls		P
	N	m ± sd		N	m ± sd	
Sensory Nerve Conduction						
Superficial fibular						
Latency (ms)	58	2.68 ± 1.51		141	2.71 ± 0.45	0.877
Amplitude (μV)	58	12.00 ± 5.07		141	11.59 ± 6.65	0.679
Conduction velocity (m/s)	58	48.02 ± 5.73		141	45.72 ± 4.13	0.007
Sural						
Latency (ms)	21	2.93 ± 0.58		121	3.29 ± 0.56	0.009
Amplitude (μV)	21	12.41 ± 3.11		121	11.91 ± 6.08	0.575
Conduction velocity (m/s)	21	48.47 ± 4.66		121	45.81 ± 3.90	0.006
Motor Nerve Conduction						
Deep fibular						
Distal latency (ms)	52	4.07 ± 1.10		150	3.93 ± 0.73	0.402
Distal amplitude (mV)	52	4.05 ± 1.90		150	4.34 ± 2.08	0.364
Proximal amplitude (mV)	52	3.56 ± 1.77		150	3.92 ± 1.94	0.238
Conduction velocity (m/s)	52	47.87 ± 6.28		150	46.40 ± 4.08	0.122
Tibial						
Distal latency (ms)	53	3.92 ± 0.80		150	3.96 ± 0.71	0.728
Distal amplitude (mV)	53	8.88 ± 4.22		150	10.03 ± 3.69	0.063

Table 1. Nerve conduction parameters

Radiculopathy was found in 64.5%. Impairment of one root was seen in 30% of patients with radiculopathy whilst 40% had four or more roots with lesions. The radicular lesion was bilateral in 55% of the cases and the frequency between both sides was similar. The most often affected roots were L5 (60% on the right, and 70% on the left) and S1 (70% on the right, and 60% on the left).

Table 2 compared radiculopathy frequency with clinical and radiological findings. The frequency of radiological radiculopathy was 33%, 74% and 100% for those with compression of the spinal canal by the vertebra, by the intervertebral space, and by both respectively (P=0.046).

Variable	Without Radiculopathy N(%)	With Radiculopathy N(%)	P
Gender			
Male	2 (22.2)	7 (77.8)	0.429
Female	9 (40.9)	13 (59.1)	

Age range (years)				
	60-69	3 (23.1)	10 (76.9)	0.468
	70-79	5 (45.5)	6 (54.5)	
	80+	3 (42.9)	4 (57.1)	
Lumbar pain				
	Yes	11 (39.3)	17 (60.7)	0.535
	No	0 (0.0)	3 (100.0)	
Sciatic pain				
	Yes	8 (32.0)	17 (68.0)	0.638
	No	3 (50.0)	3 (50.0)	
Asymmetric reflex				
	Yes	11 (39.3)	17 (60.7)	0.535
	No	3 (42.9)	4 (57.1)	
Significant weakness				
	Yes	10 (34.5)	19 (65.5)	1.000
	No	1 (50.0)	1 (50.0)	
Alteration in sensitivity				
	No	9 (40.9)	13 (59.1)	0.544
	L2-L4	1 (33.3)	2 (66.7)	
	L5-S1	1 (16.7)	5 (83.3)	
Classification by MR imaging				
	Vertebra	6 (66.7)	3 (33.3)	0.046
	Intervertebral space	5 (26.3)	14 (73.7)	
	Combined	0 (0.0)	3 (100.0)	
Vertebral arch involvement				
	1 level	4 (80.0)	1 (20.0)	0.242
	2+ levels	2 (33.3)	4 (66.7)	
Intervertebral space involvement				
	Central	0 (0.0)	2 (100.0)	0.342
	Lateral	1 (12.5)	7 (87.5)	
	Centrolateral	4 (36.4)	7 (63.6)	
Spinal stability				
	Stable	3 (18.8)	13 (81.2)	0.553
	Unstable	2 (40.0)	3 (60.0)	
Region of stenosis				
	Entrance zone	2 (40.0)	3 (60,0)	0.456
	Mid-zone	7 (43.8)	9 (56.2)	
	Exit zone	2 (20.0)	8 (80.0)	

Table 2. Clinical, EMG and imaging findings in LSS patients.

Discussion

A cross-sectional study was performed to identify the role of neurophysiology study in LSS. To address this question we correlated neurophysiology findings, LSS symptoms and MRI abnormalities. We believe that our findings are relevant although we also consider that it is important to repeat this study in a larger population.

We found LSS to be more common in women. There is no consensus regarding the exact LSS gender ratio. A higher proportion of female patients with lateral stenosis (68%) was described in 1993 as opposed to central stenosis where just 46% were women [15]. On the other hand an equal gender distribution has also been reported previously [16].Pain was considered a major feature as 83.9% of patients reported moderate or severe pain, and the vast majority of patients took pain relief medication. Based on the sample analyzed, pain was the most common symptom of LSS, although the exact prevalence of pain among LSS patients is not clear from the literature.

In relation to the neurophysiology findings, nerve conduction study (NCS) was normal in LSS patients. Although patients have normal test, we agree that NCS should be performed in patients with LSS symptoms as it is an important diagnostic tool to evaluate the presence of other neuromuscular conditions [5,13,17-19].It has been previously suggested that SSR could be important in diagnosing spinal stenosis [23].This present study is the first to analyse SSR in LSS and found that the SSR was also normal in the LSS patients. We conclude that lumbar stenosis does not affect SSR although we also consider that it is important to repeat this study in a larger population.

An interesting finding of this research was the EMG abnormalities. Our study showed a high frequency of radiculopathy particularly multiradiculopathy. L5 and S1 roots were the most susceptible to injuries and the prevalence of L5 and S1 radiculopathies were almost the same. We also found a high prevalence of L4 radiculopathy. It has been described, when considering MRI abnormalities, that L4-5 is the commonest involved level in LSS, followed by L5-S1 and L3-4 [7]. Maybe it could reflect that MRI is not a sensitive method to assess radiculopathy. Similar results based on EMG were also found in this study confirming that this may be a reliable diagnostic tool for root assessment in LSS. According to the literature, LSS is the most common cause of polyradiculopathy. Spondylosisis a more common cause of root disease in older adults [20].Further researches should assess if EMG may be of assistance in grading the severity of LSS, especially when multiradiculopathy is a factor, as it gives an objective indication of root injury. In accordance with Nardinet al. we believe that EMG and MRI are complementary tools for the evaluation of radiculopathy [21].

Regarding MRI findings, the majority of patients with radiculopathy had compression of the intervertebral space or a combined compression – type B and C according to Landim (2008) [22]. The only variable that showed a significant association with EMG diagnosis of radiculopathy was the compression of intervertebral space. We do not believe that MRI could replace the EMG as diagnostic tool for radiculopathy although this study was not designed to address this question.

Another important finding of this study is the comparison between clinical variables and EMG. It showed that medical history is not a good indicator of radiculopathy when the major complain is back pain. Sciatic pain is also a poor indicator of the disease as half of people who did not complain of sciatic pain had a diagnostic EMG for radiculopathy. All clinical variables based on the P value were not significant.

Summarizing, there is currently no specific test that gives an accurate diagnosis of LSS. This research showed that LSS clinical presentation – the most important starting point of a clinical evaluation – was poor in terms of identifying radiculopathy caused by LSS. Although EMG does not help as a diagnostic tool for LSS, it may confirm radiculopathy even in patients with no classical symptoms of root involvement. Future research could correlate EMG and treatment approach as EMG may add by defining which root is compromised, which help grading disease severity and guiding surgical can approach, particularly if a diffuse MRI abnormality is present.

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