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Research article

Nerve conduction assessments in patients with lumbar radiculopathy – an observational study

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Abstract: The main aim of this study was to identify the changes in nerve conduction parameters in cases of lumbar radiculopathy due to lumbar spondylosis and intervertebral disc pathology with no clinical neurologic deficit and to identify the potential of nerve conduction studies in the early diagnosis of these cases. Eleven patients aged between 41 and 78 years (mean age 58 ± 13.1 years; 4 males, 36.36%) met the inclusion criteria and agreed to participate in this study. Nerve conduction studies were performed with Neuro - MEP - Micro (Figure 1), a digital system designed to record electrical activity of muscles and nerves at 1 or 2 - channel stimulation, and to measure and analyze their parameters. Conduction velocity was reduced in 29.41% of the examined tibial nerves, and in none of the examined peroneal nerves. The registered amplitudes, for none of the tibial or peroneal nerve, have not been lower than the reference values. Patients with reduced tibial conduction velocity had a Grade 2 nerve root involvement on MRI. Nerve conduction studies should be used to complete the physical and imagistic assessment of patients with lumbar radiculopathy, to detect functional abnormalities not only structural ones provided by the MRI.

Keywords: lumbar radiculopathy; electrodiagnostic; nerve conduction studies

1. Introduction

Lumbar spondylosis is a form of degenerative rheumatic disease caused by intervertebral disc damage, accompanied by repair reactions,i.e. osteophytes in the vertebral bodies of the lumbar region [1]. Degenerative disorders of the lumbar segment include both intervertebral disc damage and interapophyseal arthrosis. The main symptom of lumbar spondylosis is pain. It may be located either vertebrally, at the site of morphopathological changes, or remotely, along a radicular pathway [2]. Pain in spondylosis is usually moderate. Pain in lumbar spondylosis is exacerbated by prolonged standing, carrying heavy objects, heavy lifting, forced flexion or extension of the spine. Structural damage to the disc is manifested either by localised or radiating pain along the sciatic nerve, less commonly it can generate crural neuralgia [1]. Radiculopathy is usually the result of nerve root compression from a structural lesion, but secondary can also result from irritation

from inflammation of surrounding tissues. The main symptoms of radiculopathy are radiating pain, weakness, tingling and numbness [3]. On clinical assessment, muscle strength is preserved because muscles often receive innervation from more than one root, it is only affected in severe cases of radiculopathy [4]. There is a decrease or loss of muscle strength involving the hamstrings and the muscles supplied by the peroneal and tibial nerves. Numbness occurs on the lateral half of the leg and over the entire leg [4].

In clinical practice, electrodiagnostic studies, i.e. electromyography and nerve conduction studies, are used to confirm an injury involving the tibial and common peroneal nerves. Nerve conduction studies provide information on myelin viability. Delayed conduction velocity as well as delayed latency indicates nerve compression [3].

The main aim of this study was to identify the changes in nerve conduction parameters in cases of lumbar radiculopathy due to lumbar spondylosis and intervertebral disc pathology with no clinical neurologic deficit and to identify the potential of nerve conduction studies in the early diagnosis of these cases. We hypothesized that nerve conduction studies could be used for the early diagnosis of lumbar radiculopathy, even when no evident neurological deficit was present.

2. Results

Eleven patients aged between 41 and 78 years (mean age 58 ± 13.1 years; 4 males, 36.36%) met the inclusion criteria and agreed to participate in this study. Patients characteristics are presented in Table 1. All patients had pain for more than 3 months. The mean duration of symptoms was 3.81 ± 1.6 months. Pain intensity was 74.54 ± 6.87 on the VAS scale. At physical examination, only one patient had a negative straight leg raise test. None of the patients reported muscle weakness, numbness, hypoesthesia in specific dermatomes and myotomes.

Table 1. Patients characteristics

	Patients (n=11)
Age (years) mean±SD	58 ± 13.1
Weight (kg) mean±SD	81.73 ± 10.01
Height (cm) mean±SD	166.09 ± 6.12
BMI (kg/m^2)	29.65 ± 3.63

Almost all EQ-5D-5L domains scores revealed moderate problems – EQ-5D-5L mobility score was 3.18 ± 0.98, EQ-5D-5L Usual activities score was 3.09 ± 0.53, EQ-5D-5L pain score was 3.63 ± 0.5 and EQ-5D-5L Anxiety score was 3.18 ± 0.4. Only the EQ-5D-5L self care score suggested slight problems. Most of the patients (n=7, 63.64%) rated the pain domain with a score of 4, indicating severe problems. For the Self care, Usual activities and anxiety domains, most patients considered that they have moderate problems (n=7, 63.64% for Self care; n=8, 72.73% for Usual activities and n=9, 81.82% for Anxiety, respectively).

On MRI, bilateral nerve root involvement due to intervertebral disc protrusion was described in 6 patients (54.54%), most of them at L4-L5 and L5-S1 level. Based on MRI descriptions, there were 4 cases of Grade 1 (contact) (36.36%) and 7 cases of Grade 2 (63.64%).

For those with bilateral root compression and bilateral symptoms, the electrodiagnostic parameters were analysed for both sides. Thus, electrodiagnostic parameters were recorderded and analysed for 17 lower limbs, being presented in Table 2. Results were compared with the reference values recomemended by Chen et al. [5] for tibial and peroneal nerve. Conduction velocity was reduced in 29.41% of the 17 examined tibial nerves, and in none of the examined peroneal nerves. The registered amplitudes, for none of the tibial or peroneal nerve, have not been lower than the reference values recommended by Chen et al [5]. Patients with reduced tibial conduction velocity had a Grade 2 nerve root involvement on MRI.

Table 2. Electrodiagnostic parameters.

	Distal motor latency (ms)	Amplitude (mV)	Conduction velocity (m/s)	Residual motor latency (ms)
Tibial nerve	3.38 ± 0.53	9.95 ± 2.68	43.07 ± 5.33	1.39 ± 0.42
Peroneal nerve	3.02 ± 0.35	5.37 ± 2.05	45.12 ± 2.64	1.76 ± 0.25

Data are presented as mean±SD.

3. Discussion

The aim of the present study was to identify the changes in nerve conduction parameters in cases of lumbar radiculopathy due to lumbar spondylosis and intervertebral disc pathology with no clinical neurologic deficit and to identify the potential of nerve conduction studies in the early diagnosis of these cases. Patients included in this study were diagnosed with lumbar radiculopathy based on clinical an imagistic data. All patients reported a high intensity pain, with moderate self-reported problems on the EQ-5D-5L questionnaire. The nerve root involvement was described as Grade 1 (contact) or Grade 2 (deviation) on MRI results.

Our hypothesis was partially sustained by our results. We found a reduced conduction velocity only in the tibial nerve in 29.41% cases. Although nerve conduction study is a standard diagnostic test in patients with neuromuscular complaints, there are no established universal reference values. The American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM), through their Normative Data Taskforce, gathered rigoursly published data that met high quality criteria [6], and recommended a set of reference values to be used in electrodiagnostic practice [5]. We compared our nerve conduction study results with these reference values for tibial and peroneal nerve and found that only in 29.41% cases the tibial nerve conduction velocity was reduced. Studies in literature do not compare their electrodiagnostic study results with universal reference values; they either used a control group, or the uninvolved side as reference, or rely on their own laboratory data and experience. Ghugare et al. [7] found no significant difference in nerve conduction results between a group of patients with chronic low back pain with no clinical neurodeficit and a control group, except for peroneal nerve amplitude and conduction velocity.

Yousif et al. [8] found a reduced amplitude of the common peroneal nerve in 20% of patients diagnosed with lumbosacral radiculopathy caused by lumbar intervertebral disc herniation, while a reduce conduction velocity only in 10% of patients. For the tibial nerve, they reported a reduced amplitude in 6.7% of paitnets, and a reduced conduction velocity in 16.7%. The above mentioned authors have not found a significant correlation between abnormal nerve conduction study results and abnormal physical examination, nor between abnormal nerve conduction results and the presence of nerve root compression in MRI [8]. In this study, all cases with abnormal nerve conduction results presented on MRI a Grade 2 nerve involvement, meaning a dorsal displacement of the nerve root by disk material [9].

The positive predictive values of nerve conduction study results reported in Yousif et al. [8] study was 75%, with a sensitivity of 65.2% and a specificity of 28.6%.

Patients included in this study had a mean symptom duration of 3.81 ± 1.6 months. Nafissi et al [10] found a significant relationship between electrophysiological findings and the duration of symptoms, with more abnormal results in patients with clinical lumbosacral radiculopathy for more than 6 months.They also reported reduced or absent peroneal amplitude in patients reporting pretibial muscle weakness and in 27.6% of patients with positive straight led rise test.

The main limitation of this study is the small sample size. Further studies are needed with larger sample size to further investigate the electrodiagnostic characteristics in patients with lumbar radiculopathy with and without clinical neurologic deficit and to assess the potential use of the nerve conduction studies in the early diagnosis of these patients.

4. Materials and Methods

4.1. Patients

Patients addressing to physical medicine and rehabilitation services for lumbar pain associated with radiculopathy symptoms were recruited to be included in the study. Inclusion criteria were 1) age over 18 years, 2) lumbar radiculopathy with no clinical neurologic deficit, 3) MRI assessment performed in the last month, 4) no spine surgery or other invasive procedures, 5) no history of lower neuromuscular disorders, polyneuropathies, diabetes mellitus or malignancy.

Study protocol was explained to all participants and those who fulfilled the inclusion criteria and agreed to participate in the study signed an informed consent. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of „Victor Babes" University of Medicine and Pharmacy Timisoara, Romania.

4.2. Assessments

Demographic data were collected, including age, sex, weigth and height. Clinical assessment was performed at the first visit, including history taking (symptoms duration, side affected, symptoms dermatomal distribution) and physical examination (posture and mobility assessment, palpation, straight leg raising test).

Pain intensity was quantified on the visual analogue scale (VAS) from 0 (no pain) to 100 (maximal pain). Patients also completed the EQ-5D-5L questionnaire, a standardized measure of health status [11]. The five dimensions assessed by EQ-5D-5L questionnaire are mobility, self-care, usual activities, pain/discomfort and anxiety/depression. The answers are ranked on 5 levels, from 1 indicating no problem, to 5 indicating unable/ extreme problems.

From the MRI reports, data about the level of the affected intervertebral disc, the extent of disc prolaps or herniation, the presence/ absence of the nerve root compression were collected. Nerve root involvement was graded according to Pfirmann et al. [9] in Grade 0 – normal – no nerve root compromise; Grade 1 – contact – visible contact between the disk material and nerve root, which has a normal position and no dorsal deviation; Grade 2 – deviation - dorsal displacement of the nerve root by disk material; and Grade 3 – compression – nerve root compression between disk material and the spinal canal wall.

Nerve conduction studies were performed with Neuro-MEP-Micro (Figure 1), a digital system designed to record electrical activity of muscles and nerves at 1 or 2-channel stimulation, and to measure and analyze their parameters [12].

Figure 1. The Neuro-MEP-Micro device

The recording was performed at room temperature, with patient in relaxed position. The algorithm for examining the lower limb muscles was established and the ground electrode was fixed in the area. Surface electrodes were used for the measurements.

In this study for peroneus nerve, the stimulation point was set in the middle of ankle line, 1-2 fingerbreadths over this line (Figure 2). For tibialis nerve, stimulation point was located behind the medial malleolus, a midpoint between ankle and Achilles tendon (Figure 3). The ground electrode was placed either at the foot back or at the middle third of a shin.

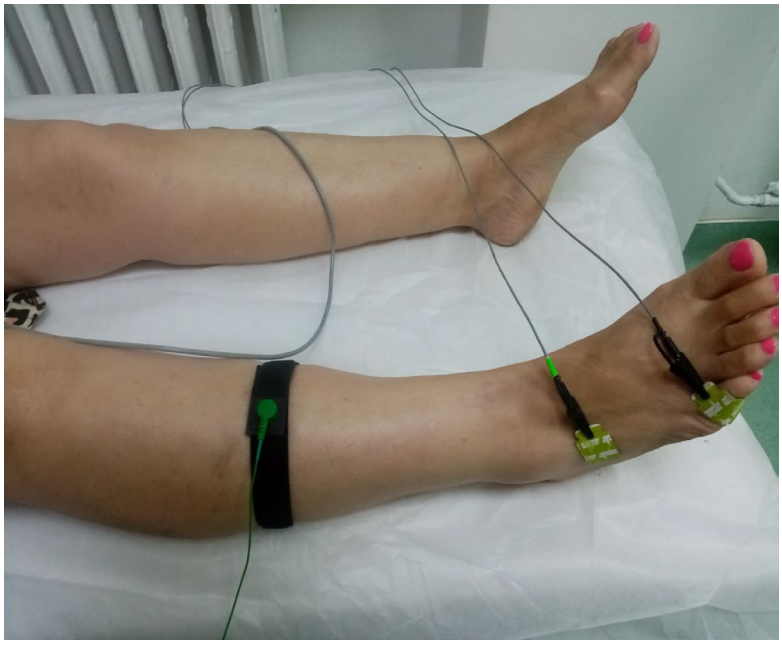

Figure 1. Electrodes placement for peroneus nerve, along the extensor digitorum brevis muscle

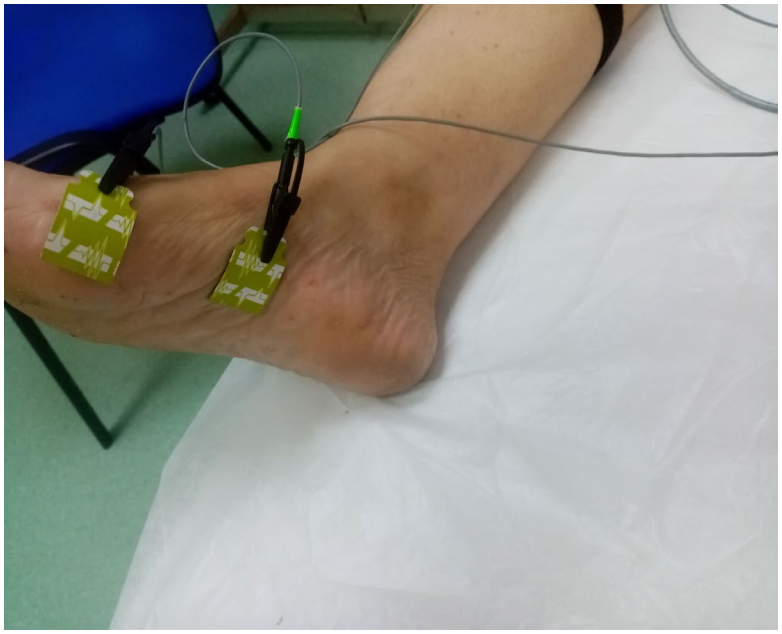

Figure 2. Electrodes placement for tibialis nerve, along the abductor hallucis

The stimulator emited isolated electrical pulses and the oscilloscope allowed visualization and measurement of distal and residual latency and amplitude of the muscle action potential evoked by the electrical stimulation. The parameters of evoked muscle action potentials analyzed in this study were amplitude, latency and motor nerve conduction velocity (MCV). Latency was measured from the onset of the stimulation artefact to the first deflection of the motor evoked potential. Stimulation at the proximal and distal

points allowed the measurement of conduction time along the entire nerve impulse propagation pathway. The difference between the two points represented the proximal (LP) and distal (LD) latency. For nerve conduction velocity, the distance between the two stimulation points was measured in mm. Nerve conduction velocity was calculated using the formula: NCV = S / LP-LD, where S = distance between the two stimulation points, LP = proximal latency, LD = distal latency, which is measured on the oscilloscope screen.

Residual latency (mRL) was calculated as follows: mRL = Distal motor latency − (distal nerve conduction distance /proximal MCV), MCV= motor conduction velocity [13].

5. Conclusions

Nerve conduction studies should be used to complete the physical and imagistic assessment of patients with lumbar radiculopathy, to detect functional abnormalities not only structural ones provided by the MRI. Nerve conduction velocity plays an important role in establishing the functional diagnosis of primary nerve damage.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

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