NEUROMETRY APPLICATION IN DIAGNOSING THE DISKOGENIC ACUTE LUMBOSACRAL RADICULOPATHIES

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Annotation. *The aim of the study was to assess the capabilities of the neurometric diagnosis of acute lumbosacral radiculopathy due to hernias of the intervertebral discs and stenotic lesions of the spinal canal and lateral openings. It was revealed that with acute lumbosacral radiculopathy caused by hernias of the intervertebral discs, regardless of the level of lesion, sensory afferents responsible for conducting tactile and temperature sensitivity and for rapid pain management are more damaged. Neurometry makes it possible to objectify the assessment of the state of sensory afferents of affected roots from the first days of a disco-radicular conflict and can be proposed as a method for early diagnosis of acute lumbosacral radiculopathy.*

Key words: *neurometry, lumbosacral radiculopathy, spinal stenosis, lateral stenosis, intervertebral disc herniation.*

Vertebrogenic diseases are dominant in the structure of population's sickness rate in Ukraine; notably, about 80% of country citizens had low back pain at least once in a lifetime [4, 12.]. About 30% of all the cases of the initial disability state are currently related to the diseases caused by degenerative changes in intervertebral disks of the lumbosacral spine region [2, 6]. There is the annual permanent tendency to the rejuvenescence of patient population, especially with the acute lumbosacral radiculopathies (ALSR) secondary to herniated intervertebral disks prone to protracted and sometimes even recurrent course [8]. This is the key factor in searching the new approaches to the early ALSR diagnosis [5]. For objective assessment of the functional state of root nerve involved into the disk-radicular conflict, neurometry has been brought into application over recent years as one of the new techniques of the Quantitative Sensory Testing [9, 10, 13, 14]. Neurometry examination makes it possible to perform extremely accurate functional assessment of the fine unmyelinated C-fibers responsible for slow guidance of pain, thick myelinated Aβ-fibers – responsible for tactile sensitivity and Aδ-fibers – responsible for temperature sensitivity and quick guidance of pain. These three main types of sensor guides make over 90% among all sentient fibers in peripheral nerve and it is impossible to assess their state using other electrophysiological methods [1]. Any manifestation of ALSR depends directly on the type of nerve fibers involved into the disk-radicular conflict; and upon identifying the most significant pathophysiological mechanisms of the disease process, it is possible to develop new modern concepts in radiculopathy treatment strategy, thus motivating the

relevance of this research.

Objective: to assess the possibilities of ALSR neurometric diagnosing caused by to herniated intervertebral disks and constrictive lesions of spinal canal and lateral apertures.

Materials and methods. With regards to the research objectives and tasks, 100 persons with acute compression lumbosacral radiculopathies secondary to vertebrogenic pathology have been examined. Depending on the character of vertebrogenic disorders, the examined persons were split into two clinical groups. The man group included 45 patients having lumbosacral radiculopathy caused by diskogenic pathology along with the constrictive process in spinal canal and lateral apertures. The control group consisted of 55 persons with lumbosacral radiculopathy developed only in the setting of intervertebral disk pathology on the level of one spinal motion segment.

The examination was carried out over time within 1-7 days, 10-14 days, and 30 days. The time intervals for patient examination have been chosen considering the pathomorphological disease stages.

The acute stage (1-7 days) is characterized by the exudative inflammation development, accompanied by the perifocal edema adjacent to fiber disk-radicular conflict zone, compression of epidural cavity and roots and their vessels, as well as the vertebral venous plexus.

Subacute period (2-3 weeks) presents the stage of productive inflammation accompanied by the formation of adhesions around the hernia which distort the epidural cavity by compressing the roots.

The start of proliferative period corresponded to the early recovery stage (4-6 weeks).

Neuroimaging assessment of disk-radicular conflict was carried out using the helix CT-scanner Toshiba (120 kV, 206 mAs, 0.75 – 1.0 s). Neurometry was performed using the machine Neurometer NS3000® (США) for functional assessment of the fine unmyelinated C-fibers responsible for slow guidance of pain, thick myelinated Aβ-fibers – responsible for tactile sensitivity and Aδ-fibers – responsible for temperature sensitivity and quick guidance of pain.

The results were processes statistically using Microsoft® Excel and software application STATISTICA for Windows 6.1 (Microsoft®).

Results. All patients finished the examination in the planned mode. The obtained data were analyzed considering the dynamics of neurometric indicators.

The Quantitative Sensory Testing (neurometry) was carried out using the automatic electrical diagnostic instrument Neurometer NS3000 according to the manufacturer's standard procedure on the level of the affected root nerve, superjacent and subjacent roots. Automatic character of examination made it possible to minimize the dependence of the obtained data on the patient's subjective perception.

The dynamic assessment of neurometric indicators of the patients from both groups at all examination stages is given in the Table 1.

Table 1

The assessment of state dynamics of fine nociceptors by means of Quantitative Sensory Testing of the patients from both groups depending on the gender at all examination stages (in points)

Fiber type	Main group						Control group					
	I stage		II stage		III stage		I stage		II stage		III stage	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
C	6.7 ± 1.1	5.6 ± 1.3	7.2 ± 1.8	7.6 ± 2.0	8.8 ± 2.3	7.4 ± 1.9	3.8 ± 2.1	13.2 ± 2.1	5.3 ± 3.4	9.9 ± 2.5	10.2 ± 2.1	8.7 ± 2.4
Aβ	5.2 ± 1.8	4.5 ± 2.1	5.9 ± 0.9	5.1 ± 1.7	7.7 ± 2.8	8.1 ± 2.5	17.1 ± 4.0	14.2 ± 3.6	13.5 ± 3.3	5.7 ± 2.3	7.9 ± 2.4	8.6 ± 3.7
Aδ	5.0 ± 1.4	4.1 ± 1.9	5.2 ± 1.2	3.9 ± 1.5	7.0 ± 2.2	8.7 ± 2.9	16.5 ± 3.2	17.3 ± 4.1	5.0 ± 1.3	5.8 ± 2.5	9.4 ± 3.6	10.1 ± 2.6

It has been found that during the 1st examination stage in case of the stimulation threshold value the sensory disorders of the patients from the main group were of the apparent hyperesthetic character, except for the fine unmyelinated C-fibers in men (6.7 ± 1.1). The sensory changes in the control group indicated the hypesthesia and besides the response to stimulation from the side of C-fibers was minimal (13.8 ± 2.1 in men and 13.2 ± 2.1 in women). The most significant hyperesthetic disorders were detected in women of the main group during the 1st and 2nd examination stages ($p<0.05$). Thus, they had minimal electrical current sensitivity threshold (ECST) at the frequency of 2 kHz during the 2nd examination stage (3.9 ± 1.5), and at the frequency of 250 Hz – during the 1st stage (4.5 ± 2.1). By the 3rd examination stage there was a tendency to normalization of indicators (8.7 ± 2.9 along Aδ-fibers, and 7.7 ± 2.8 – along Aβ-fibers).

The most apparent hypesthetic changes on the control group were detected during stimulation of Aβ- and Aδ-fibers. Thus, while assessing the value of threshold stimulation at the frequency of 2 kHz obtained from Aβ-fibers during the 1st examination stage, the maximum indicators were 7.1 ± 4.1 in men and 17.3±4.1 in women. The function of C-fibers of all patients from the control groups was disordered to a far lesser extent (13.8 ± 4.2 in men и 13.2 ± 2.1 in women), but along with this there was the hypesthetic tendency of sensory disorders.

During the 2nd examination stage the patients from the main group started to demonstrate the tendency to the improvement of neurometric indicators: thus, the electrical current sensitivity threshold for Aβ- fibers was 5.9 ±0.9 in men and 5.1 ± 1.7 in women, for C-fibers – 7.2 ± 1.8 in men and 7.6± 2.0 in women. While examining Aδ- fibers in men during the 2nd stage, ECST indicators improved slightly (5.2 ± 1.2),

and in women it even decreased slightly; along with that the most minimum value of the electrical current sensitivity threshold (3.9 ± 1.5) was recorded. The men from the control group with changes of ECST indicators while examining the functioning of Aδ-fibers during the 1st stage demonstrated the tendency to rather fast transition from the state of apparent hyperaesthesia (16.5 ± 3.2) to hypoaesthesia (5.0 ± 1.3).

While assessing the functioning of Aβ-afferents during the 2nd examination stage, the men from the control group demonstrated the regression of hyperesthetic indicators (13.5 ± 3.3), whereas the women demonstrated the changes similar to those detected during the examination of Aδ- fibers (5.7 ± 2.3).

While assessing ECST indicators of C-fibers of the patients from the control group during the 1st and 2nd examination stage, the hyperesthetic changes detected during the 1st stage in men (13.8 ± 4.2) were normalized partially in 15 cases, and 6 patients demonstrated the transition into slightly apparent hypesthetic changes. In women, these indicators tended to permanent decrease of hyperpathia (9.9 ± 2.5).

During the 3rd examination stage the patients of the main group demonstrated the normalized functioning of C-afferents of the affected roots almost in all men (23 cases) (8.8 ± 2.3) and in most women (27 patients) (7.4 ± 1.9). The electrical current sensitivity threshold while assessing the functioning of Aβ- fibers in the main group by the last stage also went back to normal indicators (8.1 ± 2.5 in women and 7.7 ± 2.8 in men) in most cases. The similar situation was observed in this group of patients during the stimulation of Aδ- fibers. By the 3rd examination stage, the most patients demonstrated normalization of ECST indicators along Aδ- fibers (8.7 ± 2.9 in women and 7.0 ± 2.2 in men). Likewise, the patients from control group demonstrated normalization of functioning indicators for Aβ-, Aδ- and C–fibers by the 3rd stage. It was found that the disk-radicular conflict disorganizes significantly the functioning of all sensory afferents of the affected root nerve from the very first days. As for the patients from the main group, in case of stimulation threshold value the sensory changes in the fibers under examination were of hyperaesthetic character during the first two examination stages with the following normalization of indicators by the 3rd examination stage κ in 46 patients (83.6 %).

As for the patients from control group, during the 1st stage the state of all examined sensory afferents of the affected roots, by contrast with the main group, was assessed as hypaesthetic; and along with this these changed were recorded mostly apparent in fibers responsible for guidance of tactile and temperature sensitivity. During the 2nd stage hypaesthetic changes in unmyelinated C-fibers in the most patients from control group passed and returned to the level of normal functioning. And the state of Aβ- and Aδ-fibers during this period was assessed as apparent dysfunction as in 46.7% patients the hyperaesthetic changes remained, in 53.3% – the indicators denoted the hypaesthesia. By the 3rd examination stage, most patients of control group (86.7%) demonstrated normalization of neurometric indicators in all groups of the examined sensory fibers.

Therefore, the neurometric monitoring made it possible to perform for the first time the objective assessment of the state of fine nociceptors (myelinated fibers of Aβ-

and Aδ- types and unmyelinated fibers of C-type) in patients with diskogenic ALSR. It has been found that in case of ALSR secondary to herniated intervertebral disks, irrelevant the affection level, the sensory afferents responsible for tactile and temperature sensitivity and rapid guidance of pain are damaged to a greater extent. The common factor has been determined in the dynamics of changes of the examined fiber stimulation indicators. Thus, during the 1st examination stage in case of the stimulation threshold value, the sensory changes in the examined fibers in patients from the main group were of hyperaesthetic character, whereas in control group – hypaesthetic one. During the 2nd stage the patients from the main group demonstrated the tendency to the improvement of neurometric indicators, whereas the patients from control group tended to the apparent sensory dysfunction. By the 3rd examination stage, 83.6% of patients from the main group and 86.7% from control group demonstrated the complete recovery of the functional activity of myelinated fibers of Aβ-, and Aδ- type and unmyelinated C- fibers.

Conclusions. 1) The results obtained analizing the data of neurometric examination of patients with diskogenic ALSR showed that the afferents responsible for tactile and temperature sensitivity and rapid guidance of pain are damaged the most severely.

2) Neurometry makes it possible to objectify the assessment of state of the affected root sensory afferents from the very first days of the disk-radicular conflict and can be offered as ALSR early diagnosis method with recommendations for wider application in routine medical by neurologists, vertebrologists, and neurosurgeons.

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