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A B S T R A C T

of the dissertation submitted for the degree
of Doctor of Philosophy

APPLİCATİON OF THE INTERFERENTIAL CURRENT AND SPİNAL COLUMN TRACTION METHOD IN THE COMPLEX TREATMENT OF VERTEBROGENIC LUMBOSACRAL RADICULOPATHIES

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Applicant:	**Parviz Yashar Akhundov**

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The dissertation work was carried out at the Scientific-Research Medical Rehabilitation Institute of Azerbaijan and National Institute of Sports Medicine and Rehabilitation

Scientific supervisor: doctor of medical sciences, professor, **Alishir Veys Musayev**

doctor of medical sciences, professor, **Sadagat Ganbar Huseinova**

Official opponents: doctor of medical sciences, professor **Rovshan Lazer Hasanov**

doctor of medical sciences, professor **Yusif Qadir Naghiyev**

doctor of philosophy **Isbi Salman Babakhanov**

doctor of philosophy **Shohrat Talib Talibov**

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Chairman of the Dissertation council:

doctor of medical sciences, professor **Garay Chingiz Garaybayli**

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Chairman of the scientific seminar:

doctor of medical science, professor **Nadir Ismayil Huseinov**

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Tibb elmləri doktoru, professor
Nazim Adil oğlu Pənahov
16.09.24

GENERAL CHARACTERISTICS OF THE STUDY

Actuality of the topic. Vertebrogenic lumbar radiculopathy (VLR) is characterized as a disorder of the lumbar vertebrae, manifested by pain syndrome, sensory, motor and reflex disorders[1]. According to the Global Disease Burden Survey (2017) conducted by the Institute for Health Metrics and Evalution, back pain was one of the leading causes of disability between 1990 and 2017, when systematic analysis was conducted[2]. The fact that the disease is more common in people with working capacity, often exacerbated, chronic, significantly worsens the quality of life and causes disability increases the urgency of the problem[3,4]. At present, it is believed that mechanical and non-mechanical causes play a role in the development of radiculopathy. Mechanical causes account for up to 90% of all cases, which are mainly due to skeletal-muscular (non-specific) reasons and pathological changes, such as vertebrogenic-degenerative dystrophic disease of the spine[4].

Despite the widespread prevalence, long-term progression and recurrence of the disease and the huge economic losses associated with it, there is still no optimal approach to its treatment. In this regard, the development of new effective treatment methods for the treatment of VLR is urgent. In addition to the surgical and drug treatments used, the application of physical therapy methods, the effectiveness of which has been proven by numerous studies, is of

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great importance. Many studies in recent years have shown high efficacy of impulse currents, including interferenial current (IC), in vertebrogenic neurological diseases, especially pain syndrome. Impulse current contributes to the improvement of neural regulation of muscles, increases permeability in nerve tissue and accelerates its recovery. In addition to the above, the improvement of local blood supply, elimination of hypoxia and reduction of edema also play an important role in the analgesic effect [5,6].

Due to the complexity of the progression of VLR and the tendency to recurrence, in many cases, monotherapy by a single method is not effective enough, and in this case a complex approach with a combination of different physical factors is needed. In this regard, the complex application of the method of spinal column traction (SCT) with IC may be more effective by affecting various pathogenetic sections of the disease. The purpose of SCT is to relieve irritation in the nerve root and disc, reduce pressure on the disc, and prevent disc contents from flowing into the spinal canal by creating negative intradisc pressure. At the same time, traction improves local blood circulation, reduces tissue edema, local aseptic inflammation, weakens reactive processes in tissues, reduces muscle contracture, pathological muscle tension[7,8].

Lack of information in the existing literature on the complex application of IC and SCT methods in the treatment and rehabilitation of VLR was the basis of the current research, defined the goals and objectives of the dissertation.

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The object and subject of the research.

The study included 97 patients with vertebrogenic radiculopathy in the lumbar region. The near and long-term results of the application of IC and SCT methods separately and in a complex in these patients were selected as the subject of the study (prospective study).

The purpose of the study.

Clarification of the mechanisms of action of IC and SCT methods in patients with vertebrogenic radiculopathy in the lumbar region, and on this basis the development and pathogenetic substantiation of a new complex treatment method.

Research objectives.

1. Study of clinical features of the disease, the condition of the segmental-peripheral neuro-motor apparatus, assessment of the relationship between vertebrogenic factors and radiculopathies detected by neuroimaging methods;
2. Assessment of pain syndrome and quality of life (QL) during VLR with the help of clinical scales and surveys;
3. To study the effect of therapeutic factors - IC and SCT methods on the clinical course of the disease, the intensity of the pain syndrome, QL, the condition of the segmental-peripheral neuromotor apparatus;
4. Assessment of the effectiveness of a comprehensive application of IC and SCT methods in the rehabilitation of patients with vertebrogenic radiculopathy.

Research methods.

In the study, patients diagnosed with VLR were treated with "Superkine" and "Supertrak" devices. Clinical-neurological and neurophysiological examinations, various surveys and scales were applied before and after treatment to assess the effectiveness of the treatment in patients.

The main provisions of the thesis:

1. Treatment and rehabilitation of patients with vertebrogenic lumbar radiculopathy is based on the assessment of motor and senso-

ry functions, including QL, as well as neurophysiological assessment of the condition of the peripheral neuromotor apparatus;

2. The application of IC and SCT methods in the treatment of vertebrogenic radiculopathy is of pathogenic character and therapeutically effective;

3. Interferential current and SCT have a positive effect on the clinical course of the disease, reduce the intensity of pain syndrome, cause regress of existing motor and sensory disturbances, improve QL, increase nerve conduction velocity (NCV) along the motor nerve fibers of peripheral nerves, has a positive effect on the afferent and efferent ring of the reflex arc, as well as the functional state of motoneurons of the spinal cord;

4. Complex application of IC in combination with SCT in vertebrogenic lumbar radiculopathy is more effective than their separate application, has a better effect on the clinical course of the disease, the intensity of the pain syndrome, QL parameters, the condition of the segmental-peripheral neuromotor apparatus.

Scientific novelty of the research.

In the prospective study, a pathogenetically justified effective treatment method with the use of IC and SCT methods in the rehabilitation treatment of veretebrogenic lumbar radiculopathies was developed. Due to complex clinical, neurophysiological and neuroima- ging studies, the causes of vertebrogenic radiculopathy, clinical polymorphism were studied. It was identified, that in the rehabilitation of patients IC and SCT have changed the clinical picture of the disease, reduced the intensity of pain syndrome, the expression of existing static-dynamic and sensory disturbances, improved patients QL, had a positive effect on segmental-peripheral neuromotor apparatus. Based on all this, this method can be considered an effective treat- ment method. It became clear that the improvement was more noticeable with the complex application of interferential therapy and traction.

Based on the obtained data, the clinical and neurophysiological mechanisms of the therapeutic effect of the introduced therapies have been analyzed. It has been studied that under the influence of these treatment methods there is an increase in the impulse transmission

speed in peripheral nerves, the normalization of the functional arousal of alpha motoneurons. The obtained data underlie the pathogenetic mechanisms of independent and combined application of IC and SCT methods and explain the mechanism of recovery of lost functions. It has been shown that the combined use of IC with SCT has a better effect on the clinical course of the disease, including the intensity of the pain syndrome, QL parameters and the condition of the segmental-peripheral neuromotor apparatus than their separate application. Based on this, a new methodology has been developed for the complex application of IC and SCT in vertebrogenic radiculopathy.

Practical significance.

1. A comprehensive approach is recommended for timely and early diagnosis of vertebrogenic lumbar radiculopathy, as well as to determine the severity of the disease, to assess the effectiveness of the applied treatment and rehabilitation procedures. For this purpose, in addition to clinical and neurological examinations, it is advisable to conduct complete clinical, neuroimaging and neurophysiological examinations using various scales and surveys, including VAS, McGill and Roland-Morris surveys.

2. Treatment methods based on the complex use of IC and SCT methods to increase the effectiveness in the rehabilitation of patients with vertebrogenic lumbar radiculopathy can be used in hospitals, rehabilitation centers and sanatoriums.

Realization of research results.

The complex treatment methodology developed with the use of IC and SCT in vertebrogenic lumbar radiculopathy is used in the Department of Neurology and Polyclinic of the SR Institute of Medical Rehabilitation, in the polyclinic department of the National Scientific-Practical Institute of Sports Medicine and Rehabilitation.

Approbation and application of the dissertation.

The materials of the dissertation were discussed at a number of republican and international conferences: at the scientific conference dedicated to the 90th anniversary of the corresponding member of ANAS, Ph.D., professor D.Hajiyev (Baku, 2019); Karabakh II

International Congress of Applied Sciences Azerbaijan National Academoy of Sciences (8-10 November 2021, Azerbaijan); at the 8th International Conference and Expo on Novel Physiotherapies, Physical Rehabilitation and Sports Medicine (London, 2021); At the scientific-practical conference “Medical rehabilitation: scientific views and modern approaches” (Baku, 2021); In the hybrid event "Scientific and practical aspects of cardioneurology" (Baku, 2021); At the interdepartmental meeting held jointly by the profile departments of the Scientific- Research Institute of Medical Rehabilitation (Baku, 2021).

Printed works. 18 works were published on the topic of the dissertation, including 9 articles (3 of them abroad) and 9 theses (5 of them abroad).

Volume and structure of the dissertation. The dissertation is presented in 178 typed pages, consisting of the following sections: introduction (13783 characters), literature (59401 characters), the chapter “Materials and methods of research” (25207 characters), 3 chapters of personal research (III – 19771 characters, IV – 5074 characters, V – 45869 characters), discussion (27971 characters), conclusion (28712 characters) and practical recommendations (1278 characters). The dissertation is presented with 51 tables, 16 graphs, 14 figures. The list of literature includes sources from 241 local, Turkish, Russian and foreign authors**.**

MATERIALS AND METHODS OF RESEARCH. TREATMENT METHODS

We have examined 97 patients with vertebrogenic radiculopathy in the lumbar region.

The clinical and neurological examination was carried out on a standard scheme and consisted of collection of complaints, life and medical history, and assessment of general and neurological status. To confirm the diagnosis and rule out other pathologies of the spine, patients underwent magnetic resonance imaging (MRI) of the lumbar spine. The condition of the neuromuscular apparatus in the observed

patients was studied by neurophysiological methods – electroneuromyography (ENMG), electromyographic late responses.

During the clinical and neurological examination, a digital rating scale form of the Visual Analogy Scale (VAS) (Kuzmenko V.V. et al., 1986) was used to assess the pain syndrome that caused the most maladaptation in the majority of patients. 1975). A short version of the McGill pain survey (Melzack, 1975) was used to qualitatively assess pain syndrome.

The "five-point scale of vertebroneurological symptoms" (Belova A.N., 2000) was used to measure the volume of movements, to assess the expressiveness of scoliosis, root symptoms, neurodystrophic syndrome. Muscle strength was assessed on a six-point scale (R. Broddom, 1996; M. Weiss, 1986). QL in VLR was assessed using the Roland-Morris “back pain and disability” survey (M. Roland, R. Morris, 1983).

In electroneuromyographic (ENMG) examinations the followings were analyzed: indicators of M-response in the "sick" and "healthy" lower extremities in the tibial and peroneal nerves - amplitude, NCV, terminal latency; Indicators of F-wave - minimum latency, F-wave chronodispersion, F-wave NCV, F-wave block; H-reflex indicators – latency, amplitude, M-potential amplitude were analyzed. Electromyographic examinations were performed on Nicolet (USA) and Neurosoft (Russia) electromyographs.

Depending on the treatment and rehabilitation measures, patients were divided into 3 groups. All patients in the first group (n =33) were treated with the “Superkine” device (variant “B”) by applying interferential current of 30-100 Hz in the lumbar region and on the sciatic nerve in the painful lower extremities. In this case, one of the frequencies changed constantly, the other according to the instruction. The electrodes were placed on the posterior surface of the thigh along the sciatic nerve, corresponding to the lumbar paravertebral region and the damaged nerve root, so that they could interact with each other. The treatment lasted 12-15 minutes.

Patients in the second group (n=32) were subjected to horizontal "dry" traction with the "Supertrak" device. The treatment

was carried out by an intermittent method, with the scheme increasing the duration and strength of traction from 20% to 40% of body weight. In patients of the third group (n=32), both methods were introduced on the same day, in combination with the above methods. In this case, patients were given traction 1-3 hours after interference therapy. To increase the effectiveness of the treatment, all groups of patients were prescribed therapeutic exercise and massage.

Therapeutic sports included strengthening, isometric bending of the spine, active and passive opening, aerobic exercises.

The course of treatment in all three groups lasted 10-12 days.

Inclusion criteria included patients over the age of 18 and under the age of 70, clinically and neuroimaging-confirmed, with radiculopathy accompanied by compression of one or more roots in the lumbar region. Criteria for exclusion from the study included general contraindications to physical therapy as well as specific contraindications to interference therapy and traction, also pregnancy, history of alcoholism, diabetes mellitus,

The data entered into the computer were processed using the program "SPSS 26" (Statistical Package for the Social Sciences), "Microsoft Excel 2010" "Data Analysis". The information obtained is described in detail in the "Description and Interpretation of Results" section. All findings in the study were tested at $p < 0.001$ and $p < 0.05$ accuracy degree and bilaterally.

RESEARCH RESULTS AND THEIR DISCUSSION

The majority of patients were men - 54 (55.7%) were men and 43 (44.3%) were women. The mean age of the patients was 43.63 ± 11.75. The duration of the disease was different: up to 3 months - 51.5%, from 3 months to 6 months - 22.7%, from 6 months to 1 year - 21.7%, more than 1 year - 4.1% of patients. Anamnestically, 41.2% of patients cited a sedentary, hypodynamic lifestyle as the cause of pain, 36.1% cited work related to physical exertion, and 22.7% did not cite any detrimental factor as the cause.

At the center of the clinical picture is pain syndrome, which has been observed in all patients of varying intensity and nature. The pain was mostly located in the lower back, and after a while began to irradiate the lower extremities. Right-sided pain syndrome was observed in 45.4% of patients, left-sided pain syndrome in 48.4%, and bilateral pain syndrome in 6.2%. Moderate pain was observed in 43.3% and noticeable pain in 54.7% of patients. The mean VAS was 6.46±0.12 cm, which corresponds to moderate pain (Table 1).

Table 1

Intensity of pain syndrome on VAS (n=97)

Pain intensity	Before treatment	
	Number of patients	
	In figure	%
No pain (0)	0	
Weak (1-3)	2	2,0
Moderate (4-6)	42	43,3
Severe (7-9)	53	54,7
Unbearable (10)	0	3,8
Total	97	100
VAS, cm	6,46±0,12	

The McGill pain survey assessed significant disorders in both sensory and affective-emotional areas during pain assessment. According to the scale, the pain is mostly burning (34.4%), tensile (34.4%), dull and aching (22.6%), piercing (15%). Other types of pain, including acute (15%), stabbing (5.4%), piercing (5.4%), beating (2.1%) and pulsating (2.1%) pain were relatively rare. On the affective subcale pain was mainly tiring.

According to the "five-point scale of vertebroneurological symptoms", in the assessment of the pre-treatment condition, significant changes were observed mainly in the subclass of root damage symptoms (2.72±0.09 points). Changes in the range of motion in the affected area of the spine were relatively small (1.05± 0.12), neurodystrophic syndrome (0.75±0.10 points) and scoliosis (0.68±0.11 points) were less common.

Changes in the emotional and mental status of patients in the form of emotional lability, sensitivity, arousal were observed in 52 (53.6%) patients. Correction of lumbar lordosis, a characteristic feature of static-dynamic changes in the spine, was observed in 63 (64.9%) patients. Correction of lumbar lordosis in these patients was accompanied by varying degrees of tension in the paravertebral muscles. Thus, tension in the long muscles of the lumbar spine was detected in 66 (68%) patients. Antalgic scoliosis was observed in 16 (16.5%) patients as a protective reaction of the spine. In addition to static disorders, significant changes in biomechanical functions occur during degenerative-dystrophic disease of the spine. Restriction of active movements was observed in 76.3% of patients, which in most cases manifested itself in the limitation of forward flexion. The "finger-floor distance" test was 33.6±6.49 cm. Objective examination revealed pain in the lumbar paravertebral points in 78 (80.4%) patients, pain in the exit points of the sciatic nerve in 77 (79.4%) patients, and pain in the Valle points along the nerve pathway in 69 (71.1%) patients.

The walking of the patients was disturbed in different ways depending on the intensity of the pain syndrome and the degree of decrease in the strength of the lower extremity muscles - protective walking was observed in 39 patients, and limping during walking in 19 patients.

The neurological symptoms characteristic of root damage in patients included tension symptoms, reflex, sensory, and motor disorders.

Mainly the Lasegue symptom was positive among tension Symptoms – 77 (79.4%). The mean angle of pain in patients with expressive pain syndrome was 49.26±1.65.

Dermatoma superficial sensory examination also played a role in the clinical diagnosis of VLR. Disorders of superficial (pain) sensation were observed in the form of hypoesthesia and hyperesthesia. The sensory disturbance corresponded to the innervation zone of the damaged roots (root type).

Root syndromes detected in all patients during clinical-neurological examination were mainly monoradicular. Thus, monoradicu-

lar root syndrome was 64.9%, biradicular root syndrome (L_4 and L_5, L_5 and S_1) was 35.1%. 6.3% of monoradicular root syndromes were observed with the damage of L_4 roots, 49.2% with the damage of L_5 roots and 44.5% with the damage of S_1 roots (Table 2).

Table 2

Classification of patients according to the localization of root damaging

Root syndromes / Number of patients	Monoradicular syndrome			Biradicular syndrome	
	L_4	L_5	S_1	$L_4;L_5$	$L_5;S_1$
Abs	4	31	28	5	29
%	4.1	31.9	28.9	5.2	29.9

Roland-Morris's survey on "low back pain and impaired quality of life" allowed us to study changes in QL in patients with vertebrogenic radiculopathy in the lumbar region. Analysis of the results of pre-treatment surveys showed changes in physical and social functionality, general health, daily activity, as well as psycho-emotional status of patients. According to the survey, patients with low back pain mainly avoided heavy work at home (89%), bending and kneeling (80.2%), they had difficulty in wearing socks (85.7%), turning in bed (82.4%), moving on the stairs (67%) and getting up from the chair (65.9%). 73.6% of patients had difficulty staying in the same position for a long time due to pain, and had to lie down and rest. The average percentage of decrease of quality of life indicators on the survey was 55.59±13.32%.

In the ENMG examination, a decrease in NCV was observed in biradicular root damages compared to monoradicular damages: 41,97 ±3,96 m/sec.($p<0,05$) along the tibial nerve, 46,92±3,72 m/sec. along the peroneal nerve. There was a moderate decrease in the amplitude

of the M-response obtained from the short muscle that opens the toes (m. extensor digitorum brevis) and the long muscle that bends the big toe (m.abductor hallucis longus). Thus, in the case of damage to the L_5 root in the vicinity of the "sick" extremity, the M- response amplitude was 5.6±1.05mV in the peroneal nerve, 9.55±2.2 mV in the tibial nerve, and 7.26±2,61 mV ($p<0,05$); 10.22±3,24 mV ($p<0,01$) in the S_1 root, respectively. Damage to the roots led decrease in the amplitude of the M-response obtained by examin - ing both the tibial and the peroneal nerve in the "healthy" extremity. It should be noted that there was a correlation between the M-response amplitude and the NCVeff indicators and the existing clinical signs, especially motor disorders.

Examination of electromyographic late responses in patients also revealed changes. Thus, monosynaptic H-reflex examination showed a decrease in the amplitude of the H-reflex over the soleus muscle (m.soleus). Structural changes in the S_1 root (involved in the formation of the H-reflex in the calf muscles), as well as damage to the Ia afferent fibers in the tibial nerve led to changes in the H-reflex, which was mainly manifested by a decrease in its amplitude. During recording on M. soleus, the amplitude of the H-reflex was 2.60 ± 0.30 mV ($p<0.001$). Along with the amplitude of the H-reflex, a delay in its latency was also observed. Thus, the mean latency index was 32.88±0.69 ms ($p<0.001$).

Other electromyographic late response - F-wave examination also showed significant changes: when comparing "sick" and "healthy" lower extremity F-wave readings, the F-wave latency on the side with the root syndrome and, consequently, the chronodisper-sion index was prolonged, impulse transmission speed decreased. Thus, the minimum latency of the F-wave (Fmin.) during stimulation of the peroneal nerve on the side with the root syndrome was 48.71± 0.68 ms, chronodispersion (Fc) is 6.46±0.42 ms ($p<0.01$), F-NCV was 50.81±0.65 m/s ($p<0.01$). Changes in these parameters were also observed in the F-wave examination of the tibial nerve; Fmin: 47.97±0.65 ms, Fc.: 6.67±0.36 ms ($p<0.01$), F- NCV 51.80±0.54 m/s.

During the analysis of the conducted MRI examination, signs of degenerative dystrophic changes of the lumbar intervertebral disc to various levels were detected in all patients, which manifested itself in changes such as a decrease in their height, the appearance of sclerotic changes on the closing surfaces, and a decrease in the degenerative signal in the intervertebral discs. MRI scans revealed an intervertebral disc hernia that caused a root-disc conflict in 26 (34.6%) patients, a protrusion in 23 (30.7%) patients, and a combination of hernia and protrusion in 26 (34.7%) patients. Circular swelling of the fibrous ring was observed in 38.6% of patients. The size of intervertebral disc hernias (IVDH) and protrusions found in the examined patients was 4.54±0.2 mm. Hernias and protrusions were mainly of the posterior median- paramedian localization - in 50.7% of patients. The pathological process was mainly located at the level of L_4-L_5 (33,3 %), L_5-S_1 (36%) IVDH. In addition to the mentioned changes, other manifestations of degenerative-dystrophic changes of the spine in a certain number of patients: smoothing of the lumbar lordosis (33.3%), Schmorl's nodes (18.7%), facet joints arthropathies (25.3%), damage to the ligament apparatus (13.6%) was detected. The results of the MRI examination showed that the nature of degenerative-dystrophic changes in the spine and FAD is the same in most patients, and the degenerative process appears as the main etiological factor for the formation of vertebrogenic lumbosacral radiculopathy. Due to the location of the pathological process at different levels and localizations, the clinical picture of the disease has an individual character.

Clinical observations have shown that patients respond well to IC and SCT, with relief in most patients after the first procedures. At the end of the course of treatment, the complaints of patients decreased in all groups. The intensity of the pain syndrome decreased, and positive changes in the nature, irradiation, and reaction to the factors provoking the pain were observed. The method of treatment we use has also reduced the sensational and motor disorders in patients. In most patients, walking was improved and numbness in the lower extremities was reduced.

At the end of the course of treatment, the existing muscle tension in patients was reduced, and walking was improved. These changes have led to an increase in the range of movements in the lumbar region, which has been evident in the re-application of the 'finger-floor distance' measurement test after treatment. In the group of patients treated with complex physical factors, the volume of active movements increased more than in other groups and was statistically more reliable. Thus, in the 1st research group the indicator (distance, cm) increased from 35.33±1.15 to 23.54±1.82 ($p<0.01$), in the 2nd research group from 33.89±1.25 to 21.94±2.14 ($p<0.05$), and in group 3 from 32.22±1.34 to 14.70±1.76 ($p<0.001$).

The methods of treatment we have used have reduced the intensity and nature of the pain syndrome, and in some cases completely eliminated it. Prior to treatment, the majority of patients reported moderate to severe pain (6-7 cm in VAS). As a result of the treatment, the intensity of pain on VAS in the 1st study group reduced from 6.52±0.25 cm to 3.97±0.36 cm ($p<0.01$), in the 2nd research group from 6.31±0.23 cm to 3.88±0.35 cm ($p<0.01$), and in the 3rd research group from 6.53±0.17 cm to 2.91±0.27 cm ($p<0.001$).

Positive dynamics was observed in all groups in the assessment of pain syndrome with the McGill pain survey during the applied treatment: In research group 1 40,3% positive dynamics was seen in pain rank index (PRI) and 18.8% in the number of selected descriptors (NSD). In the 2nd study group, 53.9% efficiency was observed in PRI and 29.9% in NSD. Due to the combined effect of physical factors in the 3rd research group, where both methods were applied together, a positive dynamics was observed in 64.8% of the total PRI and 42.2% in the NSD. In the treatment group, where the interferential current and the vertebral column traction were used together, the sensory nature of the pain, as well as the emotional-affective nature, were significantly reduced compared to other groups ($p<0.01$, $p<0.001$).

The analysis of the "five-point scale of vertebroneurological symptoms" before and after the treatment showed a positive dyna-

mics in the course of treatment in all groups. In general, the treatment had a positive effect on all the indicators assessed on the scale - the volume of movement in the affected area of the spine, scoliosis, root and neurodystrophic syndromes. Thus, as a result of treatment, the total indicator (in scores) in the 1st research group decreased from 4.91±0.37 to 3.39±0.34 ($p<0.01$), in the 2nd research group from 4.9±0.35 to 3.35±0.42 ($p<0.05$), and in the 3rd research group from 5.82±0.37 to 2.91±0.42 ($p<0.001$).

The treatment also had a positive effect on sensory disorders, which manifested itself in the restoration of sensation in dermatomes corresponding to the root innervation or narrowing of the existing sensory disturbance. Improvement was observed in 32% of patients treated with IC, 28.6% of patients treated with SCT, and 42.85% in the group where both methods were used in combination.

A more pronounced regression of tension symptoms was observed in the treatment group in which IC was applied in combination with SCT. In this group, the angle of pain after treatment was significantly increased compared to other groups. Thus, in groups treated with IC or SCT alone, the angle of pain after treatment was 65.0±4.11; 66.67±3.95, respectively (>75 degrees, 1 point). The angle noted in the group of complex application of both methods was greater than 75 degrees – 79.09±2.99 (0 points) ($p<0.001$).

The decrease in the intensity of the pain syndrome, the elimination of the changes in the movement and feeling sphere, the decrease in the symptoms of stretching have a positive effect on the walking function of the patients at the same time.

The decrease in the intensity of the pain syndrome led to an increase in physical activity in daily life, an improvement in emotional state, which was reflected in a statistically significant decrease in the integrated indicators of the Roland-Morris survey in all three groups ($p<0.001$). In general, as a result of treatment in the 1st research group, the level of QL decline reduced from 60.0% to 44.2%, in the 2nd group from 51.7% to 38.0%, in the third group from 56.8% to 32.6%. The coefficient of effect of the applied

treatment on QL shows that the treatment is effective in all groups, and this effectiveness is higher in the 3rd research group.

Simultaneous improvement in clinical symptoms was observed in all groups with an increase in the speed of impulse transmission along the peripheral nerves (NCVeff), but a more significant and statistically significant improvement in both nerves examined was observed in the group treated with complex therapy. At the end of the course of treatment in this study group, on the side with the root syndrome, NCVeff increased from 46.05±0.81 m/s to 50.20±1.36 m/s in the tibial nerve, and from 48.97±0,97 m/s to 52.48±0.85 m/s in the peroneal nerve with high statistical reliability ($p<0.001$). Along with IST, there was an increase in the amplitude of the M- response from the lower extremity motor nerves, indicating an increase in the process of reinnervation of the muscles supplied with the tibial and peroneal nerve – the amplitude of the M-response from the long muscle moving the big toe away increased from 10.01±0.49 mV to 12.07±0.71 mV, and in the short muscle stretching toes the increase from 7.06±0.42 mV to 9.32±0.49mV was observed ($p<0.001$). However, the effect of IC and SCT on the neuromuscular apparatus in terms of statistical reliability is less reliable when used separately ($p<0.05$; $p<0.01$;) and highly reliable when used together ($p <0.001$).

After the course of treatment, positive dynamics in H-reflex indicators was observed in all groups. Thus, the minimum latency of the H-reflex in group 1 reduced from 33.52±1.27 ms to 30.88±1.04 ms, in group 2 from 32.5±1,01 ms to 31.5±1.72 ms and in group 3 from 32.13±1.06 ms to 28.79±1.17 ms ($p<0.01$). A decrease in the latency of the H-reflex can be assessed as an indicator of improved reflex excitability of motor neurons and nerve conduction. The positive dynamics in the H-reflex amplitude ranged from 3.0±0.42 mV to 4.25±0.3 mV in group 1 ($p<0,05$), from 2.33±0.58 mV to 5.09±1,0 mV ($p<0,01$) in group 3. Although positive dynamics (from 2.97±0.93 mV to 4.26±0.65 mV) was observed in the group where the traction was applied alone, it was not statistically reliable ($p>0.05$).

An increase in the amplitude of the H-reflex was also observed with positive changes in the amplitude of the M-response, and the dynamics of this indicator was more noticeable in the 3rd research group. Thus, due to the combined effect of physical factors, the indi- cator increased from 8.82±1.12 mV to 12.2±1.1 mV ($p < 0.001$).

In most cases, the results of re-examination of the monosynaptic H-reflex after treatment with physical factors were consistent with the clinical results. Improvement in the motor sphere was accompanied by positive dynamics in H-reflex indicators.

Thus, it was determined that monitoring the dynamics of the monosynaptic H-reflex in the rehabilitation of patients is important in terms of evaluating the effectiveness of the applied rehabilitation.

The effect of the applied treatment procedures on F-wave parameters mainly covered its minimum and maximum latency and chronodispersity arising out of their difference, observation ratio to F-wave phenomenon and NCV. In the group of complex treatment, F-wave-based NCV increased from 49.5±1.14 m/s to 56.35±1.01 m/s for peroneal nerve and from 51.59±0.90 m/s to 55.11±1.03 m/s for tibial nerve and reached a significant and statistically reliable level ($p<0.01$). In the group in which the interferential current was applied alone, the increase was from 51.67±0,8 m/s to 55.18±1.69 m/s; from 51.95±0.90 m/s to 53.63±1.14 m/s for peroneal and tibial nerves respectively and in the group where spinal column traction was applied alone the increase was from 51.44±0.88 m/s to 55.33±2.94 m/s for peroneal nerve and from 51.9±1.12 m/s to 52.6±1.12 m/s for tibial nerve.

Statistically, the reliability was relatively low in both groups ($p<0.05$). The positive dynamics observed in F-wave chronodisperse, one of the most sensitive indicators in radiculopathies, was statistically accurate ($p<0.01$) in the group in which the interferential current was applied in combination with spinal column traction and this value reduced from 7.26±0.97 ms to 4.99±0.84 ms for the peroneal nerve and from 6.83±0.54 ms to 5.13±0.55 ms for the tibial nerve.

No statistical accuracy was identified in the study groups in which the methods were applied separately ($p>0.05$).

Thus, the results of the study show that the therapeutic factors used have a positive effect on the functional state of the neuromuscular apparatus, which is manifested by an increase in decreased ITS along the peripheral motor nerves, increase in the maximum amplitude of M-response and its area, shortening of terminal latency. The increase in NCVeff in peripheral nerves under the influence of applied physical factors suggests that they occur due to the improvement of peripheral blood circulation, acceleration of regeneration and recovery in nerve roots. In the study group, where both factors were applied together, the improvement was more expressive and noticeable in terms of statistical reliability.

The results of the treatment were evaluated on the criteria of "improvement", "relative improvement", "unchanged". The improvement rate was higher in the 3rd study group, in which the interferential current was applied in combination with spinal column traction, compared with other groups, as the overall improvement rate was 84.4% in this group. In research groups I and II, this value was 75.6% and 62.5%, respectively. Thus, a comparative analysis of the treatment showed that the complex application of interferential therapy and spinal column traction is more effective than monotherapy in VLR.

Thus, the results of the study show that the use of IC and SCT methods (individually, as well as in combination) in vertebrogenic lumbar radiculopathies is highly effective. The application of physical factors in the treatment and rehabilitation of this group of patients prevents the development of the disease, creates conditions for the regression of existing sensory and motor disorders. The analgesic and antispasmodic effects of the complex application of these methods are more expressive and statistically accurate.

The complex application of IC with SCT is highly effective in the rehabilitation of this group of patients, which is reflected not only in clinical tests and scales, but also in the positive

dynamics of the results of neurophysiological studies. This is due to the positive effect of the treatment on both the afferent and efferent ring of the reflex arc and the motoneurons of the spinal cord. The obtained data show the possibility of differentiated use of IC and SCT methods in vertebrogenic radiculopathies, both individually and in combination.

CONCLUSION

1. Vertebrogenic lumbar radiculopathy manifests itself with mono (64.9%) and biradicular (35.1%) root syndromes, and in most cases the L_5 and S_1 roots are damaged, which leads to MRI- confirmed intervertebral disc herniation. and protrusions, as well as hypertrophic changes in the facet joints and longitudinal ligaments. Clinically, pain syndrome of varying intensity is the leading symptom and is accompanied by neurological deficits in the form of sensory, motor, and reflex disorders. Vertebrogenic lumbar radiculopathies have their own neurophysiological characteristics: a decrease in NCV, shortening of M-response amplitude ($p<0.05$) for the peroneal nerve in the damaging of L_5 root, decrease in the NCV, shortening of M-response amplitude ($p<0.05$) for the tibial nerve in S_1 root damage, decrease of monosynaptic H-reflex amplitude (2.60 ± 0.30mV)($p<0.001$), elongation in F-wave chronodispersion (Fc) ($p<0.01$) [3,4,13].

2. Assessment of the intensity of pain syndrome, QL indicators and vertebra-neurological symptoms in general by clinical scale and surveys has allowed to study the clinical manifestations of pathology and the degree of disability, assess the effectiveness of treatment and rehabilitation measures applied. Pain syndrome is the main reason for the decline in quality of life. The average percentage of QL decline is $55.59\pm13.32\%$ [2,7,9,10].

3. The use of interferential current (IC) in vertebrogenic lumbar radiculopathy has a positive effect on the clinical symptoms of the disease, supports the morpho-functional recovery of the peripheral neuromotor apparatus, on the other hand, spinal cord traction (SCT) reduces pathologically tense muscle tone, reduces intervertebral disc

pressure and prevents dislocation of disc contents caused by a negative intradisc pressure, thus increasing the therapeutic effect [1,4,5].

4. The therapeutic efficacy of complex application of IC and SCT is higher than their separate application. This is confirmed by the persistent elimination of pain syndrome ($p<0.001$), significant improvement in QL ($p<0.001$) determined by clinical tests and scales, which is based on the improvement of the structural and functional condition of the segmental-peripheral neuromotor apparatus: at the end of the treatment in the group of complex treatment, on the side with the root syndrome, NCVeff increased tibial and in the peroneal nerve with high statistical integrity ($p<0.001$). In this group, at the same time the amplitude of the H-reflex increased ($p<0.01$), and the F-wave chronodispersion index significantly shortened on the peroneal nerve ($p<0.01$). It can be assumed that the complex application of these therapies enhances the therapeutic effect due to the complementarity and summation of their mechanisms of action [11,14,15].

PRACTICAL RECOMMENDATIONS

1. Complete clinical, neuroimaging and neurophysiological examinations are recommended using complex clinical scales and surveys (VAS, McGill and Roland-Morris curves) for timely and early diagnosis of vertebrogenic lumbar radiculopathy, as well as to determine the severity of the disease, to assess the effectiveness of treatment and rehabilitation procedures.

2. A methodology based on the integrated use of IC and SCT methods has been developed to increase the effectiveness in the rehabilitation of patients with vertebrogenic lumbar radiculopathy. The proposed treatment methods can be used in hospitals, rehabilitation centers and sanatoriums. The interferential current was applied on the lumbar region and along the sciatic nerve, in which one frequency was constant and the other changed. For this purpose, with the device Superkine, variant B, frequency 30-100 Hz is used, the paravertebral zones of the spine and the side with the root

symptoms are exposed for 12-15 minutes along the sciatic nerve route. Traction of the lumbar region is applied 1-3 hours after interventional therapy. Traction is horizontal, "dry" ("Supertract" device), the duration of the procedure is carried out according to the scheme, intermittently, from 10 to 30 minutes, increasing from 20% to 40% of body weight. The course of treatment lasts 10-12 days, including massage and therapeutic sports.

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LIST OF ABBREVIATIONS

ENMQ – electroneuromyography
IVD – intervertebral disc
SCT – spinal column traction
QL – quality of life
IC – interferential current
IFT – interferential therapy
LSR – lumbosacral radiculopathy
MRI – magnetic resonance imaging
NCV – nerve conduction velocity
VAS – visual analog scale
VLR – vertebrogen lumbar radiculopathy

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