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Effect of rehabilitation training combined with neuromuscular electrical stimulation on delayed organophosphorus neuropathy

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Abstract: *Objective: to observe the rehabilitation training combined neuromuscular electrical stimulation (NMES) for the curative effect of organophosphorus late-onset neuropathy (OPIDP). Methods: 44 patients with OPIDP were randomly divided into control group and experimental group, 22 cases in each group. The control group after admission to start rehabilitation training; On the basis of the experimental group patients increased NMES treatment. Compare two groups of patients with short form Fugl - Meyer rating scale (FMA) score, modified Barthel index (MBI) score, Berg balance scale (BBS) rating points and ulnar nerve and peroneal nerve conduction velocity of total nerve. Results: 10 weeks after treatment, two groups of score FMA, MBI scores and BBS are higher than before the treatment, scores and test group is superior to the as group (P < 0. 05). 10 weeks after treatment, two groups of god by the conduction velocity is faster than before the treatment, faster than the control group and test group (P < 0. 05). Conclusion: rehabilitation training can promote OPIDP patients restore nerve function, improve sports ability, balance ability and OPIDP patients daily life activities ability; On the basis of this combined therapy with NMES can further improve the clinical efficacy of OPIDP patients.*

Keywords: *Rehabilitation training, Neuromuscular electrical stimulation, Delayed organophosphorus neuropathy*

1. Introduction

Organophosphorus pesticides are toxic chemicals, which are usually used as insecticides to prevent and control pests in agriculture, forestry and animal husbandry production. Acute organophosphorus pesticide toxicity (AOPP) refers to a series of injuries mainly caused by nervous system damage caused by ingestion, inhalation or contact of organophosphorus pesticides [1-3].

The clinical manifestations of the patients are diverse, including axonal polyneuropathy characterized by distal weakness and sensory disturbances, foot and wrist ptosis, and muscle atrophy of the limbs in severe cases. In this study, rehabilitation training combined with neuromuscular electrical stimulation (NMES) was carried out for patients with OPIDP to explore its effects on motor function and nerve conduction velocity of patients with OPIDP.

2. Data and Methods

2.1 General Information

Choose from January 2018 - October 2020 emergency medicine in our hospital, rehabilitation medicine and 44 patients with OPIDP.

Inclusion criteria: all met OPIDP diagnostic criteria; Lucid; Vital signs are stable; ≥20 years old; Normal cognitive function]; Signed informed consent; Approved by the Ethics Review Committee. Exclusion criteria: other medical conditions that cause motor dysfunction; Patients with implanted pacemakers; Patients with plate internal fixation of limbs; A history of malignant tumors; Patients who can not cooperate with rehabilitation training and quit during the course.

Forty-four patients were randomly divided into control group and experimental group, with 22 patients in each group. There was no significant difference in basic data between the two groups (P >

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0.05) (Table 1)

Table 1: Two sets of basic information

group	Man /Woman	Age	Poisoning type			Disease Time	
			Dichlorvos	Methamidophos	Others	≤3Weeks	>3Weeks
Experimental Group	12/10	54.54±14.01	8	7	7	8	14
Control Group	14/8	56.41±17.97	11	6	5	6	16
t/χ^2	0.376	0.384		0.884		0.419	
P	0.540	0.703		0.643		0.517	

2.2 Methods

Patients in both groups received symptomatic treatment and basic nursing with glucocorticoid, vitamin B group and nerve growth factor.

1) Patients in the control group started rehabilitation training immediately after admission, including (1) rehabilitation education: through rehabilitation education, patients can know OPIDP, understand the basic clinical symptoms and treatment methods, and improve the compliance and enthusiasm of patients. (2) Range of motion training: give patients range of motion training, maintain or increase the range of motion of patients, prevent joint adhesion. (3) Muscle strength training: different training methods are selected according to patients' muscle strength rating. Passive training is adopted for patients with muscle strength at level 0 or level 1.Muscle strength level 2 or 3 use power training, muscle strength level 4 use resistance training. (4) Joint loosening: Grade i, ii and iii joint loosening techniques were used for painful joints, and grade iii and iv joint loosening techniques were used for joints with joint stiffness or contracture. (5) bridge movement: the patient supine position, flexion hips and knees, the sole of both feet flat step on the bed surface, forcibly lift the buttocks off the bed surface, told the patient to maintain 10s, during which the therapist pushes the patient's hip joint and knee joint, told the patient to maintain the position. (6) Balance training: start from sitting balance training, transition to standing balance training, and finally use boBATH ball to train the patient's balance function. (7) Gait training: with the improvement of the patient's condition, gradually began to increase gait training, up and down the stairs training. (8) Ability training of daily living activities: guide patients to correctly independently put on and take off clothes, move and eat. Kangfu training for 30min every time, twice a day, 5d every week, 10 weeks of treatment.

2) The experimental group was treated with NMES on the basis of the control group, and the en-STIM4 NMES instrument produced by Shanghai Xibei Electronic Technology Development Co., LTD was adopted. The parameters were set as follows: The frequency was 20Hz, the waveform was triangular wave, the time was 20min, and the position was bilateral flexor carpi ulnar muscle, thenar muscle, bilateral fibula neck and tibialis anterior muscle. The intensity of the treatment was 20min, twice a day, 5d a week, for 10 weeks.

2.3 Evaluation Indictors

1) Recovery scale(1) Simple FuGL-Meyer Rating Scale (FMA): a total of 100 points, including 33 upper limb scores, a total of 66 points; There are 17 lower limb evaluation points, a total of 34 points. Grade i was < 50, indicating severe motor impairment and almost no movement. Grade ii was 50 ~ 84, indicating obvious movement disorder. Grade iii was 85 to 95, indicating moderate motor dysfunction and hand dysfunction. Grade iv was 96 to 99, indicating mild dyskinesia.

(2) Modified Barthel index (MBI) [8] : the total score was 100, 0 ~ 20 indicated extremely severe dysfunction, 21 ~ 45 indicated severe dysfunction, 46 ~ 70 indicated moderate dysfunction, 71 ~ 99 indicated mild dysfunction, and 100 indicated complete self-care in daily living activities.

(3) Berg Balance Scale (BBS) : The highest score is 56, and the lowest score is 0. The higher the score is, the stronger the balance ability is. 0 ~ 20 points prompt balance function is poor, the patient needs to take a wheelchair,21 ~ 40 points prompt have certain balance ability, the patient can walk under the assistance,41 ~ 56 points prompt balance function is better, the patient can walk alone, < 40 points prompt have the risk of falling.

2) Emg keypoint-4 emG machine manufactured by Dandi Dynamics was used to record sensory nerve conduction velocity and motor nerve conduction velocity of the ulnar nerve and common peroneal nerve before and after treatment.

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2.4 Statistical Treatment

Spss23.0 software was used for statistical analysis. The measurement data are expressed by mean ± standard deviation (x ±s), and t-test is performed; The count data is expressed as a percentage, in rows χ 2 inspection; P < 0.05 was statistically significant.

3. Results

3.1 Two Groups of Rehabiltation Scale Scores

Two groups of patients before treatment of various rehabilitation rating scale has no statistically significant difference (P > 0. 05); In the two groups after treatment in patients with FMA scores, MBI scores, BBS score is better than that of before treatment (P < 0. 05), and the experimental group after treatment in patients with various score higher than the control group (P < 0. 05) (table 2).

Table 2: Two groups of rehabilitation scale scores

group	FMA Score	MBI Score	BBS Score
Experimental Group	38. 14±5. 30	34. 77±5. 66	10. 36±1. 94
	68. 36±5. 79^{ab}	64. 55±6. 88^{ab}	37. 63±3. 30^{ab}
Control Group	36. 55±5. 05	32. 27±5. 50	11. 06±2. 17
	47. 14±4. 13^{a}	45. 91±5. 70^{a}	25. 55±4. 01^{a}

Compared with before treatment, aP < 0.05 compared with control group, bP < 0.05

3.2 EMG Nerve Conduction Velocity in Both Groups

Two groups before treatment there was no statistically significant difference in patients with nerve conduction velocity (P > 0. 05); In the two groups after treatment in patients with motor nerve conduction velocity, sensory nerve conduction velocity faster before the treatment (P < 0. 05), and the experimental group after treatment in patients with motor nerve conduction velocity, sensory nerve conduction velocity is better than that of control group (P < 0. 05) (table 3).

Table 3: Nerve conduction velocity of the two groups (m/s, x±S, n = 22)

group	Motor nerve conduction velocity	
	Ulnar nerve	nervus peroneus communis
Experimental Group	43. 96±2. 73	32. 83±3. 72
	49. 72±2. 32^{ab}	38. 60±3. 74^{ab}
Control Group	44. 19±2. 58	33. 27±4. 37
	48. 02±2. 61^{a}	35. 43±4. 06^{a}

Sensory nerve conduction velocity	
Ulnar nerve	nervus peroneus communis
45. 18±2. 07	30. 87±3. 70
49. 68±2. 40^{ab}	35. 61±3. 89^{ab}
44. 75±2. 29	31. 39±4. 22
46. 87±3. 64^{a}	32. 98±4. 16^{a}

Compared with before treatment, aP < 0.05 compared with control group, bP < 0.05.

4. Discussion

AOPP can be divided into three stages: acute cholinergic effect, intermediate syndrome and OPIDP. OPIDP is an axial peripheral neuropathy characterized by distal weakness and sensory loss, which usually occurs after large doses of certain organophosphorus pesticides, and is mainly manifested by numbness,

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tingling, gastrocnemius pain, limb weakness, stride gait, low muscle tone, and muscle atrophy in the distal extremities, especially in the lower extremities. The recovery after peripheral nerve injury is slow and the process is very complicated. Tessa et al. [10] believed that rehabilitation treatment should be started immediately after peripheral nerve injury to effectively prevent muscle atrophy and promote functional recovery. Therefore, early comprehensive rehabilitation training for PATIENTS with OPIDP is the key to improve their motor function.

The results of this study showed that after 10 weeks of treatment, the neurological function, motor ability, balance ability and daily activity ability of patients in the control group and experimental group were significantly improved.

Animal studies have shown that exercise can regulate a variety of cellular and molecular responses after peripheral nerve injury, thereby promoting nerve regeneration and functional recovery, and increasing the number of regenerated neurons, axon growth rate and nerve reinnervation after peripheral nerve injury.

Even a short period of exercise training will have a positive regulatory effect on nerve regeneration ability and improve the acute response to peripheral nerve injury. Active and/or passive activity can also maintain denervation muscle activity, promote the release of nutritional factors, and increase the number of distal nerve regeneration axons.

In this study, rehabilitation training for PATIENTS with OPIDP can effectively improve the range of motion of patients, improve muscle strength, promote blood circulation, accelerate the growth rate of axons, promote nerve recovery, and improve the motor function of patients. Joint loosening training can relieve the degree of pain caused by peripheral nerve injury in PATIENTS with OPIDP, release joint adhesion, improve joint range of motion, and increase ontological feedback. Gait training and daily living activities training for OPIDP patients can help patients master more life skills and improve their daily living activities.

The results of this study showed that the combination of NMES on the basis of rehabilitation training can further improve the neurological function, motor ability, balance ability and daily activity ability of OPIDP patients.

NMES was first introduced by Moe et al. In 1962. After more than 60 years of development, NMES has been widely used in clinical practice, but there is no study on THE treatment of OPIDP patients with NMES, so the selection of appropriate parameters is the focus of this study: (1) Frequency: The stimulation frequency of NMES after peripheral nerve injury is generally 10-100Hz. Clara et al. pointed out that with the increase of frequency, the effect of stimulating peripheral nerves would be weakened, and the stimulation frequency of 20Hz was the safest. Chan et al. pointed out that NMES can effectively promote the regeneration of axons and improve the function of patients with severe carpal tunnel syndrome who were stimulated with median nerve axon damage at 20Hz frequency. (2) Waveforms: NMES has a variety of waveforms, which can achieve the prickling effect can be selected. (3) Time: Gregory et al [4-6]. Believed that appropriately prolongation of NMES stimulation time could increase torque and improve muscle strength, but it should also be noted that prolonged stimulation time could easily lead to muscle fatigue. Huang et al and Foecking et al took 20min as the most appropriate time for NMES treatment after peripheral nerve injury, and achieved positive efficacy. (4) Location: The electrode is placed at the nerve fiber of the injured nerve, and the cathode is placed at the distal end of the nerve fiber to promote axon regeneration [7-9]. (5) Intensity: The stimulation intensity of NMES is mainly based on the subjective feeling of patients. Since different patients have different tolerance intensity of current, it is advisable for patients to not produce pain and maintain pleasant feeling. Patients in the experimental group were treated with NMES parameters set in this study, and no adverse reactions such as electrical burns occurred, and positive effects were achieved. [10-12]

In conclusion, rehabilitation training can effectively improve the nerve conduction velocity of PATIENTS with OPIDP, promote the recovery of nerve function and improve OPIDP.Patients exercise capacity, balance ability, daily life activities ability, on the basis of this combined therapy with NMES can further improve the clinical efficacy of OPIDP patients. But there are some shortcomings in this study, although this study set NMES parameters achieved positive effect, but whether it is the best parameter combination still needs further research.

References

[1] Wang Shun-Min Samuel, Huang Yi-Jing, Chen Jia-Jin Jason, Wu Chun-Wei, Chen Chien-An, Lin

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Che-Wei, Nguyen Van-Truong, Peng Chih-Wei. Designing and pilot testing a novel high-definition transcranial burst electrostimulation device for neurorehabilitation [J]. Journal of Neural Engineering, 2021, 18(5):

[2] Kelly Christina, Meyer Jen, Hanks Valery, Barefield Christy. Neurorehabilitation for an individual with bilateral thalamic stroke and preexisting visual impairment presenting with impaired use of sensory cues: a case report [J]. Physiotherapy Theory and Practice, 2021, 37(10):

[3] Putort ìAlessia, Corrado Michele, Avenali Micol, Martinelli Daniele, Allena Marta, Cristina Silvano, Grillo Valentina, Martinis Luca, Tamburin Stefano, Serrao Mariano, Pisani Antonio, Tassorelli Cristina, De Icco Roberto. The Effects of Intensive Neurorehabilitation on Sequence Effect in Parkinson's Disease Patients With and Without Freezing of Gait [J]. Frontiers in Neurology, 2021,:

[4] Klyce Daniel W, Pugh Mickeal, Perrin Paul B. Factor structure of the Modified Mini Mental State (3MS) exam among participants in inpatient neurorehabilitation. [J]. Brain injury, 2021,:

[5] Wang ShunMin Samuel, Huang YiJing, Chen JiaJin Jason, Wu ChunWei, Chen ChienAn, Lin CheWei, Nguyen Van Truong, Peng ChihWei. Designing and pilot testing a novel high-definition transcranial burst electrostimulation device for neurorehabilitation. [J]. Journal of neural engineering, 2021,:

[6] Klyce Daniel, Mills Ana, Dukarm Paul. The science and practice of neuropsychological assessment in neurorehabilitation: An introduction to the special issue. [J]. NeuroRehabilitation, 2021,:

[7] Bigler Erin D, Allder Steven. Improved neuropathological identification of traumatic brain injury through quantitative neuroimaging and neural network analyses: Some practical approaches for the neurorehabilitation clinician. [J]. NeuroRehabilitation, 2021,:

[8] Ghosh Manonita, Nosaka Kaoru, Whitehead Lisa, Nosaka Kazunori. Identifying key elements to assess patient's acceptability of neurorehabilitation in stroke survivors - a Delphi method. [J]. Disability and rehabilitation, 2021:

[9] Cesar Marquez Chin, Naaz Kapadia Desai, Sukhvinder Kalsi Ryan. Brain–Computer Interfaces: Neurorehabilitation of Voluntary Movement after Stroke and Spinal Cord Injury [M]. Morgan & Claypool Publishers: 2021-08-12.

[10] Tramontano Marco, De Angelis Sara, Mastrogiacomo Sara, Princi Alessandro Antonio, Ciancarelli Irene,Frizziero Antonio, Iosa Marco, Paolucci Stefano, Morone Giovanni. Music-based techniques and related devices in neurorehabilitation: a scoping review [J]. Expert Review of Medical Devices, 2021, 18(8):

[11] Brennan Kimberly, Curran Jessica, Barlow Ann, Jayaraman Arun. Telerehabilitation in neurorehabilitation: has it passed the COVID test? [J]. Expert Review of Neurotherapeutics, 2021, 21(8):

[12] Boughen Keaton, Neil Tyler, Dullemond Shayan, Lutowicz Kevin, Bilgasem Ahmed, Hastings Tyler, Brooks Dina, VaughanGraham Julie. Cranial Nerve Noninvasive Neuromodulation in Adults with Neurological Conditions: Protocol for a Scoping Review. [J]. JMIR research protocols, 2021, 10(7):