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Original Article

Clinical effects of electrical stimulation therapy on lumbar disc herniation-induced sciatica and its influence on peripheral ROS level

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Abstract

Objective: To study the clinical effects of electrical stimulation therapy on lumbar disc herniation-induced sciatica and its influence on peripheral reactive oxygen species (ROS) level. **Methods:** 100 patients with lumbar disc herniation-induced sciatica were selected, and were randomly divided into the control and research group. The control group was treated with traction and other basic therapies, while the research group was treated with electrical stimulation. The pain degrees, peripheral ROS levels and clinical effects prior to treatment and at 4 weeks after treatment were examined. **Results:** The total cure-remarkable-effectiveness rate of patients in research group was higher than that in control group (p<0.05). Before treatment, the pain rating index (PRI), present pain intensity (PPI) and visual analogue scale (VAS) score had no statistically significant differences between the two groups. After treatment, PRI, PPI and VAS scores in the two groups were lower than those prior to treatment; these indexes in research group were lower than those in control group, and the differences were statistically significant (p<0.05). After treatment, the peripheral ROS levels in the two groups were lower than those before treatment; it was lower in research group than that in control group (p<0.05). **Conclusion:** Electrical stimulation has a significant effect in the treatment of lumbar disc herniation-induced sciatica, which can effectively reduce the pain, alleviate the clinical symptoms and signs of patients, regulate the peripheral ROS level, and prevent the oxidative damage of myocardial tissues.

Keywords: Electrical Stimulation, Lumbar Disc Herniation-Induced Sciatica, Clinical Effects, Peripheral ROS

Introduction

Sciatica is the primary and secondary disease of sciatic nerves caused by a variety of reasons, which belongs to the clinical common and multiple disease[1]. Studies have shown that lumbar disc herniation is an important cause of sciatica, which leads to fibrous ring rupture, nucleus pulposus herniation, nerve root compression, lumbocrural pain and neurological dysfunction on the basis of intervertebral disc degeneration; if patients do not receive the effective treatment in time, the work and life of them will be seriously harmed[2]. At present, surgery and non-surgical treatment are dominated in the clinical treatment of lumbar disc herniation-induced sciatica, the former of which can temporarily relieve the clinical symptoms; but varying degrees of complications will occur easily after operation because of the damage to the spinal structure and stability, and there is a certain risk of recurrence with long-term poor curative effect[3]. Electrical stimulation therapy, as an innovative physical therapy, can effectively avoid the side effects brought by analgesic drugs, so it is widely used in clinical treatment[4]. Based on this, electrical stimulation was used to treat the lumbar disc herniation-induced sciatica in this study, and its clinical effect and influence on peripheral reactive oxygen species (ROS) were analyzed. It is now reported as follows.

The authors have no conflict of interest.

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Materials and methods

Selection criteria

Inclusion criteria[5]

1) Patients diagnosed with sciatica via X-ray, computed tomography (CT) and other clinical examinations, accompanied with lumbar disc herniation-induced unilateral pain; 2) patients without serious functional diseases in heart, lung, liver, kidney and other organs; 3) patients without mental illness and disturbance of consciousness, who could actively cooperate in clinical examination and treatment; 4) patients without blood system diseases. This study was approved by Ethics Committee of Shengli Oilfield Central Hospital; all patients and their families were informed of this study and signed the informed consent.

Exclusion criteria[6,7]

1) Patients with exacerbated lumbar disc herniation after the failed conservative treatment for 3 months, complicated by nerve root adhesions; 2) pregnant or lactating women; 3) patients who received other clinical tests within 3 months before the study; 4) patients complicated by central, incarcerated, giant or free lumbar disc herniation; 5) patients with cauda equina syndrome or foot drop; 6) patients complicated by spinal stenosis or spondylolisthesis.

General data

100 patients with lumbar disc herniation-induced sciatica treated in Shengli Oilfield Central Hospital from March 2015 to October 2016 were selected as the objects of study, and they met the inclusion criteria. Patients were divided into the control group (n=50) and research group (n=50) using a random number table. In control group, there were 24 males and 26 females aged 20-65 years old with an average of (43.4±13.8) years old; the course of disease was 7-70 d with an average of (33.7±24.8) d. In research group, there were 22 males and 28 females aged 20-65 years old with an average of (43.8±12.7) years old; the course of disease was 8-70 d with an average of (34.4±22.9) d. There were no statistically significant differences in the general data between the two groups ($p>0.05$).

Methods

The two groups of patients were treated with traction and other basic therapies; the pelvis and shoulders were pulled till the tension force of patient's waist or 1/2 of the weight for 90 s (30 min/time) at an interval of 10 s; after the traction, patients rested lying for 10 min. Patients in research group, on this basis, were treated with electrical stimulation therapy using the functional electrical stimulation therapy instrument (purchased from Wuhan Xiandai Youbang Technology Co., Ltd.) with the electrode of 3 cm × 3 cm; the electrodes were placed in the relevant motor points of anterior tibial muscle and extensor digitorum longus on the affected side, and the motor points were defined under the guidance of electromyogram. Under the supine position or sitting position, the extension of lower limb toes on the affected side was triggered via the stimulation intensity; the parameter setting of functional electrical stimulation therapy instrument was as follows: frequency of 35 Hz, 0.28 ms under the maximum-tolerated intensity of patients, 1 times/d, 30 min/time, treatment for 4 weeks.

Observation indexes

The pain degrees and peripheral ROS levels before treatment and at 4 weeks after treatment were observed and compared between the two groups of patients. Pain degree was expressed by the simple McGill pain scale, including pain rating index (PRI), present pain intensity (PPI) and visual analogue scale (VAS) score. 1) PRI[8]: It includes 11 sensory words, such as jumping pain, sharp pain, burning pain and stabbing pain, and 4 emotional words, such as discomfort, fatigue, torment and fear; each word is presented as 0-3 points; the higher the score is, the higher the pain grade will be and the severer the pain will also be; 2) PPI[9]: It is presented as 0-5 points; the higher the score is, the higher the PPI will be; 3) VAS[10]: It is presented as a line segment with a length of 100 mm; 1 point for 1 of the 100 points; 0 point: no pain; 100 points: excruciating pain; the patients determine according to their own pain; the higher the score is, the severer the pain will be. Peripheral ROS[11]: 3 mL fasting peripheral venous blood was drawn from all patients in the morning before and after treatment, placed into the ethylenediamine tetraacetic acid (EDTA) anticoagulant tube, and centrifuged at 3500 rpm for 10 min to separate the serum and plasma; peripheral ROS was detected via enzyme-linked immunosorbent assay (the reagent was provided by Guangzhou Forevergen Biotechnology Co., Ltd.) strictly according to the instructions, and the quality of operation was controlled.

Clinical effects

The clinical effects were evaluated according to the clinical symptoms and signs of patients before and after treatment[12]: Cure: After treatment, the clinical symptoms and signs disappear, patients can act freely, and the work and life return to normal; remarkable effectiveness: After treatment, the clinical symptoms and signs are improved, the activity of patients is not limited, but there is painful discomfort; improvement: After treatment, the clinical symptoms and signs are improved, the activity of patients is slightly limited, and the pain is relieved; ineffectiveness: After treatment, the clinical symptoms and signs have no change or are aggravated. Total cure-remarkable-effectiveness rate=(cure + remarkably effective + improvement) / total cases × 100%.

Statistical analysis

Statistical Product and Service Solutions (SPSS) 20.0 software (IBM) was used for data analysis. The data were presented as percentage and cases. Chi-square test was used for the intergroup comparison. Measurement data were presented as "$\bar{x} \pm s$"; paired t test was used for the intragroup comparison before and after treatment; $p<0.05$ suggested that the difference was statistically significant.

Table I. Comparisons of treatment effects between the two groups of patients [n (%)].

	Cure	Remarkable effectiveness	Improvement	Ineffectiveness	Total cure-remarkable-effectiveness rate
Control group (n=50)	14 (28.0)	17 (34.0)	15 (30.0)	4 (8.0)	31 (62.0)
Research group (n=50)	27 (54.0)	15 (30.0)	6 (12.0)	2 (4.0)	42 (84.0)
x^2	-	-	-	-	8.962
p	-	-	-	-	0.008

Table II. Comparisons of PRI between the two groups of patients before and after treatment ($\bar{x} \pm s$, point).

Group	Before treatment	After treatment	*t*	*p*
Control group (n=50)	3.3±1.0	2.0±0.9	4.766	0.041
Research group (n=50)	3.4±0.8	1.4±0.6	6.071	0.029
t	1.007	6.271		
p	0.451	0.038		

Table III. Comparisons of PPI between the two groups of patients before and after treatment ($\bar{x} \pm s$, point).

Group	Before treatment	After treatment	*t*	*p*
Control group (n=50)	2.2±0.6	1.2±0.4	5.097	0.023
Research group (n=50)	2.1±0.8	0.8±0.5	7.728	0.017
t	0.951	4.277		
p	0.085	0.033		

Table IV. Comparisons of VAS scores between the two groups of patients before and after treatment ($\bar{x} \pm s$, point).

Group	Before treatment	After treatment	*t*	*p*
Control group (n=50)	45.2±12.3	8.9±4.7	11.272	0.009
Research group (n=50)	46.3±10.8	4.1±2.3	9.062	0.017
t	1.014	6.688		
p	0.405	0.013		

Table V. Comparisons of peripheral ROS levels between the two groups of patients before and after treatment ($\bar{x} \pm s$, ng/L).

Group	Before treatment	After treatment	*t*	*p*
Control group (n=50)	32.3±4.0	24.6±3.2	5.089	0.027
Research group (n=50)	31.8±5.7	17.5±2.7	8.808	0.033
t	1.007	7.094		
p	0.988	0.019		

Results

Clinical effects

The total cure-remarkable-effectiveness rate in research group (42/50, 84.0%) was significantly higher than that in control group (31/50, 62.0%), and the difference was statistically significant ($p<0.05$) (Table I).

Pain degree

After treatment, PRI, PPI and VAS scores in the two groups were lower than those before treatment; these indexes in research group were lower than those in control group, and the differences were statistically significant ($p<0.05$) (Table II-IV).

Peripheral ROS level

After treatment, the peripheral ROS levels in the two groups were lower than those before treatment; it was lower in research group than that in control group, and the difference was statistically significant (p<0.05) (Table V).

Discussion

Overview of lumbar disc herniation-induced sciatica

Lumbar disc herniation is a kind of clinically common degenerative disease[13,14]. The varying degrees of degenerative lesions in the nucleus pulposus and fibrous rings of patient's lumbar intervertebral disc leads to the reduced lumbar joint toughness, and the herniation of nucleus pulposus results in secondary spinal stenosis, nerve root edema, ischemia and inflammation, thus causing the vertebral loosening, instability and other pathological changes[15]. There are many high-risk factors of lumbar disc herniation, and its pathogenesis is very complex. The clinical manifestations of lumbar disc herniation-induced sciatica are obvious and mainly reflected in the following aspects: The pain area is usually located in the waist, buttocks, thighs, etc., and it can also occur in the posterior-lateral thigh. Persistent and paroxysmal stabbing pain is dominated in sciatica, and radiating pain, burning pain and other symptoms are also accompanied at the same time[16]. Sciatica can be exacerbated due to the bending, coughing or overwork of patients. After patients lie down resting, the pain symptoms will be alleviated, and show positive in straight-leg raising test[17]. Clinical studies have shown that sciatica is located in the sciatic nerve path of the human body, and the lumbar disc herniation will involve the sciatic nerve, thus leading to the radiating pain along the sciatic nerve distribution area[18]. According to the statistical data, unilateral pain is usually dominated in patients with sciatica due to long-term sitting working; but bilateral pain symptoms will also occur if the posterior lumbar zone is involved[19].

Pathogenesis of lumbar disc herniation-induced sciatica

Lumbar disc herniation-induced sciatica has complex conditions and diverse pathogeneses, which are mainly manifested in the following aspects: (1) Intervertebral disc[20]: With the increase of age, the protein content in intervertebral disc nucleus pulposus in the body is gradually decreased, thus directly affecting the elasticity of nucleus pulposus of patients, and increasing the risk of lumbar discs herniation or rupture. At the same time, due to the insufficient collagen content in intervertebral disc nucleus pulposus fibrous ring, the fiber ring results and hardness are changed, resulting in cracks easily. In addition, the degeneration, dehydration and even necrosis of lumbar intervertebral disc chondrocytes make the cartilage plate thinner and thinner with the increase of age, thereby aggravating the intervertebral disc degeneration[21]; (2) external injury[22]: Trauma and long-term stress-strain are the common pathogeneses of inducing lumbar disc herniation-induced sciatica, among which the long-term stress strain is the most important cause of lumbar disc herniation. This is because the long-term and excessive stress load will easily lead to the lack of normal filling of lumbar intervertebral disc nucleus pulposus, and the serious shortage of nutritional supply. At the same time, the lumbar lordosis of the human body will make it difficult for intervertebral disc fibrous ring to bear the mechanical impact of nucleus pulposus under the external stress load, leading to the lumbar disc herniation.

Electroacupuncture stimulation therapy

Acupuncture, as an important branch of traditional Chinese medicine theory, has become the most effective treatment means in acupuncture and moxibustion therapy. The electrical stimulation therapy is based on traditional acupuncture theory combined with electronic low-frequency pulse technique. Studies have found that electronic low-frequency pulse is similar to the bioelectricity in human body, and the current can produce the directional movement, thus effectively changing the distribution of pulse in the human body, affecting the function of human cells[23]. Clinical research results show that the treatment with low-frequency electronic pulse current through the acupuncture needle can not only effectively play sedative and analgesic effects to adjust the muscular tension of human body, but also promote the blood circulation system in the body and help repair the human meridians[24].

Electroacupuncture stimulation and peripheral blood ROS

ROS is a series of reactive oxygen species produced by aerobic cells during the metabolic process. Experimental studies have shown that ROS is essential in initiating and maintaining the regeneration reaction in human body, because ROS is critical for activating the Wnt signal of the body, the latter of which plays a key role in the regeneration process. Electroacupuncture stimulation therapy can reduce the concentration of free radicals, thus affecting a series of signal transduction pathways in the body. The free radicals in human body ensure the life-death balance of cells through the regulation of ROS concentration[25]. Reducing the ROS concentration can not only effectively regulate the apoptosis and necrosis, but also activate the transcription factors in human body, which is beneficial to promote the cell proliferation and differentiation.

The results of this study showed that the total cure-remarkable-effectiveness rate of patients in research group (84.0%) was higher than that in control group (62.0%), and the difference was statistically significant (p<0.05), suggesting that the electrical stimulation therapy has a significant effect in the treatment of lumbar disc herniation-induced sciatica and can effectively improve the healing effect. Before treatment, PRI, PPI and VAS score had no statistically significant differences between the two groups of patients. After treatment, PRI, PPI and VAS scores in the

two groups were lower than those before treatment; these indexes in research group were lower than those in control group, and the differences were statistically significant (p<0.05). After treatment, the peripheral ROS levels in the two groups were lower than those before treatment; it was lower in research group than that in control group, and the difference was statistically significant (p<0.05), indicating that the electrical stimulation therapy can effectively reduce the pain degree of patients with lumbar disc herniation-induced sciatica and improve the peripheral ROS level, thus promoting the recovery of patients.

In conclusion, in the treatment of lumbar disc herniation-induced sciatica, electrical stimulation therapy can effectively reduce the pain degree, relieve the clinical symptoms and signs, improve the peripheral ROS level and prevent the oxidative damage of myocardial tissues and other complications, so it is worthy of clinical application and promotion.

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