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ORIGINAL ARTICLE

The effect of short-term spinal cord electrical stimulation on patients with postherpetic neuralgia and its effect on sleep quality

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Abstract

OBJECTIVES: To investigate the effect of short-term spinal cord electrical stimulation (stSCS) on postherpetic neuralgia (PHN) and its effect on sleep quality in patients in Guangxi, China.

MATERIAL AND METHODS: 160 patients with acute PHN patients were divided into a control group and an experimental group according to the random number table method, 80 cases each. The experimental group was implanted with percutaneous epidural electrodes and given short-term spinal cord electrical stimulation treatment, while the control group was treated with nerve block therapy to compare the efficacy and sleep quality of the two groups of patients in different periods. Pain Visual Analogue Scale (VAS) score and Pittsburgh Sleep Quality Index (PSQI) were used to evaluate the analgesic effect and sleep quality, respectively.

RESULTS: The patients in the experimental group had significantly lower visual analog scale (VAS) scores and Pittsburgh Sleep Quality Index (PSQI) scores at 1, 2, 3 d, 1 week, and 1 and 3 months after treatment than those in the control group [after treatment 3 months: (0.86±0.31) points to (2.97±0.55) points, (5.4±1.16) score to (7.46±1.27) score], the difference was statistically significant (both $P<0.05$), and VAS and PSQI scores of the two groups showed a significant downward trend with the increase of treatment time.

CONCLUSION: The clinical effect of short-term spinal cord electrical stimulation on PHN is good, and it can play a rapid and effective relief effect on pain in patients. At the same time, it will effectively improve patient's sleep quality, with high safety.

Abbreviations:

stSCS	- short-term spinal cord electrical stimulation	VZV	- varicella-zoster virus
PHN	- postherpetic neuralgia	DSA	- digital subtraction angiography
VAS	- Visual Analogue Scale	GCT	- gate control theory
PSQI	- Pittsburgh Sleep Quality Index		

INTRODUCTION

Shingles is an infectious skin disease caused by re-replication and activation of varicella-zoster virus (VZV) lurking in the sensory ganglia (Harbecke *et al.* 2020; Sullivan *et al.* 2019). Because VZV is neurotropic, patients with herpes zoster are often accompanied by neuropathic pain (Oh *et al.* 2019). According to reports, 13.3% to 42.2% of patients with herpes zoster will have postherpetic neuralgia (PHN), which manifests as neuropathic pain that persists and increases intermittently (Lee *et al.* 2020; Freeman *et al.* 2015; Friesen *et al.* 2017). Once PHN occurs, there is no clinically effective treatment (Park and Choi 2017; Malec-Milewska *et al.* 2015). Most of the treatments are poor, and patients suffer from pain for a long time (Salvetti *et al.* 2019). Kim's research found that early nerve block therapy in HZ patients can effectively reduce the occurrence of PHN, so it is important to predict the occurrence of PHN and treat it early (Kim *et al.* 2018). The occurrence of PHN is related to the patient's age, location, skin lesion area, pain level, and course of disease (Yamada *et al.* 2019; Gu *et al.* 2019).

PHN is the most common complication of herpes zoster, it generally lasts for a long time and causes severe pain (Texakalidis *et al.* 2019). PHN manifests as burning, knife-like, and acupuncture-like pain, which affects the psychological state of patients, causes sleep disturbance and reduces their quality of life (Schuster and Hsia-Kiung 2018). At present, the clinical pathogenesis of PHN has not been fully elucidated. Therefore, how to cure PHN safely and effectively is the goal of research. Short-term spinal cord electrical stimulation (stSCS) is to place the stimulation electrode into the epidural space, stimulate the conduction beam of the posterior column of the spinal cord with electric current, and block the pain signal to achieve the purpose of treating pain. This study provides a scientific basis for the treatment of PHN by exploring the effect of stSCS in the treatment of PHN and the effect on the sleep quality of patients in Guangxi, China.

MATERIALS AND METHODS

Recruitment of research subjects

A total of 160 patients with acute PHN who were admitted to the Southern China ** Hospital from February 2018 to February 2019 were selected as the research subjects. According to the random number table method, they were randomly divided into a control group and an experimental group, 80 cases each. All patients and their families were aware of the content of this study and signed an informed consent form. This study has been approved by The Second Affiliated Hospital of Guangxi Medical University's ethics committee.

Inclusion criteria: the clinical symptoms of the patients all met the diagnostic criteria of acute PHN (Gan *et al.* 2013); the course of the disease was within 3 months; there was no new herpes during the illness; received comprehensive treatment for at least 1 week (intravenous infusion of acyclovir, 0.25 g/time, 3 times/day, produced by Sinopharm Group Rongsheng Pharmaceutical Co., Ltd., batch number: 19032104. Oral pregabalin capsules, 75 mg/time, 2 times/d, produced by Chongqing Saiwei Pharmaceutical Co., Ltd., batch number: AN2688; oral amitriptyline tablets, 12.5 mg/ time, 1 time/night, produced by Hunan Dongting Pharmaceutical Co., Ltd., batch number: 18075473). The current/previous treatment effect was not ideal [Pain Visual Analogue Scale (VAS) score >4 points]. If the affected nerve segment was the lumbar spine segment, no abnormalities were found after magnetic resonance imaging examination; no deformity or disease occurred in the spine. Exclusion criteria: Heart, lung, liver, kidney, etc. have severe dysfunction; have coagulation dysfunction; have mental and intellectual disorders and diseases; infection at the puncture site.

Intervention method

Patients in the experimental group were treated with stSCS. Treatment location: interventional treatment room. Treatment equipment: 22G puncture needle, stimulation electrode, extension lead, electric pulse generator manufactured by Medtronic in the United States. Treatment: The patient takes the prone position and uses digital subtraction angiography (DSA) imaging to accurately locate the puncture point. Sterilization and layout according to the routine operation, inject 1% lidocaine for local anesthesia. After the anesthesia takes effect, use 22G epidural needle for puncture. DSA is used for real-time guidance during puncture. Continue to adjust the epidural needle until the needle is punctured at the correct position and continue to advance the needle. It is advisable to have a sense of breakthrough. At this time, the standard of withdrawal of blood and cerebrospinal fluid should be reached. Implanting electrodes for patients requires DSA real-time guidance for this process. Continuously adjust the electrode coverage. Until the electrode is covered at the corresponding target position (the dorsal side of the spinal cord segment, the distance from the posterior midline of the spinal cord is 2 to 4 mm). After that, connect the extension cable and the pulse generator to test the connectivity. Under the guidance of the debugging results, the position of the electrode can be adjusted slightly, and finally, the original pain area should be covered by the electrode. Separate the extension cord and the pulse generator, hook the two sutures into the subcutaneous position of the puncture, as a spare. Finally, the puncture needle is pulled out, the electrode is fixed in the form of a surgical knot, locally pressed for 5 minutes, and the local puncture is applied. Postoperative treatment: In order to avoid excessive displacement of the patient's electrodes,

Tab. 1. Comparison of the general characteristics of the two groups.

Variables	Control group (n=80)	Experimental group (n=80)	χ^2 or t	*P*
Gender				
Male	42	44	0.101	0.751
Female	38	36		
Age (yrs)	62.24±4.49	62.51±5.50	-0.335	0.738
Course (days)	30.14±4.73	30.31±5.12	-0.226	0.8821
Lesion location				
Cervical nerve involvement	26	24	0.122	0.941
Chest nerve involvement	37	38		
Lumbar nerve involvement	17	18		

the patient's spine activity should be highly restricted within 24 hours after surgery. Strengthen the care of the puncture after surgery. Patients will inevitably have slight electrode displacements of different degrees after the operation, resulting in poor electrode coverage and changes in stimulation intensity, so appropriate adjustments should be made for electrode displacements. The patient should be reexamined regularly after the operation, through X-ray examination, to determine whether the electrode is displaced and the degree of displacement. No patients had serious complications during or after surgery.

The patients in the control group were treated with the nerve block method, and the anti-inflammatory analgesic solution was formulated. That is, 2% lidocaine injection 5 ml, vitamin B12 1 mg, vitamin B6 200 mg, betamethasone 3.5 mg plus water for injection to 20 ml, no diabetes hormones. The epidural block and intercostal block were used according to the nerve distribution in the pain area. The epidural block was injected with 10 ml of the anti-inflammatory analgesic solution once a week. The intercostal nerve block was injected with 2 ml of anti-inflammatory analgesic solution for each intercostal block, blocking up to 4 intercostal spaces at the same time, once per week. The lesion was located in the planetary ganglion block of the head, face, and neck. The drug was 8ml of the anti-inflammatory analgesic solution, once per day, and 10 times was a course of treatment. The second course of treatment was performed after 7 days.

Observation index

Compare and analyze the analgesic effect of the two groups of patients before and after treatment 1, 2, 3d, 1 week and 1, 3 months, and take VAS to evaluate the analgesic effect. Compare and analyze the sleep quality of the two groups of patients at more than time points, and use the PSQI to evaluate sleep quality. The PSQI score ranges from 0 to 21 points, and the score is inversely proportional to sleep quality. It takes about 5 to 10 minutes for each patient to ask questions.

Statistical analysis

Use SPSS 21.0 statistical software for data analysis. The measurement data is expressed as Mean ± SD, and the t-test is used for comparison between groups. The count data is expressed by the number of cases, and $\chi 2$ test is used for comparison between groups. $P<0.05$ was considered statistically significant.

RESULTS

Analysis of general characteristics of research objects

A total of 160 patients with acute treatment of postherpetic neuralgia (PHN) were included as subjects. The average age of the patients in the control group was 62.24±4.49 years, and the average course of the disease was 30.14±4.73 days. There were 42 males and 38 females. In the control group, there were 26 cases of cervical nerve involvement, 37 cases of chest nerve involvement, and 17 cases of lumbar nerve involvement.

The average age of the patients in the experimental group was 62.51±5.50 years, and the average course of the disease was 30.31±5.12 days. There were 44 males and 36 females. In the experimental group, there were 24 cases with cervical nerve involvement, 38 cases with chest nerve involvement, and 18 cases with lumbar nerve involvement.

There was no statistically significant difference in the age, course of the disease, gender, and lesion location between the control group and the experimental group ($P>0.05$). The statistical analysis results are shown in Table 1.

Comparison of VAS scores between the two groups

Before treatment, the VAS score of the control group was 7.48±0.82 points, and the VAS score of the experimental group was 7.39±0.88 points. The difference between the two groups was not statistically significant ($t=0.657$, $P>0.05$). The VAS scores of the two groups of patients were significantly reduced at 1, 2, 3 d, 1 week, and 1 and 3 months after treatment, and the VAS scores showed a significant downward trend with

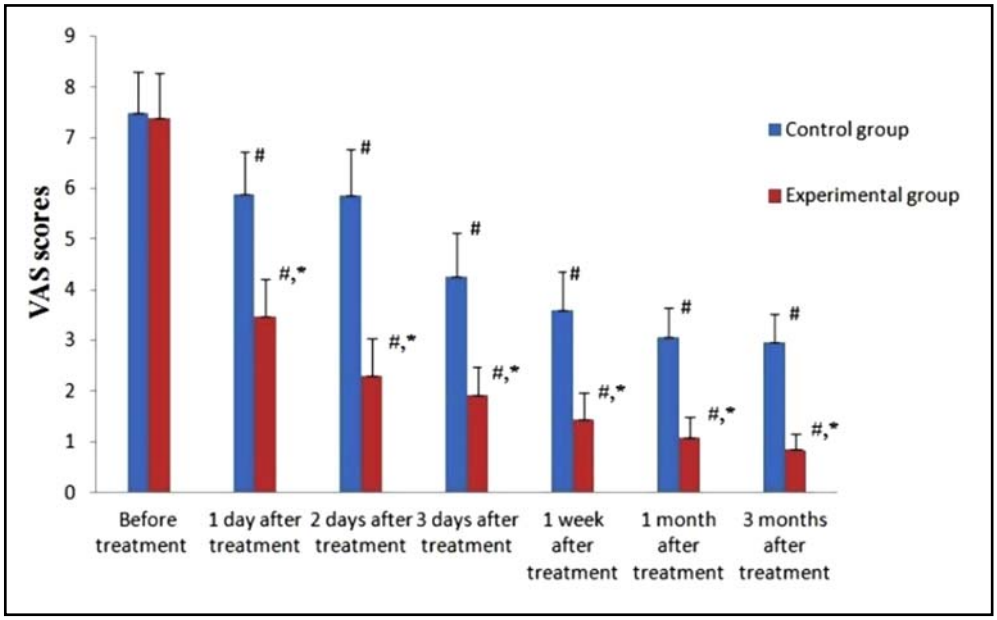

Fig. 1. Comparison of VAS scores between the two groups (*compared with before treatment, $P<0.05$. # compared with control group, $P<0.05$).

the increase of follow-up time. The scores were significantly lower than those of the control group, and the differences were statistically significant ($P<0.05$). The statistical analysis results are shown in Figure 1.

Comparison of PSQI scores between the two groups

Before treatment, the PSQI score of patients in the control group was 16.09±2.48 points, and the PSQI score of patients in the experimental group was 16.37±2.88 points. The difference between the two groups was not statistically significant (t=-0.663, $P>0.05$). The PSQI scores of the two groups of patients decreased significantly at 1, 2, 3 d, 1 week, and 1 and 3 months after treatment, and the PSQI score showed a significant downward trend with the increase of follow-up time. The scores were significantly lower than those of the control group, and the differences were statistically significant ($P<0.05$). The statistical analysis results are shown in Figure 2.

DISCUSSION

Herpes zoster is a skin disease caused by varicella-zoster virus infection and is one of the common clinical diseases (Bricout *et al.* 2019; Nair and Patel 2020). PHN is defined as pain that persists for more than 1 month after the rash of herpes zoster heals (Kramer *et al.* 2019; Saguil *et al.* 2017). Patients with PHN are accompanied by significant peripheral nerve pain in the focal area, resulting in approximately 50% of patients with post-herpetic neuralgia after cure, which affects the patient's daily life, work, and study to a certain extent (Honda *et al.* 2017; Arnold *et al.* 2017). PHN is one of the common clinical and multiple neuropathic pain syndromes (Ko *et al.* 2016). From the current medical level, there is still no complete treatment.

PHN is mainly manifested by continuous paroxysmal burning, acupuncture, and pulling pains (Sharif *et al.* 2019). The pain is severe and lasts for a long time, causing adverse effects on the patient's physiology and great psychological and economic pressure (Park *et al.* 2019). The current clinical treatment of PHN includes calcium channel regulators and tricyclic antidepressants, capsaicin and opioids, nerve block and nerve regulation, and spinal cord electrical stimulation (Matthews *et al.* 2019). Studies have shown that some PHN patients have poor treatment effects, and some patients have repeated or even increased pain (Ghanavatian *et al.* 2019; De Vloo *et al.* 2019; Price *et al.* 2017).

The results of this study indicate that 160 patients with PHN were given nerve block therapy and stSCS surgery, respectively. The results showed that after treatment, the VAS and PSQI scores of all patients showed a significant downward trend with the increase of follow-up time, and the VAS and PSQI scores of the patients in the experimental group were significantly lower than those of the control group ($P<0.05$). Epidural block, selective nerve root block, etc. all belong to the scope of minimally invasive interventional therapy. Its advantage is that the treatment is very effective, and the disadvantage is that it does not last long. One of the most significant interventional treatment methods is intrathecal hormone injection, but this method is controversial in clinical treatment because its adverse reactions are very serious. Electroacupuncture combined with ultraviolet therapy can also effectively treat acute herpes zoster neuralgia, but because long-term follow-up is difficult to achieve, it leads to a lack of evidence for efficacy and difficulty in promotion and application (Wang *et al.* 2020; Pei *et al.* 2019).

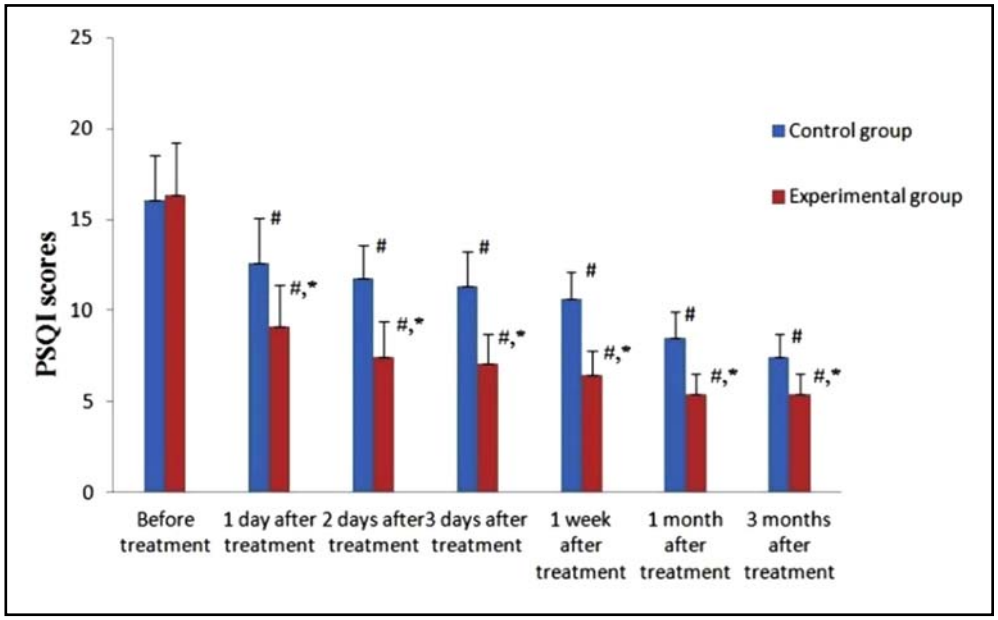

Fig. 2. Comparison of PSQI scores between the two groups (*compared with before treatment, $P<0.05$. # compared with control group, $P<0.05$).

The stSCS analgesic mechanism is complex, and it is currently believed that it is mainly based on Melzack and Wall's classic pain "gate control theory (GCT)". That is, stSCS stimulates the thick myelin sheath and thick nerve fibers in the posterior column of the spinal cord to retrogradely interfere with the pain signals transmitted by the thin myelin sheath and thin nerve fibers, thereby inhibiting the pain of the spinal dorsal horn (Lin *et al.* 2019; Liu *et al.* 2015). In recent years, stSCS has been widely used in all kinds of chronic intractable pain, including postoperative failure syndrome of the lumbar spine, complex regional pain syndrome, ischemic diseases of lower extremities, intractable angina, pudendal neuralgia, etc (Texakalidis *et al.* 2019; Huang *et al.* 2020).

In conclusion, stSCS and nerve block therapy can alleviate the pain of PHN patients and improve their sleep quality. However, the clinical effect of taking stSCS to treat PHN is better, which can provide quick and effective relief to the patient's pain level, effectively improve the patient's sleep quality, and has higher safety. It also has a significant effect on preventing PHN. Because this study has not yet explored the analgesic principle of stSCS and the prevention mechanism of PHN. At the same time, this study is single-center, small sample size, and short follow-up time (the longest observation time is 3 months). In the future, a multicenter, large sample further study is needed to demonstrate the results of this study.

DECLARATIONS

Ethics approval and consent to participate

This study has been approved by The Second Affiliated Hospital of Guangxi Medical University's ethics committee. All patients and their families were aware of the content of this study and signed an informed consent form.

Consent for publication

Not applicable.

Availability of data and material

Not applicable.

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Competing interests

There are no potential conflicts of interest to disclose.

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