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ORIGINAL ARTICLE

Analysis of the effects of pulsed microcurrent on pain, depression, and anxiety in patients with herpes zoster

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Abstract

Background: Herpes zoster is a common viral skin infection and has a high incidence rate in China. At present, conventional drugs combined with adjuvant measures are used for treatment. To improve the efficiency and shorten the time of treatment, we propose the use of pulsed microcurrent as a new adjuvant therapy.
Aim: This study aimed to investigate the effects of pulsed microcurrent on pain, depression, and anxiety in patients with herpes zoster.
Methods: A total of 58 patients with herpes zoster who were admitted to our hospital between April and August 2022 were selected as study participants and divided into two groups. The control group (n = 29) received conventional drug therapy, while the experimental group (n = 29) received pulsed microcurrent electrical therapy in combination with conventional drug therapy.
Results: After 14 days of treatment, the scores from the visual analog scale, patient health questionnaire (PHQ) (i.e., PHQ-9), and generalized anxiety disorder (GAD) assessment (i.e., GAD-7) of the experimental group were reportedly significantly lower than those the control group ($P < 0.05$).
Conclusion: These findings suggested that pulsed microcurrent electrical therapy combined with conventional drug therapy could effectively alleviate the pain, depression, and anxiety symptoms in patients with herpes zoster, highlighting its potential to be widely used in clinical practice.
Relevance for Patients: Patients suffering from herpes zoster may opt for pulsed microcurrent electrical therapy to effectively alleviate the pain, depression, and anxiety symptoms.

1. Introduction

Herpes zoster is a viral skin infection that manifests in immunocompromised individuals and is caused by the varicella-zoster virus in the trigeminal ganglion. The condition is characterized by severe pain and herpetic lesions, significantly impacting an individual's quality of life and often triggering depression and anxiety [1]. The current guidelines for diagnosis and treatment [2] recommend conventional therapeutic approaches for herpes zoster, inclusive of antiviral agents combined with neurotrophic support, anti-inflammatory drugs, analgesics, and potential adjunctive physiotherapy in China [3]. While pulsed radiofrequency technology has been extensively studied for postherpetic neuralgia, the approach is challenged by the long duration of treatment, specific puncture positioning techniques, and cumbersome standardization of radiofrequency parameters [4-8]. Consequently, therapeutic outcomes of pulsed radiofrequency technology remain suboptimal. A pulsed microcurrent electrical neuromuscular stimulator (Figure 1) is a portable and wearable device that is commercially available and can function as an adjunctive treatment option.

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Figure 1. A pulse microcurrent electrical neuromuscular stimulator.

The device mechanism is relatively similar to transcutaneous electrical nerve stimulation and additionally induces analgesic effects, similar to pulsed radiofrequency therapy [9]. Herein, this study aimed to investigate the effect of pulsed microcurrent on pain, depression, and anxiety experienced by patients with herpes zoster, thereby suggesting a new adjunctive therapeutic option for herpes zoster.

2. Methods

2.1. Study design and population

The cohort study of herpes zoster in China (i.e., the COMFORT study) is an ongoing single-center, prospective, observational study that started in April 2022 to investigate the effects of pulsed microcurrent on pain, depression, and anxiety of herpes zoster patients in China. This study was approved by the Human Research Ethics Committee of the First Affiliated Hospital of Xi'an Medical University.

2.1.1. Inclusion criteria

The inclusion criteria for this study were established based on the Chinese expert consensus on herpes zoster [2], and the criteria are as follows: (i) Adult patients aged 18 years and older; (ii) patients diagnosed with herpes zoster; (iii) patients who had not received anti-varicella zoster virus treatment after the onset of the infection (e.g., antiviral drugs, analgesics, and nerve protectors); (iv) patients with pain intensity of the ≥3 points on the visual analog scale (VAS) (reported within 7 days from the onset of herpes zoster); (v) patients who voluntarily received the relevant assessments (i.e., VAS, nine-item patient health questionnaire [PHQ-9], and seven-item generalized anxiety disorder assessment [GAD-7]); and (vi) patients who provided informed consent and were compliant to the treatment regimen.

2.1.2. Exclusion criteria

The exclusion criteria for this study were: (i) Patients with specific herpes zoster conditions, such as ophthalmic or internal organ involvement; (ii) patients with severe systemic diseases or organ dysfunction; (iii) patients with a history of allergy or hypersensitivity to pulsed microcurrent or conventional therapeutic medications; (iv) patients with psychiatric diseases or cognitive dysfunction that impairs normal verbal communication; or (v) patients deemed unsuitable for participation in this study by the judgment of the researcher, such as some patients who had poor compliance and low cognition.

2.2. Patient groups

The included patients were divided into the experimental and control groups according to a random allocation table generated using the Statistical Analysis System software.

2.2.1. Control group

The conventional medication regimen of the control group comprised: (i) Valaciclovir hydrochloride capsules, taken orally, 0.6 g/dose, three times daily; (ii) methylcobalamin tablets, taken orally, 0.5 mg/dose, three times daily; (iii) vitamin B_1 tablets, taken orally, 10 mg/dose, three times daily; (iv) fusidate cream, topically administered to the affected area, twice daily (or as required by the patients based on their condition); (v) prednisone acetate tablets, taken orally, once daily, administered after 6 AM, at the following dosages for a total of 7 days (5 mg/dose): days 1 and 2: 80 mg/day; days 3 – 4: 30 mg/day; days 5 and 6: 15 mg/day; and day 7: 5 mg/day; (vi) glycolite lotion, topically administered to the affected area, twice daily; (vii) aminophenol dihydrocodeine tablets, taken orally, 1 – 2 tablets every 4 – 6 h or as needed by the patients for pain relief (up to a maximum of 8 tablets/day).

2.2.2. Experimental group

The experimental group received pulsed microcurrent electrical therapy in combination with conventional drug therapy. The pulse microcurrent electrical neuromuscular stimulator (model ICW-001, Xi'an Aikaier Medical Technology Co., Ltd., China) consisted of a wristwatch-style main unit and electrode pads, equipped with intensity adjusters (mid-frequency: 1 – 30 kHz; low-frequency: 1 – 120 Hz), auditory feedback, and a pulse width range of 30 μs to 30 ms. Treatment procedures were carried out in accordance with the provided instructions, with patients wearing 4 – 8 electrode pads daily based on their physical condition. Each session of electrode pad application lasted for 4 – 8 h/day.

2.3. Assessments

2.3.1. VAS

VAS is a linear horizontal 10 cm scale, where the ends are labeled "no pain" and "most severe pain imaginable." After pulsed microcurrent stimulation, the patients were to draw a vertical line on

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the scale within 30 s to indicate the pain intensity, which was rated from 0 to 10: 0: No pain; 1 – 3: Mild/moderate pain; 4 – 6: Severe pain; 7 – 10: Very severe pain/most severe pain imaginable [10].

2.3.2. PHQ

PHQ-9 was used to assess symptoms of depression and measure the response to treatment. Each item was rated on a four-point scale, and the responses were summed to provide a total score ranging from 0 to 27, with higher scores indicating a greater frequency of symptoms [11,12].

2.3.3. GAD assessment

GAD-7 was used to measure symptoms of generalized anxiety before treatment and 2 weeks after treatment [13]. The items were graded based on the Likert scale (i.e., 0: not at all; 1: several days; 2: more than half the days; and 3: nearly every day), where the total scores could range from 0 to 21. We used the Chinese version of the GAD-7, which was validated in a previous study [14]. In this study, patients completed the GAD-7 within a short time (approximately 3 min).

2.4. Observational analysis

The levels of pain, anxiety, and depression of the patients in both groups were assessed before and after treatment (i.e., after 14 days). To evaluate the efficacy of pain management, the reduction rate (RR) of the treatment was calculated as follows [15]:

RR = (Pre-treatment score – post-treatment score)/Pre-treatment score × 100% (I)

The criteria for evaluating the efficacy of pain management were as follows: (i) Cured: symptoms disappeared or substantially disappeared, with RR exceeding 75%; (ii) significant effect: noticeable improvement in symptoms, with RR ranging from 50% to 75%; (iii) effective: symptoms improved, with RR between 25% and 50%; (iv) ineffective: no significant improvement in symptoms, with RR equal to or less than 25%. The total effective rate was calculated using the formula:

Total effective rate = (Number of cured cases + number of significant effect cases + number of effective cases)/total number of cases × 100% (II)

In both patient groups, the severity of depression and anxiety was evaluated using PHQ-9 and GAD-7, respectively, before and after treatment. Higher scores on both scales corresponded to a greater degree of depression and anxiety, respectively.

2.5. Statistical analysis

Statistical analysis was conducted using SPSS 22.0 (IBM, USA). Descriptive statistics for the measurement data are presented as mean ± standard deviation. The comparison between groups was performed using the independent samples *t*-test. Within-group comparisons were assessed using either the rank-sum test or paired samples *t*-test. The Chi-squared (χ^2) test was employed for the analysis of count data. Statistical significance was determined at a significance level of $P < 0.05$.

3. Results

3.1. Sample characteristics

A total of 58 patients diagnosed with herpes zoster were recruited from the outpatient dermatology department of the First Affiliated Hospital of Xi'an Medical College between April and August 2022. The patients were divided into two groups: 29 patients in the experimental group and 29 patients in the control group. Within the experimental group, there were 16 male and 13 female patients with an average age of 52.47 ± 3.28 years, ranging from 35 to 68 years. In general, the duration from herpes zoster onset was 14–21 days [16], while the average duration of this study was 11.35 ± 2.78 days. The control group consisted of 15 male and 14 female patients with an average age of 55.63 ± 4.96 years, ranging from 37 to 71 years. The average duration from herpes zoster onset was 15.17 ± 3.32 days, ranging from 9 to 24 days. Statistical analysis revealed that there were no significant differences in gender and age between the two groups ($P > 0.05$), ensuring their comparability. However, a statistically significant difference was observed in the duration from herpes zoster onset between the groups ($P < 0.05$).

3.2. Comparison of VAS scores of both groups before and after treatment

Before treatment, there was no statistically significant difference observed in the VAS scores between the two groups (0.1076 ± 0.1070; 95% confidence interval [CI]: (−0.1068, 0.3220); $P > 0.05$). After 14 days of treatment, a significant discrepancy in VAS scores was observed in both groups in comparison to the pre-treatment status (0.6841 ± 0.2175; 95% CI: (0.2485, 1.1198); $P < 0.05$). Moreover, the VAS scores of the experimental group were significantly lower than those of the control group ($P < 0.05$) (Table 1).

3.3. Comparison of the efficacy of pain management between the control and experimental groups

Statistical analysis of the efficacy of pain management revealed that the experimental group exhibited a significantly higher efficacy rate (96.55%) in comparison to the control group (86.21%) ($P < 0.05$) (Table 2).

3.4. Comparison of psychological states of both groups before and after treatment

After treatment, the PHQ-9 and GAD-7 scores of both groups were lower than their respective pre-treatment scores. Furthermore, the PHQ-9 scores of the experimental group were significantly

Table 1. Comparison of VAS scores of both groups before and after treatment

Condition	VAS scores	t	*P*	95% CI
Before treatment (*n*=29)	0.1076±0.1070	1.005	0.319	(−0.1068, 0.3220)
After treatment (*n*=29)	0.6841±0.2175	3.146	<0.01	(0.2485, 1.1198)

Abbreviation: CI: Confidence interval; *n*: Number of patients; *P*: *P*-value; *t*: *t*-value; VAS: Visual analog scale.

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lower than the control group (t = 9.8287; 95% CI: (2.4551, 2.8116); P < 0.001). Similarly, the GAD-7 scores of the experimental group were also significantly lower than the control (t = 7.8190; 95% CI: (3.4477, 3.7689); P < 0.001) (Table 3).

3.5. Side effects

During the study, two patients in the control group (6.90%) and one patient in the experimental group (3.45%) experienced mild nausea and vomiting. The nausea and vomiting disappeared after a few days without any therapy. After further evaluation, it was concluded that nausea and vomiting were caused by the use of valaciclovir, as these are common adverse reactions of valaciclovir. Nonetheless, none of the patients withdrew from the study because of the nausea and vomiting. There were no other adverse effects reported during the follow-up period, and the patients did not experience any discomfort or symptoms due to the use of therapeutic drugs or the pulse microcurrent electrical neuromuscular stimulator.

4. Discussion

Herpes zoster is a viral ailment associated with high morbidity, and its clinical symptoms primarily manifest as severe pain and herpes lesions. These symptoms may predispose patients to varying degrees of anxiety and depression, ultimately affecting their quality of life. Contemporary research implicated neuralgia as the primary cause of the severe pain caused by herpes zoster, primarily associated with central nerve abnormality and peripheral neuropathy induced by viral neuropathic invasion. Therefore, the treatment of herpes zoster focuses on antiviral therapy, neurotrophic support, anti-infective measures, and pain management [3]. In this study, the control group received conventional drugs recommended by the guidelines for the diagnosis and treatment of herpes zoster, while the experimental group received treatment with a pulse microcurrent electrical neuromuscular stimulator in conjunction with conventional drugs. Pulse therapy is a physical therapy modality that combines the meridian theory from traditional Chinese medicine with modern bioelectronic principles derived from acupuncture therapy. This technique leverages electrical stimulation to promote blood circulation, alleviate qi and blood stagnation, and ultimately reduce pain [17]. Certain studies have reported that appropriate, low-frequency pulsed current may activate endogenous morphine-like polymorphic neurons in the brain, thereby providing analgesic efficacy, while eliminating pain-causing chemical mediators and reducing the chemical factors of pain [18]. In addition, low-frequency pulse therapy may enhance microcirculation in the body, facilitate nerve repair, excite neuromuscular tissues, improve nutrition, expedite the absorption and dissipation of inflammatory substances, and alleviate pain from diverse causes [19]. However, low-frequency pulse therapy has not been specifically applied for the treatment of herpes zoster-associated pain.

Pulsed microcurrent stimulation involves the application of microcurrent to acupoints, employing specific frequencies, intensities, and waveforms of electric current in accordance with therapeutic needs [20]. This technique harnesses the electrical responses of nerves and muscles to low and moderate frequencies, delivering gentle electric currents across the skin surface. Furthermore, the use of electrodes stimulates targeted acupoints and exerts its therapeutic influence on the treated area, suggesting its prospective application for specific medical conditions [21].

The pulse microcurrent electrical neuromuscular stimulator utilized in this study had adjustable intensity settings for both mid-frequency (1 – 30 kHz) and low-frequency (1 – 120 Hz) ranges. As frequency and intensity correspond to each other, adjusting the intensity settings could align the frequency for specific therapeutic requirements, producing the combined effects of mid-frequency and low-frequency pulsation therapy. Our findings demonstrated that, following a 14-day treatment period, the experimental group exhibited a shorter infection duration than the control group. In addition, the experimental group displayed significantly greater improvements in pain, depression, and anxiety levels than the control group. Previous studies predominantly focused on the application of pulse radiofrequency in the physiotherapy of herpes zoster-associated pain [8,22,23] and subsequently reported remarkable efficacy. However, no reports on the utilization of pulsed microcurrent electrical therapy have been identified. Both pulse radiofrequency and pulsed microcurrent electrical therapy share similar mechanisms of action as pulse therapies. Nevertheless, pulse radiofrequency employs higher frequencies (≥300 kHz) and voltages (≥45 V), whereas the pulse microcurrent

Table 2. Comparison of the efficacy of pain management between the control and experimental groups

Group	Criteria for the efficacy of pain management (*n*)				Efficacy (%)
	Cured	Significant effect	Effective	Invalid	
Control (*n*=29)	12	8	5	4	86.21
Experimental (*n*=29)	15	10	3	1	96.55#

Note: Chi-square statistic (χ^2)=7.779, P=0.005; #P<0.05 relative to the control group.
Abbreviation: *n*: Number of patients.

Table 3. Comparison of psychological status scores of both groups before and after treatment

Assessment	Condition	Scores	*t*	*P*	95% CI
PHQ-9	Before treatment (*n*=29)	0.0335±0.1637	0.2965	0.7680	(0.0065, 0.0663)
	After treatment (*n*=29)	2.6333±0.0890*#	9.8278	<0.001	(2.4551, 2.8116)
GAD-7	Before treatment (*n*=29)	−0.3386±0.1750	0.8655	0.3904	(−0.6893, 0.0121)
	After treatment (*n*=29)	3.6083±0.0802*#	7.8190	<0.001	(3.4477, 3.7689)

Note: *P<0.05 relative to before treatment; #P<0.05 relative to the control group.
Abbreviation: CI: Confidence interval; GAD-7: Seven-item generalized anxiety disorder assessment; n: Number of patients; *P*: *P* value; PHQ-9: Nine-item patient health questionnaire; *t*: *t*-value; VAS: Visual analog scale.

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electrical neuromuscular stimulator utilizes lower frequencies and voltages (≤21 V).

It has been reported that pain severity is correlated to the impact on the quality of life of individuals suffering from herpes zoster-related pain [24]. Furthermore, the integration of the pulsed microcurrent with standard medication in the experimental group resulted in superior pain relief outcomes compared to the control group. This combined approach also effectively ameliorated depression and anxiety symptoms in the patients, consistent with the findings by Zhang *et al.* that distinct pulsed radiofrequency temperatures resulted in notable improvements in pain, depression, and anxiety among postherpetic neuralgia patients [25].

Immunosuppression, particularly prevalent among the elderly, stands out as a pivotal factor in the onset of herpes zoster. Beyond the age of 50, there is a gradual waning of varicella zoster virus-specific cell-mediated immunity, leading to an increased occurrence of herpes zoster. The prevalence of herpes zoster in China closely mirrors that of other global regions, with an incidence rate among the elderly aged 50 and above of 2.9–5.8 cases per 1000 people [26]. Notably, the present study featured a relatively small sample size with a broad age spectrum, i.e., the mean age of the experimental and control groups was 52.47 ± 3.28 and 55.63 ± 4.96 years, respectively. The experimental group, characterized by a comparatively younger average age, exhibited a significantly shorter recovery duration than the control group, suggesting a potential synergistic effect of age and pulsed microcurrent electrical therapy.

5. Conclusion

Pulsed microcurrent electrical therapy demonstrated remarkable effectiveness in reducing herpes zoster-related pain. Consequently, the intervention also significantly alleviated herpes-zoster-induced depression and anxiety in patients. Taken together, the widespread implementation and utilization of pulsed microcurrent electrical therapy in clinical settings hold significant promise as a therapeutic option for herpes zoster. However, further studies are warranted to delve into the underlying mechanisms involved in the reduction of herpes zoster-associated pain.

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Conflicts of Interest

The authors declare that they have no competing interests.

Ethics Approval and Consent to Participate

This study was approved by the Human Research Ethics Committee of the First Affiliated Hospital of Xi'an Medical University.

Consent for Publication

The authors have obtained the written and signed informed consent of the patients for releasing their data in this paper.

Availability of Data

Data are available from the corresponding author upon reasonable request.

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